

Knowledge, mātauranga and science: reflective learning from the interface

Caroline Saunders^a, Paul Dalziel^a, John Reid (Ngāti Pikiao, Tainui)^b and Andrew McCallum^c

^aAgribusiness and Economics Research Unit, Lincoln University, Lincoln, New Zealand; ^bKā Waimaero Ngāi Tahu Centre, University of Canterbury, Christchurch, New Zealand; ^cMinistry of Business, Innovation and Employment, Wellington, New Zealand

ABSTRACT

This essay offers reflective learning on how researchers in the Western science tradition connect to bodies of knowledge created and held outside that tradition. It begins with endogenous growth theory, which explains the unique role of knowledge as an input into economic production. The essay describes how Western science addresses the problem of validating and accessing knowledge, by hosting an expanding corpus of peer-reviewed publications. This academic knowledge does not contain all current knowledge. The essay therefore draws on the authors' experience in four large research programmes to consider business knowledge and mātauranga Māori. It reflects on agency, tikanga [right behaviour], global conversations about Indigenous knowledge, and decolonising research. The essay finishes with models of knowledge engagement in the interface between western Science and mātauranga Māori that support the mana and integrity of diverse knowledge streams.

ARTICLE HISTORY

Received 23 August 2022
Accepted 5 April 2023

HANDLING EDITOR

Carla Houkamau

KEYWORDS

Endogenous growth;
interface; knowledge;
mātauranga Māori; science
impact; triple helix;
wellbeing economics

Introduction

The Royal Society Te Apārangi 'has a long and distinguished history of promoting knowledge, in particular of science' (Martin 2017, p. xii). These opening words of the Society's official history are well chosen. While knowledge produced by Western science has been its particular focus, the Society actively promotes other ways of exploring, discovering and sharing knowledge. Good examples are its commitments to engage with the wider innovation community and to partner with Māori research communities to enhance mātauranga Māori (Royal Society Te Apārangi 2018; Theodore et al. 2019; Ruckstuhl et al. 2019). This leads to an important question that this essay explores: how do researchers in the Western science tradition connect to bodies of knowledge created and held outside that tradition?

One influential answer to that question has assumed all knowledge should be *integrated* into Western science. Following colonisation, for example, the imported

CONTACT Paul Dalziel  paul.dalziel@lincoln.ac.nz

© 2023 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

technology of writing on paper disrupted Māori ways of holding mātauranga, which allowed Western scientists to privilege their own interpretations in the science literature (Binney 1987; Ballantyne 2011; Smith 2012). Thus, ethnography has been highly honoured for more than a century (Sissons 1993), while Indigenous studies emerged as a canonical field only very recently (Ka'ai 2008; Hokowhitu 2010; Makereti 2020; Commonwealth of Australia and New Zealand 2020). There remain strong pressures towards integration. Academics are rewarded for publishing in science journals (Ruckstuhl et al. 2021) and Indigenous knowledge continues to be treated as a source of insights that Western scientists can use for general benefit (Diamond 2012). The government's Vision Mātauranga policy (MoRST 2005) was a purposeful shift to a more positive and aspirational approach than the previous vacuum (Martin and Hazel 2020); nevertheless, its mission to unlock the innovation potential of Māori knowledge, resources and people can be used to support the commodification and globalisation of mātauranga held by Māori communities (Muru-Lanning 2012, 2021; Stewart 2022). Indeed, pursuit of private benefit has led to practices where 'traditional knowledge is merely taken and packaged into a patentable invention' (Reid 2009, p. 78), despite ongoing efforts to protect Indigenous property rights (Williams et al. 2011a, 2011b; Hudson et al. 2021; Mahuta 2022).

Tā Mason Durie (2004, 2005a) introduced an alternative approach, based on the concept of an *interface* between mātauranga Māori and Western science. This approach is also influential. The Vision Mātauranga policy document, for example, mentioned 'interface' 12 times and the concept is widely valued as an analytical frame; see Martin and Hazel (2020), Ruwhiu and Amoamo (2021), Ruckstuhl et al. (2021) and the 26 essays in Ruru and Nikora (2021a). In this journal, several articles have explored Durie's interface, drawing on mātauranga Māori as a knowledge system with its own mana and integrity, including Broughton and McBreen (2015), Hikuroa (2017), Macfarlane and Macfarlane (2019), Williams (2019), Dobson-Waitere et al. (2021), Stewart (2022) and Edwards et al. (2023). This essay offers further reflections on Durie's interface approach, based on the authors' experience in leadership roles of four research programmes funded between 2013 and 2022 to create and deliver new knowledge on capturing greater value for food and fibre exports from Aotearoa New Zealand (Tait et al. 2016; Reid and Rout 2016a; Dalziel et al. 2018b; Saunders 2019; Saunders et al. 2021; Tait et al. 2023).

The Māori economy holds substantial investments in the natural resource sectors (Nana et al. 2021); hence, the programmes included partnerships with enterprises founded by Te Rūnanga o Ngāi Tahu, Kāti Huirapa Rūnaka ki Puketeraki, Wakatū Incorporation, Tūhoe Tuawhenua and the shareholders of Miraka. Other partners in the research were Fonterra, Synlait Milk, Beef + Lamb New Zealand, Taupō Beef & Lamb, Zespri Kiwifruit, Sustainable Winegrowing New Zealand, the Foundation for Arable Research and the Kelliher Charitable Trust. Thus, the research team operated for a decade in interfaces with partners holding business knowledge and mātauranga Māori. Blundo-Canto et al. (2019) recommend that researchers engage in 'reflective learning' on programmes of this nature to sustain a culture of research impact (in the sense used by MBIE 2019) and to bring research closer to societal needs. This essay follows that advice, focusing on what our science team learned about engaging with knowledge holders outside the academy.

Economics has paid attention to knowledge at least since Hayek (1937). The first section draws on modern-day endogenous growth theory to explain how knowledge

creation and utilisation can make unique contributions to expanding capabilities for wellbeing, followed by a section describing how Western science addresses problems of validating and accessing knowledge, through hosting an expanding corpus of peer-reviewed publications. We label this corpus as *academic knowledge*. Two sections then introduce two other types of knowledge that featured in our research programmes: *business knowledge* and *mātauranga Māori*. The essay offers reflective learning on our engagement with these knowledge types, focusing on agency, tikanga [right behaviour] and global conversations about Indigenous knowledge, with a separate section on the existing process of decolonising research. The final section returns to differences between the integration approach and the interface approach for engagement between Western science and other knowledge systems. Our experience supports the interface approach and the section provides models of knowledge engagement in the interface that support the mana and integrity of diverse knowledge streams. The essay finishes with a brief conclusion.

Insights of endogenous growth theory

Economics is concerned with expanding capabilities for wellbeing. To illustrate, the opening sentence of the founding textbook of neoclassical economics states that economics ‘examines that part of individual and social action which is most closely connected with the attainment and with the use of the material requisites of well-being’ (Marshall 1920, p. 1). Solow (1956) advanced that mission through his neoclassical growth model, which demonstrates that growth in per capita production depends solely on technological progress. Solow did not explore what contributes to that progress and so technology remained an exogenous variable in his model.

Romer (1986, 1990) filled that gap, giving rise to endogenous growth theory. His theory demonstrates that mathematical properties of knowledge as an input into production mean knowledge has a unique ability to sustain growth in living standards (Jones 2019). Romer conceptualised knowledge as ‘designs’ or ‘ideas’ that increase worker capabilities. The people who specialise in discovering these new designs are not available for producing economic output; hence technological progress has an economic cost, an important idea absent from Solow’s model.

Endogenous growth theory has powerful implications for policy (Blakeley et al. 2005; Dalziel et al. 2018a, chapter 7). Marshall’s (1920) project was to understand how to increase the material requisites of wellbeing. Romer demonstrates that knowledge – which is immaterial – is the only factor able to sustain output growth per worker. New knowledge can also result in harm to wellbeing. Dalziel (2019), for example, commented on the research that produced the atomic bomb, used in August 1945 to kill tens of thousands of people in Hiroshima and Nagasaki. Marsden similarly recalled the reaction of one of his elders who asked if the scientists who had managed to rend the fabric of the universe in this way knew how to sew it back together again, adding that politicians will always abuse such ‘tapu’ knowledge (Marsden and Henare 1992). This essay does not explore that reality further; nor does it address issues of what might be termed false knowledge; see, for example, the nuanced reflections of Ngāi Tahu scholars, Tau (2001a) and Stevens (2015). Instead, we follow Jones (2019) in recognising that Romer’s model

leads to specific insights on how knowledge can contribute positively to expanding human wellbeing.

First, the endogenous growth model explains why recognising knowledge as an input into economic production is vital for understanding growth in living standards. Knowledge is ‘non-rival in consumption’, since a person using knowledge does not prevent others from using the same knowledge at the same time for different purposes (Stiglitz 1999). Hence, a doubling of other inputs (labour and physical capital, for example) can double output without any increase in the knowledge input. This exhibits the mathematical property of increasing returns to scale, which is a necessary condition for achieving ongoing productivity growth (Young 1928; Romer 1986; Krugman 1991).

