

Is there a lack of science resources and specialists for kaiako at Kura reo o Waikato?

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Executive Summary

The New Zealand debates on culture and science education for Maaori are grounded in the concern for the under-achievement of tauira in science. In 1995, a lack of subject experts, specialists and resources to implement the Ministry of Education's science curriculum was identified (McKinley *et al.*, 1995). I investigated the concept of a mobile science laboratory to provide subject experts, specialists and resources to Kura Reo o Tainui as a way of improving and enhancing tauira literacy and engagement in puutaiao. This study used a semi-structured survey to elicit the whakaaro and perceptions of kaiako puutaiao from four Wharekura, three Kura Kaupapa Maaori, and three Rumaki Total Immersion classes in Waikato-Tainui, using registered participants in the inaugural Kura Reo o Tainui Waananga in 2008 to select survey participants.

Most of the kaiako puutaiao surveyed use the Living World programme in their marautanga. Most kaiako have taaonga in the landscape they are interested in investigating, most have transport options, and most have existing practicals included in their studies. Kaiako puutaiao at Wharekura perceive a mobile science laboratory concept will assist their marautanga puutaiao with programme enhancements, technical assistance, and access to local projects. Kaiako puutaiao at Kura kaupapa perceive the laboratory concept will assist with equipment, specialists and providing and maintaining direction with projects, while kaiako puutaiao at Rumaki perceive the laboratory concept will provide experience, resources, identifying projects, and developing fluency in reo puutaiao. The block option was the most preferred option by kaiako for the laboratory to visit, and from the list of equipment items (n=27) in the questionnaire, Wharekura kaiako had sufficient equipment to implement The Living World programme but Kura kaupapa and Rumaki did not. Asked to rate the usefulness of their equipment to them on a scale of poor, fair, good and great, kaiako at Wharekura rated theirs between good and great, kaiako at Kura kaupapa rated theirs poor, and kaiako at Rumaki rated theirs fair.

Kaiako puutaiao at Kura kaupapa have been teaching puutaiao the longest and they teach the most units. Kaiako at Kura kaupapa proposed the highest koha at a mean \$2.67 (SEM ±

0.66c) per taura, per visit. The average decile rating among all kura was 2.23. The mobile laboratory concept was rated highly by all kaiako puutaiao and there were between 867 and 960 taura taking science in Kura Reo o Tainui in 2009. Key concerns among all kaiako puutaiao regarding the laboratory concept were the laboratory's programme structure, internal policy and regulations, delivering outcomes for taura, safety and set-up and support systems. The few common concerns among kaiako puutaiao were that the delivery of any programmes would be in te reo, the costs that might be incurred through hosting the mobile science laboratory, and that they were female.

The author recommends that a trial mobile science laboratory should be implemented for a period of six months to assess costs, internal kura policies and regulations, and the logistics of such a concept. Three separate Puutaiao Maaori programmes should be compiled and delivered specifically to one Wharekura, one Kura kaupapa Maaori and one Rumaki class selected randomly. Future studies are recommended to investigate the funding requirements for implementing the trial mobile laboratory, how the concept could provide the best outcomes for taura puutaiao at Kura Reo o Tainui, and explore the establishment of a Waikato-Tainui Puutaiao Community.

1. Introduction

This study investigated the potential interest among Waikato-Tainui Wharekura, Kura kaupapa Maaori and Total Immersion (Rumaki) classes in the concept of a mobile science laboratory visiting their kura. These kura teach in te reo Maaori and their aims, purposes and objectives support the Te Aho Matua (saying of the parents) philosophy (Smith, 1997). Some Wharekura are Kura Motuhake and these Wharekura, Te Wharekura o Rakaumanga and Nga Taiatea Wharekura have special characteristics pertaining to Waikato-Tainui such as Kiingitanga and Tainuitanga that take precedence over Te Aho Matua (K. Tamatea, pers comm). Anecdotal evidence suggests opportunities for tauira to investigate and pursue projects in the landscape near their kura are limited because either equipment and/or appropriate expertise may not currently be available at these kura to support investigations into such projects. Decades of cultural eutrophication, in Waikato particularly, has impacted adversely on the mauri of open water bodies such as lakes, rivers, streams and repo. This has resulted from the activities of the pastoral industry, e.g. discharges of chemical and animal wastes, and discharges from municipal waste-water treatment plants, and industry. Opportunities for tauira to identify projects for a Living World Programme to potentially experience hands-on learning in the immediate vicinity of their kura are therefore speculated to be significant in areas other than the most remote communities.

Kaupapa Maaori is a theory and an analysis of the context of research which involves Maaori, and of the approaches to research with, by or for Maaori (Smith, 1996). Included within Kaupapa Maaori research methodology principles is whanaungatanga. Whanaungatanga refers to the building and maintaining of relationships and is defined by Bishop (1998) as the process of establishing meaningful, reciprocal and family relationships in cultural ways to establish connectedness, engagement and commitment. Similarly, manaakitanga, aroha, maahaki, and mana are important Kaupapa Maaori values (Smith & Cram, 2001).

A Kaupapa Maaori framework necessitates a research process that affirms Kaupapa Maaori ethics that are informed by tikanga Maaori (Cram *et al.*, 2002). Ethics are a vital consideration for any research undertaking that underpins an entire research process based on moral principles that all communities, institutions and people live their lives by, and form relationships.

