Indigenous Knowledge and Science. A New Representation of the Interface Between Indigenous and Eurocentric ways of Knowing

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He Whakarāpopoto

Ko te tūāpapa o te taha "pūtaiao hauāuru" me te "taha mātauranga ā-tangata whenua" me te noho tahi mai o "kanohi kitea tahi" i roto i ēnei whakataunga ē rua, e tohu ana i te hohou nuku o te pūtaiao ki roto i te ao Hauāuru Pākehā, tuarua, ka whakaritea he taumata e āhei ai te taha mātauranga o Pākehā tuku iho kia hahua kia kaua e wareatia. Me te mea nei e kitea ana te hanga pai o te mahi tahi mai o "kanohi kitea tahi," Ko te tino rangatiratanga mō ngā tāngata whenua kāore e tino tipu tika, e, noho pōnānā ai te tino whakaū o te taha mātauranga tangata whenua. Ki roto i ēnei uauatanga, ko tēnei tuhinga whakapae e whakaatu ana i tētahi tohu ariā, kia whakahoutia ake te karanga "kanohi kitea tahi" i waenga i te taha "hauāuru pūtaiao" me te mātauranga tangata whenua, e āhei ai te whakawhitiwhiti mō ngā ritenga e kī ana te "pūtaiao" me te "mātauranga," e mata kitea ana te āhua me te tohu mai o te taha ariā pūtaiao i tipu ake mai i ngā orooro o te tangata whenua me te hanganga o te mātauranga Māori. Ko tēnei tuhinga whakapae ka whakarāpopoto i ngā tirohanga e rua, momo mātauranga e noho mai ana i te "kanohi kitea tahi" e kato kōrero mai ana i tā te Māori momo mātauranga me te taha o te tau ahupūngao.

Abstract

The dichotomisation of Western science and indigenous knowledge and subsequent invention of an interface between these two ways of knowing firstly provides a framework that retrenches science in the Western European world, and secondly, sets up a platform from which the European academic tradition can potentially mine indigenous knowledge with impunity. While indigenous and non-indigenous people alike see the promise of working at the interface, tino rangatiratanga for indigenous peoples at this knowledge frontier becomes less assured, whilst the boundaries about what constitutes indigenous knowledge remain undefined. In light of these difficulties, this article suggests a conceptual reframing of the so-called interface between Western science and indigenous knowledge, that allows greater freedom of exchange between notions of what constitutes science and knowledge, inviting reflection upon the nature and extent of scientific philosophy embedded in indigenous, and particularly Māori, knowledge creation. The paper will also briefly discuss two new and distinct educational initiatives that sit at the interface, drawing from both a Māori knowledge, and a physics paradigm.

Introduction

The interface between science and Māori knowledge presents an exciting and new frontier of exploration, which has attracted New Zealand Government investment via the Foundation for Research Science and Technology and the Te Tipu o te Wānanga portfolio. One of the four main goals for Te Tipu o te Wānanga is "Enabling the vitalisation and evolution of mātauranga Māori (Māori knowledge) and exploring the interface between indigenous knowledge and other knowledge streams particularly science and technology" (Foundation for Research Science & Technology, 2007). While it is encouraging that mechanisms are established for research in this area, retention of tino rangatiratanga over Māori knowledge by iwi and hapū is a concern. This is the primary focus of the Waitangi Tribunal indigenous flora and fauna and cultural intellectual property inquiry (Wai 262) and behind the government's signal to develop a policy on bioprospecting in Aotearoa New Zealand.

At one extreme, Deloria argues that one of the concerns "in bringing non-Western traditions within the scope of serious scientific perspective... is the inherent racism in academia and in scientific circles" (Deloria, 1997, p.34). This often has the unfortunate effect of science, or rather, scientists, taking credit for traditional knowledge, highlighting, "a fundamental struggle over the question of authority, since even when Indian ideas are demonstrated to be correct there is the racist propensity to argue that the Indian understanding was just an ad hoc lucky guess – which is perilously close to what now passes for scientific knowledge" (Deloria, 1997, p.45). Allaying this anxiety is a key challenge for scientists. However, at the other extreme is the potential for knowledge revitalisation and the documentation of indigenous knowledge (IK), for the immediate and long term benefit of local communities.

