

Exploring Issues in Mathematics Education

An Evaluation of Te Poutama Tau 2002

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He Whakamārama

The whenu harakeke in the cover design represents growth and potential. The tukutuku pattern, Poutama, represents knowledge sought and recognises that this is a continuum. The unshaded area represents the things we know, the lessons we have learnt already. The shaded area represents the unknown, knowledge we seek, and future possibility.

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Ngā Mihi

E mihi ana ki ngā tamariki, ki ngā pouako, ki ngā kaitakawaenga, ki ngā kaitautoko katoa i whai wāhi mai ki te Te Poutama Tau i te tau 2002. Tēnā koutou i runga i te āhua o tā koutou āwhina i tēnei rangahau kia mōhio ai tātou, e pēhea ana te haere o tēnei kaupapa. Mā konei e tōtika ai, ā, e eke anō ai ā tātou tamariki i ngā taumata o te mātauranga tau.

Me mihi hoki ki a Brendan Stevenson, nāna te āwhina nui ki te wetewete i ngā hua o ngā uiui aromatawai i whakaurua ki te pātengi raraunga. Kei a ia mō te tauanga!

Ka tuku mihi hoki ki a Tony Trinick, mōna i arotake i tēnei pūrongo, tae atu anō ki āna mahi āwhina katoa i Te Poutama Tau.

Tēnā koutou Te Rōpū Whāiti o Te Poutama Tau, te rōpū whakaruru i te kaupapa, te rōpū whakawhitiwhiti i ngā take, e tōtika ai te haere o ngā mahi.

Tēnā hoki te Tāhuhu o te Mātauranga nā rātou te pūtea i tutuki ai tēnei kaupapa rangahau.

Hei Whakaräpopoto

Ko Te Poutama Tau tētahi kaupapa whakapakari i te hunga pouako o roto i ngā kura reo Māori, ko te whakapiki i te mātauranga tau te whāinga. E aro ana Te Poutama Tau ki ngā whāinga matua nei a te iwi Māori, arā, kia ora tonu te reo, kia tū rāngatira hoki te iwi. Kei te hāngai hoki ki ngā whāinga a te Tāhuhu o te Mātauranga me te rautaki a te Kāwanatanga hei whakapiki i te mātauranga pānui/tuhituhi me te mātauranga tau. Nō te wāhanga tuarua o te tau 2002 i kawea tuatahitia a Te Poutama Tau ki roto i ngā kura. Tekau mā rua ngā kaitakawaenga, e 42 ngā kura, e 97 ngā pouako, e 949 ngā tamariki i whai wāhi mai. Ko te kaupapa whakapiki i te mātauranga tau e whakahaerehia ana i ngā kura whānui o te motu mai i te tau 2000 te tūāpapa i tipu ai a Te Poutama Tau.

Ko te iho o te kaupapa, ko tētahi Mahere Tau e whakaatu ana i ngā kaupae hei hikoi mā te tamaiti, e mātau ai ia ki tēnei mea te tau me ōna rautaki paheko. I te tūmatanga me te mutunga o te kaupapa, ka whakahaerehia tētahi uiui aromatawai ki ia tamaiti kia āta kitea ki tēhea kaupae o te Mahere e noho ana, ā, he pēhea nei te whanake o te tamaiti.

E hora nei i tēnei pūrongo ngā whakakitenga o te rangahau i te whaihua o Te Poutama Tau hei whakapiki i te mātauranga tau o te tamaiti, hei āwhina anō i te pouako. Ka matapakina hoki ngā take e pā ana ki te whakamahi i te reo Māori hei reo whakaako i tēnei mea te tau.

Ngā Whakakitenga Matua

- E kaingākau ana te hunga pouako ki ēnei āhuetanga o te kaupapa:
 - te raupapa o te Mahere Tau, me te ngāwari o te tautuhi i te taumata mātauranga o tētahi tamaiti;
 - te tautoko a te hunga kaitakawaenga, me te āhua o te huarahi whakapakari pouako;
 - ngā mahi ā-ringa o te kaupapa, arā, te whakamahi rauemi ā-ringa hei whakawhanake i te mātauranga tau o te tamaiti;
 - te tino whanake o ētahi tamariki;
 - te pai o te uiui aromatawai hei whakamahere i ngā kaupapa ako, hei whakaröpū anō i ngā tamariki;
 - te rekareka o ngā tamariki ki te mahi pāngarau.
- Häunga tētahi wāhanga kotahi o te Mahere Tau, he hanga whakamiharo te whanake o ngā tamariki. Ina kāore a Te Poutama Tau, kāore i pērā rawa te whanake. Kāore i tino rerekē ake te whanake o te hunga kōtiro me te hunga tamatāne.
- Ko te whakaröpū tau, te uara tū, me te pūnaha tau ngahuru te wāhanga o te Mahere Tau i tino whakararu i ngā tamariki, arā, kāore he whanaketanga o tēnei wāhanga o te mātauranga tau. E tika ana kia āta arotahi atu ki tēnei wāhanga hira o te Mahere Tau.

- He kaha ake te whanake o te hunga i tūmata mai ai i ngā kaupae raro o te Mahere ki te hunga i puta te ihu ki ngā kaupae runga i te aromatawai tuatahi. Koinei e whakaatu mai ana he iti ake ngā kaupae raro o te Mahere, ā, he ngāwari ake te whakatutuki. E hāngai hoki ana ki te pakeke o ngā tamariki i whai wāhi mai ki Te Poutama Tau, arā, ko te nuinga mai i te tau kura 1 ki te tau kura 3.
- E whā tekau mā rua ōrau te toharite o ngā tamariki kāore i whanake i tētahi wāhanga o te Mahere. He take māharahara tēnei ina te whāinga kia eke ngā tamariki katoa i ngā taumata o te mātauranga tau. Me aro turuki tēnei āhuratanga i roto i ngā tau e haere tonu ana a Te Poutama Tau, ā, ki te pēnei tonu te ia o ngā whakakitenga, me āta whakatakoto he rautaki hei whakawhanake i ngā tamariki katoa.
- He tokoiti ngā tamariki i tae atu ki te taumata whakamahi i ngā rautaki wāwāhi tau o te Mahere. Ahakoa e hāngai ana tēnei whakakitenga ki te pakeke o te hunga tamariki i whai wāhi mai ki Te Poutama Tau, e tohu ana pea i te uaua o te whanaketanga mai i ngā rautaki tatau ki ngā rautaki wāwāhi tau. He take tēnei me āta arotahi i roto i ngā mahi whakahīkoi i te kaupapa.
- He take nui te matatau o te tamaiti ki te reo. Ki te kore e autai te reo he uaua te piki atu ki ngā kaupae runga o te Mahere. Kāore te matatau e tino pāngia ana ki te whanake a te tamaiti i ngā kaupae raro o te Mahere.
- Ko tā te nuinga o ngā pouako, i whakapikia ō rātou ngākau titikaha, me ō rātou mōhio ki te whakaako i te mātauranga tau, tae atu ki tō rātou mārama ki ngā huarahi e ako ai te tamaiti i te mātauranga tau.
- E eke ai te kaupapa ki ōna taumata, me tautoko mai te tumuaki o te kura, me whai wāhi mai ia ki te kaupapa, ā, me tau anō hoki ngā tikanga whakahaere i roto i te akomanga.
- He take nui ki te hunga pouako kia tika, kia mārama, kia hāngai te āhua o tā rātou whakamahi i te reo i roto i ngā akoranga pāngarau. Arā ētahi wāhi he kaha ake te whakamahi i ngā kupu ake o te pouako, o te kura rānei, tē aro i ngā kupu ake o te marautanga. Kāore ētahi pouako e tino mārama ana, e tautoko ana rānei i te wāhi ki ngā kupu pāngarau ake ā-motu.
- E tino whirinaki ana te kaupapa ki ngā pūkenga reo o te pouako me te tamaiti, ā, i ētahi wāhi, ko te matatau ki te reo e whakararu ana i tā te tamaiti eke i ngā taumata o te mātauranga tau.

Executive Summary

The Programme

Te Poutama Tau is a professional development programme for teachers in Māori medium education that aims to lift their students' levels of achievement in numeracy. It is responsive to Māori goals of language revitalisation and empowerment through education, as well as to the Ministry of Education's Literacy and Numeracy strategy. Te Poutama Tau was first initiated in schools in the second half of 2002. It is based on, and adapted from, the Numeracy Project in mainstream schools. It involved 12 facilitators, 42 schools, 97 teachers, and 949 students.

Central to the programme is The Number Framework, which outlines for teachers the stages of number knowledge and operational strategies through which students progress in their learning of number. Students are assessed against the framework, with teachers using a diagnostic interview at the start of the programme and again at the end in order to measure progress.

The research findings presented in this report focus on the impact of Te Poutama Tau on student learning, on teacher knowledge, and on linguistic issues arising from the use of Māori as a medium of instruction for numeracy.

Key Findings

- Teachers were generally very positive about the following aspects of the programme:
 - the sequential nature of The Number Framework and the ability to determine where on the framework a student was situated;
 - the support they received from their facilitators and the model used for professional development;
 - the “hands on” approach to teaching encouraged in the programme – developing students' understanding through the use of concrete apparatus;
 - the impressive progress many students made;
 - the ability to use information from the diagnostic interview to plan and group for instruction and to report on progress;
 - the enjoyment of the students in doing maths.
- In all but one aspect of The Number Framework, students made impressive gains over the duration of the programme, significantly greater than what might be expected to occur naturally over time. There was no significant difference in the progress made by girls and boys.
- Overall, students made very little progress in their understanding of place value and the base ten number system. This signals that more attention needs to be focused on this aspect of The Number Framework.

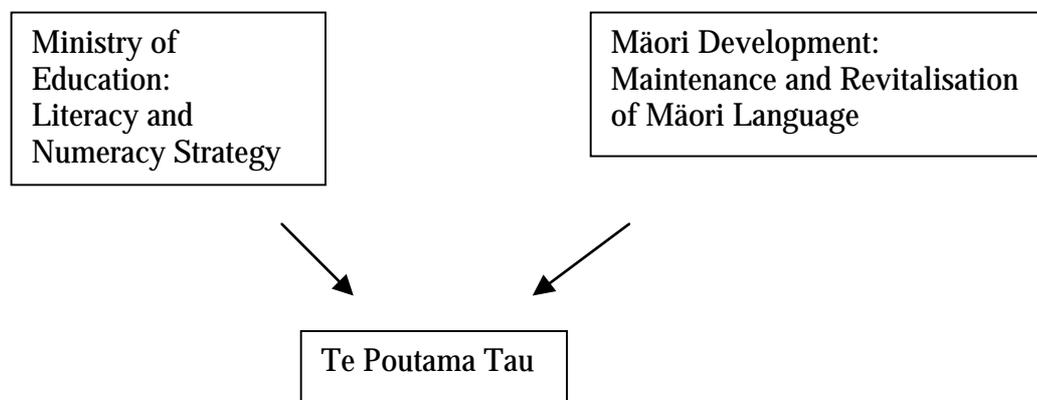
- Greater gains were made by students who started at the lower stages of The Number Framework in comparison with students who were initially diagnosed at a higher stage. This indicates that the lower stages are made up of smaller steps that are easier to progress through. It is also consistent with the age of the students involved in Te Poutama Tau, the majority of whom were in their first three years of schooling.
- An average of 42% of the students made no stage gains in at least one aspect of The Number Framework over the duration of the programme. This is of concern and will need to be monitored as the programme develops. A continuation of this trend may signal the need for a change in approach.
- Very few students progressed to using part-whole strategies when undertaking number operations. While this is indicative of the age profile of the Te Poutama Tau students, it also suggests that the transition from using counting strategies to part-whole thinking is challenging and is therefore an area in need of more focus within the programme.
- Language proficiency is a significant factor that impacts on students' progress in the higher stages of The Number Framework. However, students with lower levels of proficiency did not seem to be disadvantaged at the earlier stages of the framework.
- The large majority of teachers felt the programme had helped improve their confidence and ability in teaching numeracy and their knowledge of how students learn about number.
- An enthusiastic, supportive, and involved principal and effective classroom management practices were found to be important factors in successfully implementing the programme.
- Teachers were generally concerned to ensure their use of language in the pāngarau lesson was correct, concise, and clear. However, in many cases "local" vocabulary for mathematics concepts was favoured ahead of standardised terms, and the rationale for having standardised terms was not well understood or supported.
- The programme was seen to make high demands on teachers' and students' language use and in some cases language proficiency was identified as an impediment to student achievement.

Chapter One: Background

Te Poutama Tau is a professional development programme in numeracy for teachers in Māori medium schools. The programme focuses on the first eight years of schooling. Implementation began in 2002, largely as a result of demand from the increasing numbers of Māori medium teachers enrolling for the mainstream Numeracy Project, which had begun in 2001 after a trial in 2000. Teachers, facilitators, and the Ministry of Education recognised that implementing the project in Māori medium schools presented different challenges and required different approaches to mainstream schools.

