

Mātauranga and science

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Mātauranga – Māori knowledge and Māori ways of knowing – developed in Aotearoa along with the cultural and epistemological identities of iwi Māori, thus is rooted in these islands and holds a well of human understanding of Aotearoa ecosystems. Mātauranga encompasses traditional and contemporary knowledge and is becoming increasingly sought after and integrated into mainstream education, research, and environmental policy in Aotearoa New Zealand. With 'Vision Mātauranga' a critical point of engagement for researchers, what does the scientist working in this space need to know about mātauranga? I have highlighted what I see to be key aspects of the discussion on how scientists work with those who hold and access mātauranga, and with mātauranga itself. The scholarly literature on mātauranga is extensive, so I focus on that which is relevant to science education and science research. Throughout I describe and explore the potential of research in which mātauranga and science connect and relate.

What is Mātauranga Māori?

Mātauranga Māori, or simply 'mātauranga', has come to refer to Māori knowledge, ways of knowing and knowledge generation practices, and it is a broad system that encompasses time, space, place and discipline. Mātauranga comes from the root word matau, which means 'to know, be acquainted with; to understand; feel certain of' (Williams 1971) and as such, refers to reliable, tested and socially accepted knowledge. In Samoan, 'matau' means memory and in Tahitian 'matau' means 'to be used to or accustomed to' (see Benton *et al.* 2013). 'Mātauranga Māori', with the cultural qualifier included, likely arose with European settlement, to mark out the space of knowing that did not relate to the Western literature, embodied in the Holy Bible: 'historically, mātauranga māori referred to knowledge arising from atua māori or non-Christian gods, which was the preserve of tohunga māori, the non-Christian priests.' (Royal 2012). But mātauranga is now understood more broadly, representing the whole distinctive body of Māori knowledge in relation to society and environment. Furthermore, women were important holders of the knowledge, with many testifying that their mātauranga came from their kuia/grandmothers (see Benton *et al.* 2013).

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Mātauranga's knowledge and epistemology traces back through the Pacific and Asian ancestral whakapapa of the people who became Māori. According to Māori studies professor Hirini Moko Mead:

Mātauranga Māori is not like an archive of information but rather is like a tool for thinking, organising information, considering the ethics of knowledge, the appropriateness of it all and informing us about our world and our place in it. (Mead 2003, p. 306)

Mātauranga is thus a knowledge-generating system, not just the knowledge itself. The related term 'kaimānga', or 'masticated knowledge' (Royal 2009) alludes to the importance of 'chewing over' and processing of information to create mātauranga. Mātauranga Māori encompasses all branches of Māori knowledge, past, present and still developing' (Mead 2003, p. 305); thus it includes, but is not limited to, traditional Māori knowledge. Professor Whatarangi Winiata concurs, stating that:

mātauranga Māori has no beginning and is without end. It is constantly being enhanced and refined. Each passing generation of Māori make their own contribution to mātauranga Māori. The theory, or collection of theories, with associated values and practices, has accumulated mai i te ao Māori / from Māori beginnings and will continue to accumulate providing the whakapapa of mātauranga Māori is unbroken. (Winiata 2001 cited in Mead 2003, p. 321)

Mātauranga is a system into which values are overtly interwoven. Mātauranga is the theory behind tikanga Māori (values, practices, rituals), the 'procedural knowledge, which is the practice of ideas, beliefs and knowledge of mātauranga Māori' (Duncan & Rewi 2018, p. 33). It also includes tikanga Māori. In pedagogy it is considered as connected to 'mōhiotanga' (know-how, common knowledge) and 'māramatanga' (understanding) (Ministry of Education 2009). As such it has echoes of the Data-Information-Knowledge-Understanding-Wisdom hierarchy (see Mercier *et al.* 2012). Just as 'Western knowledge' is wide, broad-ranging, encompassing of philosophy, religion and ethics, and historically and culturally inflected; so too is mātauranga Māori. And as Western knowledge has various tools



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with which to critique itself, so mātauranga contains tools to epistemologically self-analyse (Sadler 2012).