Second, Romer’s model addresses the issue of incentives for entrepreneurs to invest in the costly activity needed to discover and develop new ideas. For perfectly competitive firms, the price of output exactly equals the average cost of production, which leaves no financial surplus to fund a search for new knowledge. Further, in the absence of intellectual property laws or some other departure from pure competition, a firm that invests in developing a new idea cannot prevent competitors from copying the idea for a fraction of the cost. Thus, models of market innovation typically require some form of monopolistic competition (Arrow 2000), perhaps fostered by public policy.

Third, researchers create novel ideas using the stock of existing knowledge. Hence, a discovery expands opportunities for further discoveries. Competitive markets do not reward knowledge workers for this positive externality, which provides a further rationale for public policy to support science and innovation. This insight also points to the benefits of ensuring that knowledge workers access what Grayling (2021) calls the frontiers of knowledge, in order to reduce wasted research effort. The following section discusses this point further.

Academic knowledge

Popper (1983, p. xxxv) commented that ‘the special thing about human knowledge is that it may be formulated in language, in propositions [which] makes it possible for knowledge to become conscious and to be objectively criticisable by arguments and by tests’, which is how ‘we arrive at science’. Popper’s description is consistent with observations that ‘Māori have always been scientists’ (Matamua 2021, p. 191) and that it is more helpful to think of the connection between mātauranga and the *philosophy* of science (Stewart 2022). We therefore follow the example of Martin and Hazel (2020) and IPCC (2022) in using ‘Western science’ (rather than the generic word ‘science’) to label the system that emerged in Western Europe from the mid-sixteenth century for producing and disseminating what Grayling (2021, p. 9) carefully calls ‘highly credible and well-supported beliefs that we informally call “knowledge”’. This production is now a global activity carried out by researchers of diverse cultures around the world (Royal Society 2014; Larner 2019; Theodore et al. 2019), which places high demands on collaboration and knowledge exchange. Consequently, Western science has adopted norms and protocols to build trust and confidence (Dalziel et al. 2018a).

Following Popper (1959), Kuhn (1962) and Lakatos (1970), this practice can be summarised as follows. Communities of researchers make progress through formulating and

testing propositions within science programmes that accept a hard core of theories as irrefutable, at least for the time being. A paradigm shift occurs when a research community accepts evidence that an alternative way of framing their science appears more promising. Researchers publish their results after peer review to confirm, among other things, that the manuscript cites previous publications relevant to its research question (acknowledging the ways in which this process has held back Indigenous scholarship; see Movono et al. 2021). This practice ensures knowledge builds on the frontiers of existing knowledge and develops an integrated body of expanding scientific knowledge. The Web of Science Core Collection, for example, has tracked well over one billion cited references in a curated collection of more than 18,000 peer-reviewed, high-quality scholarly journals going back to 1900 (Dalziel et al. 2018a, p. 156).

The aggregate collection of published research can be labelled as academic knowledge; that is, knowledge produced by and for the academy. Figure 1 presents a conceptualisation. AK represents the current stock of academic knowledge. Researchers use this knowledge to create further academic knowledge (the horizontal arrow moving from left to right). The figure assumes the new knowledge is proportional to the size of current knowledge (Romer 1990; Jones 2019). This feeds back into the next period's stock of academic knowledge (the bottom arrow moving from right to left), expanding opportunities for further research and development.

It is not difficult to recognise outstanding scientists working in this tradition who have advanced the frontiers of academic knowledge. The Academy has also found room for researchers whose aspiration is to impact directly on the wellbeing of identified communities. An exemplar from Aotearoa New Zealand is Distinguished Professor Linda Tuhiwai Smith, elected as he Ahurei a Te Apārangi (Fellow of the Royal Society) in 2016. Smith explains her motivations in the foreword to the second edition of her influential text (Smith 2012, p. xi):

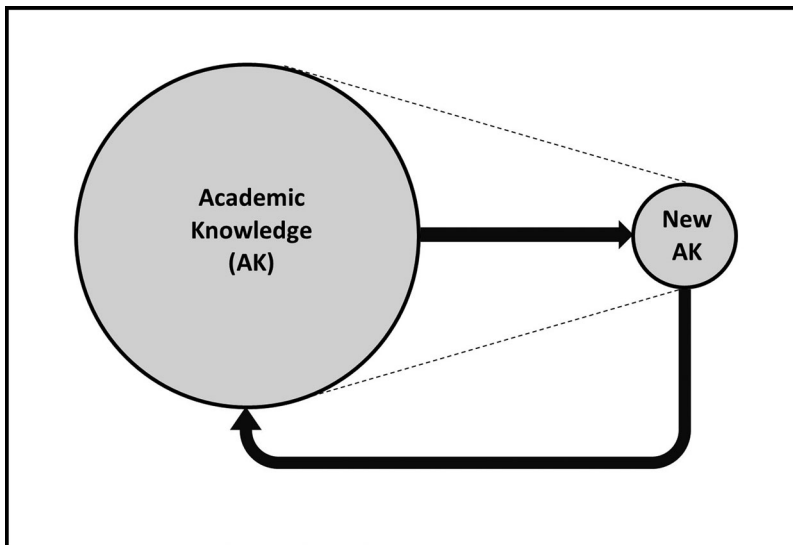


Figure 1. Production of new academic knowledge draws on, and expands, the current stock of existing academic knowledge.

The audience I imagined for the book would be the indigenous scholars, students and activists I had been meeting around the world who were engaged in similar struggles to mine, to develop research that was meaningful for my communities, to find an academic voice and identity that sat well with a strong indigenous identity, to draw together a literature that spoke to the indigenous condition at local, national and global levels, and to develop ideas and resources that would assist our development as peoples and communities.

Smith addresses scholars, but aims also to develop meaningful and useful research for her communities. The relationship with communities moves in both directions, as Smith (2021a, p. xv) explains: ‘I, in turn, celebrate all Indigenous Peoples and communities who have shared with me their stories and knowledge that have been core to my life and work over the past two decades’. The two elements highlighted by Smith – delivering knowledge that is meaningful and helpful to communities outside the academy and drawing respectfully on the knowledge held in those communities – have implications for the application of endogenous growth theory by Western scientists. The remainder of this essay reflects on those implications.

Business knowledge

Endogenous growth theory explains how creating new knowledge from existing knowledge can expand capabilities for wellbeing. The depiction in [Figure 1](#) is incomplete, however, since not all knowledge is published as academic knowledge. Thus, the boundary of academic knowledge in the figure does not represent the frontier of *all* knowledge, since it does not incorporate knowledge held outside the academy. This leads to the possibility that researchers can increase their knowledge and impact by engaging with knowledge holders outside the scientific community.

An important example is *business knowledge* held by commercial enterprises. A world authority on this subject is Professor David Teece (Grimes 2016), elected as an Honorary Fellow of the Royal Society Te Apārangi in 2023. Teece (1982, 2017, 2019) created the capability theory of the firm, which explains why business knowledge is a key element of commercial success; see also Haskel and Westlake (2017). Teece’s theory highlights three dynamic capabilities that drive a firm’s entrepreneurial innovation: sensing, seizing and transforming. Sensing is the capability to identify, develop, co-develop and assess technological opportunities in relationship to consumer needs. Seizing is the capability to mobilise resources to capture value from addressing these opportunities and needs. Transforming is the capability for continued renewal of the firm and the industry in which it operates. The dynamic capabilities and their associated business knowledge create commercial value (Teece 2017, pp. 698–699):

The dynamic capabilities approach helps explain why intangible assets, including a firm’s collective knowledge and capabilities, have become the most valuable class of assets in a wide range of industries (Lev 2001; Hulten and Hao 2008). The reason is that knowledge, capabilities and other intangibles are not only scarce; they are often difficult to imitate.

Like Smith, Teece recognises a two-way relationship between holders of academic knowledge and holders of business knowledge. His publications draw on case studies with business leaders, and he engages in ‘translational research’ to provide business executives with access to academic knowledge (quoted in Eckhardt 2018, p. 7):

The academic literature is quite frankly impenetrable to execs and they don't read anyway. ... Few people understand the academic literature very well, and it's not enough to know just one piece of it. You've got to know a lot of different fields to be a useful advisor in the executive world, but I think there is a very valuable role that academics can have.

Mātauranga Māori

Māori enterprises have distinctive characteristics and opportunities (Spiller et al. 2011; Reid and Rout 2016b, 2018; Mika et al. 2019, 2022b; Haar 2020; Rout et al. 2020; Vuni-bola et al. 2021; Dell et al. 2022). Māori entrepreneurship can be understood as 'a differentiated form of entrepreneurship shaped by kaupapa Māori' (Awatere et al. 2017, p. 81; Spiller and Stockdale 2013; Mika et al. 2019). Crucial to this is mātauranga Māori, which Tau (2001b, pp. 67–68) describes as 'simply the epistemology of Māori – what it is that underpins and gives point and meaning to Māori knowledge'. Thus, mātauranga Māori is 'a source of limitless creativity' for Māori entrepreneurs and tribal practitioners (McMeeking 2021, p. 115). Citing Solomon (2005), Durie (2005b, p. 303) states that mātauranga Māori 'recognizes the interrelatedness of all things, draws on observations from the natural environment, and is imbued with a life force (mauri) and a spirituality (tapu)'. This is consistent with global Indigenous knowledge as 'a system of knowledge that integrates indigenous worldviews, values, and experience, and generates a framework for a distinctive environmental ethic' (ibid; see also Viergever 1999).