Durie's discussion on research at the interface (Durie, 2005, p.141) positions the interface in the intermediate space on a linear continuum between IK and science, accentuating the assumed polarity of the "colloquial dyad"

(Aikenhead & Ogawa, 2007, p.540). Others represent the interface between western science (WS) and IK with a Venn diagram intersection, WS occupying one geometric space and IK the other (Barnhardt & Kawagley, 2005, p.16; Roberts, 1996, p.61). However, Agrawal argues that the separation of these two knowledge forms is fraught as he states:

> the classification into Indigenous and Western knowledge fails not only because there are similarities across these categories and differences within them... it seeks to separate and fix in time and space... knowledge systems that can never be so separated or fixed.
> (Agrawal, 1995, p.3).

Taking a lead from this sentiment, Nakata shifts the nexus to an experiential one, calling "the intersection of the Western and Indigenous domains the Cultural Interface" (Nakata, 2002, p.285). In this space:

> traditional forms and ways of knowing, or the residue of those, that we bring from the pre-contact historical trajectory inform how we think and act and so do Western ways, and for many of us a blend of both has become our lifeworld.
> (Nakata, 2002).

This resonates with the geographical conception of knowledge put forward by Turnbull, who argues that the decentering of knowledge from the Eurocentric position of ownership is first necessary for negotiating knowledge interfaces, or "a third space, an interstitial space" (Turnbull, 1997, p.560).

In this article I suggest a new representation of the interface that is sympathetic to Nakata's concept of a cultural space, one that is informed by different cultural influences. This proposed model also allows for greater freedom of movement between the Western European and indigenous forms of knowledge and science, potentially destabilising the Eurocentricity criticised by Turnbull. This article will also give voice to unwritten traditions by examining a case study in which misinformation resulted from the privileging of written knowledge over oral testimony. From this reminder, I will discuss issues of tino rangatiratanga at the interface and introduce a new conceptual model of the interface and apply the model to two interface projects. Through this discussion, I will demonstrate that more open frameworks for IK, science and wisdom and its interaction with Western forms of knowledge, will aid us in advancing projects at the interface.

Is Rongoā Māori Pre or Post European?

Issues around knowledge ownership that arise when drawing from both knowledge systems are never more painfully crystallised for indigenous peoples than in cases where unwritten histories are challenged, or even dismissed, by written knowledge. In March 2006, Bob Brockie published a *World of Science* column in the Dominion Post, its headline asserting that *Early Māori had no herbal medicine* (Brockie, 2006, p.B6).

Brockie's key argument, only a little less sensational than his headline, is that before European contact Māori "*were quite good at dealing with external injuries... but were not so hot at dealing to internal ailments, for they believed these were caused by offending tapu, by evil spirits or by the evil eye, makutu*" (Brockie, 2006, p.B6). This position is generally supported by the writings of Elsdon Best and Peter Buck. While Best is somewhat reserved "*Very few internal medicines were used by the old-time Māori*" (As cited in Goldie, 1904, p.2), Buck seems particularly single minded, "*with few exceptions, all the so-called Māori medicines have originated since the advent of the Europeans*" (Buck, 1910, p.67). Buck's position was informed by his medical thesis research that was undertaken a few years after the passing of the 1907 Tohunga Suppression. Since practices associated with Māori medicines had just become outlawed it is highly questionable whether his informants were able to speak freely to Buck of their craft.

Brockie claims that "much of the evidence against the existence of early Māori herbals is summarised in Laurie Gluckman's book Tangiwai" (Brockie, 2006, p.B6). Surprisingly however, Gluckman himself is actually ambivalent on this argument, and writes "It is hard to believe the intellectual Tohunga ...did not have some therapeutic skill and knowledge. The esoteric practices of Tohunga Ahurewa would be difficult of observation in any event. They may have been deliberately concealed from European observers" (Gluckman, 1976, p.151). The tohunga were likely to have jealously protected the knowledge of rongoā, partly out of fear of the knowledge losing its tapu, or possibly, because individual tohunga may have wanted to retain a monopoly on their enterprise:

> That we can estimate, with any degree of accuracy, their dexterity or versatility in preparing and compounding drugs, is impossible owing to the great secrecy with which such manipulations were carried out. The tohunga ... did not wish others to participate in his knowledge – or gains.
> (Goldie, 1904 as cited in Riley, 1994, p.9)

The fact that no written records of wairākau (herbal medicine) have been found does not disprove its existence. You cannot record that which is hidden. Furthermore,

ethnographers expecting to find medicine receptacles as evidence of wairākau Māori were misled and probably sorely disappointed by their own, Western, medicinal conventions. Tohunga harvested wairākau from the forest on a case by case basis, and with dedicated karakia for the particular tūroro (patient) in need. Wairākau was not stockpiled or produced en-masse.

Another difficulty with Brockie's position on Māori herbals is that many of the early ethnographers only had access to, or chose only to record, the practices of men. And yet oral histories report generations of women having the roles of kaitiaki of rongoā and wairākau. Cook's 1774 observation of the preparation of a therapeutic steam infusion (Cook, 1955) and Rutherford's 1820 report of poultices being prepared for his battle wounds (Gluckman, 1976, p.152) all speak of women as principal actors in these medicinal remedies. While none of these accounts detail internally imbibed concoctions, the neglect of 'herstory' is a typical 19th century experience and continues to impact negatively upon the state of our anthropological knowledge, as typically recorded in writing, by men. Women's practices related to internal medicines have been more recently documented, whether focussed on preventative health care through detoxifying drinks (Moon, 2005, p.126), or internal remedies for more severe, gastrointestinal afflictions (Riley, 1994).

Even if, for argument's sake, internal, herbal, remedies for illness were more a feature of post-contact times, the vast quantity of Māori medicinal remedies now documented would represent an explosion of Māori research and development, suggesting prior knowledge and experience with the diverse qualities of different rākau. What the Brockie article highlights when considering the interface between Māori and Pākehā medicinal knowledge is how easy it is for the coloniser to claim mātauranga Māori as his own, if not written down. In addition, the privilege of documentation allows the Western world to take credit for the scientific techniques of trial and error, experimentation, and theory implementation that is just as much a feature of Māori knowledge development as it is of Western knowledge development.

How can Māori achieve tino rangatiratanga at the interface if the extent of Māori knowledge is not appreciated? How do Māori participate at the interface when their knowledge is culturalised, spiritualised, but never intellectualised? The Best-Buck-Brockie view that the power of a tohunga came from the atua is an over-romanticisation. Tohunga Māori, while imbued with spiritual understanding, were also in tune with the physicality of the natural world. To think that oral traditions apply only to the spiritual realms is a misconception, as Deloria argues in relation to similar experiences in North America, "The bulk of American Indian traditions probably deal with commonsense ordinary topics such as plants, animals, weather, and past events that are not particularly of a religious nature." (Deloria, 1997, p.36). It is thus timely and needful for those claiming knowledge of te ao Māori to feel the weight of oral tradition, whether the specifics are remembered by the surviving generations, or not.

However, the need for Māori to pursue anti-colonial strategies (Simpson, 2004) in the recovery and revival of mātauranga Māori competes against globalising economic pressures. This tension has been brought into sharp focus recently with the New Zealand government's call, through the Ministry for Economic Development, for the country to develop its own bioprospecting policy. The development of this policy has attracted criticism with regard to the Eurocentric framework in which dialog has been driven, an inadequate consultation period and suspicion that concerns will be listened to but ultimately bypassed. In addition, the pervasive use of terms such as *harnessing* and *capture* (Ministry of Economic Development, 2007) tend to ring alarm bells in the ears of indigenous peoples, who have suffered the ill effects of their traditional knowledge being *captured* by others (Simpson, 2004).

Projects at the interface

Work at the interface, then, as Mason Durie argues, must not be done without clear acknowledgement of the validity of both knowledge systems, and clear guidelines around benefit sharing (Durie, 2005). Durie suggests four principles that should guide an interface researcher, two of which - mutual respect and shared benefits - are also relevant to education at the interface. The interface should ideally be a neutral space, and the mutual respect aspect practised by taking the validity of both knowledge systems for granted. Neither one is set above the other, nor used as a means of measuring the value of the other. The shared benefits consideration dictates, that indigenous peoples should be active participants in interface research, thereby ensuring that indigenous peoples retain control over their own knowledge, and that the benefits flow directly to their communities. Shared benefits at the interface arise from the input of two knowledge systems, both of which are striving to create new knowledge within their own established guidelines; primarily values-based for IK and primarily naturalistic models-based for WS.