The annual science waananga for senior Waikato-Tainui taura is co-sponsored by the University of Waikato, and the Waikato Raupatu Lands Trust. The two-day waananga is targeted specifically at year 12 and 13 taura who whakapapa to Tainui, and is hosted by Waikato University. Since its inception in 2008 it has hosted 71 taura from 11 kura. Kura Reo o Tainui aims to improve the quality of kaiako reo from a Waikato-Tainui perspective, in Waikato-Tainui kura. At the inaugural Waikato-Tainui Kura Reo Waananga hosted by the Waikato Raupatu Lands Trust in Hopuhopu in 2008, a variety of kaupapa including Kiingitanga, Waikato raupatu, whaikoorero, waiata and kiwaha were investigated, presented and discussed. The main purpose of the waananga is to find ways to improve the quality of kaiako reo at Wharekura, Kura Kaupapa Maaori and Rumaki throughout the Waikato. Wharekura are combined primary and secondary kura (Harrison and Hughes, 2004), Kura kaupapa are Maaori worldview kura (Gilbert *et al.*, 2005), while Rumaki are total immersion classes operating within a mainstream school system.

Literature Review

The New Zealand debates on culture and science education are grounded in considerable concern for the under-achievement of Maaori taura in science education (Bell, 2005). Policy development processes in the literature have identified educational disparities between Maaori and other groups. The reasons for the adverse outcomes for taura were identified as “deficit theory” (Davies & Nicholl, 1993), cultural deprivation, cultural depreciation and assimilation policies of the 1960s (Smith, 1999), deficiencies in the home, family and culture (Marshall, 1991), epistemological racism or racism embedded in the fundamental principles of the dominant culture (McKinley, 2003), and integration (Bishop and Glynn, 1999).

Education became a replacement rather than an addition to cultural values where individualism replaced community-based learning (Snively & Corsiglia, 2000). Literacy, Christianity and English language teaching not only intruded on Maaori custom, they imposed social control and affected development, especially in raupatu areas (Openshaw *et al.*, 1993). Maaori were forced into a school curriculum that not only restricted them to manual and technical instruction, it used school textbooks that “deliberately demeaned, marginalised and vilified their culture” (Bell, 2005). These policies were developed in such a way that living as Maaori provided a barrier to learning (Bishop and Glynn, 1999) and eventually Maaori suffered confusion and cultural breakdown because they were forced to abandon their culture, language and customs (Bell, 2005). Generations of under-achievement and failures for Maaori therefore meant they were relegated to the bottom of the economic strata of New Zealand society (Stewart, 1992).

Stewart (2007) credits the 1985 Curriculum Review in Science and the work of the Science Aotearoa Development Group in particular for the development of Maaori science education. McKinley and Waiti (1995) recognised the lack of individuals able to provide detailed, informed, critique of the contents of the puutaiao curriculum particularly in comparison to what would be considered appropriate as a level of discourse for a national curriculum document. Politically and educationally the puutaiao curriculum could not be regarded as equivalent to science and apparently it failed on many fronts, e.g. lack of practitioners, teaching and learning deficiencies, lack of acknowledged subject experts, lack of accepted pedagogy, and pre-existing curriculum texts, programmes, and resources. The advice for science educators effectively was to call for a re-organisation at the pedagogical level to deliver science more effectively for Maaori (McKinley and Waiti, 1995), and to seek the best approach for delivering success in science for Maaori students as proposed by Smith (1995).

There is a “denial that alternative world views exist with differing cultural aspirations, preferences and practices” (Bishop and Glynn, 1999). “Every culture has its own science” (Ogawa, 1989) that interprets how the local world works from a particular cultural perspective. Using indigenous science gives value to cultural knowledge because

indigenous knowledge has commonality with modern science (McKinley *et al.*, 1992). Science-based literature and the universality of the standard scientific accounts are important for science educators because the definition of science is a de facto gate-keeping device for determining what can be included in a school science curriculum or not. It displaces “local indigenous knowledge because this knowledge does not conform to western science, rather, western science is taught at the expense of indigenous science” (Snively and Corsiglia, 2000).

Maaori had a sophisticated and functional education system prior to colonisation (Titus, 2001). The Maaori education system was flexible and adaptable, made up of complex traditions, a strong knowledge base, and a dynamic ability to respond to changing needs and challenges e.g. Waikato Maaori were agriculturalists and horticulturalists (Morton, 1946; Craig, 1995), and produced and exported flour ground in their own mills (McCan, 2001). The Maaori way of life was dependent upon being part of an integrated social system based on whanaungatanga, manaakitanga, and wairuatanga (Bishop, 1998). Traditional Maaori are whole concept learners who begin with the big picture before moving to the detail (Walters *et al.*, 1993), teaching one on one where the “learner observes and then imitates what is being modeled” (Kent and Besley, 1990). Advancing Maatauranga Maaori and particularly its potential contribution to the sciences and innovation can give value to cultural knowledge (Durie, 2005). A natural setting provides the cultural framework and patterns of cultural coherence to emphasise learning rather than teaching (Kent and Besley, 1990).

The Marautanga o Aotearoa envisages young Maaori with a strong sense of identity as Maaori, participating actively in the Maaori world. Te Marautanga o Aotearoa is inherently student-centred and future-focused seeking to engage and challenge students while upholding the mana of each individual. It endorses the crucial role of family, whaanau, hapuu, iwi, and the wider community in helping students realise their potential while making appropriate decisions about their learning and career pathways. Ultimately, it envisages young Maaori gaining a rich base of skills that will offer them a range of career choices.