Mātauranga is held by particular communities in particular places, where it remains connected to 'the people who grew, applied, tested, reworked, recorded, shared and own that knowledge' (Mercier 2020, p. 72). Consequently, some authorities suggest that the generic reference to 'mātauranga Māori' can be problematic (Matamua 2021). McDonald (2021) offers phrases such as 'mātauranga ā-hapū' and 'mātauranga ā-iwi', while Mahuika (2021, p. 151) refers to 'te mātauranga-a-Ngāti Porou'. Whānau are important for holding and passing on mātauranga (Tau 2020; Jackson 2021; Kukutai 2021; Pitama 2021; Watene 2021; Kitson 2021). Māori express mātauranga in diverse ways, including through material art and kōrero tuku ihi or oral traditions (Mahuika 2012; Ruru and Nikora 2021b).

Mātauranga is a taonga [treasure] covered by Article 2 of te Tiriti o Waitangi (Martin and Hazel 2020), which is clear on who exercises authority. The following is the Māori text, with the English translation provided by Professor Sir Hugh Kawharu (both from <https://waitangitribunal.govt.nz/treaty-of-waitangi/>).

Ko te Kuini o Ingarani ka wakarite ka wakaee ki nga Rangatira ki nga hapu-ki nga tangata katoa o Nu Tirani te tino rangatiratanga o o ratou wenua o ratou kainga me o ratou taonga katoa.

The Queen of England agrees to protect the chiefs, the subtribes and all the people of New Zealand in the unqualified exercise of their chieftainship over their lands, villages and all their treasures.

Agency, tikanga and indigenous knowledge

The first lesson from our programmes emphasises the *agency* of research partners. It is standard ethical practice, of course, for researchers to 'safeguard the health, safety,

wellbeing, rights and interests of people involved in or affected during the conduct of their activities' (Royal Society Te Apārangi 2019, p. 4). This lesson involves a further step that requires researchers to understand and respect that partners create business knowledge and mātauranga Māori for their own purposes. Business knowledge, for example, is costly to create and has commercial value. Hence, enterprises may be cautious about sharing their knowledge with researchers, or may be unwilling to fund research for new knowledge that will become freely available to competitors through academic publication. In two of our case studies, Lincoln University acknowledged this by signing non-disclosure agreements requiring the research team to hold in confidence any provided knowledge that a partner identified as commercially sensitive. Although not applicable in our own studies, a research team may also agree that new knowledge discovered in a project will not be published until partners (including the university) can consider whether the knowledge should be protected as intellectual property.

Similarly, the guarantee of tino rangatiratanga in te Tiriti o Waitangi requires Crown-funded researchers to respect the chieftainship exercised by holders of mātauranga Māori (Broughton and McBreen 2015). A community may choose to have aspects of its mātauranga transmitted into the stock of academic knowledge; an example is the article by Dobson-Waitere et al. (2021) that publishes mātauranga on a Ngāi Tahu taonga species. In our experience, however, there can be no general presumption that Māori partners will choose to place their mātauranga in the public domain (Muru-Lanning 2021). Like business knowledge, a process for guaranteeing tino rangatiratanga may be formalised in a written memorandum of understanding (Timoti et al. 2017).

Arrangements like these can be in tension with the ethical obligation for researchers to 'support the public interest by making the results and findings of their activities available as soon as it is appropriate to do so' (Royal Society Te Apārangi 2019, p. 4). Determining the 'appropriate' balance between creating public knowledge and expanding private knowledge requires judgement by all the research partners, mindful of wider public interest norms reflected in documents such as te Tiriti o Waitangi and in intellectual property law.

A second key lesson is that mātauranga Māori is closely connected to tikanga, or the right way of doing things according to Māori custom (Mead 2016). Hence, a science team should learn and respect the relevant tikanga of its Māori partners. To illustrate, Martin and Hazel (2020) record that research teams have an obligation to ensure their work genuinely contributes to creating community benefits for Māori partners. This aspect of tikanga recognises that 'attainment of mātauranga-driven objectives and aspirations does not occur in isolation from our collective responsibility to the well-being of our community' (Durie 2021, p. 30).

Further, epistemological and methodological insights derived from mātauranga Māori provide ethical parameters for the use and critical combining of knowledge drawn from different systems. This has implications for applications of endogenous growth theory and of the capability theory of the firm, particularly regarding how Indigenous knowledge is brought into firms to create commercial value, or is utilised across society to raise living standards. Sharing and incorporating Indigenous knowledge into economically productive activities must lead to benefits for Indigenous communities, while also shaping how firms and the broader economy operate as communities of workers guided by relational values (Wilson 2008; Spiller et al. 2011).

A third key lesson is that collaborations with Māori partners take place against a background of global conversations about Indigenous knowledge within a global knowledge system (Durie 2005b). Begun by Indigenous communities during colonisation, these conversations are now growing in the academic literature; see, for example, Semali and Kincheloe (1999), Denzin et al. (2008), Ford et al. (2016), Whyte et al. (2016), Nakashima et al. (2018), Smith (2018), Shava (2020), Thornton and Bhagwat (2020), Lovo et al. (2021), MacLeod (2021) and Jessen et al. (2022). Local scholars such as Distinguished Professor Linda Tuhiwai Smith are leaders in this literature. Denzin et al. (2008, p. xiii) write that Smith's 'insights, understandings, and grasp of the field of indigenous scholarship, in its multiple discourses, are unparalleled'. Tuck (2013, pp. 366–367) describes *Decolonizing methodologies* (Smith 1999, 2012, 2021b) as 'timeless' and 'profoundly influential'. Our own experience is that collaboration in the interface between Western science and mātauranga Māori is enhanced if researchers are able to engage with Māori partners on issues analysed by Smith and others on the process of decolonising research.

Decolonising research

Smith (2012) begins her analysis by observing that imperialism frames the Indigenous experience. In this journal, Barnes and McCreanor (2019) have described colonisation's profound consequences for health and wellbeing outcomes of Māori populations over seven or more generations. Citing Reid et al. (2014), they observe how historical trauma is transmitted across generations as a result of fundamental societal-level structural changes created by colonisation, particularly 'the loss of economic and political power and the loss of culture and traditional ways of life wrought by the loss of land' (Barnes and McCreanor 2019, p. 526; see also Waretini-Karena 2017). Jackson (2020, p. 133) states, 'in the simplest sense colonisation is the violent denial of the right of Indigenous peoples to continue governing themselves in their own lands'; see also Ross (2020).

Foundational to colonisation has been the overpowering use of the machinery of government to dispossess Indigenous peoples of lands and natural resources, in order to create and transfer property rights to settlers. Aotearoa New Zealand is no exception (O'Malley 2019, 2021), despite a long history of Indigenous environmental defenders that continues to the present day (Mika et al. 2022a). Reflecting on that experience, Smith (2012, p. 1) writes, 'The ways in which scientific research is implicated in the worst excesses of colonialism remains a powerful remembered history for many of the world's colonized peoples'. Western scientists reaching out to partner with Indigenous communities cannot ignore those remembered histories. As the title of Smith's book indicates, Māori are engaged in a process of decolonising research. Te reo Māori is preeminent in this process (Mercier 2020), as Matamua (2018, p. 5) exemplifies:

He wāhanga tēnei whakaaranga o te tātai arorangi nō tētahi kaupapa nui kē atu, e ngana nei a Māori ki te whakapuaki i ōna anō hitori, i āna anō kōrero i runga tonu i tā te Māori i whakaae ai, i tāna hoki i pai ai. Kei te wetekina ngā kākahu Pākehā o te nuinga o ngā mātauranga, ā, e kōrerotia ana anō e te Māori i runga i te whakapono Māori, i ngā tikanga Māori, i te whakaaro Māori, ki te reo Māori anō hoki.¹

O'Malley and Kidman (2017) observe that many Pākehā New Zealanders find honest reappraisals of the realities of settler colonialism deeply troubling, but those realities raise unavoidable questions for researchers in tertiary education institutions. Given each university's settlement history, Royal (2022, p. 57) asks 'is it possible to decolonise a university' and 'to what degree can mātauranga Māori find expression in that university and at a fundamental level'. Simmonds (2021) asks similar questions. To illustrate, Lincoln University opened as a School of Agriculture on 19 July 1880. The first Director published an article that year, setting out his purpose, 'I take it that the aim of the Agricultural School is ... to train those sons of colonists who are intended to follow the calling of the farmer' (Ivey 1880, p. 276). The official history on the 75th anniversary reproduced the passage without any objection to its racism and sexism, commenting instead that Ivey's viewpoint 'has stood the test of time and can be reiterated in 1955 in respect to the years that lie ahead' (Blair 1956, p. 21). Given those deep colonial foundations, and given the violent dispossession of Māori land during colonisation, Royal's questions are a just and urgent challenge for academics at New Zealand's specialist land-based university.