While research and education at the interface has the potential to realise the best of each world, we must accept that the loss, and at times deliberate concealment of oral knowledge, might mean a degree of 'reinventing the wheel' in our activity. Respect must be given to that which is implicit, embedded and possibly even hidden within oral traditions and latent tribal memory.

Tino rangatiratanga at the interface

Amidst all the talk of WS, we should ask to whom then, do the techniques of science *belong* (Kawagley, Norris-Tull & Norris-Tull, 1998)? Indigenous peoples have survived millennia, living in synchronicity with their environment thanks to mature and highly developed philosophies. By contrast the "immature cosmology" of the Western Scientific Revolution "spawns immature individual values" (Cajete, 2000, p.59). Recent discussions that use the term WS do so to emphasise that science has its own cultural heritage and a tumultuous history of critique, oppression and persecution. However it also serves to divorce non-Western knowledge from science and from an association of rational and valid way of knowing, or at least in the minds of those embroiled in the Western scientific enterprise. Roberts points out that there are about as many similarities between WS and IK as there are differences (Roberts, 1996). In doing so, she suggests that there's nothing peculiarly Western, or European, about many of the aspects of science. It is similarly argued that, "science in the general sense of systematic knowledge was never uniquely Western, having its origins in a wide variety of cultures including Islam, India and China" (Turnbull, 1997, p.552). Though these scientific processes may not be documented, it is not a leap of faith to claim that trial and error, observation, experimentation, hypothesis-making and theoretical frameworks, were all endeavours critical to the accumulation of traditional Māori knowledge. So if aspects of WS are actually generic to indigenous peoples, then one might also argue that areas of the *unexplored* interface are already occupied by indigenous processes and methods. Indigenous people, and Māori specifically, should thus feel well within their rights to exercise tino rangatiratanga over that interface, and it behoves us now to examine more closely how the interface could be better represented to contribute to that goal.

A Framework for Science and Knowledge

In an effort to reframe thinking around the IK and WS separation, this article suggests a re-conceptualisation around the grouping of the terms knowledge, indigenous, science and western. In doing so, the author acknowledges that "Indigenous knowledge is not a uniform concept across all Indigenous peoples:" (Battiste & Henderson, 2000, p.35) and that terms such as Indigenous Wisdom are becoming more widespread. It was recently suggested that more appropriate alternative terminology for IK might be "Indigenous Ways of Living in Nature" (Aikenhead & Ogawa, 2007). The potential utility of this term is acknowledged: it avoids critiques that have been levelled at the term Traditional Ecological Knowledge (TEK), the *Traditional* suggesting that IK is somehow fixed in time, and *not* the cumulative and dynamic system of understanding the world (Battiste & Henderson, 2000, p.45; McGregor, 2000), and it strips away Eurocentric values around the commodification of knowledge, as an object subject to ownership (Aikenhead & Ogawa, 2007). However, partly to avoid invoking colonial images of naked tree-hugging natives (living in nature), and partly to forestall discussions of wisdom in comparison to knowledge this discussion persists with the more pervasive and still prevalent term IK.

Figure 1 displays a compass-point diagrammatic representation of the interface, which positions science and knowledge along the vertical axis and two unique cultures at opposite ends of the horizontal axis. The latter forms a continuum along which the *cultural interface* idea is represented (Nakata, 2002). It thus divides the spectrum into four quadrants, labelled IK, IS, WS and WK, within which different forms of science and knowledge can be positioned appropriately, depending on which culture *owns* that form of knowledge. A two-tiered central area denotes a region of interaction. The middle circle represents the interface, where the knowledge and/or science from both cultures would be drawn upon fairly equally. However, research could be positioned at one side of the circle or another, depending upon whether it is a project that uses IK to supplement WS or vice versa. The penumbral circle represents an area in which some interaction between ways of knowing occurs, but there is a clear bias toward one or the other.