A small research project was commissioned by the Ministry of Education to run alongside the Te Poutama Tau programme. Its purpose was to evaluate the impact of the programme on teachers and their teaching and students and their learning, and also to highlight issues regarding the use of Māori language as the medium of instruction. Results from the research are discussed in this report.

Te Poutama Tau, like the mainstream Numeracy Project, is responsive to the Ministry of Education's strategy for improving levels of literacy and numeracy in New Zealand schools (see Ministry of Education, 1999). Unlike the Numeracy Project however, Te Poutama Tau is also firmly located within the overall context of Māori development, which includes the maintenance and revitalisation of the Māori language.



Numeracy Strategy

Following publication of the results of the 1994/95 Third International Mathematics and Science Study (TIMSS), which found that New Zealand students' achievement in mathematics was below international averages (see Garden, 1997), the Ministry of Education established the Mathematics and Science Taskforce. The taskforce identified that primary teachers lacked confidence in teaching mathematics through a lack of understanding of mathematics content knowledge and little understanding of associated pedagogy. It recommended professional development for all teachers to address this issue, along with the publication of support material for students and teachers. The then National Government also announced its intention that by 2005, every student turning nine would be able to read, write, and do maths for success.

Together with the taskforce recommendations, this led to a national pilot of the Count Me In Too (CMIT) programme in 2000 (see Ministry of Education, 2001a). This formed the basis of the current Numeracy Project in mainstream schools (begun in 2001) and the Te Poutama Tau programme.

In addition to this, a report from the Literacy Taskforce, published by the Ministry of Education in 1999, provided direction and alignment for a range of policies, projects, and programmes aimed at improving achievement in literacy and numeracy by learners at every level of New Zealand's education system.

The strategy provides a common set of evidence-based principles to underpin policies and practice. Three key themes have been used as an organising framework. They are:

- *raising expectations for learners' progress and achievement;*
- *lifting professional capability throughout the system so that everyone plays their part in ensuring that the interaction between teacher and learner is as effective as possible; and*
- *developing community capability – encouraging and supporting family, whānau and others to help learners.* (Ministry of Education, 1999)

The developmental work outlined above reflects the Ministry's determination to improve levels of numeracy in the community to meet the growing daily demands on individuals' numeracy skills and to ensure full access and participation for New Zealand in the global knowledge economy.

The various groups involved in the Strategy have agreed on a working definition of a numerate person that reflects this vision: "to be numerate is to have the ability and inclination to use mathematics effectively in our daily lives – at home, at work, and in the community". (Ministry of Education, 2001b, page 1)

The importance of the Numeracy Strategy for Māori is highlighted by the findings of the 1998 TIMMS study:

... in 1998, the mean mathematics score for students in the Pākehā/European and Asian groupings were statistically significantly higher than those achieved by students in the Māori and Pacific ethnic groupings ... the magnitude of the gaps between Pākehā/European and both Māori and Pacific students were maintained as students progressed from the middle primary level in 1994 through to the lower secondary level in 1998. (Chamberlain and Walker, 2001, page 41)

Further testing in the TIMMS programme was undertaken toward the end of 2002, and for the first time tests translated into Māori were available for Māori medium students. While it will be too early for the Te Poutama Tau programme to impact on the results of these tests, mapping the trends longitudinally will be one measure of the relative success of the initiative.

Māori Development

In a paper entitled *Contemporary Māori Development: Issues and Broad Directions*, Durie discusses two aims for Māori development, "...facilitating Māori access to New Zealand society and the economy on the one hand; and enhancing Māori lives, Māori society and Māori knowledge on the other" (Durie, 2001, page 7). Being numerate enables access and participation in society and the economy; being

numeracy through the Māori language strengthens and develops Māori society and knowledge.

Numeracy impacts on a person's ability to access and participate in society in two ways. First are the number knowledge and skills that can be applied directly in many situations. This includes such things as calculation, measurement, and using number sense and estimation to check the reasonableness of a calculation or measurement. (See Saunders, 1981 and Knight et al., 1992 for a discussion on the use of mathematics in everyday life). Second, being numerate helps a person to think about and understand their world with intelligence. For example, this might be in conceptualising the relative merits of various allocation models for Māori fishery assets. At another level, this could be the effective management of family finances, or understanding the intricacies of hire purchase when buying a car.

Hankes (1998) discusses poor performance and limited participation in mathematics by Native Americans and argues that "... this situation ... has serious implications for economic self-determination as well as political self-sufficiency for all American Indians" (Hankes, 1998, page 4). The situation for Native American peoples has many similarities with Māori, and this argument accords with the overall direction for Māori development.

Clearly, Māori society and Māori lives are enhanced through greater access to and participation in the New Zealand (and indeed international) society and economy. Complementary to Māori access and participation in wider society is the retention and enhancement of Māori culture. In his book *Te Mana Te Kāwanatanga*, Durie argues that access to and participation in wider society will amount to little if "... no room were left for the strengthening of a Māori identity and the continuing expression of Māori culture – the advancement of Māori peoples as Māori" (Durie, 1998, page 52). Fundamental to Māori culture is the language. Therefore, from the outset, the Te Poutama Tau programme recognised the need to focus on developing Māori pedagogy and patterns of discourse¹ that were authentic to the culture and syntax of the language, that retained integrity with The Number Framework, and that facilitated communication about essential concepts.

Māori Language

Efforts to reverse the decline of the Māori language began in earnest in the 1970s, with initiatives being concentrated largely in the education sector. Recent research undertaken by the Māori Language Monitoring Team from the Ministry of Māori Development shows that the number of Māori speakers has stabilised, that Māori are optimistic about the future of the language, and that there has been growth in enrolments in Māori language education programmes, including Māori immersion (Te Puni Kōkiri, 2002, page 7). The establishment of Māori immersion education within a context of language decline has resulted in a demand for resources (both human and material) that has been difficult to satisfy. It has also resulted in new demands being placed on the language itself (see Barton, et al., 1998).

¹"Patterns of discourse" refers to the many ways language is used to talk about number. It includes the way teachers give instructions, how various concepts are explained, the types of questions that are asked, the responses to questions, the feedback to responses, and the scaffolding of interaction in a way that best leads to understanding. The talk can be between teacher and student/s in a one-to-one, small group or classroom situation or between learners themselves.

Historical evidence points to an initial rapid development of Māori language on contact with settlers from the English-speaking world, to enable the expression in Māori of newly introduced aspects of technology, commerce, and social order. In 1858, an arithmetic book was translated into Māori for use in native schools (Taratoa, 1858). This represented an expansion of the language into a new area of use – terms were needed for the new concepts that were expressed. In addition to this, Māori were quick to acquire the skills of literacy.

... by 1842 there was scarcely a village in the North Island whose members between the ages of 10 and 30 could not read and write in their own language, and poorer class Europeans were often taunted for their illiteracy. (Miller, 1958, pages 97-98)

The growth and development of the language was to be short lived, however, as policies and practices soon became focused on assimilation and the acquisition of English. The 1867 Native Schools Act that decreed English was to be the language of instruction in all schools (see Barrington, 1966) heralded a long period of decline. It was not until the early 1980s that the Kōhanga Reo and Kura Kaupapa Māori movement re-established the Māori language as a medium of instruction in New Zealand schools. For the first time in over 100 years, Māori was being used across all subjects of the curriculum. This presented a number of difficulties because the language had not been allowed to develop and grow naturally over previous generations. There was now a need for rapid development of the Māori language corpus to establish lexical items and accepted patterns of discourse necessary for the various curriculums. Barton and Fairhall (1995) outline the work that has been done to develop a Māori vocabulary for mathematics. This work has been ongoing since the early 1980s. The Te Poutama Tau programme has provided an opportunity to continue this work and for the first time to create a coordinated structure to disseminate the vocabulary and patterns of discourse and enhance teachers' linguistic competency.

This development has not been without its critics. They have argued that there have been too many new words for teachers who are second language learners to internalise, or that the new discourse cannot be understood by native speakers who have not encountered Māori language being used to communicate mathematical concepts previously. In spite of this criticism, most Māori medium teachers have recognised that students need to become competent in the numeracy and mathematics they will need to participate fully in all aspects of their world and that to do this through the medium of Māori language, new items of vocabulary and new patterns of discourse are necessary.

An important aim of the Te Poutama Tau programme (and indeed previous pāngarau initiatives) has been to advance the teaching and learning of mathematics while taking cognisance of linguistic concerns. These include ensuring that the authenticity of the language is maintained and that the new patterns of discourse and items of vocabulary are simple, concise, and enhance understanding.

The Pāngarau Curriculum

The new pāngarau curriculum for Māori medium schools was published in 1996, following a trial in 1995. Lockwood Smith, the Minister of Education at the time, required the curriculum to contain at least the same achievement objectives as the mathematics curriculum for mainstream schools. This caused some dissension and

concern that Māori knowledge was being ignored. However, there seems to have been a growing acceptance that while the document does not make Māori knowledge explicit as part of the curriculum, it does not discount it and does allow communities to include it where they consider it appropriate, according to the environment, context, and ability of the school. In addition, Te Aho Matua, the guiding philosophical document for many Kura Kaupapa Māori, promotes access and participation for students to a wide range of knowledge, ensuring in the first instance however, that the child is grounded in the ethic and culture of the ancestors.

The child should not be bound to the old world, but should be left to grasp at all of the things in the new world too. Despite that however, the correct beginning is to seek out the gifts left by forebears that relate to the beginning of the world. (Te Aho Matua o Ngā Kura Kaupapa Māori)

Many would argue that pāngarau is a body of knowledge that relates more to students' participation in wider society than Māori culture and that mathematics need not be a subject that determines the Māori culture of its students. Importantly however, it should not diminish the use of Māori pedagogy, Māori language, and Māori contexts, nor should it devalue or invalidate a student's Māori identity.

Hankes (1998) describes the pedagogy of "cognitively guided instruction" and a research project that employed this pedagogy in teaching mathematics in Native American schools. She saw this as a "culturally responsive pedagogy" (page 6) that could help improve the performance and participation of Native American children in mathematics. The pedagogy is not dissimilar to some of the underlying principles of Te Poutama Tau; in particular it encourages students to discuss their mental strategies for solving problems as a way of becoming more active and empowered in the learning process. A major focus of the Te Poutama Tau programme is on developing a pedagogy for pāngarau that is appropriate for Māori medium schools, thereby fulfilling a need that was recognised soon after the publication of the curriculum.

... the document is likely to be an in-service tool and will act as a model of what is possible. It is unlikely to become a manual for individual teachers. (Barton and Fairhall, 1995)

The greater challenge will be in providing resource material and other forms of support in order to ensure that schools, teachers and their communities are able to translate the document into good Māori mathematics practice. (Christensen, 1996, page 44)

More recently, research commissioned by the Ministry of Education for the purposes of a curriculum stocktake found that "teachers indicated a desire to have the documents more reflective of Māori pedagogy and tikanga" (Ministry of Education, 2002b, page 3). Comments from teachers involved in Te Poutama Tau indicate the programme is responsive to this desire and therefore may represent a significant step forward in the development of appropriate Māori pedagogy for pāngarau (see Chapter Four). It will be important, therefore, to ensure that the results and experience gained from the Te Poutama Tau programme inform the curriculum stocktake being undertaken at present by the Ministry.

Kaupapa Māori Research

Growth in research involving Māori has resulted in a much-needed critique of appropriate ethics and methodologies. The long-standing dissatisfaction with the way

research on Māori people has been conducted and with the benefits that accrue from that research have been critically examined, resulting in new approaches that are more consistent with Māori culture, aspirations, and development.

The new approaches have been necessary, not only because of growing dissatisfaction amongst Māori academics but also because of the scepticism of the wider Māori community who have become reluctant to take part in research projects that are often only tenuously linked to Māori advancement. These new approaches include an established relationship with the researcher, a closer involvement in the research process, and an understanding that the ultimate benefits of the research will accrue to themselves and their communities. This in itself represents a repositioning of the power relationship between the researcher and the researched. Hineihaea Murphy and Mike Hollings reported the following difficulties in their study of interlanguage and the Māori language ability of students in a Māori immersion primary school.

The initial difficulty was one of convincing and reassuring the school community of the need for such research, their anonymity, and that the results would be used ultimately to benefit the subjects. The issue of putting a community under a microscope, for any reason, and analysing the results, is always a large one for people whose past experiences with research of any kind has lead to their exploitation. This research was viewed no differently despite the fact that Māori were doing the research primarily to meet Māori needs. (Murphy and Hollings, 1993, page 12)

While new approaches to Māori research are emerging and developing and there is some debate about exactly what constitutes Kaupapa Māori research or Māori-centred research, five important dimensions can be identified. From the outset these became guiding principles for the Te Poutama Tau methodology outlined in Chapter Two.