Some scholars use the lens of 'whiteness' to explore how historical legacies and unexamined racial biases support ongoing disadvantage in postcolonial and other societies (Ballara 1986; Moreton-Robinson 2004; Arday and Mirza 2018; Feagin 2020; Stewart 2020). We also acknowledge Indigenous critiques of structuring the analysis of colonial relations in this way; important contributors include Said (1978), Bhabha (1983, 1994), Nandy (1988) and Hogan (2000). Such scholars view this style of analysis as an internalisation and inversion of destructive and racist colonial binaries within Indigenous communities that lead to psychosocial identity conflicts, and in turn suffering, within the Indigenous communities themselves. Nevertheless, it is clear that social norms can privilege a dominant cultural group and foster institutional racism (Rangihau 1988; Coates 2015; Eddo-Lodge 2017). Indeed, Ruru (2021, p. 17) observes that 'tertiary institutions for the most part have been a hostile place for Indigenous students and staff'. Kidman (2020) draws on interviews with Māori senior academics completed in a wider study (Kidman and Chu 2017) to record their experiences of high levels of cultural marginalisation in New Zealand universities and also their concerns about assimilation pressures faced by early career colleagues. McAllister et al. (2020b, 2022) report similar issues for Māori and Pasifika scientists, while McAllister et al. (2020a) identify and measure significant gaps in academic salaries.

Engagement in the interface

The introduction to this essay described ongoing pressures towards integration of mātauranga Māori and Western science. As Williams (2019) observes, integration was the key theme in the Hunn (1960) Report, which became the basis for public policies that 'remained assimilative in all but name' (citing Hill 2009, p. 93). We similarly recognise that attempting to integrate mātauranga Māori into Western science transfers tino rangatiratanga from Māori communities to the science community deciding what it chooses to publish (Durie 2005b; Smith et al. 2016; Mika and Stewart 2017; Burgess et al. 2021). Hepi et al. (2018, p. 497) address this point in the context of environmental issues in the Kaipara Harbour, arguing that the challenge is not 'how to integrate

indigenous knowledge into resource management’ but ‘how to integrate indigenous knowledge holders into planning and decision-making’.

Pressure to integrate mātauranga Māori and Western science can support a second wave of colonisation. In the first wave, settlers took control of the land, reducing 26.7 million hectares of land in Māori title in 1840 to 1.3 million hectares by 1975 (Asher and Naulls 1987). A second wave occurs when settlers seek access to the mātauranga Māori connected to the dispossessed land, again for the benefit of the settler economy (Mika 2012; Muru-Lanning 2021). Recognition of this possibility is a reason for our programmes’ emphasis on respecting tino rangatiratanga in engagements with mātauranga holders.

Tino rangatiratanga recognises that mātauranga Māori is valid in its own right (Hikuroa 2017) with its own ‘distinctly theoretical terrain that is Māori initiated, defined, and controlled’ (Pihama et al. 2002, p. 33). As Tā Mason Durie (2005b) advised, the tools of one body of knowledge should not be used to analyse the foundations of a different knowledge system. Tā Tipene O’Regan (2014, p. 64) similarly observed, ‘The tool of rigour may be a chisel made of steel, or it may be a chisel made of pounamu – they are handled differently, but they have, properly handled, comparable results.’ Relevant to our research, Awatere (2021) warns of risks associated with applying economic modelling techniques in the context of mātauranga Māori. Māori communities have wānanga processes guided by tikanga for testing validity (Durie 2021). An example is Te Hihiri, which is ‘an Indigenous Māori research paradigm that is underpinned by the cosmological whakapapa and describes knowledge creation as a relationship with experience’ (Nicholson 2020, p. 133). The energy of wānanga is an essential element in that process.

Inspired by Durie (2005a, 2011), Macfarlane et al. (2015) developed a model of interface engagement called *he awa whiria*, or braided river. In this model, Indigenous and Western knowledge streams flow alongside each other, each with its own mana and integrity, but interacting from time to time (see also Arago-Kemp and Hong 2018; Macfarlane and Macfarlane 2019; and Wilkinson et al. 2020). Scobie et al. (2021, p. 857) use *he awa whiria* to represent ‘a plurality of knowledge streams that can start from different sources, converge, braid and depart again, from the mountains to the sea’. Hikuroa (2021, p. 145) suggests another metaphor based on weaving discrete threads, in which ‘the integrity of each tira [individual strand] is maintained and, ideally, the finished piece has mana and mauri greater than the individual strands before they were woven together’.

Similar ideas are expressed in the Western science literature using the metaphor of a ‘triple helix’ (Etzkowitz and Leydesdorff 2000; Etzkowitz and Zhou 2018; Cai and Etzkowitz 2020; Compagnucci and Spigarelli 2020). This encourages researchers to collaborate with private and public sector organisations to share and co-create knowledge that advances wellbeing opportunities identified among all the partners. Some versions add knowledge held by civil society organisations, leading to a ‘quadruple helix’ (Roman et al. 2020). Another term is ‘Mode 2 knowledge production’ (Gibbons et al. 1994), which Amoamo and Ruckstuhl (2021) identify as embedded in the foundational Vision Mātauranga document (MoRST 2005).

Figure 2 illustrates how adopting the approach reflected in these models can expand opportunities compared to the simple model of academic knowledge in Figure 1. Focusing on the partnership types discussed in this essay, Figure 2 adds circles for business

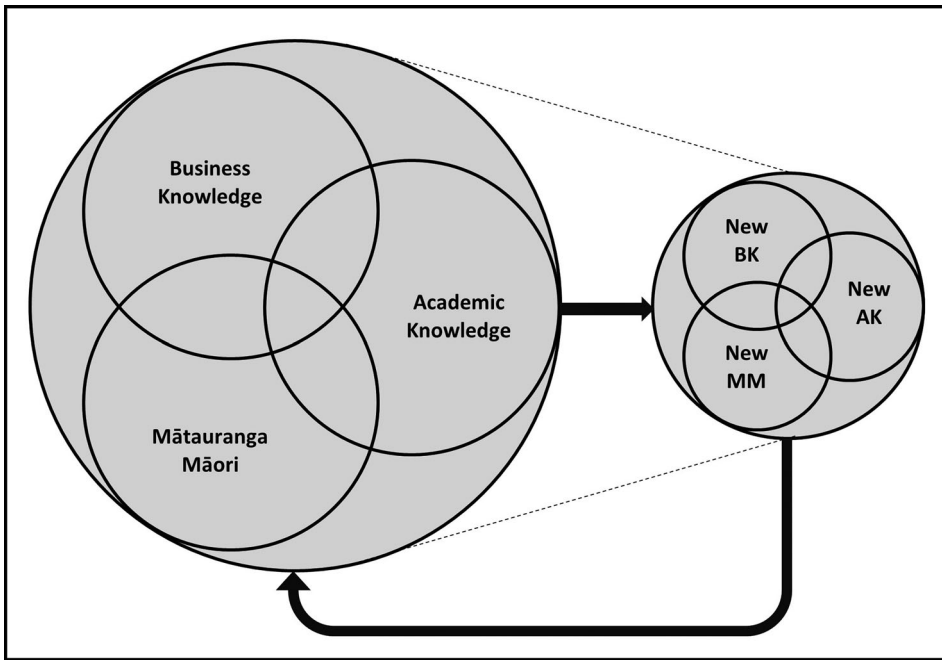


Figure 2. Conceptual model of using existing knowledge to create new knowledge, recognising academic knowledge, business knowledge and mātauranga Māori.

knowledge and for mātauranga Māori. The three circles overlap to create interfaces; some business knowledge is published as academic knowledge, for example. Academic studies on ideas important for business knowledge and for mātauranga Māori are found in the interface where all three circles meet, which is an important field in its own right (Mika et al. 2022b). Figure 2 illustrates that researchers collaborating with holders of business knowledge and mātauranga Māori can access a greater stock of knowledge. This means a greater amount of new knowledge can be created. Further, contrary to the integration approach, not all new knowledge needs to be published as academic knowledge to have impact. The research partners can increase their own business knowledge and mātauranga Māori, both through knowledge transfer from the research team and as a result of the partners' own engagements with the research questions during the programme (see, for example, Tahi 2022).

Conclusion

The sections of this essay have offered seven key points. First, endogenous growth theory explains how the discovery of new knowledge is uniquely important for wellbeing, because knowledge is the only input into economic production that is non-rival in consumption. Second, the norms and protocols created in Western science to build confidence in the accumulating stock of academic knowledge perform a vital role in sustaining this contribution to wellbeing. Third, business knowledge is a key element of commercial success, underpinning dynamic capabilities that drive innovation. Fourth, mātauranga Māori is a taonga for Māori enterprise, protected by the guarantee

of tino rangatiratanga in Article 2 of te Tiriti o Waitangi. Fifth, Western science teams who engage with holders of knowledge outside the academy need to understand and respect the agency, tikanga and global context of their research partners. Sixth, Western scientists reaching out to partner with holders of mātauranga Māori cannot ignore the remembered histories of colonisation and the ongoing process of decolonising research. Seventh, research in the interfaces between Western science and other bodies of knowledge can amplify the wellbeing impact of researchers, but requires respect for the mana and integrity of each knowledge stream.

This essay has focused on three knowledge streams: academic knowledge produced by Western science; business knowledge held by private enterprises; and mātauranga Māori held by Māori organisations and communities. Business knowledge is the oldest stream; human enterprises have been creating knowledge on food and fibre production since the discovery of agriculture more than 11,000 years ago (Weisdorf 2005; Price and Bar-Yosef 2011). Capabilities for discovering and sharing new knowledge expanded with the development of Western science, which Grayling (2021) traces back to publications in 1543 by Copernicus and Vesalius. Some 200–300 years earlier, Māori ancestors in the thirteenth century created the mātauranga needed to voyage across the Pacific to these islands (Matisoo-Smith 2012; Anderson et al. 2014), thus completing what Matisoo-Smith and Daugherty (2012) describe as the longest journey from Africa to Aotearoa. Researchers working in this country today are able to draw on these sources to explore an interface ‘teeming with possibilities’ (Spiller 2021, p. 178). This has been our own experience.