Positioning science at a point equidistant and at right angles from the two cultures invites reflection on the extent to which each culture engages in scientific activity. Science is a systematic means of producing knowledge, and as such can be seen at extremes, to be distinct from the knowledge base. As a knowledge production enterprise, a definition for science that encompasses three basic elements - observation, experimentation and theory, is adopted here. While the European world restricts itself to independently verifiable sensory observations, Indigenous science may accept single occurrences, such as dreams and visions, as viable observations.

The dashed lines (Roberts, 1996) denote some permeability and flexibility of the boundaries between different sectors. This also allows for an area (the interface) in which distinctions such as Western and indigenous become meaningless, and also allows for the areas of similarity between IK and WS. A boundary-less inner circle denotes a region of free-flowing interaction between indigenous and Western knowledge and science. Projects positioned within this area should satisfy Durie's four requirements for interface research and furthermore are brokered by trust:

The future for local knowledge traditions is, I believe, dependent on the creation of a third space, an interstitial space, a space in which local knowledge traditions can be reframed, decentred and the social organisation of trust can be negotiated. (Turnbull, 1997, p.560)

Societal values and economic imperatives inform the knowledge creation process (science). While Western/ European and indigenous values are generally seen as quite divergent, the linear continuum allows some area of similarity and overlap in the centre.

The cartesian system of coordinates could be extended into the third dimension to incorporate other cultures, such as the East. This three dimensional space might also be usefully adapted in the imagining of an interface between knowledge and science in the so-called First world (developed), Third world (developing) and Fourth world (indigenous), although these groupings are contested and strongly based in a particular economic paradigm that was invented for a localised period of history, the Cold War.

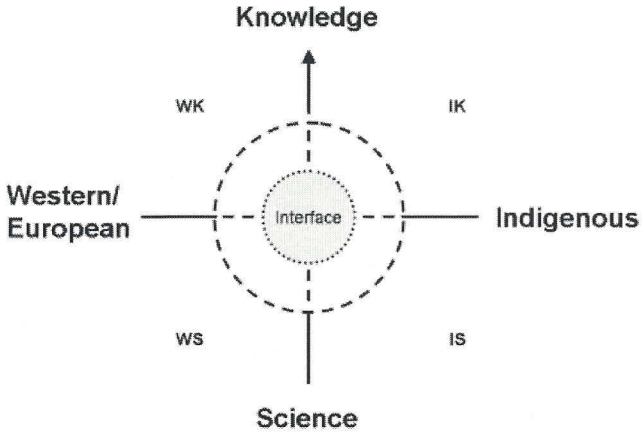

Figure 1: A 2-dimesional conceptualisation of the interface between the knowledge and science of Western/European and indigenous communities.

An interesting further 3-dimensionalising of this diagram might occur if we consider, from an information technology perspective, the pyramid-shaped relationship between data, information, knowledge, understanding and wisdom. While the concept of wisdom being a pinnacle that staircases upwards from information, then knowledge, dates back to T. S. Eliot, the data, information, knowledge and wisdom "DIKW" hierarchy was first suggested in the late 1980s in parallel by Zeleny & Ackoff (1987). Ackoff further developed the idea of a pyramid-like hierarchy with the addition of understanding inserted between the levels of knowledge and wisdom, or DIKUW (Ackoff, 1989). Envisaging the DIKUW pyramid in combination with the circular cultural interface of figure 1 invites us to consider a cone as an appropriate 3-dimensional shape, conceptually invoking complex cultural interactions in the DIKUW paradigm. The above diagram could be seen as a horizontal slice at the knowledge/understanding section of the cone. It could be argued that while the European world's conic section is bottom heavy with data (the result of observation), information (the result of experiment) and knowledge (the result of analysis), the indigenous world's section is top heavy on understanding (the result of theory) and wisdom (the result of all previous factors and intuition).

Interface Education and Research

Promoting Māori participation in physics

The Te Reo Māori Physics project unites te reo Māori, physics and multimedia (Lukefahr, Hannah, Mercier & Richardson., 2007). The research team has produced more than a dozen short educational films that explain physics principles, mostly related to electricity and magnetism. These films are free for internet download at http://www.tereophysics.school.nz (Lukefahr, Hannah, Mercier, Higgins & Richardson, 2006) and serve as a teaching and learning resource in the NCEA system. The physics links traditional Māori knowledge and contemporary experiences of Māori and Pacific students with technology. The webpage accompanying each film contains supplementary material and other links for the physics concepts covered.