A Māori world view

Nepe (1991), Rangihau (1981), and Kāretu (1990) have all argued that Māori interaction with the world is governed by a unique Māori world view that stems from what is described as “very different epistemological and metaphysical foundations” (Nepe 1991). These foundations, coupled with the Māori experience of colonisation and the present political and socio-economic realities of Māori, “frame the way we see the world, the way we organise ourselves in it, the questions we ask and the solutions we seek” (Mead, 1996, page 204).

Culturally safe research practices

Māori research that is not culturally safe will inevitably result in what Mead has termed “getting it wrong” (1996, page 215). The consequences of this may impact negatively on the participants, on the researcher, on Māori attitudes to research in general, or on the overall efficacy of the research, including its validity and potential contribution to Māori development. Irwin (1994) includes mentoring by kaumātua and research being undertaken by a Māori researcher as two aspects of culturally safe practices. Te Awekotuku (1991) argues that culturally safe practices for Māori researchers are founded in culturally appropriate ways of behaving, including aroha ki te tangata (human respect and understanding), kanohi kitea (fronting up in person), and titiro, whakarongo, kōrero (listen and observe before engaging in dialogue).

Challenges to existing power relationships

The reasons for the growth of Kaupapa Māori research include dissatisfaction with traditional approaches to researching Māori and the tenuous links that the research

results have had with Māori development. If Māori development involves the repositioning of Māori in cultural, political, social, and economic terms with the rest of New Zealand society, then Kaupapa Māori research is necessarily concerned with challenging the status quo, with “notions of critique, resistance, struggle and emancipation” (Mead, 1996, page 201).

Accountability and mediation

Irwin (1994) and Bishop (1994) use the term whānau to describe a Māori supervisory group. Their role is clearly linked to re-locating the locus of control with Māori. It is this group that provides not only support of a supervisory and organisational nature to researchers but also a Māori ethical validation that goes beyond informed consent and confidentiality. This group ensures that the research is worthwhile and contributes to Māori development.

While research in the Western scientific tradition may be categorised as individualistic in nature, where the researchers, having gained ethics approval, are then able to get on with the job largely under their own jurisdiction, Māori research is subject to ongoing scrutiny by the whānau or supervisory group. This is a process of continually validating both the research and the researcher and ensuring cognisance is taken of a Māori world view and culturally safe research practices.

The researcher is concerned with Māori advancement

Most discourse on Kaupapa Māori research has highlighted the importance of the identity of the researcher in terms of the position they take relative to the research topic (see for example Smith, 1990; Mead, 1996; Bishop, 1994; Irwin, 1994; Soutar, 2000). This is consistent with the anti-positivist stance taken by feminist researchers and is an acknowledgment that Kaupapa Māori research is about making a contribution to Māori development and advancement rather than just describing, or finding out, or knowing for the sake of knowing. The explicit positioning of the researcher relative to the research topic is simply an acknowledgment that the research is founded on a Māori world view and “does not preclude us from being systematic, being ethical, being scientific in the way we approach a research problem” (Mead, 1996, page 203).

An Overview of the Te Poutama Tau Programme

Central to the Te Poutama Tau programme is The Number Framework that was developed for the mainstream Numeracy Project. The Number Framework makes explicit the stages students move through in their acquisition of number concepts, and as such provides teachers with an effective framework to assess and monitor progress, group students, and plan for instruction. In 2001, the Ministry first called together an advisory group of teachers, Numeracy Project facilitators working in Māori medium schools, advisors, teacher educators, and university personnel to discuss and plan the implementation of the Te Poutama Tau programme for Māori medium schools. This group subsequently became known as Te Rōpū Whāiti o Te Poutama Tau. Te Rōpū Whāiti decided that while The Number Framework was an appropriate starting point for Te Poutama Tau, the implementation of the programme in the first few years would provide important information to refine the framework to better reflect Māori pedagogy and to be responsive to Māori medium learners and the Māori language.

The Number Framework consists of two interdependent parts – strategy and knowledge. The strategy section is included as Appendix One to this report. It outlines nine stages of number processing that students employ to solve number

problems. The division between the less sophisticated “counting strategies” and the more advanced “part-whole” strategies is important, as is ensuring that students progress through to the higher levels of The Number Framework. An evaluation of the Numeracy Project 2001 found that:

The most concerning difference is in the proportions of students who made the transition from advanced counting to early additive or advanced additive strategies ... just 36% of the Pacific Islands students made the transition compared to 49% of the Maori students, 57% of the New Zealand European students and 58% of Asian students. (Thomas and Ward, 2002, page 19)

Te Rōpū Whāiti recognised early on the importance of monitoring students’ progress through these strategy stages.

The knowledge section of The Number Framework consists of four content areas: numeral identification; number sequence and order; grouping/place value and basic facts; and written recording. Significant to the knowledge section is a recognition that written recording is a means to “think through” calculations and help the mental strategy being employed. Such written recording can be done in many ways, and the standard vertical algorithms are seen as only one possible means of recording that is better left until students are able to use part-whole strategies for number operations (stage 5).

Te Poutama Tau began to be implemented in 2002. Twelve advisors to schools working through colleges of education were identified as facilitators for the programme, and a training hui was held in February. Forty-seven Māori medium schools, 97 teachers, and 949 students between the ages of five and twelve became involved in the programme. Results and feedback from these students, teachers, and facilitators form the basis of this report.

A further training hui was held in March and the facilitators were also encouraged to work alongside their mainstream counterparts to become familiar with the Numeracy Project. The present research project was commissioned and, after much preparatory work by Te Rōpū Whāiti, arrangements were made for the translation of key materials, including the diagnostic interview used by teachers to assess the knowledge and strategy level of students and other teaching booklets. This work was ongoing throughout the year. It was unfortunate that the facilitators were required to begin work with teachers before they had access to the completed Māori language materials. This is discussed further in Chapter Four.

The model for implementation of the Te Poutama Tau programme was based on that of the Numeracy Project and required the facilitator to work closely with individual teachers in their schools and classrooms. A series of after-school professional development workshops were followed by in-class visits where the facilitator could model the programme, as well as observe and provide feedback for teachers. However, it was soon realised that the model needed to be adjusted to cater for additional factors not present in mainstream contexts. The extent of the extra demands placed on facilitators and teachers to deliver the programme in Māori had not been foreseen. As outlined above, the lack of historical development of the language as a medium of mathematics instruction meant that much time and attention had to be spent on this aspect in the workshops. Use of the Māori language was also informed by implementation in the classroom and the kinds of language that either

helped or hindered communication. Language issues arising from the Te Poutama Tau programme are discussed in Chapter Five.

The facilitators and Te Rōpū Whāiti met again in August, and the feedback showed clearly that adherence to the mainstream implementation model outlined in Figure 1.1 would not produce the best results. The Ministry was quick to recognise this and recommended that the facilitators adopt a more flexible approach, tailored to the needs of individual schools. An important aspect of future research will be to monitor the various models of professional development that facilitators and schools develop to best meet their own needs.

Figure 1.1: An overview of the Numeracy Project development workshops

| | |
|------------|--|
| Workshop 1 | Introduction to The Number Framework and the Numeracy Development Project |
| Workshop 2 | Introduction to the diagnostic interview and its use |
| Workshop 3 | Review of videotapes to clarify diagnostic issues and grouping for instruction |
| Workshop 4 | Planning and resources for teaching |
| Workshop 5 | Feedback, project evaluation, and looking forward |

Chapter Two: Methodology

Aims of the Te Poutama Tau Research Project

The Te Poutama Tau research project had the following aims. The first two aims were focused on evaluating the programme and the third concentrated on identifying Māori language issues associated with The Number Framework and the teaching of early numeracy.

1. To study the impact of the Te Poutama Tau professional development programme for Māori medium classrooms on teachers and their teaching.
 - What is the impact on teachers' professional and curriculum knowledge?
 - What factors and experiences have led to change in classroom practice?
 - What is the nature of that change?
2. To study the impact of the Te Poutama Tau professional development programme for Māori medium classrooms on learning.
 - What overall progress do students make on The Number Framework?
 - What factors impact on the progress that students make?
 - In which areas of The Number Framework do students perform well and in which areas do they perform poorly? Why is this so?
3. To study how the use of Māori language impacts on the learning and teaching of number.
 - In what areas of the Te Poutama Tau framework do teachers and students have difficulty communicating?
 - What are the important influences on effective communication about number in Māori?
 - What approach best encourages students to describe their mental strategies and reasoning?

Data Collection

The research questions outlined above were investigated in four ways. While it was recognised that this would result in some overlap and repetition, this was also seen as a strength, in terms of providing for some triangulation of data and therefore confirming the validity of the findings.

The researcher must consciously utilise designs that allow counter patterns as well as convergence if data are to be credible. (Lather, 1986, page 270)

1. An analysis was conducted of the results from the diagnostic interviews completed before and after the implementation of the Te Poutama Tau programme. This allowed the progress of students through the stages of The Number Framework to be evaluated and is reported in Chapter Three. In addition

to the interview results, the following information was also collected about each student to help identify factors influencing students' progress:

- date of birth
- year level
- gender
- language/s spoken at home
- Māori language proficiency.

The Te Toi Huarewa study found that “students entering Māori-medium schools came from a far broader language continuum than do the majority of their English speaking peers who are entering English-medium education” (Te Toi Huarewa, 2002, page 27). The authors of the study outlined four categories for describing students' language background. They argued that students from each category were either advantaged or disadvantaged in terms of their readiness for academic learning and that different programmes were necessary for the four groups.

For this reason, questions about the language background and proficiency of the Te Poutama Tau students were included to gain some understanding about whether or not this was an important factor in the learning of number.

By mid-November 2002, when analysis of the data took place, 949 initial diagnostic interviews had been completed and entered by teachers onto the database. This represented students from 61 different classrooms and 30 schools. However, only 364 second diagnostic interviews had been completed, a reflection of the fact that in many schools, the programme did not begin until the third term, and progress was slow due to linguistic and other factors discussed in Chapter One. Because of the small sample size, the researchers decided, in discussion with Te Rōpū Whāiti and the Ministry, to view this aspect of the research as ongoing throughout 2003 and possibly beyond. This will enable the database to grow and in time will provide the basis for a more in-depth analysis. SPSS 10.1 was used to conduct the analysis of the Te Poutama Tau database.

2. All teachers and facilitators involved in the Te Poutama Tau programme were asked to complete a questionnaire. The questionnaires were designed to collect information about specific aspects of the Te Poutama Tau programme, such as the facilitators' training, the impact on teacher knowledge and practice, the implementation of the support materials, aspects of number that were either difficult or problematic to teach in Māori, and so on. (See Appendix 2 for a copy of the Teacher Questionnaire and Appendix 3 for the Facilitator Questionnaire.) In total, 28 questionnaires were completed and returned. The information was entered into a Microsoft Access database and analysis undertaken using SPSS 10.1. Some questions could be “counted” and others were more qualitative in nature where teachers and facilitators were required to write their responses.
3. Four meetings with groups of teachers were set up to discuss aspects of the programme in a more wide-ranging and detailed way than was possible through the questionnaires. Discussion focused on four key aspects – changes in teacher knowledge and practice, future needs, language issues, and ownership of the programme. In addition to this, questions about the administration of the programme, school-wide needs, and teacher progress were discussed with the principals of the schools where the meetings were held. These formal meetings

were augmented further with notes taken during discussion sessions held at the three facilitators' training meetings and information was gleaned from informal discussions with facilitators and teachers.

4. The facilitators were asked to keep a diary describing various aspects of their work, including anecdotal information about the implementation of the Te Poutama Tau programme in schools. This provided further triangulation of data and, in particular, allowed the day-to-day aspects of the programme to illuminate the data from the other sources.

A large amount of qualitative data was generated from the teacher and facilitator questionnaires, the teacher discussions, and the facilitator diaries. This information was organised according to themes and sub-themes, partly in response to the information itself and partly as the information applied to the research questions.

The first theme was organised around information about student learning. This included resource material and equipment, aspects of The Number Framework that were found to be difficult for learners, and grouping for learning. The second theme was teaching, and included information about the training and facilitation of the programme, teachers' understanding of The Number Framework, as well as any changes in teaching approach as a result of the programme. The third theme was the language itself, and included information about vocabulary, patterns of discourse, language acquisition, and transfer.

Ethics Approval

Te Rōpū Whāiti, the group established to oversee the implementation of Te Poutama Tau, provided an important forum for the discussion and mediation of research issues as they arose. In particular, the kaumātua in Te Rōpū Whāiti provided guidance to ensure that tikanga Māori was not compromised and that the research was conducted in a way consistent with kaupapa Māori. Approval for the research methodology was sought from Te Rōpū Whāiti at their meeting in March 2002. Following this, the methodology was presented to a meeting of all the facilitators, who gave valuable feedback. This led to changes in some aspects of the research project. Approval was subsequently sought (and granted) from the Massey University Human Ethics Committee.

Research Participants

Schools

Teachers from 42 schools participated in the programme during 2002. Of these, 16 were Kura Kaupapa Māori, 22 were schools with immersion units or fully bi-lingual schools, two were area schools, one was a year 7–13 college, and one a special character school. It is important to note that for some of these schools, participation in 2002 was limited to attending some of the workshops at the invitation of the facilitators, in order to learn about the programme in readiness for full participation in 2003. Others were schools with bilingual units participating in the mainstream project, where the facilitator had invited the bilingual class teachers to participate in the Māori medium workshops.