Note

1. Professor Matamua also published his book in English, where he expressed his observations as follows (Matamua 2017, pp. 4–5): ‘This regeneration in Māori astronomy is part of a larger movement, where Māori themselves are striving to tell their own history and stories, in a manner that is acceptable and appropriate to Māori. Much of this knowledge is now being decolonised, and re-told by Māori based on Māori beliefs, Māori culture, Māori ways of thinking and Māori language.’

Acknowledgements

The authors thank five referees who provided thoughtful and insightful reports on two earlier drafts; their sharing of their knowledge and mātauranga has led to considerable improvements. We also thank Carla Houkamau, Richard McDowell and Fei He for their manaakitanga and careful consideration during the review process.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by Ministry for Business Innovation and Employment [Grant Number LINX1701]; Our Land and Water National Science Challenge [Grant Number Rewarding Sustainable Practices].

References

- Amoamo M, Ruckstuhl K. 2021. Kāhui Māori: distinctive leadership in science and technology. In: Amoamo M, Kawharu M, Ruckstuhl K, editors. *He pou hiringa: grounding science and technology in te ao Māori*. Wellington: Bridget Williams Books; p. 35–54.
- Anderson A, Binney J, Harris A. 2014. *Tangata whenua: an illustrated history*. Wellington: Bridget Williams Books.
- Arago-Kemp V, Hong B. 2018. *Bridging cultural perspectives*. Wellington: Social Policy Evaluation and Research Unit.
- Arday J, Mirza HS, editor. 2018. *Dismantling race in higher education: racism, whiteness and decolonising the academy*. Cham: Palgrave Macmillan.
- Arrow KJ. 2000. Knowledge as a factor of production. In: Pleskovic B, Stiglitz JE, editors. *Annual World Bank Conference on Development Economics 1999*. Washington, DC: World Bank; p. 15–20.
- Asher G, Naulls D. 1987. *Māori land. Planning paper no. 29*. Wellington: New Zealand Planning Council.
- Awatere S. 2021. Rangahau: ōhanga. In: Ruru J, Nikora LW, editors. *Ngā kete mātauranga: Māori scholars at the research interface*. Dunedin: Otago University Press; p. 70–79.
- Awatere S, Mika J, Hudson M, Pauling C, Lambert S, Reid J. 2017. Whakatipu rawa ma ngā uri whakatipu: optimising the “Māori” in Māori economic development. *AlterNative*. 13(2):80–88.
- Ballantyne T. 2011. Paper, pen, and print: the transformation of the Kāi Tahu knowledge order. *Comparative Studies in Society and History*. 53(2):232–260.
- Ballara A. 1986. *Proud to be white: a survey of Pākehā prejudice in New Zealand*. Auckland: Heinemann.
- Barnes HM, McCreanor T. 2019. Colonisation, hauora and whenua in Aotearoa. *Journal of the Royal Society of New Zealand*. 49(Sup1):19–33.
- Bhabha HK. 1983. The other question *Screen*. 24(6):18–36.
- Bhabha HK. 1994. *The location of culture*. London: Routledge.
- Binney J. 1987. Māori oral narratives, Pākehā written texts: two forms of telling history. *New Zealand Journal of History*. 21(1):16–28.
- Blair ID. 1956. *Life and work at Canterbury Agricultural College*. Christchurch: Caxton Press.
- Blakeley N, Lewis G, Mills D. 2005. *The economics of knowledge: what makes ideas special for economic growth? Policy Perspectives Paper 05/05*. Wellington: The Treasury.
- Blundo-Canto G, Triomphe B, Faure G, Barret D, de Romemont A, Hainzelin W. 2019. Building a culture of impact in an international agricultural research organization: process and reflective learning. *Research Evaluation*. 28(2):136–144.
- Broughton D, McBreen K. 2015. Mātauranga Māori, tino rangatiratanga and the future of New Zealand science. *Journal of the Royal Society of New Zealand*. 45(2):83–88.
- Burgess H, Cormack D, Reid P. 2021. Calling forth our pasts, citing our futures: an envisioning of a Kaupapa Māori citational practice. *MAI Journal*. 10(1):57–67.
- Cai Y, Etkowitz H. 2020. Theorizing the triple helix model: past, present and future. *Triple Helix*. 7:189–226.
- Coates T-N. 2015. *Between the world and me*. Melbourne: Text Publishing.
- Commonwealth of Australia and New Zealand. 2020. *Outcomes paper: Australian and New Zealand Standard Research Classification review 2019*. Canberra and Wellington: Australian Research Council and Ministry of Business, Innovation and Employment.
- Compagnucci L, Spigarelli F. 2020. The third mission of the university: a systematic literature review on potentials and constraints. *Technological Forecasting and Social Change*. 161:120–284.
- Dalziel P. 2019. *Wellbeing and knowledge*. Treasury Guest Lecture, 12 November. Wellington: The Treasury; [accessed 10 October 2021]. <https://treasury.govt.nz/news-and-events/our-events/wellbeing-and-knowledge>.
- Dalziel P, Saunders C, Saunders J. 2018a. *Wellbeing economics: the capabilities approach to prosperity*. Cham: Palgrave Macmillan.

- Dalziel P, Saunders C, Tait P, Saunders J, Miller S, Guenther M, Rutherford P, Driver T. 2018b. Rewarding responsible innovation when consumers are distant from producers: evidence from New Zealand. *International Food and Agribusiness Management Review*. 21(4):487–504.
- Dell K, Houkamau C, Mika J, Newth J. 2022. Māori perspectives on conscious capitalism. In: Dion M, Pava M, editors. *The spirit of conscious capitalism*. Cham: Springer; p. 379–397.
- Denzin NK, Lincoln YS, Smith LT, editors. 2008. *Handbook of critical and Indigenous methodologies*. Thousand Oaks (CA): Sage Publishing.
- Diamond J. 2012. *The world until yesterday: what can we learn from traditional societies?* New York: Penguin.
- Dobson-Waitere A, MacIntosh R, Ellison MF, Smallfield BM, van Klink JW. 2021. Taramea, a treasured Māori perfume of Ngāi Tahu from *Aciphylla* species of Aotearoa New Zealand: a review of mātauranga Māori and scientific research. *Journal of the Royal Society of New Zealand*. 52(1):1–17.
- Durie M. 2004. Exploring the interface between science and Indigenous knowledge. Paper presented to the 5th APEC Research and Development Leaders' Forum, Christchurch, 10–11 March.
- Durie M. 2005a. *Ngā tai matatū: tides of Māori endurance*. Oxford: Oxford University Press.
- Durie M. 2005b. Indigenous knowledge within a global knowledge system. *Higher Education Policy*. 18:301–312.
- Durie M. 2011. The Treaty of Waitangi: domestic relations, global impacts and a New Zealand agenda. In: Durie M, editor. *Ngā tini whetū: navigating Māori futures*. Wellington: Huia Publishers; p. 219–231.
- Durie M. 2021. Mātauranga at the interface. In: Ruru J, Nikora LW, editors. *Ngā kete mātauranga: Māori scholars at the research interface*. Dunedin: Otago University Press; p. 22–35.
- Eckhardt J. 2018. An interview with David Teece, a practicing business intellectual. *Entrepreneur & Innovation Exchange*. 1–11. doi:10.17919/X9J09V.
- Eddo-Lodge R. 2017. *Why I'm no longer talking to white people about race*. London: Bloomsbury Circus.
- Edwards W, Hond R, Ratima M, Tamati A, Treharne GJ, Hond-Flavell E, Theodore R, Carrington SD, Poulton R. 2023. Tawhiti nui, tawhiti roa: tawhiti tūāuriuri, tawhiti tūāhekeheke: a Māori lifecourse framework and its application to longitudinal research. *Journal of the Royal Society of New Zealand*. doi: 10.1080/03036758.2022.2113411.
- Etzkowitz H, Leydesdorff L. 2000. The dynamics of innovation: from national systems and “mode 2” to a triple helix of university–industry–government relations. *Research Policy*. 29(2):109–123.
- Etzkowitz H, Zhou C. 2018. *The triple helix: university–industry–government innovation and entrepreneurship*. 2nd ed. New York: Routledge.
- Feagin JF. 2020. *The white racial frame: centuries of racial framing and counter-framing*. 3rd ed. New York: Routledge.
- Ford J, Cameron L, Rubis J, Maillet M, Nakashima D, Willox AC, Pearce T. 2016. Including indigenous knowledge and experience in IPCC assessment reports. *Nature Climate Change*. 6:349–353.
- Gibbons M, Limoges C, Nowotny H, Schwartzman S, Scott P, Trow M. 1994. *The new production of knowledge: the dynamics of science and research in contemporary societies*. London: Sage.
- Grayling AC. 2021. *The frontiers of knowledge: what we now know about science, history and the mind*. Dublin: Penguin Random House.
- Grimes A. 2016. Citation for David Teece to mark his Distinguished Fellow award by the New Zealand Association of Economists. *New Zealand Economic Papers*. 51(3):327–328.
- Haar J. 2020. *The performance of Māori firms: a strategic management approach*. Report prepared for the New Zealand Productivity Commission. Auckland University of Technology: New Zealand Work Research Institute.
- Haskel J, Westlake S. 2017. *Capitalism without capital*. Princeton, NJ: Princeton University Press.
- Hayek FA. 1937. Economics and knowledge. *Economica*. 4(13):33–54.
- Hepi M, Foote J, Makey L, Badham M, Te Huna A. 2018. Enabling mātauranga-informed management of the Kaipara Harbour, Aotearoa New Zealand. *New Zealand Journal of Marine and Freshwater Research*. 52(4):497–510.