While mātauranga is used to talk about a 'global' corpus of Māori knowledge, in practice, people will deal with localised knowledge. The term mātauranga-ā-iwi is used to denote knowledge related to specific iwi, hapū (subtribe), places and people. For instance, te matauranga-a-Ngati Porou 'is our unique tribal and hapu knowledge and way of thinking' (Te Runanganui o Ngati Porou 2014). It refers to the mātauranga generated by our tupuna (ancestors), through educational institutions such as traditional whare wānanga (houses of learning), and more recent education forums such as church schools and universities.

He Hononga – Working at a mātauranga–science Interface

Many of the commentators in this field refer to science as modern science, Western science or modern Western science. I try to use the term 'Western science' sparingly in what follows, but its pervasive use in the literature demands reuse, and a brief explanation and justification. 'Western science' is used to differentiate it from other sciences or knowledge-producing practices from the 'non-West'. This can be useful when considering, for example, that printing technology was first developed by the Chinese. 'Western science' is also used when tracing a history of modern science. This version of events usually starts with Greek philosophical traditions (such as attributed to Aristotle and Pythagoras), and ends with the enlightenment and the scientific revolution (key players include Galileo, Descartes and Newton). Those who use the term 'Western science' thus may be drawing attention to historic movements and philosophies that led to, and remain embedded within, modern science. Others see Western science used in this way as ethnocentric, ignoring science's plurality of cultural contributions (see Medin & Bang 2014). In discussions with mātauranga, a preference for 'Western science' signals a desire for perceived distinctions to be maintained, so as to fully differentiate, and allow for renegotiation of what is 'science'. This may be because many link 'Western science' to a broader Western history of imperialism and conquest, and the assimilation and/or suppression of other cultural traditions.

There are many examples of projects and endeavours that incorporate both mātauranga and modern science. In some instances the knowledge streams may 'parallel play', engaging in dialogue but not much interaction. In others there are attempts to exchange and engage. Important to this engagement is understanding about *how* to work at an interface between science and Indigenous knowledge. A coming together of different entities is an opportunity to learn about the Other, and to learn about the Self. An important set of mutual and reflexive learnings at this interface, is to understand that (1) mātauranga includes aspects of what we might understand as a modern scientific nature; and (2) science systems cannot be completely unshackled from a social, values-based nature (Medin & Bang 2014). This may give scientists a more comfortable point of engagement with mātauranga, and give mātauranga holders a more comfortable point of engagement with modern science.

Some of the more commonly used models for engagement are: common ground (Barnhardt & Kawagley 2005; Roberts 1996); converging streams or braided rivers approach, He Awa Whiria (MacFarlane *et al.* 2015); a third 'Treaty house' space (Whatarangi Winiata, cited in Royal 1998); Te Hau Mihi Ata's negotiated space (Smith *et al.* 2008); and the 'superset'¹

(Stewart 2007). A recent report even makes a new interface of interfaces, by braiding together He Awa Whiria and negotiated spaces (Arago-Kemp & Hong 2018). Many suggest particular principles and values that should guide interaction, such as a Treaty-based framework (Harmsworth *et al.* 2013), mutual respect (Durie 2005) and acknowledgement of each other's expertise (Hudson 2012).

Mātauranga contains practices consistent with the scientific method (Hikuroa 2017), such as observation, and trial and error. Theorising of results according to a Māori worldview enabled such knowledge to be stored in and recalled from memory. Controlled experimentation must also have been part of the mātauranga toolkit. Evidence of this includes: the development of growing and storage techniques for kumara; and naming, categorisation, mixing and use, of flora and fauna in Aotearoa for food and medicinal purposes.

Mātauranga was dynamic and changeable across time and place. It could be exchanged, critiqued and reshaped between individuals or communities. It could experience small, iterative changes, or seismic, sudden ones.