Information about school decile rating is summarised in Table 2.1. Because the vast majority of the participating schools (70%) had a low decile rating (level 1 or 2), it

was decided that analysis of the results according to this variable would be of little merit.

Table 2.1: Decile rating of participating schools

| | | | | | | | | | |
|-------------------|----|----|---|---|---|---|---|---|---|
| decile rating | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| number of schools | 23 | 10 | 3 | 4 | 1 | 0 | 1 | 0 | 0 |

Table 2.2 shows the geographical distribution of the participating schools.

Table 2.2: Geographical location of participating schools

| Region | Number of schools |
|-------------------------------|---|
| Te Taitokerau | 1 |
| Tāmaki Makaurau | 7 |
| Waikato | 4 |
| Te Tairāwhiti | 9 (including 7 “limited participation” schools) |
| Te Arawa, Tūhoe, Ngāti Manawa | 3 |
| Te Matau-a-Māui | 7 |
| Manawatū | 2 |
| Te Taihauāuru | 2 |
| Te Upoko o te Ika | 5 |
| Te Taihu o te Waka o Māui | 2 |

Teachers

Ninety-seven teachers participated in the Te Poutama Tau professional development programme, and 61 of these completed the first diagnostic interview with their students and entered the results onto the database. In total, 39 teachers completed both diagnostic interviews and entered results on the database. Questionnaires were returned by 22 of the participating teachers. Information about these 22 teachers is summarised in Table 2.3.

Table 2.3 Gender and experience of participating teachers

| gender | | years teaching | | | years teaching junior school | | |
|--------|------|----------------|-----|----|------------------------------|-----|-----|
| female | male | 0-3 | 4-7 | 8+ | 0-2 | 3-5 | 6-8 |
| 20 | 2 | 11 | 6 | 5 | 15 | 5 | 2 |

Several facilitators reported that the high rate of teacher turnover in some schools made the project very difficult to implement. In one school, there were three different teachers in the junior classroom over the 20-week duration of the project.

Facilitators

Twelve Te Poutama Tau facilitators, employed by colleges of education, provided the professional development programme for the teachers involved. The facilitators were asked to complete a questionnaire to evaluate the programme. However, at the time of writing this report only four had been received. All the facilitators were experienced teachers, and the four respondents had been working as advisors to schools for between one and three years. One of those who responded had been a facilitator for the mainstream Numeracy Project in 2001.

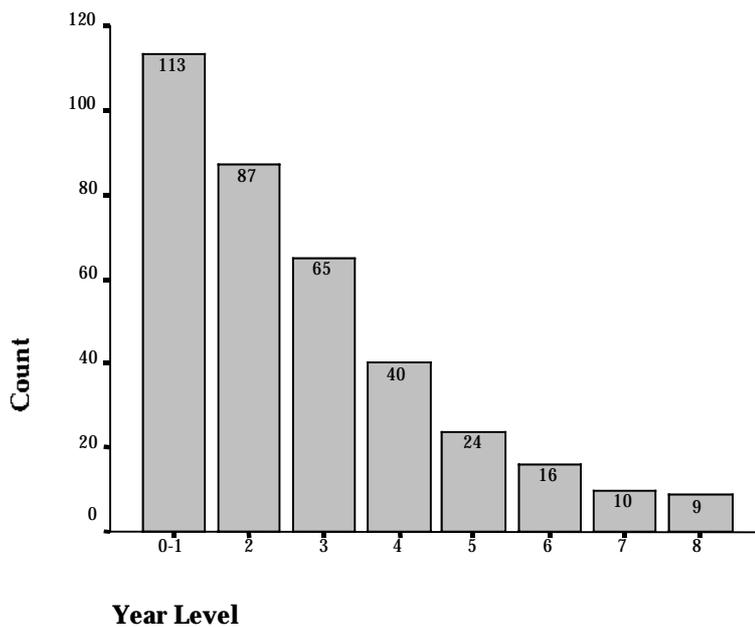
It should be noted that the return rate for both the facilitator and teacher questionnaires was poor in spite of positive feedback from the facilitator meetings about both the method and the purpose of data collection. An alternative method of achieving participation from both these groups will need to be tried in the future.

Students

The teachers entered results from the first diagnostic interviews of 949 students onto the database. Fifty-two percent were boys and 48% were girls, and this gender profile was similar for the 364 children who completed both interviews. Figure 2.1 shows the distribution of year levels for the students who completed both interviews.

Eighty-four percent of the students were in the first four years of schooling. Because of the small numbers in years five, six, seven, and eight, the results for these year groups should be interpreted carefully.

Figure 2.1: Distribution of Te Poutama Tau students across year level



Chapter Three: Results and Discussion – Diagnostic Interviews

The students were assessed at the beginning and end of the Te Poutama Tau programme to determine their achievements and progress in relation to The Number Framework. The diagnostic interview assessed the students' competencies in the five aspects of number described briefly below:

The Five Aspects of Number

Strategy Use

“Strategy use” refers to the mental processes that students use to solve number operations. Nine stages of strategy use are described on The Number Framework and assessed in the diagnostic interview. The first five stages (0 to 4) are based on counting strategies (emergent, one-to-one counting, counting from one on materials, counting from one by imaging, and advanced counting). Stages five and above involve part-whole reasoning, where students come to see numbers as “whole” units that can be broken down into “parts” or proportions and re-grouped in order to simplify an operation.

Forward Number Sequence

The ability to count forwards from a given number and identify the next number in a forward counting sequence.

Backward Number Sequence

The ability to count backward from a given number and identify the next number in a backward counting sequence.

Numeral Identification

The ability to read and write numbers, including fractions and decimals.

Grouping and Place Value

An understanding of how the number system works, in particular the groupings of ten and powers of ten. Students' natural inclination to use groupings of five is also encouraged.

Overview of Student Progress

In four aspects of The Number Framework, the students' progress through the early stages was very good. The gains that students could be expected to make over time as a natural course of events without the intervention of a programme was calculated for the mainstream Numeracy Project (see Thomas and Ward, 2002, page 13). Progress made by the Te Poutama Tau students was significantly greater than this in strategy use, numeral identification, and both forward and backward number sequence. The exception was grouping and place value. Figure 3.1 shows the mean gain made by Te Poutama Tau students in each of the aspects of number, and Table 3.1 compares this with the gains calculated for the reference group in the mainstream Numeracy Project.

Figure 3.1: Mean gains across the five aspects of The Number Framework

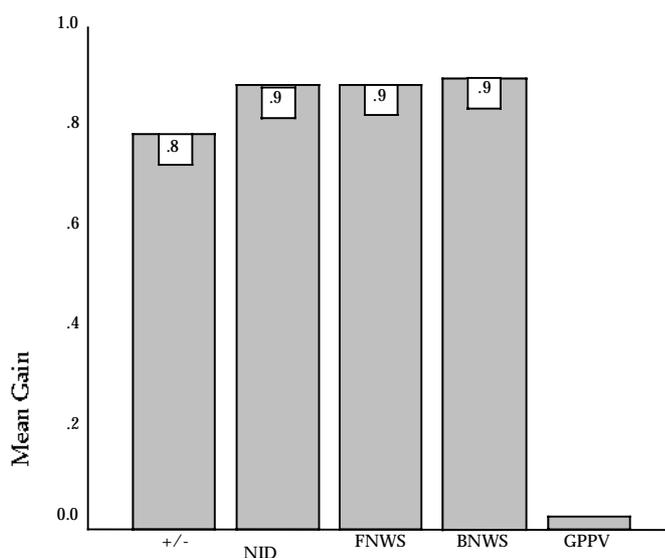


Table 3.1: Mean gains for the Te Poutama Tau students and the mainstream reference group

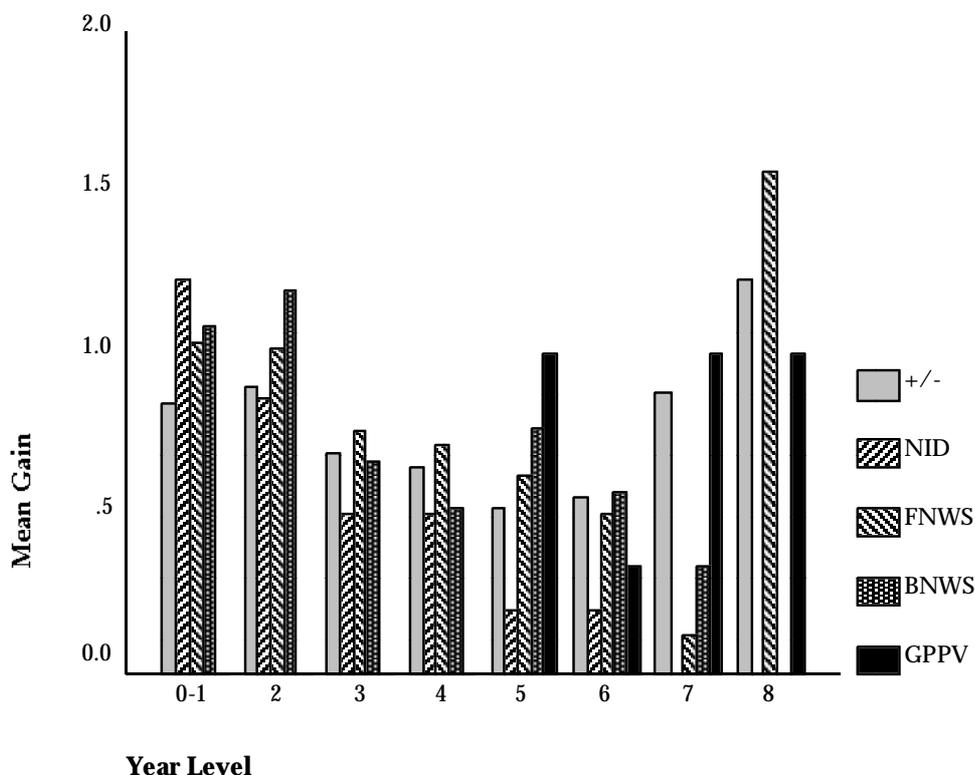
| | strategy (+/-) | NID | FNWS | BNWS | GPPV |
|---|----------------|------|------|------|------|
| Mean gain for the Te Poutama Tau students | 0.8 | 0.9 | 0.9 | 0.9 | 0.03 |
| Mean gain calculated for the mainstream reference group | 0.2 | 0.15 | 0.2 | 0.2 | 0.15 |

Figure 3.2 shows the mean stage gains for each aspect of The Number Framework for each year level². Greater gains were generally made by the younger students in the study,³ which supports the argument that the early stages of The Number Framework are smaller and less complex to learn, and therefore students progress more quickly at this level (see Thomas and Ward, 2002, page 16). Older students who were operating at the lower stages of The Number Framework also made gains more quickly.

² Twenty-four students had been diagnosed as making a negative gain, several moving from stage six in the initial assessment to stage zero in the final. Discussion with facilitators suggested this would most probably have been a result of misdiagnosis or incorrect data entry. Therefore, the students were removed from the analysis to prevent misleading skewing of the data.

³ The large mean gains shown for year 8 students were not considered to be typical, because the small sample size was skewed by a few students moving from stage zero to stage six.

Figure 3.2: Mean gains of each year level



Students in years one to four made no gains in grouping and place value and, while the graph suggests that progress for years five to eight was very good, a grouping and place value diagnosis was made for only five students across these four levels. Four out of these five students made a gain of one stage. The data shows that achievement in grouping and place value is a major concern. Table 3.2 shows that only a small number of students achieved above stage zero, even in the second diagnostic interview. Possible reasons suggested by facilitators for students' poor performance in grouping and place value were:

- teachers' own limited knowledge and awareness of the importance of this aspect of number;
- a deficiency in the actual programme (it was suggested that a coherent teaching sequence for grouping and place value was not explicit and relied instead on a series of games and activities that left the students to make the connections and make sense by themselves);
- a lack of focus on this aspect in the teacher workshops;
- skewing of the results, due to a small sample size and the possible poor performance of a small number of schools.
- assessment items relating to grouping and place value occur at the end of the diagnostic interview, which may have led to learner and teacher fatigue or to people rushing this part to get finished.

Table 3.2: Achievement in grouping and place value in the second diagnostic interview

| Stage | GPPV | | | | | | | Total |
|-------------------|------|---|---|---|---|---|---|-------|
| | 0-1 | 1 | 2 | 3 | 4 | 5 | 6 | |
| Initial Interview | 146 | 0 | 0 | 0 | 5 | 0 | 0 | 151 |
| Second Interview | 146 | 0 | 0 | 0 | 1 | 4 | 0 | 151 |

Grouping and place value requires students to understand and use groupings with and within five and ten. The stages are outlined in Table 3.3.