Te Aho Matua is a foundation document written by a unified group of pioneers of Kura Kaupapa Maaori. Te Aho Matua is written in a style that requires interpretation rather than translation, and is viewed not only as a vital component in the teaching and learning of tamariki, but also a basis from which curriculum planning and design can evolve. It is a unique schooling system intended for inclusion in the charters of Kura Kaupapa Maaori providing the means by which their special nature can be clearly identified from mainstream kura. Te Aho Matua is presented in te reo in six parts, each having a special focus on what is crucial in that system. Te Aho Matua allows for diversity while maintaining an integral unity and philosophical base and provides policy guidelines for parents, teachers and boards of trustees.

A study by Leach *et al.* (2002) found taurira perceived tertiary science study as too hard and laden with facts, as non-friendly, un-cooperative, individualistic, lacking whakawhanaungatanga, manaakitanga, without tikanga and appears exclusive of maatauranga Maaori, while its usefulness to kaumaatua is not always apparent. The Maaori world view is not recognised, so it is perceived “Maaori” must be left at the door. Matthews (1995) claims that the notion of Maaori science is not only invalid but harmful, because “Western science and indigenous knowledge are in different categories of human endeavour”, while Dickison (1994) said Maaori science doesn’t qualify as science because science and Maatauranga Maaori do not seek to do the same thing, and wonders why it is even promoted. By comparison, Walker (1997) suggests science should be “decolonised” because science has behaved in a manner of other colonial institutions. Parents and science educators just want science education that takes account of cultural backgrounds (Bell, 2005), however, multicultural science education in Aotearoa-New Zealand (as in most parts of the world) has made little or no difference to the disparity of outcomes in science education (Smith, 1995) – a pattern of disparity that was so common, it was accepted as normal by New Zealand society (Jenkins and Ka’ai, 1994).

Review Summary

In Aotearoa, the western world view of education as it applied to Maaori was based on literacy, Christianity and the English language. Ultimately, the integration and assimilation policies of the dominant culture were viewed by commentators as epistemological racism, cultural deprivation and cultural depreciation that intruded on Maaoritanga values. The western world view education policies replaced traditional values and forced Maaori to abandon their culture, language and customs and imposed social control and development that ultimately relegated Maaori to the bottom of NZ society.

Indigenous knowledge provides a cultural perspective on the world for taurira. Te Aho Matua focuses on the physical and spiritual endowment of tamariki, te reo, whakapapa, whanaungatanga, te ao, and developed teaching principles and characteristics for tamariki that emphasises learning rather than teaching. The Maaori world view is dynamic, is responsive to changes, needs and challenges based on whanaungatanga manaakitanga, wairuatanga, tikanga and kawa. However, disparities in secondary education achievement between Maaori and others meant taurira found science difficult at tertiary level, and as a result there is a lack of practitioners, subject experts, and resources in kura.

The motivation for this study originates from an initiative to introduce a basic water quality monitoring programme to taurira at Te Kareti o Te Kauwhata. The head of department of science at Te Kareti o Te Kauwhata science revealed that most of the science teaching resources required for this type of work were discarded when the NCEA programme was implemented at the kareti. Lake Waikare is in the near vicinity of Te Kareti o Te Kauwhata and an ideal candidate for monitoring given it is not monitored by any government or non-government agencies, and its current trophic status is classed as hypertrophic (extremely productive with very low/degraded water quality). Introducing puutaiao to taurira at Te Kareti o Te Kauwhata in a way that is inclusive of maatauranga Maaori may ultimately inspire them into a tertiary career in science at whare waananga. Precedents for using a mobile laboratory concept to introduce lake water quality monitoring techniques to taurira

could not be found elsewhere in New Zealand but some examples exist in other countries e.g. America.

2. Research Objective

This research seeks to explore the potential usefulness of a mobile science laboratory concept to visit Kura Reo o Tainui as a method to drive and deliver a programme to improve taura literacy and engagement in science.

3. Methods

A semi-structured survey was conducted to determine if there was potential interest in a mobile science laboratory concept among Kura Reo o Tainui. A survey questionnaire (Appendix 1) was compiled and framed to elicit participant kura's rating of the concept, if kura had any science equipment, and their assessment of the potential usefulness of that equipment to study the Living World Programme – a science curriculum requirement. Unit kura were selected from a sample frame comprising recorded participants at the inaugural Kura Reo o Tainui Waananga in 2008. The four Wharekura participants at the waananga were automatically included in the sample, and a further six unit kura were randomly selected by lot to make a sample size $n=10$ from a population of $n=29$. The random selection process was scrutinised by staff from the Biology Department administration office at Waikato University.

The Kaupapa Maaori methodology used in this study involved a kanohi ki te kanohi hui with participants of the survey. Kaupapa Maaori methodology is a recognised research method and was used to elicit the whakaaro and perceptions from participating kaiako puutaiao. A hui was held at a time that suited the kaiako, at their kura and where the time taken to complete the survey was not a mitigating factor. A verbal outline of the objectives and requirements of the survey was provided at the hui where it was made clear that the consent of the Tumuaki had been gained to ask questions of their kaiako, clarification of any points that may arise during the completion of the survey would be provided, and a signed approval was required of the kaiako to verify their willingness to participate in the

survey. Further, the kaiako were assured that the ethics compliance requirements were submitted to, and subsequently approved by the Faculty of Science and Engineering Human Research Ethics Committee at Waikato University.

4. Results

The selection of Kura Reo o Tainui to participate in the survey resulted in four Wharekura, three Kura kaupapa and three Rumaki being subjected to quantitative and qualitative analyses for this study. They are referred to collectively hereinafter as ‘unit kura’.