Encounters with the new land, its weather patterns, and new flora and fauna all challenged the knowledge that was brought with those early ancestors. Slowly, with periods of experience, empirical research, and experiments of cause and effect, the knowledge process led to the development of a uniquely Māori, indigenous knowledge base, intrinsically connected to physical and spiritual environments. (Duncan & Rewi 2018, p. 32)

Today, a community or individual with new knowledge (scientific or otherwise) can feed this knowledge back into mātauranga through a variety of mechanisms. Ever more frequently this includes peer-reviewed publications and processes. Knowledge in this space is open to new processes of critique and challenge. For instance, engineer Kepa Morgan suggested a theoretical way to quantify mauri (energy, life force). He operationalised this theory through proposing a mauri scale spanning -2 to +2, and from this developed a digital diagnostic tool that he called the 'mauriometer' (Morgan 2013). This has been tested by other researchers (Hikuroa *et al.* 2011), and reused in some cases. Yet others have developed their own diagnostic tool for mauri. The mauri compass, for instance, is specifically designed for waterways in Gisborne / Tūranganui a Kiwa, and engages community, iwi and council (Ruru 2018).

While some commentators muse that the absence of a hypothesis in Indigenous knowledge is what differentiates its scientific aspects from a modernist form of science (Crawford 2009), this is another contestable assertion. Ranginui Walker points out that observations of bird migration led to the hypothesis of land in the direction of the yet-to-be-discovered Aotearoa (Walker 1994).

Mātauranga and science in education

While ecology and environmental studies have long been interested in mātauranga as an evidence base, it is the education discipline that has arguably been the centre for generation of discourse around Māori and science, mātauranga and science. This may be because it often appears with kaupapa Māori discourse, which emerged from education also. Mātauranga

¹ The 'superset' idea posits that 'Western science' is philosophically a subset of Indigenous knowledge.

with a scientific bent has long been a part of the New Zealand educational curriculum for Māori children, beginning with native schools. Philosophical discussion on the epistemological bridging are furthered within tertiary education contexts and courses (for instance Roberts 1996; Mercier 2011). Furthermore, two edited volumes on the subject of mātauranga Māori have been published by the New Zealand Qualifications Authority (Black 2012, 2014). The emphasis is there because, to some, success of Māori in science subjects signals success across education more broadly.

Over several decades now, a purposeful, sustained and widespread effort has been spent on promoting Māori recruitment into and engagement in science, across all levels of schooling: primary, secondary and tertiary. This includes sector-connective programmes such as Te Rōpū Awhina at Victoria University of Wellington and Tuakana at University of Auckland. Postgraduate students act as mentors for undergraduate students, and university students engage in outreach with primary school tamariki and secondary school rangatahi.

The provision of schooling in te reo Māori, through kōhanga reo (early childhood), kura kaupapa (primary) and whare kura (secondary) includes teaching science – pūtaiao – in te reo. Pūtaiao is a relatively recent Māori word used to denote modern science, particularly natural and physical sciences. It translates as the source (pū) of the ebbs and flows (tai) of the phenomenological world (ao). Pūtaiao (the word) thus loosely describes a system of understanding the mechanisms behind the world's material and dynamic characteristics. Pūtaiao presents science explored within a recently developed and developing lexicon in te reo Māori. Pūtaiao words have been carefully selected and developed to connect concepts. For instance, a *transformer* (of voltage) is translated as *tōrua* (two magnets), which efficiently describes the mechanism by which voltage is transformed. The word *ngaohiko* (voltage, literally energy electric) makes explicit the connection to electrical energetic potential, and its companion concept of *iahiko* (current, lit. current electric). Post-implementation of a scientific lingua franca in te reo has meant a revisiting of modern science concepts. For better or worse, it has also omitted some of the history of Western science, for example, in the exclusion of inventor 'Volta'².

