MAI Journal A NEW ZEALAND JOURNAL OF INDIGENOUS SCHOLARSHIP
DOI: 10.20507/MAIJournal.2024.13.1.2

PRACTICE THEORY

A framework for enabling Vision Mātauranga in science, technology and innovation

*Katharina Ruckstuhl**
Maria Amoamo†

Abstract

The science policy framework Vision Mātauranga (VM) was launched in 2005 by the former Ministry of Research Science and Technology (MoRST) with the aim of unlocking the science and innovation potential of Māori knowledge, resources and people through "distinctive R&D" (MoRST, 2007, p. 4). Plenty of literature theorises *why* mātauranga Māori is necessary for innovation, but the *how*, or *practice*, of implementing VM in a meaningful way is unresolved and under-researched. In this article, we look to practice theory to identify constituent and interdependent elements that are required to form, change or embed the VM policy practice aim of distinctive R&D activities. To do this, we examine Māori discourses in published literature over the past 10 years. We then analyse key themes from the literature using Shove et al.'s (2012) three-element model of materials, competences and meanings to show the practice of VM requires improved integrative work reliant on the "carrying" of interdependent elements between different practices that either enable or constrain VM policy. We suggest that practice theory provides a tool to establish VM as normal practice and shape the trajectory of VM practice necessary to meet the scale of science, innovation and technology in Aotearoa New Zealand.

Keywords

Indigenous science, innovation, practice theory, sci-tech collaboration, Vision Mātauranga

Introduction

In 2005, the Vision Mātauranga (VM) science policy framework was launched with the ambition to unlock the science and innovation potential of Māori knowledge, resources and people (Ministry of Research Science and Technology [MoRST], 2007). It was an initiative amongst several others begun at that time that might be referred to as the "Māori potential" approach, aimed at ensuring "Māori aspirations for optimal quality of life" (Te Puni Kōkiri, 2007) so that Māori "make choices for themselves" (Barcham, 2012, p. 64). Over the

* Ngāi Tahu, Rangitāne. Associate Professor, Otago Business School, University of Otago, Dunedin, New Zealand. Email: katharina.ruckstuhl@otago.ac.nz
† Whakatōhea. Research Fellow, Otago Business School, University of Otago, Dunedin, New Zealand.

intervening years, much has shifted and changed in the research and science & technology (sci-tech) sectors to meet this ambition. However, criticisms abound as to how the policy has been and ought to be implemented, including at the present time, with the new Sixth National Government aiming "to improve the effectiveness and impact of New Zealand's science, innovation and technology system" (Ministry of Business, Innovation & Enterprise [MBIE], 2024).

MBIE (2024) is currently convening a Science System Advisory Group to review and make recommendations to strengthen the science, innovation and technology system and ensure its future success. In a system where "diversity is limited, and Māori and Pacific Peoples are under-represented and under-served" (MBIE, 2024), there is a need to provide stronger support and direction for Māori research, science and innovation (RSI) than is currently given by VM (MartinJenkins, 2023). The Science System Advisory Group is tasked with developing a set of evidence-based recommendations, including "how opportunities and solutions for Mātauranga can be better realised" within a system that is challenged by systemic issues. These include funding, research infrastructure, regulatory frameworks, system inefficiencies and fragmentation, workforce, and competition. Coordination across government and industry needs strategic redevelopment, and competition between research organisations limits collaboration. If Māori aspirations are to be realised, the "system" and VM require practice change.

In this article, we, who like other Māori researchers have contributed to the discourse on VM, reflect on what we and our peers have been saying over the last 10 years. Our conclusion is that while many of us found a consensus about why a Māori worldview and/or approach should be "standard" within the RSI sector, the *how*, or *practice*, of implementing the policy in a meaningful way is still unresolved. This is not just related to the level of funding, the nature of research undertaken, or the number of Māori involved in the RSI sector—all of which remain problematic. Rather, many of the tensions are at the level of "worldview", or ideology; at the level of infrastructure and institutions; and at the micro-level of human behaviour as individuals and teams react to the demands of Māori and policy. The almost 20 years of the VM policy show that barriers to Māori participation in and benefit from sci-tech still exist. Change will require a more integrated policy approach, including better alignment of the macro (government), the meso (research institutions) and the micro (individual scientists) to give effect to te Tiriti and mātauranga Māori (Amoamo & Ruckstuhl, 2023).