- Hikuroa D. 2017. Mātauranga Māori, the ūkaipō of knowledge in New Zealand. *Journal of the Royal Society of New Zealand*. 47(1):5–10.
- Hikuroa D. 2021. Being Māori, being Pākehā: a journey of discovery in science, mātauranga and kaitiakitanga. In: Ruru J, Nikora LW, editors. *Ngā kete mātauranga: Māori scholars at the research interface*. Dunedin: Otago University Press; p. 138–147.
- Hill RS. 2009. *Māori and the State: Crown-Māori relations in New Zealand/Aotearoa, 1950-2000*. Wellington: Victoria University Press.
- Hogan PC. 2000. *Colonialism and cultural identity: crises of tradition in the Anglophone literatures of India, Africa and the Caribbean*. New York: State University of New York Press.
- Hokowhitu B. 2010. Introduction – Indigenous studies: research, identity and resistance. In: Hokowhitu B, Keramoal N, Andersen C, Reilly M, Petersen A, Altamirano-Jimenes I, Rewi P, editors. *Indigenous identity and resistance: researching the diversity of knowledge*. Dunedin: Otago University Press; p. 9–20.
- Hudson M, Thompson A, Wilcox P, Mika JP, Battershill C, Stott M, Brooks RT, Warbrick L. 2021. *Te nohonga kaitiaki: guidelines for genomic research on taonga species (with background)*. University of Waikato: Te Kotahi Research Institute.
- Hulten CR, Hao X. 2008. What is a company really worth? Intangible capital and the ‘market to book value’ puzzle. NBER Working Paper No. w14548. Cambridge, MA: National Bureau of Economic Research.
- Hunn J. 1960. Report on Department of Maori Affairs with Statistical Supplement, Printed in AJHR 1961, G-10.
- IPCC. 2022. *Climate change 2022: impacts, adaptation, and vulnerability. Contribution of Working Group II to the sixth assessment report of the Intergovernmental Panel on Climate Change* [Pörtner H-O, Roberts DC, Tignor M, Poloczanska ES, Mintenbeck K, Alegria A, Craig M, Langsdorf S, Lösschke S, Möller V, Okem A, Rama B, editors]. Cambridge: Cambridge University Press, in press.
- Ivey WE. 1880. The object of a school of agriculture. *New Zealand Ctry Journal*. 4(5):275–279.
- Jackson A-M. 2021. E kore te waka e whakapakari i runga i te wai marino – A waka is not strengthened through calm waters. In: Ruru J, Nikora LW, editors. *Ngā kete mātauranga: Māori scholars at the research interface*. Dunedin: Otago University Press; p. 234–243.
- Jackson M. 2020. Where to next? Decolonisation and the stories in the land. In: Elkington B, Jackson M, Kiddle R, Mercier OR, Ross M, Smeaton J, Thomas A, editors. *Imagining decolonisation*. Wellington: Bridget Williams Books; p. 133–155.
- Jessen TD, Ban NC, Claxton NX, Darimont CT. 2022. Contributions of Indigenous knowledge to ecological and evolutionary understanding. *Frontiers in Ecology and the Environment*. 20(2):93–101.
- Jones CI. 2019. Paul Romer: ideas, nonrivalry, and endogenous growth. *The Scandinavian Journal of Economics*. 121(3):859–883.
- Ka’ai TM. 2008. Te ha whakawairua, whakatinana i te Mātauranga Māori i te whare wānanga: the validation of Indigenous knowledge within the university academy. *Te Kahoaroa*. 1(1):50–85.
- Kidman J. 2020. Whither decolonisation? Indigenous scholars and the problem of inclusion in the neoliberal university. *Journal of Sociology*. 56(2):247–262.
- Kidman J, Chu C. 2017. Scholar outsiders in the neoliberal university: transgressive academic labour in the whitestream. *New Zealand Journal of Educational Studies*. 52:7–19.
- Kitson J. 2021. My hikoī to the interface of science and mātauranga. In: Ruru J, Nikora LW, editors. *Ngā kete mātauranga: Māori scholars at the research interface*. Dunedin: Otago University Press; p. 264–273.
- Krugman P. 1991. Increasing returns and economic geography. *Journal of Political Economy*. 99(3):483–499.
- Kuhn TS. 1962. *The structure of scientific revolutions*. Chicago: University of Chicago Press.
- Kukutai T. 2021. Finding Tahu. In: Ruru J, Nikora LW, editors. *Ngā kete mātauranga: Māori scholars at the research interface*. Dunedin: Otago University Press; p. 48–59.

- Lakatos I. 1970. Falsification and the methodology of scientific research programmes. In: Lakatos I, Musgrave A, editors. *Criticism and the growth of knowledge*. Cambridge: Cambridge University Press; p. 91–196.
- Larner W. 2019. Guest editorial. *Journal of the Royal Society of New Zealand*. 49(1):1–2.
- Lev B. 2001. *Intangibles: management, measurement, and reporting*. Washington, DC: Brookings Institution Press.
- Lovo E, Woodward L, Larkins S, Preston R, Baba UN. 2021. Indigenous knowledge around the ethics of human research from the Oceania region: a scoping literature review. *Philosophy, Ethics, and Humanities in Medicine*. 16:12.
- Macfarlane A, Macfarlane S. 2019. Listen to culture: Māori scholars' plea to researchers. *Journal of the Royal Society of New Zealand*. 49(Sup1):48–57.
- Macfarlane S, Macfarlane A, Gillon G. 2015. Sharing the food baskets of knowledge: creating space for a blending of streams. In: Macfarlane A, Macfarlane S, Webber M, editors. *Sociocultural realities: exploring new horizons*. Christchurch: Canterbury University Press; p. 52–67.
- MacLeod L. 2021. More than personal communication: templates for citing Indigenous Elders and Knowledge Keepers. *KULA: Knowledge Creation, Dissemination, and Preservation Studies* 5 (1). doi:10.18357/kula.135.
- Mahuika, N. 2012. *Kōrero tuku iho: reconfiguring oral history and oral tradition*. Thesis submitted for the degree of Doctor of Philosophy at the University of Waikato.
- Mahuika N. 2021. The value of historical mātauranga. In: Ruru J, Nikora LW, editors. *Ngā kete mātauranga: Māori scholars at the research interface*. Dunedin: Otago University Press; p. 148–159.
- Mahuta, Hon. N. 2022. *Te tumu mō te Pae Tawhiti*. Cabinet paper prepared by the Office of the Associate Minister for Māori Development, proactively released via the Te Puni Kōkiri website, 1 February 2022.
- Makereti T. 2020. Indigenous studies: Aotearoa/New Zealand. In: *Oxford research encyclopedia of literature*; [accessed 20 June 2022]. doi:10.1093/acrefore/9780190201098.013.984.
- Marsden M, Henare TA. 1992. *Kaitiakitanga: a definitive introduction to the holistic world view of the Māori*. Essay for the Ministry for the Environment. Reproduced. In: Royal C, editor. *The woven universe: selected writings of Rev. Māori Marsden*. Otaki: Estate of Rev. Māori Marsden; p. 54–72.
- Marshall A. 1920. *Principles of economics*. 8th ed. London: Macmillan.
- Martin JE. 2017. *Illuminating our world: 150 years of the Royal Society Te Apārangi*. Wellington: Royal Society Te Apārangi.
- Martin W-J, Hazel J-A. 2020. *A guide to Vision Mātauranga: lessons from Māori voices in the New Zealand science sector*. Wellington: Rauika Māngai.
- Matamua R. 2017. *Matariki: the star of the year*. Wellington: Huia Publishers.
- Matamua R. 2018. *Matariki: te whetū o te tau*. Wellington: Huia Publishers.
- Matamua R. 2021. The science of Māori astronomy: a journey into the stars. In: Ruru J, Nikora LW, editors. *Ngā kete mātauranga: Māori scholars at the research interface*. Dunedin: Otago University Press; p. 182–191.
- Matisoo-Smith E. 2012. The great blue highway: human migration in the Pacific. In: Crawford MH, Campbell BC, editors. *Causes and consequences of human migration: an evolutionary perspective*. Cambridge: Cambridge University Press; p. 388–416.
- Matisoo-Smith E, Daugherty C. 2012. Africa to Aotearoa: the longest migration. *Journal of the Royal Society of New Zealand*. 42(2):87–92.
- MBIE. 2019. *The impact of research*. Position paper. Wellington: Ministry of Business, Innovation and Employment.
- McAllister TG, Kokaua J, Naepi S, Kidman J, Theodore R. 2020a. Glass ceilings in New Zealand universities. *MAI Journal*. 9(3):272–285.
- McAllister TG, Naepi S, Walker L, Gillon A, Clark P, Lambert E, McCambridge AB, Thoms C, Housiaux J, Ehau-Taumaunu H, et al. 2022. Seen but unheard: navigating turbulent waters as