Teaching pūtaiao inherently brings a Māori worldview along with it. The effort of teaching science in Māori language immersion settings was anchored in the New Zealand science curriculum by the translation into te reo, and creation of the Pūtaiao marataunga, in the 1990s. Its continued use and subsequent development have led to many different aligned resources, including papakupu (dictionaries and encyclopaediae) for Pūtaiao and Pangarau (maths), readers in te reo Māori, as well as research-based initiatives and outcomes such as Ngāti Whakaue Charter School Te Rangihakahaka, which teaches STEM subjects in Māori, and Te Whata Kura Ahupūngao, the New Zealand Teachers' Resource Bank, which produces physics teacher and student resources in English and te reo Māori (Lufkahr *et al.* 2007). Many te reo science resources are not simply translations, but acknowledge and draw upon mātauranga. Furthermore, A Nation of Curious Minds funding has supported several projects that enhance learning systems' abilities to draw upon mātauranga and science.

Reaction against deficit-based discourses (that students are the problem, not the educational systems that fail them) have led commentators to critique (amongst other things) the alien culture of science in the classroom (Aikenhead & Jegede 1999), wider societal expectations that women and Māori don't become scientists (McKinley 2008), and the lack of awareness of science history and philosophy amongst teachers (Stewart, 2017). Poor understanding of the historical, social and cultural foundations of modern science, such as was gestured to in a recent debate (Salmond 2018), tends to lead to uncritical acceptance of the ideas that science is universal, value-free and objective, and that science is the only reliable way to produce knowledge. The 'scientific' perspective that these beliefs foster has excluded opportunities for presenting mātauranga alongside science in educational settings.

Combining scientific approaches with mātauranga Māori provides opportunities to involve Māori in additional science education experiences and to develop co-management strategies that engage Māori in scientific research and scientists in mātauranga Māori. (Keiha cited in Morton, 2018)

Poorer than average achievement of Indigenous students in mainstream education and the deficit-based discourses that have historically accompanied this, are a problem in many colonised nations. Recognition of this has led to many Indigenous peoples looking to their traditions, revitalising and promoting practices that affirm Indigenous knowledges, communicating and sharing their local activity with other Indigenous educators. Indigenous peoples worldwide have worked together to revive Indigenous languages and knowledges, and connect learners of like mind and experience, through both mainstream education and alternative means. The Kaupapa Māori movement, which reimagines education and research, stemmed from academics in tertiary education (Smith 1999) and has arguably inspired and supported other Indigenous initiatives, such as Kāmeheameha schools in Hawaii.

This long-term education-led project to engage Māori in science, and science in mātauranga, thus works on multiple fronts to increase cognitive access across different epistemologies. This helps level the playing field for Māori in Western education, but looks ahead to a science that honours Indigenous knowledges through increasing numbers of mātauranga holders as scientists.

Mātauranga and science: stronger together?

The time of encounter brought European and Māori knowledge together. European science and mātauranga had distinctive strengths, and the many society-changing contributions of science are widely known. This section focuses on examples in which mātauranga provided more complete contemporary understandings of our past and present. Furthermore, mātauranga is not just being used as a knowledge archive; mātauranga methodologies also influence contemporary research.

While mātauranga includes traditional multi-media, and is thus contained in historical record by oral recordings, writings, carvings, paintings, weaving, etc., much of it (as described in either English or Māori languages) is contained in anthropological literature, research, in the National Archives and in Waitangi Tribunal hearings and reports. Mātauranga includes numerous examples of science and technology. For instance, waka hull,

²The symbol V is used for ngaohiko (voltage)

sail and paddle design required trial and error, experimentation, knowledge of hard and soft materials science, chemistry and fluid dynamics; and application of these in sailing, wayfinding, mapping, and navigation required active in-situ observation, memorisation, physics (for instance, understanding refraction and reflection of waves around land masses) and many other kinds of knowledge. While some of this knowledge was shared intergenerationally in whare wānanga, or 'school'-like contexts, its intertwinedness and complexity meant that 'doing' was often the most reliable way of passing on the understandings.