There is nothing new in what we say here. As early as the year after the VM policy's launch, Helen Moewaka Barnes (2006) problematised research and science sector engagement practices, organisational structures, paradigms and processes. These have all been highlighted over the intervening years by many Māori, including ourselves (Ruckstuhl et al., 2019). The question for us, however, is why has change taken so long and been so problematic, and what might account for this?

Our specific interest in this question arises from the pathway that the VM policy has taken in relation to the innovation component of the policy, which is specifically to "realise the contribution of Māori knowledge, resources, and people to economic growth through distinctive R&D activities" (MoRST, 2007, p. 9). As Māori researchers within the Science for Technological Innovation National Science Challenge (SfTI), we have been focusing on the high-tech R&D sector with its underpinning disciplines of physics, chemistry, mathematical, engineering and computer sciences. These disciplines are said to be crucial to Aotearoa New Zealand's high-tech economy but have been some of the last to implement the VM policy. Our observations of the SfTI's processes to "enhance capacity to use" sci-tech with Māori have directed us to consider why such an approach has been necessary. This in turn has led us to practice theory (Alpenberg & Scarbrough, 2021) as a theory of change that elucidates the trajectory of the VM policy in the high-tech R&D sector. We argue that the phrase "distinctive R&D activities" inherently assumes a practice of "distinctive R&D", although what might be distinctive about such R&D is not clear.

We have turned to practice theory to help us understand why or why not distinctive R&D activities have become everyday, embodied, ongoing and routinised activities and whether they are able to realise the contribution of Māori knowledge, resources and people as a recurrent accomplishment (Cirella & Murphy, 2022; Nicolini, 2012). Hence, in the first part of this article we briefly introduce the theory and its usefulness in helping to understand VM's implementation as a phenomenon that occurs within "a field of practices" that includes "knowledge, meaning, human activity, science power, language, social institutions and human transformations" (Schatzki et al., 2001, p. 2). In the next section, encouraged by

practice theory to understand historic precedents (Schatzki, 2002), we examine a selection of literature from Māori academic sources of the last 10 years to identify key recurring themes and provide insight into the VM policy's ability to give effect to realise the contribution of Māori knowledge, resources and people. Our selection is confined to areas that might broadly be defined as high-tech science, given that these are the areas that underpin the SfTI. In the third section, we analyse the themes using Shove et al.'s (2012) three-element model of practice theory consisting of materials, competences and meanings. From this, we identify the elements most prevalent in the literature review that may require additional focusing if the VM policy's aim of unlocking Māori innovation through distinctive R&D activities is to occur. In concluding, we make the case for practice theory as a useful contribution to understanding why change has taken so long in the case of VM and what areas require further work in high-tech science innovation in Aotearoa.

Practice theory and science, technology and innovation

Technological innovation—"a social and interactive process in which collaboration and exchange of knowledge and information play crucial roles" (Hemphälä & Magnusson, 2012, p. 3)—is needed to help tackle complex societal, environmental and economic challenges over increasingly shorter time cycles (Cirella, 2021). These "grand challenges" are complex, dynamic and multi-dimensional, requiring leaders who can collaborate across disciplines and contexts and negotiate competing stakeholder interests (George et al., 2016). Consequently, cooperation amongst diverse actors—science teams, organisations, individuals—to share and integrate knowledge is key (Ardito et al., 2019). Such cooperation requires transcending different institutional or disciplinary logics and developing new capabilities at all levels, congruent with the pathway of open innovation (OI).