Work in the project's film design is potentially clearing a pathway for exploring the cross-cultural expression of physics concepts, by translation into te reo Māori and incorporation of Māori knowledge. This has the potential to create new knowledge at the interface, drawing from each of the two surrounding knowledge systems. The additional aim is to find ways in which to promote each and both, without devaluing the other, thereby encompassing Durie's recommendations of mutual respect and human dignity. While we may never fully understand the extent to which the legend of Ngatoroirangi obtaining thermal heating is encoded with specific scientific principles, by presenting this cultural knowledge alongside the explanation from the physics paradigm, the oral tradition is normalised and intellectualised. This encourages a culture of equal legitimacy for the knowledge systems, which can be envisaged as running parallel and providing alternative and complementary glimmers of our world.

In the compass-point representation, this project would principally sit on the WS side of the interface penumbra. In essence, the project is about promoting physics education. With a view to promoting Māori participation in particular, the project also aims to encourage the creation of new knowledge, at the interface, by young scholars, albeit further down their career paths. The project also draw on Māori knowledge as the physics concepts are explained in te reo Māori as well as the English language. This then

pulls it in the direction of the IK quadrant, and perhaps even through the permeable boundary, into the interface inner circle.

Parallel worlds: Quantum physics and Māori knowledge

While science methodology and philosophy is often seen as light years from Māori ways of knowing, there are some interesting parallels between quantum physics and mātauranga Māori. In the Tao of Physics, Capra writes:

> theories of atomic and subatomic physics ... revealed a basic interconnection of matter, showing that energy of motion can be transformed into mass, and suggesting that particles are processes rather than objects. All these developments suggested that the simple mechanistic picture of basic building blocks had to be abandoned, and yet many physicists are reluctant to do so.
> (Capra, 1975, p.315)

Capra here bemoans the fact that many physicists who struggle to grapple with the new physics do so because of a lack of creativity, and a lack of inclination or ability to think in a more emergent way. Thermodynamics describes the processes by which matter above absolute zero temperature is constantly in motion with kinetic and potential energy that can be converted into other forms of energy. Modern physics takes this one step further and posits that matter itself can be dissolved into energy bites by relativistic quantum processes. In doing so, it has accepted an ontological fluidity that allows the tangible to become intangible. This is not dissimilar to the way in which Māori recognise that all things with tīnana (body, or mass) also contain mauri (energy, or life force) (Best, 1934). This mauri makes inanimate things alive and gives all matter potentiality, whether they are biologically classified as living or non-living. Understanding and reading mauri is the domain of certain kaitiaki and being able to manipulate mauri flow is the domain of a tohunga or one who has access to the atua.

A recent Dominion Post article, headlined *NZ Rose Out Of The Sea* detailed *controversial* geological research which suggested that, rather than drifting to their present position, Aotearoa New Zealand's islands were "underwater till 23 million years ago" (Fawkes, 2007, p.A1). An oft-told Māori legend describes Māui's feat of snaring a great fish, what became the North Island, from the ocean, and hauling it above the water from his waka (boat). The waka, according to Ngāti Porou tradition, was subsequently stranded on the East Coast maunga (mountain) known as Hikurangi. The subheading of the article *Research Could Rewrite Prehistory* gives complete deference to the written Western tradition and nowhere in the 3-columned article is the Māui account of Aotearoa's geological history mentioned. What, or who, were evolutionary theorists inspired by? Bohm & Peat argues that, in order to continue, science must have its creative moments (1987) Science itself then is dependent upon creative, *non-rational* thinking. The move from Newtonian to Einstein's physics took a creative lateral leap beyond established scientific norms. For instance, suggesting that light travels at the same speed relative to us, no matter how close to the speed of light we ourselves get, makes no sense in a Newtonian paradigm. But in physics, models of our universe just work better when this creative assumption is taken on faith. But it begs the question, where did these physicists get their inspiration? Is credit given where it is due? How much difference is there between the idea of Māui fishing up the North Island of Aotearoa and evolutionary processes thrusting Aotearoa's land mass up from the sea?