Table 3.3: Stages in grouping and place value (from Ministry of Education 2002a: 20)

| Stage and Behavioural Indicator | |
|---------------------------------|--|
| 0-1 | Non-grouping with fives and within ten The student is unable to group with five and within ten. |
| 2-3 | With fives and within ten The student knows groupings with five (e.g., 8 is 5 and 3) and groupings to ten (e.g., 10 is 3 and 7). |
| 4 | With tens The student finds the tens in numbers to 100 by counting on in tens (i.e., 10, 20, 30, 40 ...) and teen numbers (e.g., $14 = 10 + 4$). |
| 5 | Tens in 1000 The student finds how many tens are in numbers to 1000 using their knowledge that ten tens are one hundred (e.g., for 230: 10, 20, 23). |
| 6 | Tens and hundreds in whole numbers The student knows how many tens and hundreds are in whole numbers. |

Table 3.2 above shows that the Te Poutama Tau programme had little effect on helping students to use groupings with and within five and ten. Given that this is a key area of the knowledge students need to progress from using counting strategies to part-whole thinking, it is recommended that both the learning and teaching activities, and the linguistic aspects of grouping and place value be reviewed and become an important focus for facilitator and teacher training in 2003.

Table 3.4 shows the number of stages gained across each aspect of The Number Framework.

Table 3.4: Number of stages gained

| Test | Number of stages gained | | | | | | |
|-------------|-------------------------|-----|-----|----|------|------|------|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| +/- | 45% | 36% | 16% | 2% | 0.6% | 0.3% | - |
| NID | 40% | 36% | 18% | 5% | - | - | - |
| FNWS | 42% | 37% | 14% | 5% | 2% | - | 0.3% |
| BNWS | 43% | 33% | 15% | 7% | 2% | - | - |
| GPPV | 97% | 3% | - | - | - | - | - |

Except for grouping and place value, the students who progressed by at least one stage outnumbered those who made no stage gains. However, the number who made no gains is significant. This is of concern, given that the Numeracy Project and the Te Poutama Tau programme are based on the stated aim that “every child turning

nine will be able to ... do maths for success” (Ministry of Education, 2001a). It will be important to monitor this aspect of the programme and, if the trend continues, a change in approach will be necessary. It is recommended that a case study be undertaken to find out why such a significant number of students made no gains, even after the implementation of a focused and intense programme.

Figure 3.3 shows the mean stage gains for girls and boys across The Number Framework. The results show there is no significant difference in the extent to which the programme is successful for girls and boys.

Figure 3.3: Mean stage gains for girls and boys

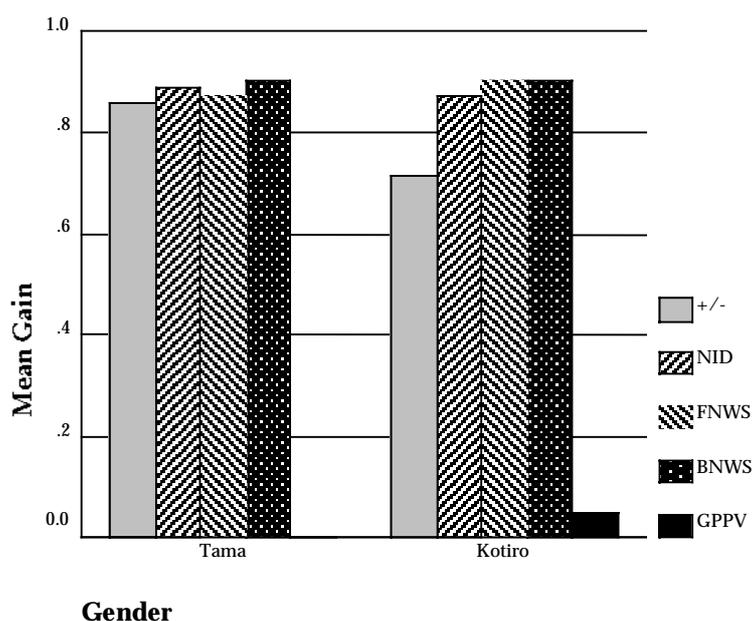


Table 3.5 shows the number of students in each language proficiency group, as judged by their teachers. Eighty-seven percent of students were judged to be “reasonably proficient”, “proficient”, or “very proficient”.

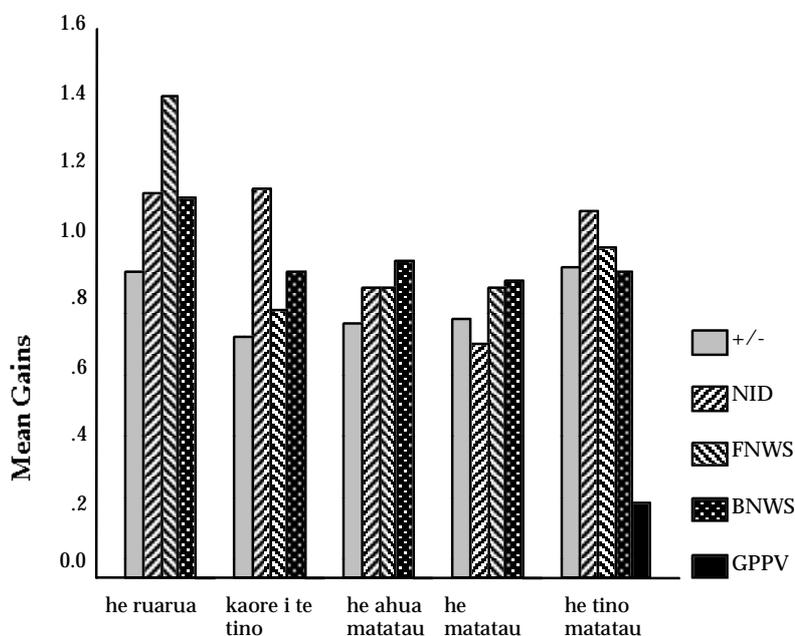
Table 3.5: Language proficiency of Te Poutama Tau students

| language proficiency | poor proficiency | not very proficient | reasonable proficiency | proficient | very proficient |
|----------------------|------------------|---------------------|------------------------|------------|-----------------|
| numbers of students | 10 | 38 | 123 | 96 | 97 |

Figure 3.4 suggests that the language proficiency of students does not impact on their progress. Further examination of the data shows this to be true for the early stages of The Number Framework – the majority of those who had low proficiency were working at stages one or two, and were able to make progress. Progress through the higher levels was more problematic for students who did not have reasonable proficiency in the language. When the influence of year level (age) was factored out of the equation, there was a significant correlation between language proficiency and performance in the diagnostic interview (partial correlation .212, $p < .001$). These results reflect the considerable demands that the Te Poutama Tau programme makes on both teacher and student use of language. While the use of symbols, diagrams,

and concrete apparatus can assist communication about number, language proficiency remains a major influence on student achievement. It is interesting to note that only students who were rated as very proficient made any progress at all in grouping and place value.

Figure 3.4: Mean stage gains and language proficiency



Gains made in strategy use – moving from counting to part-whole

The progress of students in their use of strategies to solve number operations has been identified as crucial to success in mathematics (see Clarke and Cheeseman, 2000; Wright, 1998; Young-Loveridge, 1999). It is particularly important that students move from using the less sophisticated counting strategies of stages zero to four to the part-whole thinking required for stages five and above.

Table 3.6 shows the percentage of each year level at each of the strategy stages for both the initial and final interviews. Stages five and six (part-whole thinking) are highlighted. The percentage of students using part-whole strategies increased from 12% to 17% over the duration of the programme. The largest increases were made by students in years 3 and 4, suggesting there may be a significant group of students at this age who are ready for the transition from counting to part-whole strategies. The percentage of students who progressed from using counting strategies to part-whole thinking was disappointing, and poor performance in grouping and place value may be one contributing factor. In contrast to this was the large percentage of years five, six, seven, and eight students who were assessed as being part-whole thinkers at the end of the programme. While the sample size was very small at these year levels, the results suggest the ability to progress to using part-whole strategies may be a function of age. Whatever the case, this is a critical aspect of the programme, and helping students use the more sophisticated part-whole strategies for number operations should continue to be a focus for the facilitator and teacher workshops.

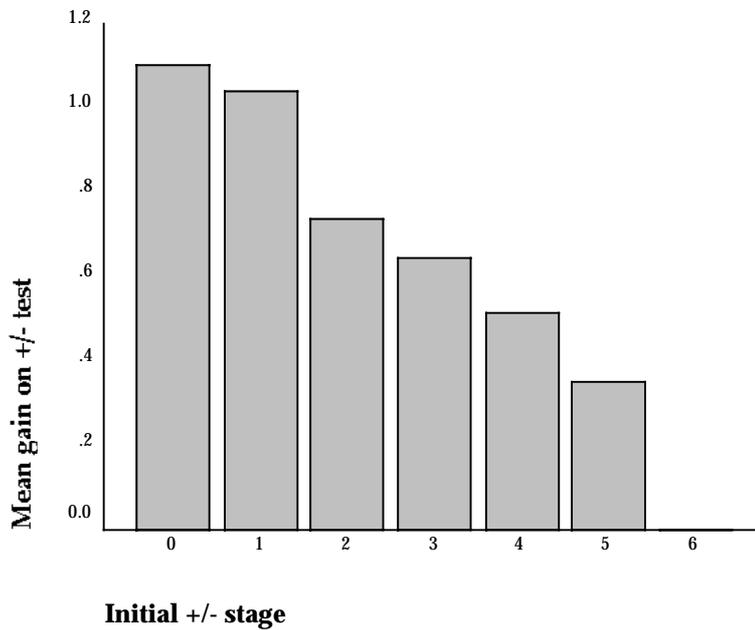
Table 3.6: Percentage of students by year level at each of the strategy stages⁴

| Year Level | +/- | 0 | 1 | 2 | 3 | 4 | 5 | 6 | Total |
|------------|--------|-----|-----|-----|-----|------|-----|-----|-------|
| 0-1 | Test | 58% | 22% | 18% | 2% | 0.9% | | | 100% |
| | retest | 19% | 34% | 35% | 6% | 6% | | | 100% |
| 2 | Test | 20% | 25% | 37% | 12% | 6% | 1% | | 100% |
| | retest | 5% | 12% | 39% | 22% | 20% | 2% | | 100% |
| 3 | Test | 8% | 3% | 42% | 22% | 23% | 3% | | 100% |
| | retest | 3% | 7% | 17% | 28% | 29% | 16% | | 100% |
| 4 | Test | | 5% | 20% | 20% | 43% | 8% | 5% | 100% |
| | retest | | 3% | 3% | 13% | 54% | 23% | 5% | 100% |
| 5 | Test | | | 13% | 4% | 33% | 46% | 4% | 100% |
| | retest | | | | 5% | 33% | 52% | 10% | 100% |
| 6 | Test | 6% | | 6% | | 25% | 25% | 38% | 100% |
| | retest | 9% | | | | 27% | 18% | 46% | 100% |
| 7 | Test | | | | | 40% | 40% | 20% | 100% |
| | retest | | | | | | 38% | 63% | 100% |
| 8 | Test | 11% | | | | 22% | 33% | 33% | 100% |
| | retest | | | | | | 22% | 78% | 100% |
| Totals | Test | 25% | 14% | 25% | 10% | 15% | 8% | 4% | 100% |
| | retest | 8% | 15% | 24% | 14% | 21% | 11% | 6% | 100% |

As expected, students who were diagnosed at the lower stages in the initial interview made greater progress over the duration of the programme. This again reflects the argument that the initial stages are smaller and easier to progress through. However, it may also be an indication that the teachers were more effective at the lower levels, and helping students achieve at the higher levels of The Number Framework should continue to be a focus for facilitators and teachers. This will become even more important as the programme is expanded to include more students at higher year levels.

⁴ Some rows do not add to exactly 100%, due to rounding of the data.

Figure 3.5: Initial strategy stage and mean gains



The information reported in this chapter was generated from the data about 364 students who were involved in the first year of the Te Poutama Tau programme and who had results from both the initial and second diagnostic interviews recorded. This is a very small data set in comparison with the approximately 15,000 students in the mainstream project. Nevertheless, it has provided some important information about various aspects of Te Poutama Tau that will help inform the continuing efforts to create a programme that is responsive to the context of Māori medium education and will improve student achievement in pāngarau. Further data collection as the programme continues will show the effect of any changes made to the programme and the growing confidence and ability of the facilitators and teachers involved.

Chapter Four: Results and Discussion – Te Poutama Tau Evaluation

This chapter reports on the findings from the facilitator and teacher questionnaires, the facilitator diaries, feedback given during facilitator training hui and meetings with groups of teachers, and informal discussions with facilitators, teachers, and principals. Overall, feedback about the programme was very positive.

Impact on Students and Learning

Ninety percent of the teachers who responded to the questionnaire felt their students had either made good or considerable progress through their involvement with Te Poutama Tau. This was supported by comments made during the teacher meetings. In one school it was reported that students from the junior classes who had been involved in the programme were consistently performing better than students in the senior level of the school when operating with larger numbers. It was felt that this was because the younger students were able to use a much broader range of strategies that had been taught in the programme.