OI proposes that enterprises will be more successful if they acquire, assimilate and exploit knowledge from a wide range of internal and external sources for innovative opportunities (Chesbrough, 2003). This raises a "paradox of openness" according to Ritala and Stefan (2021), due to the contradictory role of knowledge as the key resource that creates value when shared, but also as a source of appropriability challenges. Intellectual property (IP) concerns are a frequent initial barrier to OI. In particular, Indigenous peoples have raised concerns on how to protect science-related Indigenous IP when integrating Indigenous knowledge into the innovation system. Patents and other IP mechanisms can provide some solutions, but the paradox of openness often still persists (Ritala & Stefan, 2021, p. 282). While technological innovation sits at the core of OI, non-technical elements are equally important. These include human and relational capacities as well as contexts, assumptions, values and ideologies. How, why and when individuals and collectives engage in and practise OI is particularly relevant in the context of the ambitions of the VM policy.

We have looked to practice theory to explain particular forms of action and social order, including sci-tech systems. Practice theory stresses the importance of activity and work in the creation and perpetuation of all aspects of social life, most of which consists of routinised relations between several agents and objects (Nicolini, 2012; Reckwitz, 2002). Agents in this context are *carriers of practice*, while practices are seen as *everyday embodied activities that require the use of material resources (objects)*. Building on the socially oriented research traditions of Bourdieu (1977), Giddens (1979) and Foucault (2002), theoreticians such as Schatzki and Shove suggest that it is our everyday practices that structure the world around us (Hui et al., 2017). In practice theory, practices, rather than individuals, are the principal unit of enquiry. Consequently, practices rather than practitioners come first as meaning-making, identity-forming and order-producing activities (Chia & Holt, 2008) to enable us to understand social and organisational phenomena.

Practices are discrete entities with their own histories and trajectories and are distinguishable from moments of their enactment or performance (Shove et al., 2012). This distinction is important theoretically for understanding why practices evolve. Evolution in practices can be attributed to the way that various combinations of elements and their repeated performances over time create the practices of practice entities and their actions, institutions and structures (Maller, 2015, p. 53). Hence, a practice theory lens explains how the inter-relationships amongst science, policymaking, knowledge and culture cause organisations and people to shift their practice (Schatzki, 2002). Analytically, it is the *elements* of practice and their changing configurations over time that are important (Shove et al., 2012). Understanding the configuration of the components that make up practices and the dynamic relations between practices thus becomes a core task of analysis. Researchers have shown how social activity is

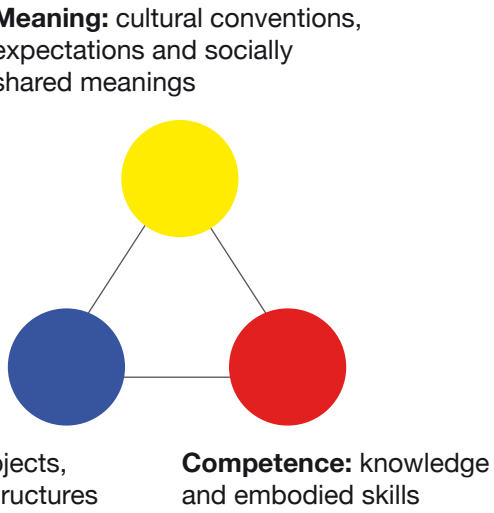

FIGURE 1 The three-element model of practice theory (adapted from Shove et al., 2012).

made up of human, material and discursive elements (Hampton & Adams, 2018; Hargreaves, 2011; Shove, 2017; Shove et al., 2012; Spotswood et al., 2015). As can be seen in Figure 1, Shove et al. (2012) propose a three-element model of practice theory in which practices consist of active integration amongst material, competence and meaning.

Materials include "things" such as technologies, tangible physical entities, and the stuff of which objects are made. *Competences* include skills, knowledge and technique, while *meanings* encompass symbolic meanings, ideas, aspirations and expectations. These elements can be adapted to a wide range of contexts and have been used specifically by Shove (2010) to critique linear models of social change that currently underpin environment policy in the United Kingdom. While often attributed to Shove, this model has drawn significantly from the works of Reckwitz (2002) and from Schatzki's (2010) ideas on materiality to form the idea that practices are composed of three interacting elements. Schatzki (2002) explored various ways in which "practices are intrinsically connected to and interwoven with objects" (p. 106). In combination with a multitude of other authors such as Pantzar and Watson, Shove's work treats these as elements of practice, paying attention to the trajectories (past and present) of elements, and to the making and breaking of links between them (Shove et al., 2012). Therefore, it becomes possible to analyse change and stability without prioritising agency or structure.