The Wharekura have a mean decile rating of 2.00 (SEM \pm 0.40), they deliver a mean 6.90 (SEM \pm 2.46) science units/year and kaiako have been teaching at their respective Wharekura for a mean 5.50 (SEM \pm 0.50) years. When asked what financial contribution they could make towards a visit from a mobile science laboratory, Wharekura have pledged a mean \$1.75 (SEM \pm 0.85c) as koha on a per-head of taura, per-laboratory visit basis (Figure 1).

Kura kaupapa pledged a mean koha of \$2.67/taura/visit (SEM \pm 0.66c). The Kura kaupapa have a decile rating of 2.00 (SEM \pm 0.57), deliver a mean 9.60 (SEM \pm 2.48) science units/year and their kaiako have been teaching at their respective Kura kaupapa for a mean 9.33 (SEM \pm 5.45) years.

The Rumaki have pledged a mean \$2/taura/visit (SEM \pm 0.68c) as koha. The Rumaki have a mean decile rating of 2.70 (SEM \pm 0.81), deliver a mean 8.60 (SEM \pm 2.33) science units/year and their kaiako have been teaching at their kura for a mean 7.30 (SEM \pm 3.26) years.

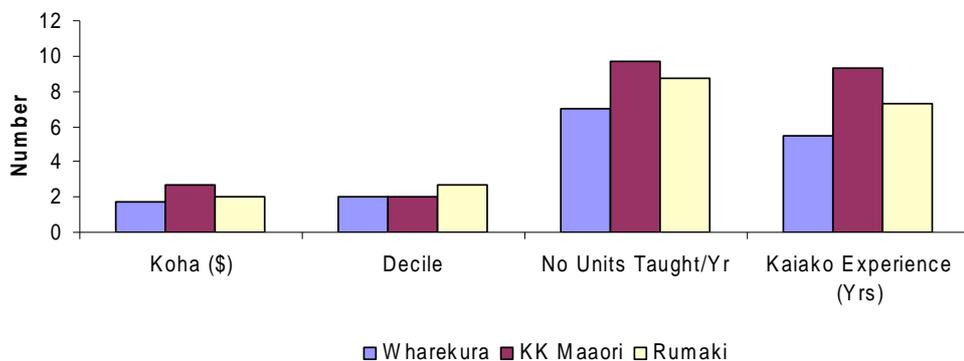


Figure 1: Distribution of Internal Unit Kura Kaupapa

The kaiako at the Wharekura have access to microscopes and associated equipment (slides, slips, petri dishes), magnifying glasses, dip and kick nets, hand-held testers and sieves they rate as in good to great condition. Kaiako at Kura kaupapa have dip and kick-nets, magnifying glasses and hand-held testers (pH and Conductivity) they rate as poor, while one Rumaki only has microscopes and associated equipment (slides, slips and petri dishes) the kaiako rates as fair.

The kaiako at Wharekura reported the highest percentage of taura taking science with 52.70%, Rumaki had 28.19% and Kura kaupapa had 19.12% (Appendix 2). The mean taura taking science at Wharekura was 209 (SEM \pm 74.73). At Kura Kaupapa the mean taura taking science was 78.00 (SEM \pm 23.43), and at Rumaki it was 74.70 (SEM \pm 25.4). . The mean overall rating of the mobile science laboratory concept among unit kura was 6.86 (SEM \pm 0.07) on a scale of 1 – 7, where 7 is high and 1 is low.

The Wharekura participate in the Living World Programme. They all have a practical component, and they have identified taaonga in the landscape for potential study. The Wharekura are interested in the state of mauri of those taaonga, and rated the mauri of these taaonga on a scale of 1 – 7 (where 7 is high) at a mean 2.87 (SEM \pm 1.47). The Kura kaupapa participate in the Living World Programme but one of the three Kura kaupapa doesn't have an existing practical component. They have identified target taaonga in the

landscape to potentially study and they are all interested in the state of mauri of those taaonga, which they assessed as a mean 2.67 (SEM \pm 1.45). Two Rumaki study the Living World Programme, all Rumaki have a practicum component, they have all identified taaonga in the landscape near them, and are interested in the state of mauri of those taaonga which they assessed at a mean 6.80 (SEM \pm 1.78).

Wharekura and Kura kaupapa have access to transport options but not all Rumaki have such options. Nine of the 10 unit kura chose block as their preferred visit option, with one Wharekura preferring a fortnightly visit option. Alternate visit options ranged from seasonal, monthly, term, fortnightly and weekly (Appendix 3).

There were differences among the unit kura in their perception of how the laboratory may assist with their marautanga. The Wharekura perceived the laboratory would assist with enhancing existing programmes, pursuing practical projects in restoration, and technical assistance and support. The Kura kaupapa perceived the provision of equipment, specialists and direction to be important while the Rumaki perceived experience, resources (including how to use existing resources), projects and developing fluency in reo puutaiao as being important.

Key concerns kaiako had for the laboratory concept were time-tabling the visits, the taurira:kaiako ratios for field work releases from kura, time constraints, back-up support, safety in the field, and fluency in te reo puutaiao. Overall, the commonalities between unit kura were limited to the delivery of any programmes needing to be in te reo, concerns over costs associated with hosting the laboratory, and that all kaiako were women.