Mātauranga is unique in that it historically embeds and connects these understandings within a system that includes the social, cultural and spiritual, as well as the physical and natural. What is packaged as a proverb, folk tale, myth or legend, requires context and experience to interpret and unpack. In what follows, I select and discuss some research that reveals some surprising points of contact between mātauranga and science. Just as sailing experience meant that Polynesians knew the Earth was round, the first example shows Māori knowledge filling a gap in European understanding at the time of encounter. Other examples show how contributions of mātauranga are useful to contemporary science research.

Pūrākau are stories or narrative accounts of events that can be tailored to audience and by genre. In Hikuroa's scientific documentary retelling of a pūrākau, we hear about Ngātoroirangi who was exploring Te Ika a Māui (the North Island), a long way from home, when he was stranded at altitude, in a blizzard. He cried out for help, and his sisters responded by travelling from Hawaiiki to Mt Ruapehu. Ngātoroirangi's sisters were subterranean, and burrowed under the landscape, popping up at various times to check on their progress towards their destination. They found Ngātoroirangi just in time to be saved. As Hikuroa points out, while this story is told in a narrative style, it contains evidence that Māori knew that geothermal sources followed subterranean networks – not a geological understanding of the place at the time. One could also argue it presents a mātauranga version of a scatter diagram. Hikuroa reveals this by overlaying the story on a map of the known geothermal sources in the Taupō Volcanic Zone (Hikuroa 2009). What one might call a naming of data points operated in other contexts too, most notably in the phenomenon of an 'oral map' (Davis 1990), in which waiata (songs) such as oriori (historical epic song) marked out places of significance, boundaries between iwi, trails from place to place, etc. As Tipene O'Regan points out, place names on their own can reveal something about a particular place. They reveal even more when understood in the context of other names. This 'web of memory that ties many Aotearoa place names together' (Davis *et al.* 1990, p. 6) is a 3-dimensional oral construct pinned by 'survey pegs of memory' (Davis *et al.* 1990, p. 5). Furthermore, in recognising the differences and similarities between contemporary and historical naming configurations in the Pacific, the possibility arises of exploring across a broad area encompassing the Pacific, but also into the past, covering the time dimension. Could this present as data for an Indigenous kind of 4-dimensional complex network?

Mātauranga in the form of whakataukī, or proverbs (Mead & Grove 2004), have formed the basis for additional understanding in exchange between mātauranga and science. Multi-disciplinary work on whakataukī of marine species considers importance of different fauna across different times, and presence or absence

in archaeological records (Wehi *et al.* 2013). Tom Roa's dating of whakataukī to different linguistic periods enabled understanding of how mātauranga developed over time. Their work to draw out the significance of 'ururoa' and 'mako' (sharks) invites a re-evaluation of the conclusions drawn from an analysis of archaeological middens. Taken as the sole piece of evidence, the appearance of moa bones and shells suggests an interpretation that moa extinction led to heavy reliance on shellfish in the human diet. This in turn leads to a 'Maori were starving' narrative, reinforcing notions about Māori as savages in need of salvation. Without mātauranga's archive of different species names, their connections to other species, and connections with humans, contained within the hundreds of recorded whakataukī, a full and complete understanding of past diet was out of reach.

Surveyor and archaeologist McFadgen's tsunami-related work recognises this, and his book (McFadgen 2007) pieces together what is known about oral histories in relation to tsunamis, presenting a record of possible tsunami events that can be correlated with current-day observations of landscape morphology. His continued research on the historic site at Wairau Bar seeks to understand the relative impact of tsunamis, climate change, erosion and other factors, and recognises that interdisciplinary effort is needed, with indigenous knowledge an important source of information (McFadgen & Adds 2018).

There are many examples in which 'innovation' (Durie 2005) was an outcome of mātauranga sitting alongside science. Some reveal recognition that Indigenous languages themselves encode other forms of knowledge. The online publication of a scientific paper abstract in te reo Māori, in the *Journal of Ecology* was driven by the paper's authors: 'If western science is to become relevant to indigenous cultures, one way forward is through the language of that culture' (Perrott, cited in Morton 2018). This may extend the journal's policy to publish abstracts in other languages, it could be politically or economically motivated, or it could reflect a natural evolution of practice within the ecological sciences. If the latter, it may herald a sea change across other sciences in relation to acceptance of Indigenous languages.