In *Blackfoot Physics* Peat explores the interface between physics and aspects of the Blackfoot, Mayan and Cree knowledge systems (Peat, 2002). As so many before him do, he acknowledges that a key distinguishing feature of Western science is that it sets out to, in Huxley's words, weigh, measure and otherwise quantify (Huxley, 1958). Whereas, indigenous knowledge aims to understand the world in a holistic way that acknowledges the influence of things that cannot be measured by tools, machines or implements of our making. The impact of the unquantifiable spirit, wairua, or mauri, may be unmeasurable in empirical terms, but that does not mean it cannot be quantified if the right instrument is properly attuned to it.

Peat is a Western-trained theoretical physicist who manages the thinking between two knowledge systems, not by trying to bring them together at an interface, but by slipping into a different mode of thinking for each one, much like, as he puts it, moving between languages. One area in which he sees quantum physics owing a lot to native ways of thinking is expressed in the following quote:

> According to quantum field theory, a photon cannot be emitted unless something is already there to receive the emission. Indeed it is not so much that the photon leaves the star and enters the eye, but rather that eye-consciousness and star lose their separate distinctions within an overall quantum process.
> (Peat, 2002, p. 212)

What he means by this, flipping the idea into a Māori context, is that in both quantum physics and Māori understandings, there is a relationship between the observed and the observer. In this contention, there can be no such thing as objective knowledge. Indeed, in a quantum universe, it is impossible to be objective when making an observation, or taking a measurement of

something, because your observation or measurement as an observer affects the behaviour of that which is being observed.

Recently the third chapter of the movie *What the Bleep do we Know?* (Vicente, Chasse & Arntz, 2005) has proved to be a valuable teaching resource. This chapter opens with a scene in which the main character, played by Marlee Matlin, is invited onto a quantum basketball court to shoot some ball. In a quantum realm, not so far removed from our every day reality as you might think, a shot at the basket has the potential to do any one of a number of things: bouncing through the hoop off the backboard, airing it on the full, or missing the rim entirely, to name just a few. The picture given is that until we make an observation of the event, all of these events are not just possible, but are *actually happening simultaneously*. In a quantum paradigm (in this case, the basketball court) all moves are possible, and until we *look* or *listen* or otherwise *observe*, the basketball is in many places at once.

This concept is most simply expressed mathematically by considering the electron. An electron has two spin states, usually named *up* and *down*. Now, as far as the electron is concerned, it can be in either state, and the actual state it is in is irrelevant until we actually *look* at the electron, or take a measurement of its state. Until then it exists in a probabilistic state, where it is actually *both* up *and* down. What this means then is that when we make an observation, we force the electron to choose one state or the other to be in. Our interaction with the object forces it to change its own behaviour as a reaction to our interference.

The theory-ladenness of observation principle (Riggs, 1992) states that the acquisition of objective knowledge is hampered by the influence of one's preconceptions. Even the supposedly *value free* enterprise of data collection can be coloured by different peoples' perceptions of the data, which are seen through a cultural lens or filter. The make up of this filter is based on a person's life experiences. Contrast this with Measurement Theory, which says that the act of observing a system influences it. The two principles are similar in their statements that objective knowledge is hidden in some way. In the theory-ladenness principle, the mechanism is our differing interpretations of the data. In Measurement Theory our measurement actually changes the data.

When scientists from Waikato University asked the tohunga Hohepa Kereopa, his advice on taking samples of flora used in Māori medicines for study in a laboratory, he retorted "If you want to study kumarahou, go up to Nga Puhi" (Kereopa, 2003). It is innately in the worldview of this Tūhoe tohunga that complex things should not be taken out of context and studied in isolation. The very qualities that matter most to the plant's healing influence, mauri, for instance, are inextricably tied to place. Take them out of that environment, and all of the mechanistic machinery of science will not find the source of kumarahou's potency. There are resonances of Measurement Theory in Kereopa's caution. If you observe a thing, you are bound to fix its behaviour in some way. Might such infinitesimal properties as mauri be a part of that quantum paradigm, alongside the electron, which are directly affected by measurements and experiments? Try to measure mauri in a laboratory. Who is to say that that form of measurement is not fixing the mauri in a kind of *dead* or *dormant* state in which it can do no good? Remember the basketball. The only way to score a basket is to interact with all of the quantum possibilities in such a way, with such a measurement or observation as will allow the ball to act accordingly. The influence on mauri of our intervention is as yet unquantifiable.