5. Discussion

The survey results present a unique opportunity to analyse the perceptions and whakaaro of kaiako from a range of Maatauranga Maaori kura within Waikato-Tainui. All kura surveyed include the Living World Programme in their science marautanga (Appendix 4). The achievement aims of the Living World Programme specified in the Ministry of Education's science curriculum requires taurira to gain a broad understanding of living organisms and

specifies that local ecosystems should be investigated and understood in terms of their physical environment (www.tki.org.nz).

Investigating local ecosystems or taaonga has been identified for potential study by unit kura (Appendix 4). Taaonga are treasures in the landscape and Maaori believe such taaonga e.g. lakes, rivers, streams, lands, forests, and their inhabitants together with natural phenomena (rain, wind) possess mauri (Marsden and Henare, 1992), the life force that ensures that within physical entities they will have continual life (Tipa and Tierney, 2003). Mauri seems to be what-ever it is in an ecosystem that maintains the health of that ecosystem (Morgan, 2004) because all creatures have mauri, and without mauri nothing can flourish (Patterson, 1999). Where unit kura are able to adopt and implement Maaori epistemology in their science studies, they must include, mauri, tikanga and kawa, and those studies are grounded in whakapapa to Papatuaanuku and Ranginuiatea.

Tauira could claim tribal knowledge as a basis of their marautanga if projects were to be undertaken in their home rohe and as part of a whanau and hapuu, they have their own epistemological traditions and are deemed unique because tupuna have framed the world view they now hold, that has allowed them to organise themselves in their world (Snively and Corsiglia, 2000). Maaori world view highlights the points of difference, the ideas and the practices of Maaori (Smith, 1999). Ultimately, local epistemological traditions and specific knowledge will require reviving because the passing on of elders constrains the traditional methods of knowledge transfer (Harrison and Papa, 2005). Teaching and learning science in a natural setting with the support of the mobile science laboratory concept would provide a cultural framework to draw in real life situations in the field to emphasise learning rather than teaching proposed by Kent and Besley (1990).

The percentage of tauira participating in science at Wharekura was 52.7%, 19.1% at Kura kaupapa, and 28.2% at Rumaki (Appendix 2). The high percentage of tauira taking science at Wharekura is a likely indication that science is a compulsory subject to at least year 11. Why more tauira are taking science at Rumaki than at Kura kaupapa is unknown but may reflect the thrust to restore language and culture at Kura kaupapa since the total immersion

system began. Further, the technical curriculum areas of mathematics and science are common in mainstream schools where Rumaki are based. Given there were 3456 new enrollments in Kura kaupapa in 2009 (Ministry of Education, 2009), and the mean number of taura taking science at Kura kaupapa in Waikato revealed in this study is 78 (SEM \pm 23.43), or between 54 and 101 (n=3). This means there is a large population of taura at Kura kaupapa who may be potentially attracted to science as a result of a mobile science laboratory visit to their kura. Whether the laboratory concept is targeted at taura intending to take science or whether it is made available to all taura must be decided, considering the history of poor science literacy and engagement by taura and the certainty of increased costs in making the laboratory available to all taura, at all 33 Kura Reo o Tainui.

All unit kura have some equipment to allow them all to participate in a Living World Programme, although not all of it may be suitable. Rather there is suggestion that deficiency and inferiority of such equipment prevails currently. From the list of useful equipment to study The Living World Programme produced in the questionnaire, only Wharekura were endowed with equipment of sufficient quantity and quality to study The Living World Programme. Kura kaupapa and Rumaki had insufficient equipment, most of which was of fair to poor quality. Five unit kura or 50% of the kura in the survey recorded having no equipment, supporting the findings of McKinley and Waiti (1995) who identified a lack of resources to deliver science more effectively to Maaori. Therefore, it is little wonder that nine of the 10 kura putaiao approve of the mobile laboratory concept, presumably in the hope that it might make available quality equipment to study The Living World Programme.

Kura kaupapa are prominent in the results pertaining to internal unit kura kaupapa (Chart 1). Apart from the obvious correlation between number of units taught and kaiako experience, Kura kaupapa pledge the highest mean koha, teach the most mean levels of units, their kaiako have taught the most mean number of years (Chart 1), and they have the most science equipment. The reason for this is speculated to be the length of time (~24 years) Kura kaupapa have been in existence, given Rakaumanga School was one of the first to be registered as a total immersion school in c. 1985 (Harrison and Hughes, 2004). Of the

three unit kura, Wharekura have sufficient equipment to study the Living World at the microscopic level, and to investigate quantitatively the quality of water in their rohe and will likely benefit from the mobile science laboratory concept through the expertise, technical assistance and access to projects it will provide. Kura kaupapa will benefit from the mobile laboratory greatly given the equipment they currently possess restricts them to investigating macro-invertebrates while Rumaki are restricted to observing macro-invertebrates and basic water quality testing.

Unit kura seek the delivery of any laboratory-based programme in te reo. Language and culture was integrated into the education curriculum after the Treaty of Waitangi Act was established in 1975 (Whaanga, 1993) and the main arguments for teaching science in te reo were political, social justice, honouring the treaty, and what it means to be a treaty partner (Bell, 1990). The inclusion of aspects of the Maaori language and culture in the philosophy, organisation and content of the curriculum was aimed at improving the under-achievement rates of tauira (Department of Education, 1984) because raising tauira self-worth and sense of identity will restore culture and language proposed by Whaanga (1993). The exclusion of the Maaori language from the primary school curriculum and the negative attitudes of kaiako towards language and culture adversely affected the attitude of Maaori toward their own language (Ka' ai-Oldman, 1988). Given that language defines Maaori as a people (Bevan-Brown, 2009), eventually Maaori were forced to not only abandon their language, but also to abandon their culture and customs (Bell, 2005).