- Māori and Pacific postgraduate students in STEM. *Journal of the Royal Society of New Zealand*. 52(Sup1):116–134.
- McAllister TG, Naepi S, Wilson E, Hikuroa D, Walker LA. 2020b. Under-represented and overlooked: Māori and Pasifika scientists in Aotearoa New Zealand's universities and crown-research institutes. *Journal of the Royal Society of New Zealand*. 52(1):38–53.
- McDonald M. 2021. Rapua te mea ngaro. In: Ruru J, Nikora LW, editors. *Ngā kete mātauranga: Māori scholars at the research interface*. Dunedin: Otago University Press; p. 192–203.
- McMeeking S. 2021. More Māui please. In: Ruru J, Nikora LW, editors. *Ngā kete mātauranga: Māori scholars at the research interface*. Dunedin: Otago University Press; p. 104–115.
- Mead HM. 2016. *Tikanga Māori: living by Māori values*, revised ed. Wellington: Huia Publishers.
- Mercier OR. 2020. What is decolonisation? In: Elkington B, Jackson M, Kiddle R, Mercier OR, Ross M, Smeaton J, Thomas A, editors. *Imagining decolonisation*. Wellington: BWB Texts; p. 40–82.
- Mika CTH. 2012. Overcoming 'being' in favour of knowledge: the fixing effect of 'mātauranga'. *Educational Philosophy and Theory*. 44(10):1080–1092.
- Mika CTH, Stewart GM. 2017. Lost in translation: western representations of Māori knowledge. *Open Rev Educ Res*. 4(1):134–146.
- Mika JP, Dell K, Elers C, Dutta M, Tong Q. 2022a. Indigenous environmental defenders in Aotearoa New Zealand: Ihumātao and Ōroua River. *AlterNative*. 18(2):277–289.
- Mika JP, Dell K, Newth J, Houkamau C. 2022b. Manahau: toward an Indigenous Māori theory of value. *Philosophy of Management*. 21:441–463.
- Mika JP, Fahey N, Bensemann J. 2019. What counts as an indigenous enterprise? Evidence from Aotearoa New Zealand. *Journal of Enterprising Communities*. 13(3):372–390.
- Moreton-Robinson A2004. *Whitening race: essays in social and cultural criticism*. Canberra: Aboriginal Studies Press for the Australian Institute of Aboriginal and Torres Strait Islander Studies.
- MoRST. 2005. *Vision Mātauranga: unlocking the innovation potential of Māori knowledge, resources and people*. Wellington: Ministry of Research, Science and Technology.
- Movono A, Carr A, Hughes E, Higgins-Desbiolles F, Hapeta JW, Scheyvens R, Stewart-Withers R. 2021. Indigenous scholars struggle to be heard in the mainstream. Here's how journal editors and reviewers can help. *The Conversation*, 12 April.
- Muru-Lanning M. 2012. Māori research collaborations, mātauranga Māori science and the appropriation of water in New Zealand. *Anthropological Forum*. 22(2):151–164.
- Muru-Lanning M. 2021. Built on the backs of our ancestors. In: Ruru J, Nikora LW, editors. *Ngā kete mātauranga: Māori scholars at the research interface*. Dunedin: Otago University Press; p. 36–47.
- Nakashima D, Krupnik I, Rubis JT, editors. 2018. *Indigenous knowledge for climate change assessment and adaptation*. Cambridge and Paris: Cambridge University Press and UNESCO.
- Nana G, Reid A, Schulze H, Dixon H, Green S, Riley H. 2021. *Te ōhanga Māori 2018 – the Māori economy 2018*. Wellington: BERL and Reserve Bank of New Zealand.
- Nandy A. 1988. *The intimate enemy: loss and recovery of self under colonialism*. New Delhi: Oxford University Press.
- Nicholson A. 2020. Te Hihiri a process of coming to know. *MAI Journal*. 9(2):133–142.
- O'Malley V. 2019. *The New Zealand Wars – Ngā Pakanga o Aotearoa*. Wellington: Bridget Williams Books.
- O'Malley V. 2021. *Voices from the New Zealand Wars – He reo nō ngā Pakanga o Aotearoa*. Wellington: Bridget Williams Books.
- O'Malley V, Kidman J. 2017. Settler colonial history, commemoration and white backlash: remembering the New Zealand Wars. *Settler Colonial Studies*. 8(3):298–313.
- O'Regan T. 2014. *New myths and old politics: the Waitangi Tribunal and the challenge of tradition*. Wellington: Bridget Williams Books.
- Pihama L, Cram F, Walker S. 2002. Creating methodological space: a literature review of kaupapa Māori research. *Canadian Journal of Native Education*. 26(1):30–43.

- Pitama S. 2021. Finding place within a space. In: Ruru J, Nikora LW, editors. *Ngā kete mātauranga: Māori scholars at the research interface*. Dunedin: Otago University Press; p. 204–213.
- Popper K. 1959. *The logic of scientific discovery*. English edition of the original published in Vienna, 1934. New York: Basic Books.
- Popper K. 1983. Introduction, 1982. In: Bartley WW, III, editor. *Realism and the aim of science. From the postscript to the logic of scientific discovery*. Routledge: Oxon; p. xix–xxxix.
- Price TD, Bar-Yosef O. 2011. The origins of agriculture: new data, new ideas. *Current Anthropology*. 52:S163–S174.
- Rangihau J. 1988. *Puao-te-ata-tu*. Report of the Ministerial Advisory Committee on a Māori perspective for the Department of Social Welfare chaired by John Te Rangi-Aniwanui Rangihau. Wellington: Department of Social Welfare.
- Reid J. 2009. Biopiracy: The struggle for traditional knowledge rights. *American Indian Law Review*. 34(1):77–98.
- Reid J, Rout M. 2016a. Getting to know your food: the insights of Indigenous thinking in food provenance. *Agriculture and Human Values*. 33:427–438.
- Reid J, Rout M. 2016b. Māori tribal economy: rethinking the original economic institutions. In: Anderson TL, editor. *Unlocking the wealth of Indian nations*. Lanham, MD: Lexington Books; p. 84–106.
- Reid J, Rout M. 2018. Can sustainability auditing be indigenized? *Agriculture and Human Values*. 35:283–294.
- Reid J, Taylor-Moore K, Varona G. 2014. Towards a social-structural model for understanding current disparities in Māori health and well-being. *Journal of Loss and Trauma*. 19(6):514–536.
- Roman M, Varga H, Cvijanovic V, Reid A. 2020. Quadruple helix models for sustainable regional innovation: engaging and facilitating civil society participation. *Economies*. 8:48.
- Romer PM. 1986. Increasing returns and long-run growth. *Journal of Political Economy*. 94(5):1002–1037.
- Romer PM. 1990. Endogenous technological change. *Journal of Political Economy*. 98(5, Pt. 2): S71–S102.
- Ross M. 2020. The throat of Parata. In: Elkington B, Jackson M, Kiddle R, Mercier OR, Ross M, Smeaton J, Thomas A, editors. *Imagining decolonisation*. Wellington: Bridget Williams Books; p. 21–39.
- Rout M, Reid J, Mika J. 2020. Māori agribusinesses: the whakapapa network for success. *AlterNative*. 16(3):193–201.
- Royal TAC. 2022. *Manu kōkiri – Māori success and tertiary education: towards a comprehensive vision*. Wellington: Taumata Aronui.
- Royal Society. 2014. *A picture of the UK scientific workforce: diversity data analysis for the Royal Society*. London: The Royal Society.
- Royal Society Te Apārangi. 2018. *Strategic plan 2018-2021*. Wellington: Royal Society Te Apārangi.
- Royal Society Te Apārangi. 2019. *Code of professional standards and ethics in science, technology, and the humanities*. Wellington: Royal Society Te Apārangi.
- Ruckstuhl K, Amoamo M, Kawharu M, Ruwhiu D, Hudson M, Martin W-J, Waiti J, Haar J. 2021. Māori interface research: rewards and risks at the technology frontier. In: Amoamo M, Kawharu M, Ruckstuhl K, editors. *He pou hiringa: grounding science and technology in te ao Māori*. Wellington: Bridget Williams Books; p. 142–163.
- Ruckstuhl K, Haar J, Hudson M, Amoamo M, Waiti J, Ruwhiu D, Daellenbach U. 2019. Recognising and valuing Māori innovation in the high-tech sector: a capacity approach. *Journal of the Royal Society of New Zealand*. 49(Sup1):72–88.
- Ruru J. 2021. Our baskets of knowledge. In: Ruru J, Nikora LW, editors. *Ngā kete mātauranga: Māori scholars at the research interface*. Dunedin: Otago University Press; p. 12–21.
- Ruru J, Nikora LW. 2021a. *Ngā kete mātauranga: Māori scholars at the research interface*. Dunedin: Otago University Press.