Vision Mātauranga: 'Māori success is New Zealand's success'

Vision Mātauranga (VM) is a policy framework that was published by the Labour-led government's Ministry of Research Science and Technology in 2007, and continues to be implemented as a research and science strategy. The aim of VM is to 'unlock the potential of Māori knowledge, resources and people' (Ministry of Research Science and Technology 2007). It is designed to support the recognition and aspiration that 'Māori success is New Zealand's success' (Ministry of Business Innovation and Employment 2018a). The recent case of Australia seeking to patent 'Manuka', a Māori word, has galvanised New Zealanders into throwing their support behind the legal response. We collectively recognise that protecting mātauranga in this case, is protecting a taonga of immense economic, social and cultural benefit to New Zealand.

In the VM climate, researchers and scientists now consider questions that, in essence, relate to how their disciplines can become more accessible spaces for Māori. These include how their research: relates to organisational-level Treaty-based policy; may support Māori partnership, grow Māori capacity and capability; and may be relevant to mātauranga. Attempts at 'the

VM section' reveal diverse levels of familiarity and knowledge. Support for those addressing the VM strategy has been found in multiple quarters, especially amongst Māori researchers. Weaknesses in researchers' VM strategies have led to the development of further guidelines for engagement, for instance, MBIE's Endeavour Round 2018 principles on how to 'Give effect to the Vision Mātauranga Policy'.

Vision Mātauranga comes alive when the following principles guide proposals that involve Māori (Ministry of Business Innovation and Employment 2018b):

- Partnership
 - genuine co-development with Māori, integrated through the programme
 - not last minute, token or to get 'a Māori view'.
- Reciprocity
 - co-development and contribution each way, sharing of benefits
 - not one way, appropriating Māori knowledge and practices.
- Empowering Māori
 - active roles and responsibilities for Māori, contributing to Māori capability
 - not gratuitous or out of context.

Treaty principles of 'partnership' and 'reciprocity' have been used here as an organising mechanism for more specific advice. 'Not appropriating' resonates with the principle of 'protection'. 'Empowering Māori' may be seen as supporting the principle of 'participation'. In a globalising world it benefits New Zealanders to support mechanisms that work to protect local relationships with each other, and with our taonga.

Te Tiriti / The Treaty

When Māori traded with Europeans, they did so with agency, volition and appreciation of the value of their transactions, including new technologies. The signing of the Treaty of Waitangi likely signalled their expectation to continue to access, contribute to and benefit from scientific advances. Amongst other things, the Treaty guaranteed to them the rights of equal citizenship – meaning equal rights and equal access to employment, markets, democratic and state processes, health, education and justice. Tangata whenua would have also expected to benefit equally from scientific and technological advances. However:

If we directly contrast historical scientific discoveries with what was happening in Aotearoa, particularly taking note of aforementioned government legislation during this time, we see that during the technological explosion that gave rise to electricity, communication and motorised transport, Māori were slowly but steadily being marginalised – from their own lands, their own culture and their own traditions (Harris & Mercier 2006).

As Māori became locked in a battle for retention of their lands, their language, their knowledge and the lives of their people, their ability to engage as equal citizens was eroded. While Māori demonstrated resilience and now thrive in many areas, colonisation and its legacy of coloniality still cast shadows over Māori. While on the increase, the still relatively low engagement of Māori in science is one of the legacies of science's implicit and explicit historic exclusion of them (Walker 1998).