In many schools, the facilitators reported a notable change in attitude in the students as the programme was implemented. They thought the students enjoyed the programme and were often quicker than their teachers to grasp new strategies, simply because they were more open to them and did not have previously learned approaches that were firmly set in their minds and therefore difficult to modify. Most teachers also reported students enjoyed the “hands on” nature of the learning activities.

Teacher comments included:

He rawe ki ahau te kite i ngā tamariki e tū tangata ana, e tū māia ana i ngā wā ka mau i a rātou ētahi whakaaro matua, ētahi mahi hou rānei. (It was neat to see the children standing tall and growing in confidence when they learned a key concept or a new idea).

He rawe ki ahau te kite i ngā tamariki, kia taka te kapa ka menemene mai ki ahau. (It was neat to see the children’s delight when “the penny dropped”).

He pai ki ahau te whakapiki i te mātauranga me te māia o ngā tamariki ki te kaupapa tau, ahakoa te pakeke o te tamaiti. Ko ngā tamariki e rima tau noa iho, he tino mōhio rātou i te kaute tae atu ki te 100, te pānui i ngā nama nui, me te tāpiri i ngā nama paku. (The children’s progress and confidence in number was good across all the ages. Children as young as five were able to count to 100, to read large numbers, and add smaller numbers).

Chapter Three reported in detail on the impact of the Te Poutama Tau programme on student achievement.

Impact on Teachers and Teaching

Comments from most teachers showed that the Te Poutama Tau programme was very effective in helping teachers understand the stages of development through which students go in their learning of number. This understanding helped teachers be more

effective in their grouping of students for instruction, their reporting about student learning, and in catering for individual needs. Table 4.1 shows the teachers' responses to questions about their own development as a result of the programme.

Table 4.1: Teacher development

| | greatly improved | improved | no change |
|--|------------------|----------|-----------|
| confidence and attitude to teaching number | 33% | 62% | 5% |
| knowledge of the number strand | 29% | 67% | 5% |
| knowledge of how students learn about number | 38% | 57% | 5% |
| ability to teach number effectively | 35% | 65% | 0% |
| knowledge of operational strategies | 25% | 65% | 10% |
| knowledge of The Number Framework | 15% | 80% | 5% |
| ability to administer the diagnostic interview | 50% | 40% | 10% |
| ability to group students for instruction | 50% | 50% | 0% |
| ability to plan for group instruction | 50% | 45% | 5% |
| ability to teach groups | 40% | 60% | 0% |

It is clear from Table 4.1 that teachers felt the Te Poutama Tau programme impacted positively on their own knowledge and ability. In the teacher meetings, teachers commented that the programme helped them cater for individual needs and report to parents. Several noted that the programme provided a “school wide” focus on pāngarau and monitoring student progress. It was not uncommon for the programme or the achievement of a student or group of students to be an informal topic of conversation in the staffroom. Teachers enjoyed sharing their successes with other teachers. In one school, the senior class teachers became envious of their junior class colleagues, because of the obvious enthusiasm they had for the programme and the progress of the junior students. One school involved the parents in the programme by holding a parents evening where they could see the programme in action. The students modelled various Te Poutama Tau activities and the aims of the programme were discussed. Teachers reported that in many cases this enhanced the enthusiasm of the students, with many wanting to take activities home for homework or to “teach their parents”.

Initially, some teachers found the programme difficult to understand and to commit to. This was consistent with comments from some of the facilitators, who reported a concern that the workshop model did not allow teachers enough time to become familiar with the programme and to consolidate their learning. One facilitator thought the model moved too fast and that at times she felt she was “throwing paper at the teachers” (in reference to the large amount of written resource material given for the teachers to digest). The Ministry of Education responded to this concern, expressed by facilitators at their August workshop, by supporting a recommendation that a more flexible approach be taken, one that was able to respond to local contexts and the readiness or otherwise of the teachers. An approach taken by one facilitator was to use the whole year to prepare the knowledge base and understanding of the

teachers (2002), before moving to classroom implementation in the second year (2003).

All teachers reported positively on their facilitators and most commented that having a combination of workshops and in-classroom work was useful. Some found that the most effective way for them to learn was when facilitators modelled the diagnostic interview or group teaching. All thought more release time was necessary to complete the diagnostic interviews satisfactorily without the distractions of managing a class at the same time. However, many also reported that it was difficult to find appropriate relievers for their schools. There was only one teacher who reported being uncomfortable with the presence of a facilitator to observe and give feedback on their teaching.

The facilitators and some teachers reported that classroom management impacted negatively on the implementation of the programme in many classrooms. It was difficult to organise and teach (or interview) individuals and groups because the rest of the class required teacher attention to keep them on task. Some facilitators used workshop time to talk about establishing more acceptable patterns of classroom work and behaviour. On a positive note, several teachers reported that their classroom management skills had improved through their involvement in the programme and that while it was difficult at first to implement group instruction, perseverance paid off. As the students became used to new expectations and a different way of working, classroom management became easier.

The facilitators reported that most teachers were willing to make changes in their teaching approach, because of the support provided through the programme. However, some found change difficult, particularly in regard to the place of vertical algorithms within the programme and the use of part-whole mental strategies for solving number operations.

There was overwhelming support for the “hands on activities” and apparatus that are promoted as part of the programme. Teachers saw the use of apparatus as key to students’ learning. Typical comments were:

Mā te raweke rauemi ka hopu ngā tamariki i ngā ariā pāngarau. (Children gain understanding of the maths through the use of “hands on” resources).

Most teachers responded positively to all Te Poutama Tau resources, mainly because they were “hands on” in nature. The ten’s frame, slavonic abacus, and fractions resources came in for special mention by several teachers as being particularly useful. Other teachers commented that it took time to understand the activities and the best way of doing this was to do the activities themselves in the teacher workshops. However, there was strong support for having the materials available in Māori. Many reported that implementing the programme was made difficult, because the resource booklets were in English. A typical comment from one teacher was:

Kua riro mā te reo Pākehā e kawē te kaupapa. (It has been left for English to carry the programme).

Teachers had to do their own translating into Māori, often on the spur of the moment, and this caused problems for the correctness and conciseness of the language and the clarity of the mathematics (see Chapter Five for a discussion of language issues).

Draft versions of the diagnostic interview and the number knowledge booklets were available in a bilingual format, where the explanation of the activity and its purpose

was in English and an example of the teacher dialogue was in Māori. This format received widespread support from teachers, because it provided a language model on which teachers could build. Several commented that the presentation of the diagnostic interview booklet was “cluttered” and that it was initially difficult to know where to enter results and transfer them to the database and schedule for grouping. It will be important for the continuing success of the programme to ensure all the resources are available in Māori or in the bilingual format and the formatting and presentation are clear and have a Māori “feel” to them. The ongoing collection of feedback and suggestions from teachers about the resources will be helpful here. Suggested resources for future development include activities relating number to the other strands, video footage of the diagnostic interview showing students operating at various stages of The Number Framework, and independent activities.

The facilitators reported that a supportive, enthusiastic, and involved principal was a key element in the success or otherwise of programme. Where there was little support from the principal, the enthusiasm and commitment of the teachers was variable. Seventy-six percent of the teachers who responded to the questionnaire felt their school was very supportive. Sixty-three percent were involved in at least one other professional development programme, and some facilitators felt frustrated that this often made it difficult for some teachers to attend workshops and give the programme the focus it deserved.

One topic of discussion in the meetings with teachers centred on the ownership of programme. Most felt that although it was linked with the Numeracy Project, the way the facilitators had run the workshops and helped implement Te Poutama Tau in their schools had given it a Māori feeling. Comments showed teachers clearly delineated between content and pedagogy. While it was recognised that the content was largely the same as that of the Numeracy Project in mainstream schools, the adopted pedagogy and language of instruction of Te Poutama Tau ensured ownership of the programme was not a problem for Māori medium schools.

Chapter Five: Results and Discussion – Language Issues

The Te Poutama Tau programme provided an opportunity to focus on te reo Māori as the medium of instruction for mathematics. From the outset, Te Rōpū Whāiti recognised the importance of the linguistic aspect of the programme for two reasons:

- The language lacks historical development as a medium of instruction for contemporary mathematics. There are no established patterns of discourse about many of the topics of learning and teaching (for example, place value, decimal fractions, and ratio).
- Māori medium educators are vitally concerned with the integrity of the language, and so the linguistic aspects of the programme would inevitably be a subject of contention and debate that would centre around vocabulary, syntax, local dialect, conciseness, and simplicity.

Results from the teacher and facilitator questionnaires indicate that language, and in particular vocabulary and patterns of discourse, should be an ongoing focus for the Te Poutama Tau programme or any other pāngarau development. The majority of teachers said they knew only “some” of the pāngarau words that were relevant to the junior level of school. Several noted that the bilingual presentation of the booklets for the diagnostic test and number knowledge activities was helpful here (although there was also some opposition to the use of English at all). It was also noted that where teachers understood the Māori origin and mathematical context of the word, acquisition was greatly assisted. Seventeen out of 20 teachers indicated that their language ability had improved as a result of the Te Poutama Tau programme (although none said that their ability had improved “greatly”).

There was a general awareness amongst teachers that pāngarau has its own register or jargon, and that this is important to communicate understanding about the concepts. However, there continued to be tension between some of the items of pāngarau vocabulary used in the Te Poutama Tau resources and what was seen as the “local school dialect”. The most frequently mentioned example was the word “tau” for number. Many preferred “nama”, borrowed from English. While on the face of it this would seem to be acceptable, there is some anecdotal evidence that problems can arise if local vocabulary varies greatly from standard terms. The mobility of students in Māori immersion is high, and coping with a different local vocabulary can be difficult for students transferring schools. In addition to this, vocabulary becomes more sophisticated as students move to higher levels of the curriculum. For example, there are 43 different types of number listed in the curriculum document that use the base word “tau” (for example, taukehe *odd number*, tau tōraro *negative number*, taurahi *scale factor*, and so on). If students are introduced to the specialised vocabulary relevant to their level, they will experience less difficulty when further terms are added as they move to higher levels.

The names for the numerous pieces of “cardware” and “hardware” associated with the Te Poutama Tau programme were also difficult to remember. One suggestion was simply to write the names on all pieces of apparatus. It could also be useful to

incorporate vocabulary and language acquisition activities into the Te Poutama Tau programme. These activities could be included in the resource booklets alongside the number activities or could be the focus of a separate booklet.

Most of the facilitators reported that “language issues”, such as vocabulary and how to say things correctly, were often a topic of debate and discussion in the teacher workshops and time had to be allowed for this. This signals teachers’ concern that they provide good language models for their students, and an awareness that the conciseness, clarity, and correctness of their own language will have a major impact on both the students’ language development and their learning in pāngarau. It was recognised by teachers that the Te Poutama Tau programme makes much greater demands on their use of language and their ability to use other tools of communication than previous methods of teaching pāngarau. This is consistent with Cazden’s argument for a greater focus on the influence of classroom language use on learning.

Creating the conditions for the interdependent goals of academic learning and language development for all students requires changes in classroom language use. ... Because of the conditions both within the classroom and outside it, we need the ‘medicine’ of more careful analysis and conscious control so that our implicit theories of the language of teaching and learning can be open to continual re-vision. Nothing less does justice to our profession and our children. (Cazden, 2001, page 181).

In the light of this, it is recommended that “events of communication” in the pāngarau lesson be a focus for further research to understand how oral and written Māori can be used more effectively in conjunction with diagrams and concrete apparatus to facilitate better learning and teaching.

One of the main differences in approach noted by teachers was the emphasis on encouraging students to “verbalise” and explain their strategy use and mathematical thinking. Many commented that while this was initially difficult for the students; by the end of the programme, the ability of students to discuss their mathematical reasoning was one of the highlights. Most recognised they could assist students by providing a learning environment where emotional safety was not a cause for students to “hold back” their ideas. Some saw teacher modeling as important, where the teachers themselves described their own strategy use. Providing feedback on student explanations, including the use of probing questions, ensuring regular opportunities for students to share their strategy use, and small group work, were also mentioned. None of the teachers recognised that allowing students to develop ways of recording their strategy use might help their thinking, their own and teacher review of strategy use, and their communicating of mental processes. This aspect could benefit from a greater focus within the programme.

There were a number of specific language issues that caused difficulty for teachers and students. Prominent among these was the use of “mua” (*before, in front*) and “muri” (*after, behind*) to ask about and describe number sequence. The diagnostic interview suggests the use of the following questions:

Ko te aha te tau o mua mai i te 6? (What number comes before 6?)

Ko te aha te tau o muri atu i te 7? (What number comes after 7?)

Confusion is compounded when the directional prefix “whaka” is added (whakamua-forwards, whakamuri-backwards). The instructions from the diagnostic interview are:

Kia tatau whakamuri mai i te 23. (Count backward from 23.)