Kaupapa Maaori theory is underpinned by specific cultural epistemology that implies a way of framing how tauira think about different ideas and practices (Smith, 1999). Children of different cultural backgrounds interpret science concepts differently to the western world view and each bring ideas based on prior experience (Snively and Corsiglia, 2000). Bicultural science education was seen to include examples and contexts that are interesting, relevant, and useful, and importantly, tauira need to know how science disciplines work as a system and how it is different from other systems (Gilbert *et al.*, 2005). Maaori prefer that science is seen as a human activity, and they need to see people they can identify with carrying out science activities. Tauira also need motivation, context, confidence, and strong

inner foundation about their origins and tribal identity (Harrison and Papa, 2005) and because they are visual, whole concept learners, they begin with the big picture (Walters *et al.*, 1993). Ultimately, taura need to understand that the detail entails examining, developing and articulating theories in order to develop practical frameworks to underpin their knowledge base (Barnes, 2006). Western science education in a strong Kura kaupapa environment is cognisant of the need to master science, but every culture has its own science that “cannot be removed from teaching, learning and assessing science” (Elkana, 1981).

Maatauranga Maaori is reliable knowledge synonymous with moohiotanga, or knowledge acquired by familiarity and the exercise of intelligence (Salmond, In: Harrison and Papa, 2005). Maatauranga Maaori is a type of western science (Barnes, 2006) that can make a potential contribution to science and innovation (Durie, 2005) because it constitutes an environmental virtue ethic (Patterson, 1999), so increasing Maaori participation and engagement in science is important and relevant to contemporary Maaori (Durie, 2005) given Maaori traditions are not located in a timeless past (Biggs, 1995). Furthermore, these ideas and practices align with the philosophical underpinnings and principles of being Maaori (Stewart *et al.*, 2008). Maaori communities have an interest in encouraging students to pursue science (Walker, 1997) and for many generations, communities in Waikato-Tainui have supported local kaupapa and traditional knowledge e.g. Kiingitanga and Tainuitanga etc being incorporated in kura programmes (Harrison and Hughes, 2004). Waikato-Tainui were always interested in western civilisation and adopted western ideas and practices as it suited (Salmond, In: Harrison and Papa, 2005). But Matthews (1995) claims Maaori science is invalid and harmful, and Dickison (1994) claims Maaori science doesn't qualify as science.

Walker (1994) advances some examples in support of Maaori science and technology e.g. navigation using geocentric astronomy, fluid dynamics in Polynesian “upside down” sail design, and Maaori canoe hull technology. Apparently zenith stars are associated with different islands and the sidereal, or star compass that define compass direction and therefore navigation, is obtained through astronomy. Knowledge of fluid flow by

Polynesians led them to design their sails with most of its area high above the turbulence caused by friction at the water surface. This design proved their vessels to be faster and more maneuverable than comparable European-designed vessels. Furthermore, the Polynesian-designed outrigger is the fore-runner of the catamaran that holds the record for non-stop sailing around the world. Hull technology is an example of the knowledge held by Maaori who sometimes adze their waka hulls in a scalloped pattern rather than smooth “kei te piri te wai ki te waka” so the water doesn’t stick to the waka. A parallel can be made with golf balls that have dimples to reduce drag through the air. Furthermore, Maaori understood the preservative qualities of wetlands which were used to store cultural treasures and domestic items for 800 years (Allen *et al.*, 2002). A contemporary example of Maaori technology is a never-go-flat automotive battery invented in the Waikato.

Decision making in the case of resource and environmental issues and the funding of those issues, was spread among government departments and ministries (Walker, 1997). Changing who makes the decisions and who decides on the funding were two of four suggestions advanced by Walker (1997) in order to “decolonise” science. Waikato-Tainui have recently formalised an agreement with the Crown to restore the health and well-being of te tupuna awa. Included with that agreement is substantial funding and 50% of the decision-making power. Guidelines provided by Dickison (1994) to establish a science community include establishing a central location to house and contain sufficient technology and associated infrastructure. Two other suggestions of Walker (1997) to decolonise science were to determine who was going to do the work, and what proportion of them should be Maaori. For Waikato–Tainui, all the guidelines can potentially be implemented using the mobile science laboratory initiative, which together with the annual science waananga would satisfy the final two guidelines advanced by Walker (1997). The mobile science laboratory aims to enhance taura literacy and engagement in science. This may ultimately translate into taura entering tertiary institutions to pursue a science career, enabling them to drive and support a Waikato-Tainui Puutaiao Community.

6. Conclusions

This study was conducted using Kaupapa Maaori research methodology. Whanaungatanga was the way all kaiako were met and greeted prior to eliciting their whakaaro and

perceptions of the mobile science laboratory concept. Unit kura reflected different perspectives on how the mobile science laboratory concept may assist them and their kura, therefore, different planning, organisation and delivery techniques and methods will be required to deliver potential programmes, techniques and methods to Kura Reo o Tainui.

The requirement among Kura Reo o Tainui for any programmes to be in te reo was expected. The focus of language throughout Wharekura, Kura Kaupapa Maaori and Total Immersion classes uphold and maintain te Aho Matua and Kura Motuhake philosophies, and this result was inevitable because te reo is a compulsory component of those philosophies. Te reo may improve engagement rates in puutaiao but only time will reveal if tauira will regain their identity and self worth sufficiently to improve achievement rates to the extent that will ultimately restore their culture and traditions for them. Historically, the only Maaori knowledge and language that has been accepted into science teaching was knowledge that would fit the definition of what could be considered as science (McKinley, 1996).