- Ruru J, Nikora LW. 2021b. Whāia kia tata – concluding comments. In: Ruru J, Nikora LW, editors. *Ngā kete mātauranga: Māori scholars at the research interface*. Dunedin: Otago University Press; p. 274–279.
- Ruwhiu D, Amoamo M. 2021. An uncertain journey: research at the science-Vision Mātauranga interface. In: Amoamo M, Kawharu M, Ruckstuhl K, editors. *He pou hiringa: grounding science and technology in te ao Māori*. Wellington: Bridget Williams Books; p. 88–99.
- Said E. 1978. *Orientalism*. New York: Pantheon Books.
- Saunders C. 2019. Sustainable agriculture – life beyond subsidies: lessons from New Zealand. *Journal of Agricultural Economics*. 70(3):579–594.
- Saunders C, Dalziel P, McCallum A. 2021. Geography matters for small advanced economies: implications for economic strategy. *Australasian Journal of Regional Studies*. 27(2):193–222.
- Scobie M, Lee B, Smyth S. 2021. Braiding together student and supervisor aspirations in a struggle to decolonize. *Organization*. 28(5):857–875.
- Semali LM, Kincheloe JL. 1999. *What is Indigenous knowledge? Voices from the academy*. New York: Falmer Press.
- Shava S. 2020. Indigenous/tribal knowledges – definition and relevance in the modern era. In: Katerere DR, Applequist W, Aboyade OM, Togo C, editors. *Traditional and Indigenous knowledge for the modern era: a natural and applied science perspective*. Boca Raton, FL: CRC Press; p. 1–15.
- Simmonds N. 2021. Ancestral geographies: finding my way home. In: Ruru J, Nikora LW, editors. *Ngā kete mātauranga: Māori scholars at the research interface*. Dunedin: Otago University Press; p. 126–137.
- Sissons J. 1993. Best, Elsdon. In: *Dictionary of New Zealand biography*. Reproduced in: *Te ara – the encyclopedia of New Zealand*; [accessed 19 June 2022]. <https://teara.govt.nz/en/biographies/2b20/best-elsdon>.
- Smith LT. 1999. *Decolonizing methodologies: research and indigenous peoples*. London and New York: Zed Books. Dunedin: University of Otago Press.
- Smith LT. 2012. *Decolonizing methodologies: research and indigenous peoples*. 2nd ed. London and New York: Zed Books. Dunedin: University of Otago Press.
- Smith LT. 2018. The art of the impossible – defining and measuring Indigenous research. In: Spooner M, McNinch J, editors. *Dissident knowledge in higher education*. Regina: University of Regina Press; p. 21–40.
- Smith LT. 2021b. *Decolonizing methodologies: research and indigenous peoples*. 3rd ed. London: Bloomsbury Academic.
- Smith LT, Maxwell TK, Puke H, Temara P. 2016. Indigenous knowledge, methodology and mayhem: what is the role of methodology in producing indigenous insights? A discussion from mātauranga Māori. *Know Cult*. 4(3):131–156.
- Smith LT. 2021a. Foreword. In: *Tebrakunna country*, Lee E, Evans J, editors. *Indigenous women's voices: 20 years on from Linda Tuhiwai Smith's decolonising methodologies*. London and New York: Zed Books; p. xv.
- Solomon M. 2005. The Wai 262 claim: a claim by Māori to indigenous flora and fauna — me o rātou taonga katoa. In: Belgrave M, Kawharu M, Williams D, editors. *Waitangi revisited: perspectives on the Treaty of Waitangi*. Melbourne: Oxford University Press; p. 217–221.
- Solow RM. 1956. A contribution to the theory of economic growth. *Quarterly Journal of Economics*. 70(1):65–94.
- Spiller C. 2021. Wayfinding odyssey: into the interspace. In: Ruru J, Nikora LW, editors. *Ngā kete mātauranga: Māori scholars at the research interface*. Dunedin: Otago University Press; p. 170–181.
- Spiller C, Erakovic L, Hēnare M, Pio E. 2011. Relational well-being and wealth: Māori businesses and an ethic of care. *J Bus Ethics*. 98:153–169.
- Spiller C, Stockdale M. 2013. Managing and leading from a Māori perspective: bringing new life and energy to organizations. In: Neal J, editor. *Handbook for faith and spirituality in the workplace*. New York: Springer; p. 149–173.

- Stevens MJ. 2015. A 'useful' approach to Māori history. *New Zealand Journal of History*. 49(1):54–77.
- Stewart GT. 2020. A typology of Pākehā 'Whiteness' in education. *Review of Education, Pedagogy, and Cultural Studies*. 42(4):296–310.
- Stewart GT. 2022. Mātauranga Māori: a philosophy from Aotearoa. *Journal of the Royal Society of New Zealand*. 52(1):18–24.
- Stiglitz JE. 1999. Knowledge as a global public good. In: Kaul I, Grunberg I, Stern M, editors. *Global public goods: international cooperation in the 21st century*. Oxford: Oxford University Press; p. 308–326.
- Tahi B. 2022. From land to brand: Manawa Honey's premium story. In *The Value Project*; [accessed 28 July 2022]. <https://ourlandandwater.nz/news/from-land-to-brand-manawa-honeys-premium-story/>.
- Tait P, Saunders C, Dalziel P, Rutherford P, Driver T, Guenther M. 2023. How much less? Estimating consumer discounts for suboptimal fruit with beneficial credence attributes. *Applied Economics*. doi: 10.1080/00036846.2023.2176460.
- Tait P, Saunders C, Guenther M, Rutherford P. 2016. Emerging versus developed economy consumer willingness to pay for environmentally sustainable food production: a choice experiment approach comparing Indian, Chinese and United Kingdom lamb consumers. *Journal of Cleaner Production*. 124:65–72.
- Tau TM. 2001a. The death of knowledge: ghosts on the plains. *New Zealand Journal of History*. 35(2):131–152.
- Tau TM. 2001b. Mātauranga Māori as an epistemology. In: Sharp A, McHugh P, editors. *Histories, power and loss: uses of the past – a New Zealand commentary*. Wellington: Bridget Williams Books; p. 61–95.
- Tau TM. 2020. *Water rights for Ngāi Tahu*. Christchurch: Canterbury University Press.
- Tece DJ. 1982. Towards an economic theory of the multiproduct firm. *Journal of Economic Behavior and Organization*. 3(1):39–63.
- Tece DJ. 2017. Towards a capability theory of (innovating) firms: implications for management and policy. *Cambridge Journal of Economics*. 41(3):693–720.
- Tece DJ. 2019. A capability theory of the firm: an economics and (strategic) management perspective. *New Zealand Economic Papers*. 53(1):1–43.
- Theodore R, Webber M, Blaikie R, Larner W. 2019. Rethinking our shared futures. *Journal of the Royal Society of New Zealand*. 49(Sup1):1–3.
- Thornton TF, Bhagwat SA. 2020. *The Routledge handbook of Indigenous environmental knowledge*. Abingdon: Routledge.
- Timoti P, Lyver PO, Matamua R, Jones CJ, Tahi BL. 2017. A representation of a Tuawhenua world-view guides environmental conservation. *Ecology and Society*. 22(4):20.
- Tuck E. 2013. Commentary: decolonizing methodologies 15 years later. *AlterNative*. 9(4):365–372.
- Viergever M. 1999. Indigenous knowledge: an interpretation of views from indigenous peoples. In: Semali LM, Kincheloe JL, editors. *What is indigenous knowledge? Voices from the academy*. New York: Falmer Press; p. 333–343.
- Vunibola S, Mika JP, Roskrug M. 2021. The productivity and innovation of Māori frontier firms. Submission to the New Zealand Productivity Commission. Massey University: Te Au Rangahau.
- Waretini-Karena R. 2017. Colonial law, dominant discourses, and intergenerational trauma. In: Deckert A, Sarre R, editors. *The Palgrave handbook of Australian and New Zealand criminology, crime and justice*. Cham: Palgrave Macmillan; p. 697–709.
- Watene K. 2021. Māori philosophy – a love story. In: Ruru J, Nikora LW, editors. *Ngā kete mātauranga: Māori scholars at the research interface*. Dunedin: Otago University Press; p. 214–221.
- Weisdorf J. 2005. From foraging to farming: explaining the Neolithic revolution. *Journal of Economic Surveys*. 19(4):561–586.

- Whyte KP, Brewer JP, Johnson JT. 2016. Weaving Indigenous science, protocols and sustainability science. *Sustainability Science*. 11:25–32.
- Wilkinson C, Hikuroa DCH, Macfarlane AH, Hughes MW. 2020. Mātauranga Māori in geomorphology: existing frameworks, case studies, and recommendations for incorporating Indigenous knowledge in Earth science. *Earth Surface Dynamics*. 8:595–618.
- Williams DV. 2019. The continuing impact of amalgamation, assimilation and integration policies. *Journal of the Royal Society of New Zealand*. 49(Sup1):34–47.
- Williams JV, Kearney R, Maaka R, Ringwood P, Walker K. 2011a. Ko Aotearoa tēnei: a report into claims concerning New Zealand law and policy affecting Māori culture and identity - te taumata tuatahi (volume 1). Waitangi Tribunal report WAI 262. Wellington: Waitangi Tribunal.
- Williams JV, Kearney R, Maaka R, Ringwood P, Walker K. 2011b. Ko Aotearoa tēnei: a report into claims concerning New Zealand law and policy affecting Māori culture and identity - te taumata tuarua (volume 2). Waitangi Tribunal report WAI 262. Wellington: Waitangi Tribunal.
- Wilson S. 2008. *Research is ceremony: Indigenous research methods*. Halifax: Fernwood.
- Young AA. 1928. Increasing returns and economic progress. *The Economic Journal*. 38(152):527–542.