Dame Anne Salmond reminds us that when the 'Western scientific project' arose out of the Enlightenment period, the arts and humanities were a part of this endeavour. She argues, as many others have, that separating out the humanities disciplines has caused an unhelpful fragmentation between 'nature' and 'culture'. This has led to a 'dysfunctional' system that compromises our ability to deal with complex environmental and social problems, and undermines the credibility of science itself. Further undermining science, she argues, are self-appointed bastions of traditional, modern science:

Far from protecting the scientific project from bias and political interest, they are trying to uphold a status quo based on ethnocentric bias and outmoded dualisms (and the power relations embedded in them), at a time when new ways of thinking about socio-environmental challenges are urgently needed. In so doing, and by speaking loudly about matters they have not themselves researched in depth and detail, they show deep disrespect, and do science itself a major disservice. (Salmond 2018)

This scientific attitude has been affectionately embodied and lampooned by Jim Parsons in the character Sheldon, of *The Big Bang Theory* (Pigliucci, 2012). The character believes that science systems are objective, universal, and value-free, has faith in a one-truth producing modern science, and takes on the role of a science evangelist. 'But to let these attitudes go unchecked would be a disservice to the scientists and researchers who value indigenous knowledge.' (Hayden 2017)

Someone who represents the body who 'value indigenous knowledge' is the President of the Royal Society: Te Apārangī. He added that 150 years on, in 2017, a time of reflection and renewal, a science society that seeks to represent all New Zealanders must acknowledge multiple ways of knowing. The RSNZ Code of Conduct was designed to better reflect multiple positions and worldviews, describing two of those systems at their point of interaction nearly 250 years ago.

Aotearoa New Zealand is a nation that has multiple knowledge systems. Next year is the 250 year anniversary of when two of these knowledge systems first met - when Tupaia, a Polynesian navigator who used the science of star-referenced navigation, guided James Cook on the Endeavour. The visitors brought science as known then in England and met other quite different forms of science from Māori – for example in food preservation and medicinal use of plant materials. We confirm our commitment to value all forms of research and scholarship. Though the methods of humanities research and Māori research may differ from the natural and physical sciences, they are no less rigorous. (Bedford 2018)

In concert with research organisations such as Ngā Pae o te Māramatanga, the Centre for Research Excellence in Māori research, the dialogue is shifting from 'should we' to 'how do we'. Many organisations in Aotearoa acknowledge that a Tiriti-based partnership should underpin research relationships, as gestured to in institutional ethics processes for years now.

Āta haere – Proceed with care

Esteemed anthropologist Sir Peter Buck (Te Rangi Hiroa) was Aotearoa's second Māori medical doctor (after Māui Pōmare). His thesis on Māori medicine was possibly the first Indigenous doctoral thesis to engage Indigenous knowledge. Buck and Pōmare entered medicine in response to Tā Apirana Ngata's

plea in 1897, for more Māori medical practitioners. 120 years later, the need is still pressing for Māori across the gamut of scientific professions.

Buck was a prolific writer and his published and unpublished manuscripts continue to be studied and analysed. Some of his writings included letters and contributions to Māori newspapers and he wrote about mātauranga in 1907, in *Te Pipiwharaura*'s 115th issue:

Homai nga korero me nga matauranga o mua hei taiaha ma matou ki te patu i nga Pakeha e ki nei he iwi kuare te Maori.

Give us the stories and the knowledge of the past as a weapon for us to combat the Pākehā who say the Māori are an ignorant people. (Te Rangi Hīroa cited in Benton et al. 2013, p. 222)

One hundred years later, the discourse has shifted to one in which policy presents an open invitation to and expectation for educationalists, environmentalists, researchers and scientists to engage with mātauranga. The sorts of attitudes towards Māori that Buck hoped to pre-empt at the turn of the last century, may not be an issue requiring a defensive 'weapon', nevertheless mātauranga is seen as a 21st century tool or key for unlocking Māori potential.

In this paper I've talked about mātauranga as a 'thing' – constrained partly by the English language and partly by the socialisation of mātauranga into our popular discourse. This encourages descriptions of mātauranga that make it sound like a mine to 'tap into', a wild creature to 'capture', a 'vehicle' or 'way' to infiltrate, or a treasure trove to be 'unlocked'. A discourse in which mātauranga is 'incorporated' or made tributary to modern science can be isolating and fragmentary, performing a dissection and disconnection of mātauranga from its context and its people. Mātauranga may not respond kindly to other epistemological tools, particularly ones whose own validity is contingent upon them maintaining the boundary between knowledge tested on Western terms and the 'epistemic wilderness'³ (Cooper 2012).