Kia tatau whakamua koe, atu i te 10. (Count forwards from 10.)

Some teachers recognised that the use of these words in Māori is different from their equivalent use in English and that this may be one of the reasons for confusion, especially for teachers and students whose stronger language is English. Most teachers reported that when they modelled the language structure and concept, their students had little difficulty in understanding and then responding to further questions. Results from the diagnostic interviews reported in Chapter Three showed that number sequence (forward and backward) was one aspect of number students performed well in, demonstrating that the reported initial confusion over the vocabulary did not have a negative impact on understanding and achievement.

One way of helping students understand concepts and vocabulary that cause confusion (such as mua/muri, whakamua/whakamuri) could be to publish readers in the Purapura series that focus on the general and mathematical use of such words. Students would then come to the pāngarau programme having already encountered many of the key pāngarau words and concepts, which would greatly help understanding.

Many teachers also had questions about the linguistic structures of the number operations. Difficulties were experienced because in Māori the words do not follow the sequence of the written symbols, as they do in English. English was also seen to be more concise than Māori. For this reason, many teachers and students simply follow the linguistic structure of English, using Māori words. For example, an addition problem is written in symbols as $3 + 2 = 5$. In English it is most common to say this as it is written, symbol for word, *three plus two equals five*. In Māori it is linguistically correct to begin with the verb *tāpirihia te toru me te rua, ka rima*. However, many teachers and students have adopted the English structure, saying *toru tāpiri rua ka rima*. While it may be pragmatic to accept this borrowed linguistic structure as an example of language change resulting from contact between English and Māori, it is unclear whether such a borrowed structure used specifically for pāngarau could transfer across to general language use. If this phenomenon is widespread beyond the example discussed here (and some would argue on the basis of anecdotal evidence that it is), the result may be a decline in the unique linguistic structure of Māori (see Barton, et al., 1998 for further discussion of this issue). Further research needs to be undertaken in order to understand how te reo Māori is changing as a result of the school curriculum and how best to ensure the long-term linguistic integrity of the language.

It is clear that language is of critical importance to the success of the Te Poutama Tau programme and, indeed, the achievement of Māori immersion students in pāngarau. Seventeen of the 22 teachers who responded thought language was a key issue in raising achievement levels of students. Comments included:

Me whakangāwari, me whakarāpopoto te reo, engari kia ū tonu ōna ake tikanga Māori. (The language should be simple and concise, but remain true to its own Māori structure).

Kia tau, kia tika te reo o te kaiako, kia mārama ai te ākonga. (The teacher's language needs to be consistent and correct in order for the students to understand).

He mea nui te ako kupu hou i ia rā, kia whānui ake ai ō rātou reo. (It is important to introduce new words each day, so that their language is expanded).

Data from the diagnostic interviews reported in Chapter Three also show that students' proficiency in the language becomes more critical to achievement as they progress to the higher stages in The Number Framework.

In light of all this, it is recommended that the possibility and utility of adding a new "linguistic strand" to The Number Framework for Te Poutama Tau be investigated. This would make the dynamic relationship between language and learning more explicit and help teachers to understand the growth in vocabulary and linguistic structure across the various stages of The Number Framework.

Chapter Six: Summary and Recommendations

Overall, the results from the Te Poutama Tau research project show that the programme is effective in enhancing teacher knowledge of and ability to teach the number strand of the pāngarau curriculum and in improving student performance. There was a high level of enthusiasm and support for the programme from facilitators, teachers, principals, and students. The data confirms that language and the effective use of language to facilitate communication in the pāngarau classroom are of critical importance to student learning. Some aspects of the programme were not as effective as others, and attention should be paid to these in the ongoing development of the programme.

All the research information gathered provides a basis for the following recommendations, which were discussed in detail throughout the report.

Language

A new “linguistic strand” should be added to the Te Poutama Tau Framework to make the dynamic relationship between language and learning more explicit and to help teachers understand the growth in vocabulary and linguistic structure across the various stages of The Number Framework.

Vocabulary and language acquisition activities should be incorporated into the Te Poutama Tau programme. These activities could be included in the resource booklets alongside the number activities or could be the focus of a separate booklet.

New readers in the Purapura series should be published to introduce students to key pāngarau vocabulary and how the vocabulary is used in both general and pāngarau discourse.

Names should be written on all pieces of apparatus, including cardware.

Student Achievement

The learning and teaching activities and the linguistic aspects of grouping and place value should be reviewed and become important focuses for facilitator and teacher training in 2003.

There should be a stronger focus within the programme on students recording their strategy use. This may help their thinking and retention of numbers when using mental strategies.

Facilitators and teachers should continue to focus on helping students to achieve at the higher levels of The Number Framework and, in particular, on the use of part-whole thinking to complete number operations.

Future Research

A study on “acts of communication” in the pāngarau lesson should be undertaken to understand how oral and written Māori can be used more effectively in conjunction with diagrams and concrete apparatus to facilitate better learning and teaching.

A case study should be undertaken to find out why such a significant number of students made no gains in number, even after the implementation of a focused and intense programme.

A study should be undertaken on how te reo Māori is changing as a result of the school curriculum and how best to ensure the long-term linguistic integrity of the language.

Resources

All Te Poutama Tau resources should be published in the bilingual format trialled in 2002. This may be best achieved as each resource is developed and published in English.

New resources should be developed that focus on activities relating number to the other strands of the curriculum and on independent activities.

A video resource of the diagnostic interview should be developed that shows exemplary teacher use of language and students performing at various stages of The Number Framework.

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Appendix A: Stages of the Number Framework

Stage Zero: Emergent

Students at this stage are unable to consistently count a given number of objects because they lack knowledge of counting sequences and/or the ability to match things in one-to-one correspondence.

Stage One: One-to-one Counting

This stage is characterised by students who can count and form a set of objects up to ten but cannot solve simple problems that involve joining and separating sets, like $4 + 3$.

Stage Two: Counting from One on Materials

Given a joining or separating of sets problem, students at this stage rely on counting physical materials, like their fingers. They count all the objects in both sets to find an answer, as in “Five lollies and three more lollies. How many lollies is that altogether?”

Stage Three: Counting from One by Imaging

This stage is also characterised by students counting all of the objects in simple joining and separating problems. Students at this stage are able to image visual patterns of the objects in their mind and count them.

Stage Four: Advanced Counting (Counting-On)

Students at this stage understand that the end number in a counting sequence measures the whole set and can relate the addition or subtraction of objects to the forward and backward number sequences by ones, tens, etc. For example, instead of counting all objects to solve $6 + 5$, the student recognises that “6” represents all six objects and counts on from there: “7, 8, 9, 10, 11.”

Students at this stage also have the ability to co-ordinate equivalent counts, such as “10, 20, 30, 40, 50,” to get \$50 in \$10 notes. This is the beginning of grouping to solve multiplication and division problems.

Stage Five: Early Additive Part-Whole

At this stage, students have begun to recognise that numbers are abstract units that can be treated simultaneously as wholes or can be partitioned and combined. This is called *part-whole thinking*. A characteristic of this stage is the derivation of results from related known facts, such as finding addition answers by using doubles or teen numbers.

Stage Six: Advanced Additive Part-Whole

Students at the advanced additive stage are learning to choose appropriately from a repertoire of part-whole strategies to estimate answers and solve addition and subtraction problems. They see numbers as whole units in themselves but also understand that “nested” within these units is a range of possibilities for subdivision and recombining. Simultaneously, the efficiency of these students in addition and subtraction is reflected in their ability to derive multiplication answers from known facts. These students can also solve fraction problems using a combination of multiplication and addition-based reasoning. For example, 6×6 as $(5 \times 6) + 6$.

Stage Seven: Advanced Multiplicative Part-Whole

Students at the Advanced Multiplicative stage are learning to choose appropriately from a range of part-whole strategies to estimate answers and solve problems involving multiplication and division. Some writers describe this stage as “operating on the operator”. This means that one or more of the numbers involved in a multiplication or division is partitioned and then recombined.

For example, to solve 27×6 , 27 might be split into $20 + 7$ and these parts multiplied then recombined, as in $20 \times 6 = 120$, $7 \times 6 = 42$, $120 + 42 = 162$. This strategy uses the distributive property.

A critical development at this stage is the use of reversibility, in particular, solving division problems using multiplication. Advanced Multiplicative Part-Whole students are also able to estimate answers and solve problems with fractions using multiplication and division.

Stage Eight: Advanced Proportional Part-Whole

Students at the Advanced Proportional stage are learning to select from a repertoire of part-whole strategies to estimate answers and solve problems involving fractions, proportions, and ratios. This includes strategies for the multiplication of decimals and the calculation of percentages.

These students are able to find the multiplicative relationship between quantities of two different measures. This can be thought of as a mapping. For example, consider this problem: “You can make 21 glasses of lemonade from 28 lemons. How many glasses can you make using 8 lemons?”

To solve the problem, students need to find a relationship between the number of lemons and the number of glasses. This involves the creation of a new measure, glasses per lemon. The relationship is that the number of glasses is three-quarters the number of lemons. This could be recorded as: 21:28 as 3:4, 21 is $\frac{3}{4}$ of 28, $\frac{3}{4}$ of 8 is 6.

10. Ki tōu whakaaro, he pēhea nei te mārama o te reo i roto i ngā rauemi o Te Poutama Tau? (arā, te whakamātautau me ngā rauemi whakaako)

- tino mārama
- āhua mārama
- kāore i te mārama

He aha ngā wāhi kāore i te tino mārama? He aha i kore ai i mārama?

11. I mārama pai ō tamariki ki te reo Māori i roto i ngā rauemi o Te Poutama Tau?

- tino mārama
- āhua mārama
- kāore i te mārama

He aha rātou i kore ai i mārama? He aha tāu mahi āwhina kia mārama ai rātou?

12. He pēhea nei te tautoko mai o tōu kura i a koe e whai ana i tēnei kaupapa Te Poutama Tau?

- i tino tautoko mai
- i āhua tautoko mai
- kāore i tino tautoko mai i ētahi wā
- he uaua taku whai wāhi atu ki tēnei kaupapa nā te kore tautoko mai o te kura

13. He aha ētahi atu o ngā mahi whakapakari pouako e whai ana koe i tēnei tau?

14. Pēhea nei te whaihua (ki ōu whakaaro) o ēnei āhuatanga o ngā hui whakangungu pouako?

| | he tino whaihua | he whaihua | he āhua whaihua | he paku noa te whaihua | kāore i whaihua |
|--|--------------------------|--------------------------|--------------------------|------------------------------|--------------------------|
| te whakamahi i te whakamātautau i te taha o ētahi tamariki | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| te mātakitaki i tōu kaitakawaenga e whakamātau ana i tētahi tamaiti | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| te mātakitaki i tōu kaitakawaenga e whakaako tamariki ana | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| te whitiwhiti kōrero e pā ana ki te whakarōpū i ngā tamariki | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| te whitiwhiti kōrero mō ngā rautaki paheko tau | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| te mātakitaki i ngā tamariki e whakamātautauria ana i ngā whiti ātaata | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| te whitiwhiti kōrero mō te āhua o Te Poutama Tau | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| te whakamahere i ngā kaupapa ako i te taha o tō kaitakawaenga | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| tētahi atu āhuatanga rānei (me tuhi mai) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

15. He pēhea nei ōu whakaaro mō ēnei āhuatanga, i muri mai i tō whai wāhitanga mai ki Te Poutama Tau?

| | |
|---|---|
| tōu māia, tōu ngākaunui ki te whakaako i te whenu 'Tau' | <input type="checkbox"/> kua tino piki ake <input type="checkbox"/> kua piki ake <input type="checkbox"/> he āhua ōrite/kāore e tino rerekē ake |
| tō mōhio ki ngā mātauranga o te whenu 'Tau' | <input type="checkbox"/> kua tino piki ake <input type="checkbox"/> kua piki ake <input type="checkbox"/> he āhua ōrite/kāore e tino rerekē ake |
| tō mōhio ki te āhua o tā te tamaiti ako i te mātauranga 'Tau' | <input type="checkbox"/> kua tino piki ake <input type="checkbox"/> kua piki ake <input type="checkbox"/> he āhua ōrite/kāore e tino rerekē ake |
| te āhua o tō whakaako i te kaupapa 'Tau' | <input type="checkbox"/> kua tino piki ake <input type="checkbox"/> kua piki ake <input type="checkbox"/> he āhua ōrite/kāore e tino rerekē ake |
| te āhua o tōu reo whakaako i te pāngarau | <input type="checkbox"/> kua tino piki ake <input type="checkbox"/> kua piki ake <input type="checkbox"/> he āhua ōrite/kāore e tino rerekē ake |
| te mātauranga o ngā tamariki ki ngā kaupapa o te whenu tau | <input type="checkbox"/> kua tino piki ake <input type="checkbox"/> kua piki ake <input type="checkbox"/> he āhua ōrite/kāore e tino rerekē ake |
| tō mōhio ki ngā rautaki paheko tau | <input type="checkbox"/> kua tino piki ake <input type="checkbox"/> kua piki ake <input type="checkbox"/> he āhua ōrite/kāore e tino rerekē ake |
| tō mārāma ki ngā tikanga o te Poutama Tau (arā, te number framework) | <input type="checkbox"/> e mārāma pai ana <input type="checkbox"/> e āhua mārāma ana <input type="checkbox"/> kāore anō kia tino mārāma |
| ō pūkenga mō te whakamahi i te puka uiui ki te whakamātautau tamariki | <input type="checkbox"/> e pai ana <input type="checkbox"/> e āhua pai ana <input type="checkbox"/> kāore anō kia tino mōhio ki tēnei mahi |
| tō whakarōpū i ngā tamariki i runga i ngā hua o te whakamātautau | <input type="checkbox"/> e mōhio pai ana ki te whakarōpū tamariki <input type="checkbox"/> e āhua mōhio ana ki te whakarōpū tamariki <input type="checkbox"/> kāore anō kia tino mōhio ki te whakarōpū tamariki |
| tō whakamahere i ngā mahi ako kia tino hāngai ki ia rōpū | <input type="checkbox"/> e mōhio pai ana ki tēnei mahi <input type="checkbox"/> e āhua mōhio ana ki tēnei mahi <input type="checkbox"/> kāore anō kia tino mōhio ki tēnei mahi |
| tō whakaako i ngā rōpū | <input type="checkbox"/> e mōhio pai ana ki tēnei mahi <input type="checkbox"/> e āhua mōhio ana ki tēnei mahi <input type="checkbox"/> kāore anō kia tino mōhio ki tēnei mahi |

16. I hopukina tō mahi whakamātau/whakaako tamariki ki te whiti ātaata hei mātakitaki anō māu?
_ Ae _ Kao
He aha ngā hua i puta ki a koe?