The examples of Walker (1997) are proof of the grounding in moohiotanga tuupuna in Aotearoa and te Moana-nui aa-Kiwa had. Tuupuna provide the context and the motivation, therefore, for tauira to realise that they too can master science with confidence, because their tupuna did just that, despite western science being taught at the expense of indigenous science (Snively and Corsiglia, 2001). The pedagogical knowledge of kaiako puutaiao must include both western and Maaori science knowledge (Bell, 2005) in fairness to kaiako who genuinely want different perspectives in science (Dickison, 1994). But across all unit kura overwhelming concerns were expressed regarding the lack of specialists, subject experts and resources, suggesting that kaiako have been delivering their marautanga puutaiao to tauira in a manner less than reasonably expected of a modern education system. It is little wonder that Maaori have been languishing among the ranks of the under-achievers in science, widely published in a context and history of cultural deprivation, and failed assimilation and integration policies.

Wharekura have equipment to investigate various aspects of the Living World marautanga. What they lack is expertise, technical assistance and access to projects that can be supplemented by the mobile laboratory. Therefore, Wharekura are poised to reap the most benefit from the mobile science laboratory concept given they have the largest taura base and their taura participating in science can progress to higher learning earlier. Kura kaupapa and Rumaki will be heavily reliant on the mobile laboratory given the limited access they have to equipment, expertise and technical assistance.

Analysis of the equipment and likely suitability of that equipment for the Living World Programme at unit kura showed it is largely insufficient, and inappropriate for this use. Funding will be required for equipment based on the types of studies and investigations contained within the existing marautanga, and whether this equipment should be contained within the mobile laboratory or with Kura Reo o Tainui needs to be determined. Arguments include the cost to source, secure and assemble a single set of materials and equipment for all unit kura to access during visits, or purchasing 33 sets, more or less to equip each Kura Reo o Tainui. The obvious advantage of the latter option is that unit kura could continue with on-going work e.g. collecting monitoring data between laboratory visits. Further, the cost to host a mobile science laboratory is a burden that needs to be subsidised, at the very least. Unit kura have pledged koha, but koha is a traditional token of aroha not intended to contribute to any costs incurred by any project or activity. How costs for equipment will be addressed is the subject of a future study.

The conditions for a science community promoted by Dickison (1994) can be effectively met with this initiative. In conjunction with guidelines to decolonise science proposed by Walker (1997), Waikato-Tainui could explore a Puutaiao Maaori Community concept using a central location and a series of mobile laboratories. By leveraging off a sub-standard marautanga puutaiao, this research could support a Waikato-Tainui Puutaiao Community initiative to obtain government funding to promote, drive and deliver its own marautanga puutaiao using the guiding principles of the local communities that align to Kura Reo o Tainui, as Te Kura o Rakaumanga did to obtain its Wharekura status. An immediate spin-off for this concept emerges from Waikato-Tainui requiring researchers to investigate ways

to enhance the health and well-being of their spiritual awa tupuna. Within that enhancement, scientists will be required to not only address the physical and chemical elements but also they will be required to address the spiritual elements of mauri, tikanga and kawa, elements foreign to western science but equally or more important to Maaori. This concept is outside the scope of this study, but is the potential topic of a future study.

7. Recommendations

The mobile science laboratory concept should be implemented on a trial basis initially. A trial period of six months will assess the feasibility of the concept, and it will test compliance issues and logistical requirements of unit kura. Wharekura require expertise, technical assistance and access to projects and the mobile laboratory will be useful to not only supplement the equipment they possess currently but also formulate strategies for assistance. Kura kaupapa and Rumaki alike currently have little equipment, expertise and technical knowledge to implement The Living World programme. The mobile laboratory will seek to fulfill their requirements for equipment, instruction and delivery of programmes that conform with the Te Aho Matua and Kura Motuhake philosophies.

It is recommended that basic equipment should be sourced of sufficient quantity and quality to equip a small mobile science laboratory, to be made available for the duration of the trial and beyond. It is also recommended that a list of subject experts and specialists in the various fields of the science be contacted for their potential interest in the concept as a way of building a support network of this resource to be used as and when required.

Future studies are recommended to investigate:

- Funding a trial mobile science laboratory vehicle and equipment;
- How the laboratory will provide the best outcome for Waikato-Tainui taura taking science;
- The establishment of a Waikato-Tainui Puutaiao Maaori Community.

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10. Appendices

Appendix 1: Survey Questionnaire

*Applied Lake & Wetland
Restorations*

PO Box 5596
Hamilton
Phone 64 7846 1249
Mob 64 27 733 9695

AM² & Associates

“Is there demand for a Mobile Putaiao Laboratory Concept to visit Kura Reo o Tainui? ”

Survey Questionnaire

Conducted by:
Aareka Hopkins MSc

Instructions:

Please answer all questions appropriately.

All parts of the survey will remain confidential.

Code: 000

Part 1: The first part of the survey relates to the Living World programme, and taaonga in the landscape near your kura.

1.

Is the Living World programme part of the teaching curriculum at your kura?

YES NO

2.

Are there taaonga (e.g. takutai moana, moana/roto, repo, ngahere etc) near your kura that you would like your tairira to visit and study?

YES NO

3.

Is there general interest at your kura in restoring the mauri, or life force of taaonga identified above, near your kura?