Relatedly, mātauranga may not be fully understandable outside of discussions in te reo Māori (Black 2012; Hunkin 2012; Royal 2008). Te reo Māori, like other indigenous languages, places emphasis on verb and action, rather than object and subject in English (Bohm & Peat 1987). Traditionally thus, we might have seen more emphasis on the concepts 'mataui' (to understand), 'mōhio' (to know), 'mārama' (to understand) and the matrix connecting these.

Finally, mātauranga is a whole system incorporating the humanities and social sciences. Policy does not differentiate aspects of mātauranga, so thrusting scientists not accustomed to working across the nature/culture divide into this territory may be unwise. Working with researchers in the social sciences and humanities disciplines first, may be a vital stepping stone.

He kupa whakamutunga – Final words

In Aotearoa New Zealand we have an opportunity to draw upon two knowledge traditions to produce a unique 'mātauranga Aotearoa' (Tauwhare 2008). But we might need to move cau-

³ The 'epistemic wilderness' is a place to which the West is argued to consign 'other knowledges'. Being in the epistemic wilderness allows mātauranga to be ignored, mythologised and even feared. But for mātauranga wilderness can be a place of freedom (Cooper, 2012).

tiously to ensure coordinated 'dancing at the interfaces' (ibid), and not step on each others' toes. This contribution has pointed out some innovations at the borders of knowledge systems. The theory and praxis that Māori, in particular, are contributing to the discourse and practice at the interface is prodigious. As such, the bibliography provided here constitutes perhaps a helpful reading list, but is just the tip of the iceberg in relation to mātauranga and science activity.

The most successful projects that engage with mātauranga: address a problem of shared concern so that there can be equal input from contributors; cannot be solved by one knowledge system alone; have equitable outcomes; build capability and capacity; are underpinned by Treaty principles such as protection and partnership; have Māori in leadership roles; and crucially, are injected with human values of honesty, truth-seeking, kindness, generosity and humility.

Many efforts have contributed to developing a way of doing science that is moderate, reflexive and uses respect, dialogue and negotiation at the borders of knowledge systems, not incursion or mining strategies. First, we should continue strengthening and revitalising mātauranga Māori. Second, the position and autonomy of mātauranga in relation to science should be strengthened. Rather than science doing the unlocking, we must ensure mātauranga has its own rangatiratanga (autonomy) (Broughton & McBreen 2015), its own right to selectively unlock and reveal. Finally, with an awareness of historical pitfalls, and with several Indigenous-led tools (such as definitions, models, frameworks, principals and ethics) for doing research here, working with mātauranga and science can be interesting, mutually enlightening, paradigm-shifting and transformative.

Glossary

Atua	god, phenomenological power
Hapū	sub-tribe
Iwi	tribe
Maramatanga	understanding
Marautanga	curriculum
Matau	to know, to understand, to feel certain of
Mātauranga	Māori knowledge, knowing, epistemology
Mauri	life force, vital essence
Mōhiotanga/mōhioranga	know-how, common knowledge
Orioi	song that recounts a historical event, epic historical tale
Pangarau	mathematics
Pūrākau	stories, narratives
Pūtaiao	science, 'Western science'
Rangatahi	young people
Rangatiratanga	leadership, self-governance, autonomy
Tamariki	children
Taonga	treasure
Te Ika a Māui	The Fish of Māui, North Island
Te reo Māori	the Māori language
Te Tiriti o Waitangi	the Treaty of Waitangi
Tikanga	values, rituals
Tohunga	priest, expert
Waiata	song
Whakapapa	genealogy
Whakatauki	proverbial saying
Whare wānanga	house of learning

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