17. He aha ngā momo pātai e tino pai ana hei āwhina i ngā tamariki ki te whakaputa kōrero mō ngā rautaki tau e whakamahi ana rātou?

18. He aha anō ētahi huarahi hei āwhina i nga tamariki ki te whakaputa kōrero mō ā rātou mahi?

19. He aha ngā tino ngohe whakaako o roto i ngā rauemi o Te Poutama Tau? He aha ai?

20. He aha ngā painga matua o te kaupapa nei, Te Poutama Tau?

21. Ki tōu whakaaro, he aha ngā āhuetanga matua hei whakapiki i ā tātou tamariki e whakaakona ana mā roto i te reo Māori ki ngā taumata o te mātauranga pāngarau?

22. He kōrero atu anō āu mō te kaupapa nei, Te Poutama Tau?

Appendix C: Facilitator Questionnaire

He Kaupapa Rangahau i te Ähua o Te Poutama Tau Te Rärangi Patapatai mö ngä Kaitakawaenga

Ngä patapatai whänui

1. E hia tau e mahi kaiako ana koe? _
2. E hia tau e mahi ana koe hei kaiako i te wāhanga köhungahunga o te kura? _
3. E hia tau e mahi ana koe hei kaitakawaenga kura? _
4. He kaitakawaenga anö koe mö te ENP (reo Pākehä) i mua i tö mahi takawaenga mö Te Poutama Tau ki ngä kura reo Māori?
_ Ae
_ Kao

Ngä patapatai mö te whakangungu i ngä kaitakawaenga

5. Pēhea nei te whaihua (ki töu nä titiro) o ēnei ähuatanga o ngä hui whakangungu i ngä kaitakawaenga?

| | he tino whaihua | he whaihua | he ähua whaihua | he paku noa te whaihua | käore i whaihua |
|---|--------------------------|--------------------------|--------------------------|------------------------------|--------------------------|
| te whakamahi i te whakamätautau i te taha o ētahi tamariki | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| ngä mahi whakamāori i te whakamätautau me ngä ngohe whakaako | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| ngä whitiwhiti körero mö te ähua o Te Poutama Tau mö ngä kura reo Māori | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| te whitiwhiti körero e pä ana ki te whakaröpü i ngä tamariki | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| te whitiwhiti körero mö ngä rautaki paheko tau | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| te mätakitaki i ngä tamariki e whakamätautauria ana i ngä whiti ätaata | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

6. He kōrero atu anō āu e pā ana ki te whakangungu i ngā kaitakawaenga?

7. He pēhea nei ōu whakaaro mō ēnei āhuatanga, i muri mai i tō whai wāhitanga atu ki Te Poutama Tau?

| | | |
|--|--------------------------|---------------------------------------|
| tōu ngākaunui/ō waiaro ki te whakaako i te whenu 'Tau' | <input type="checkbox"/> | kua tino piki ake |
| | <input type="checkbox"/> | kua piki ake |
| | <input type="checkbox"/> | he āhua ōrite/kāore e tino rerekē ake |

| | | |
|--|--------------------------|---------------------------------------|
| tō mōhiotanga ki ngā mātauranga o te whenu 'Tau' | <input type="checkbox"/> | kua tino piki ake |
| | <input type="checkbox"/> | kua piki ake |
| | <input type="checkbox"/> | he āhua ōrite/kāore e tino rerekē ake |

| | | |
|--|--------------------------|---------------------------------------|
| tō mōhiotanga ki te āhua o tā te tamaiti ako i te mātauranga 'Tau' | <input type="checkbox"/> | kua tino piki ake |
| | <input type="checkbox"/> | kua piki ake |
| | <input type="checkbox"/> | he āhua ōrite/kāore e tino rerekē ake |

| | | |
|--|--------------------------|---------------------------------------|
| te āhua o tō whakaako i te kaupapa 'Tau' | <input type="checkbox"/> | kua tino piki ake |
| | <input type="checkbox"/> | kua piki ake |
| | <input type="checkbox"/> | he āhua ōrite/kāore e tino rerekē ake |

He whakamārama anō āu mō ēnei pātai?

8. Ki tōu whakaaro, he pēhea nei te mārama o te reo Māori i roto i ngā rauemi o Te Poutama Tau? (arā, ngā whakamātautau me ngā rauemi whakaako)
- tino mārama
 - āhua mārama
 - kāore i te mārama
- He aha ngā wāhi kāore i te tino mārama? He aha i kore ai e mārama?

Ngā patapatai mö ngā mahi i te taha o te hunga pouako

9. Tokohia ngā pouako i whai wāhi mai ki Te Poutama Tau i te taha i a koe? _
10. I mārama pai ö pouako ki te reo Māori i roto i ngā rauemi o Te Poutama Tau?
- Tokohia i tino mārama? _
 - Tokohia i āhua mārama? _
 - Tokohia kāore i mārama? _
- He aha rātou i kore ai i mārama? He aha tāu mahi āwhina kia mārama ai rātou?

11. He pēhea nei te ngākaunui o ö pouako ki Te Poutama Tau ...

| | | |
|--|---|---------------------------------|
| ... i te tīmatanga o te kaupapa (arā pea i te hui tuatahi) | _ | Tokohia i tino ngākaunui? |
| | _ | Tokohia i āhua ngākaunui? |
| | _ | Tokohia kāore i tino ngākaunui? |
| | _ | Tokohia i āhua hōhā |

| | | |
|---|---|---------------------------------|
| ... i te mutunga o te kaupapa (arā pea i te hui whakamutunga) | _ | Tokohia i tino ngākaunui? |
| | _ | Tokohia i āhua ngākaunui? |
| | _ | Tokohia kāore i tino ngākaunui? |
| | _ | Tokohia i āhua hōhā |

He aha ki öu whakaaro i pērā ai?

12. Ki tōu whakaaro, he pēhea nei te āhua o ō pouako i roto i nga āhuatanga nei i muri mai i tā rātou whai wāhitanga atu ki Te Poutama Tau?

| | |
|--|--|
| tō rātou ngākaunui ki te whakaako i te whenu 'Tau' | – Tokohia i tino piki ake |
| | – Tokohia i āhua piki ake |
| | – Tokohia i āhua ōrite/kāore e tino rerekē ake |

| | |
|--|--|
| tō rātou mōhiotanga ki ngā mātauranga o te whenu 'Tau' | – Tokohia i tino piki ake |
| | – Tokohia i āhua piki ake |
| | – Tokohia i āhua ōrite/kāore e tino rerekē ake |

| | |
|--|--|
| tō rātou mōhiotanga ki te āhua o tā te tamaiti ako i te mātauranga 'Tau' | – Tokohia i tino piki ake |
| | – Tokohia i āhua piki ake |
| | – Tokohia i āhua ōrite/kāore e tino rerekē ake |

| | |
|--|--|
| te āhua o tā rātou whakaako i te kaupapa 'Tau' | – Tokohia i tino piki ake |
| | – Tokohia i āhua piki ake |
| | – Tokohia i āhua ōrite/kāore e tino rerekē ake |

| | |
|--|--|
| te āhua o ō rātou reo whakaako i te pāngarau | – Tokohia i tino piki ake |
| | – Tokohia i āhua piki ake |
| | – Tokohia i āhua ōrite/kāore e tino rerekē ake |

| | |
|---|--|
| tō rātou mōhiotanga ki ngā rautaki paheko tau | – Tokohia i tino piki ake |
| | – Tokohia i āhua piki ake |
| | – Tokohia i āhua ōrite/kāore e tino rerekē ake |

He whakamārama anō āu mō ēnei pātai?

13. He pēhea nei te whaihua o tō whakaako i ō pouako ki ēnei āhuatanga o Te Poutama Tau?

| | he tino whaihua | he whaihua | he āhua whaihua | he paku noa te whaihua | kāore i whaihua |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Te Poutama Tau tonu (arā, te number framework) | <input type="checkbox"/> |
| te whakahaere i te whakamātautau i te taha o ngā tamariki | <input type="checkbox"/> |
| te whakaröpū tamariki | <input type="checkbox"/> |
| te whakamahere i ngā mahi ako kia tino hāngai ki ngā taumata o ia röpū | <input type="checkbox"/> |
| te whakaako tamariki ki ngā kēmu me ngā mahi ako o te Poutama Tau | <input type="checkbox"/> |

14. I whakamahi anō koe i te whiti ātaata i roto i ngā mahi whakangungu i ō pouako? He aha ngā hua i puta?

15. Ki tōu titiro, he aha ngā wāhanga i tino whaihua ai i roto i ō mahi whakangungu i ō pouako? He aha ai?

Ngā patapatai e pā ana ki te kura

16. E hia ngā kura i whai wāhi mai ki Te Poutama Tau i te taha i a koe? _

17. He pēhea nei te tautoko mai o te kura, o te tumuaki rānei ...

| | | |
|---------------------------------|---|--|
| ... i te tīmatanga o te kaupapa | _ | E hia ngā kura i tino tautoko mai? |
| | _ | E hia ngā kura i āhua tautoko mai? |
| | _ | E hia ngā kura kāore i tino tautoko mai? |

| | | |
|-------------------------------|---|--|
| ... i te mutunga o te kaupapa | _ | E hia ngā kura i tino tautoko mai? |
| | _ | E hia ngā kura i āhua tautoko mai? |
| | _ | E hia ngā kura kāore i tino tautoko mai? |

He kōrero anō āu mō tēnei o ngā pātai?

Ngā patapatai mō ngā mahi i te taha o ngā tamariki

18. I kite koe i tētahi wāhanga o te whakamātautau kāore ngā tamariki i tino mārama he aha te tikanga o te pātai? He aha i pērā ai?

19. He aha ngā momo pātai pai hei āwhina i ngā tamariki ki te whakaputa kōrero mō ngā rautaki tau e whakamahi ana rātou?

20. He aha anō ētahi huarahi hei āwhina i nga tamariki ki te whakaputa kōrero mō
ā rātou mahi?

21. He aha ngā tino ngohe whakaako o roto i ngā rauemi o Te Poutama Tau? He
aha ai?

22. He aha ngā painga matua o te kaupapa nei, Te Poutama Tau?

23. Ki tōu whakaaro, he aha ngā āhuetanga matua hei whakapiki i ā tātou tamariki
e whakaakona ana mā roto i te reo Māori ki ngā taumata o te mātauranga
pāngarau?

24. Ki ōu whakaaro, me pēhea e whakapai ake te kaupapa nei, Te Poutama Tau?

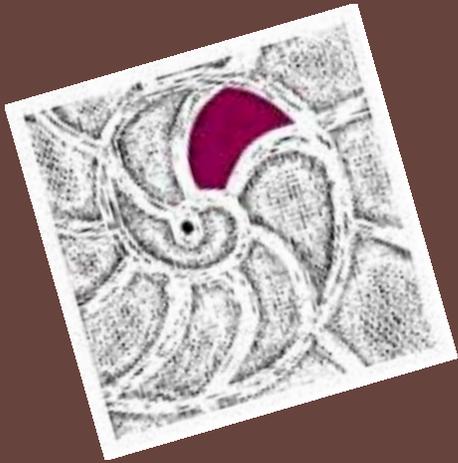


TE TĀHUHU O TE MĀTAURANGA

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