Discussions around quantum physics and Māori knowledge occupy an interesting space on the interface diagram. Modern science is now putting into mathematical formalism a form of wisdom that seems second nature to indigenous peoples. It continues to be a fascinating area for future exploration.

Tino rangatiratanga at the interface

So what is the relevance of tino rangatiratanga and research at the interface? What is the state of sovereignty, or self-determination, for Māori in this area encompassing the interface between physics and Māori knowledge? In order to answer, or even just consider, this question, we should be asking what constitutes Māori knowledge?

In the Te Reo Māori Physics project, researchers have attempted to maintain tino rangatiratanga over the films produced by ensuring that it remains Māori-led and owned. Four key members of the research team, including the reo expert, the teacher, the educationalist, and one of the three physicists and multimedia experts, are Māori. All students involved are Māori. The Māori language is seen as paramount. The researchers intend to explore and identify the various forms of Māori knowledge that resonate with and complement learning in physics.

If Māori are willing to continue to claim ownership of the useful tools that the Western world has to offer, as we did in early contact times (Harris & Mercier, 2006), then we can move science itself into interesting spaces and new frontiers - spaces that are hinted at by Bohm & Peat (1987) when they speak of science needing to incorporate a more creative and holistic approach.

However, much Māori knowledge remains undocumented and perhaps even undocumentable as its carriers and keepers pass away. Workers at the interface should therefore be sensitive to the possibility that new knowledge in this space may actually just be rediscovered knowledge and thus have previously belonged to the mātauranga Māori paradigm. There are strong implications regarding intellectual property that arise from this

eventuality. My recommendation, amidst the global interest and scrutiny around what goes on at the interface, is that Indigenous peoples are the first to investigate it and claim tino rangatiratanga in this space.

Concluding Remarks

Where is the frontier of physics? Have Māori and indigenous peoples been thinking physics too, alongside their Western counterparts? While the European world developed a mathematical language for their form of physics, what discipline enabled Māori and indigenous peoples to frame their physics within?

Physics is one of the last of the scientific disciplines to be interfaced with indigenous knowledge, and Māori knowledge in particular. Does physics represent a final frontier in our exploration of this new landscape? For those few of us whose research interests span the divide between Māori knowledge and physics, are we boldly going where no person has gone before? Whose landscape is it for the exploring anyway? Has it already been explored, and just not been charted or written about in Western ways? If the interface is old ground for some, is the interface then new ground for colonising practises? Or are we both, indigenous and Western European peoples, looking over each others' fences at the greener grass on the other side, and thus well able to mutually capitalise and benefit on any knowledge sharing?

In order for Māori to feel comfortable with research in an area that ostensibly draws on two knowledge systems, but potentially is drawing from methods that have been called Western under a misapprehension of the extent of scientific activity in Māori knowledge creation, I would argue strongly that a kaupapa Māori approach (Bishop, 1998) to interface research is the ideal.

If activity at the interface is about enhancing Māori knowledge with the use of Western tools of our own choosing, well and good. If activity at the interface is about indigenous ways of knowing, having an influence in shaping Western paradigms of science into something more meaningful, more able to get to the heart of ontological questions, well and good. But I fear we must be vigilant against work at the interface which, at face value, seeks to validate indigenous knowledge, but really means the exploitation of traditional knowledge from within a Western framework. There is a very real danger, that "Like colonization, the Indigenous Knowledge enterprise seems to have everything and nothing to do with us." (Nakata, 2002, p.282). Taking a kaupapa Māori approach to the interface, that research be undertaken *by Māori*, could go a long way to alleviating this anxiety. Disentangling the science from the WS in the compass-point framework suggested here, should also better enable us to speculate on as-yet undocumented scientific practise in the indigenous realm.

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Endnote

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