YES NO

4.

On the scale below, rate your assessment of the state of the mauri of taaonga near your kura of particular interest to you? State if you don't know.

Low

1

2

3

4

5

6

7

High

5.

Do you have access to transport options to move tairira to these locations?

YES NO

6.

What are your key concerns about agreeing to allow tairira to participate in a Living World programme with our proposed mobile putaiiao laboratory team (e.g. curriculum links, kaiako/tairira ratios, transport, costs etc)?

Part 2: This part relates to how a mobile putaiiao laboratory could potentially assist with a Living World programme at your kura.

7.

Is there a practical component offered with any Putaiiao programme at your kura?

YES NO

8.

How do you think a mobile putaiiao laboratory programme could help you meet your curriculum needs at your kura?

9. In your opinion, are there Living World kaupapa that you would implement for study at your kura if you had the support of a mobile putaiao laboratory? Use the list below as a guide for indicating your interests.

Awa	Enviro. Monitoring	Estuarine systems	Frogs
Ika	Invertebrates	Kaeo	Kaimoana
Koura	Manu	Moana/roto	Ngahere
Phytoplankton	Repo	Takutai moana	Tipu
Wai	Zooplankton	None of these	Other:

10.

Indicate the frequency you think a mobile putaiao laboratory visit would provide the best value for you at your kura by circling **ONE** option below.

Weekly	Fortnightly	Monthly	Once per term	Twice per term	Yearly
Summer	Winter	Spring	Autumn	Block visit	Don't know

11.

In the table below, 1): tick the equipment you think might be useful for studying Putaiao of the Living World, and 2): tick the status of each of the pieces of equipment from the list, at your kura.

Equipment	Useful	Status			
		Great	Good	Fair	Poor
Aquarium sets					
Binoculars					
Corers					
Compound microscopes					
Dip nets					
Disposable droppers(1 ml)					
Gumboots					
Folding tables					
Hand-held science testers					
Horizontal Secchi					
Identification charts					
Information booklets					
Invertebrate study kit					
Kick nets					
Latex gloves					
Magnifying glasses					
Microscope slides and slips					
Petri dishes					
Plastic zip-loc bags					
Plankton net					
Rubber gloves					
Secchi disc					
Sieves					
Shelter tent					
Shade tent					

Stereo microscopes					
Waterproof field book					
Other:					

Part 3: Information about you and your kura.

12.

How many years have you taught at your kura?years.

13.

At which level/s is putaiao being taught at your kura each year?

14.

Use the table below to indicate the demography of tauira studying putaiao at your kura.

Roll	Maaori tauira	Decile

15.

Indicate your assessment of the contribution tauira could provide as koha for a mobile putaiao laboratory visit to your kura by circling **ONE** option below.

0.0c 0.50 c \$1.00 \$1.50 \$2.00 \$2.50 \$3.00 \$4.00

16.

We are proposing to put together a mobile putaiao laboratory team to promote interest in putaiao in Kura Reo o Tainui. Rate your assessment of the value this team would be to your kura in the scale below. State if of no value

Low value

High value

1 2 3 4 5 6 7

17.

Other comments you may wish to make on a mobile putaiao laboratory concept to visit Kura Reo o Tainui can be made here.

Thank you for your co-operation in completing this survey.

Appendix 2: Tauria attending unit kura in sample

	Mean Roll	Proportion	Per cent
Wharekura	215	0.53	52.70
KK Maaori	78	0.19	19.12
Rumaki Unit	115	0.28	28.19
	408	1	100.00

Appendix 3: Responses to laboratory visits

	Wharekura	KK Maaori	Rumaki
Block	3	3	3
Season	2	0	0
Term	0	0	2
Monthly	1	0	0
Fortnightly	1	0	1
Weekly	0	1	0

Appendix 4: Responses to questionnaire

Question	Topic	Wharekura	KKM	Rumaki
1	Living World Programme	4/4	3/3	2/3
2	ID of TargetTaaonga	4/4	3/3	3/3
3	Interest in Mauri	4/4	3/3	3/3
4	Assessment of Mauri (scale 1-7)	2.87	2.66	6.7
7	Existing Practicum	4/4	2/3	3/3

Glossary

Kupu

aroha
awa tupuna
hapuu
hui
Kaiako
kareti
kaumaatua
kanohi ki te kanohi
kawa
Kiingitanga
kiwaha

koha
Kura Kaupapa Maaori

Kura Motuhake
Kura Reo

maahaki
maatauranga
mana
manaakitanga,
marautanga
moohiotanga
mauri
Papatuaanuku

Whakapaakeha

love
Waikato river
tribe
gathering
Teacher
college
elder
face to face
protocol
royalty
saying

gift
Maaori total
immersion school

area school
Maaori speaking
school

humility
education
respect
caring
curriculum
knowledge concepts
life force
earth mother

Kupu

puutaiao
Raupatu
Ranginui-aa-tea
repo
Rumaki

taaonga
Tainuitanga
tauirā
Te Aho Matua
Te Moana-nui aa-
Kiwa
tikanga
Tumuaki

tupuna
waananga

waiata
wairuatanga
whaikoorero,
whakaaro
whakapapa
whanaungatanga
wharekura

Whakapaakeha

science
confiscation
sky father
wetland
Maaori unit in a
mainstream school
treasure
things Tainui
student
saying of the parents
Pacific ocean

laws
principal

ancestor
forum

song
spirituality
speech
thoughts
genealogy
togetherness
Year 1-13 school