While a simplified representation of practices, Shove's approach underlines the centrality of linkages amongst elements. This supposes that elements, however defined, are "out there" in the world, waiting to be linked together. New practices are formed when connections between materials, competences and meanings are renewed time and again. Because practices are dynamic, the material configurations associated with them, and on which they depend, are not fixed. Intervention at one level (e.g., infrastructure, funding, policy or governance) has a wider effect on other aspects of material-practice relations. This has application to how policy like VM is formed and enabled, and to whether it is successful through the relationships between elements over time. As Schatzki (2012) notes, the "bundling" of practices and arrangements is mutually inclusive. That is, practices affect arrangements and arrangements affect practices (Baker, 2022). In this, practices are entities made up of connected actions, doings and sayings, linked by understandings, rules, material arrangements, structures and interwoven timespaces (see below), the bundling of which extends beyond the practice to reproduce everyday and "normal" ways of living and consuming (Blue, 2019). For Shove et al. (2012), practices connect in the bundles and complexes that they do as a consequence of competition and/or collaboration between practices.

Change, then, is a consequence of the integrative work involved. Changing practice requires breaking or challenging the links between a practice's inter-related elements. Thus, transformational change occurs through practices that involve novel combinations of new or existing elements (Shove et al., 2012, p. 7). According to practice theory,

change begins at the micro-level through activism that transforms organisations (Cardinale, 2019; Kohtamäki et al., 2020). This includes the more nuanced understanding of the micro-foundations of collaborative dynamics, relations and enactment in in-between spaces (Yström & Agogué, 2020) and increased focus on everyday praxis at the micro-level (Kohtamäki et al., 2020; Whittington, 2018). Practice theory focuses attention on the micro-practices that shape knowledge creation and exchange, and the collaborative competencies arising from such action. Knowledge is framed as a practical accomplishment through which people develop know-how and understanding (Cirella & Murphy, 2022, p. 362) through an ongoing learning process in which social interactions form, develop and change (Ollila & Yström, 2016). Developing collaborative competences at both the individual and the organisational levels requires looking beyond the *what* and *when* of collaboration to *how* to collaborate.

Practice theory also aligns with the direction of scholarship on innovation that brings into focus themes of integration and diversity. Such works have focused on issues like collective activity (Welch & Yates, 2018), the study of strategy as practice (Whittington, 2006, 2018), intermediary practices in university–industry innovation (Cirella & Murphy, 2022), the role of space and boundary objects to facilitate collaborative innovation (Caccamo, 2020), and how material objects, devices and resources figure in what people do (Shove, 2017). Shove et al.'s (2012) elemental approach is therefore a useful framework from which to consider the R&D aspect of the VM policy. It enables us to understand that practices are defined by interdependent relations between materials, competences and meanings, and that for them to be effective they need to be repeatedly linked together and renewed time and again (Shove et al., 2012).

As we noted, practices are mobile or dynamic, thus the material configurations associated with them, and on which they depend, are not fixed. The stability, routinisation and ongoing accomplishment of a practice is determined by elements being repeatedly linked together in similar ways. Hence, for the VM policy to create products, processes, systems and services from Māori knowledge, resources and people through distinctive R&D activities requires changes, for the science and innovation system generally and for Māori in particular. The initial VM policy remains vague about these elements; hence paying attention to sustained and repeated integration of elements of practice over time (Echeverri & Skålén, 2011) can provide insight into the everyday doings and interactions that support science and innovation collaboration with Māori. What is distinctive about Māori R&D comprises a nexus through which interactions occur within, against and beyond the status quo (Vunibola & Scobie, 2022). We would argue Māori partnering in or leading RSI delivery has the potential to create beneficial impacts in a way that more generic approaches do not. This leads to improving extant barriers of the past 20 years since the VM policy was implemented. We now turn to evaluating the themes in our literature review against practice theory and what this suggests about Aotearoa's science and innovation system in relation to Māori.

Methodology, findings and analysis

We analysed 56 academic outputs drawn primarily from the physical and engineering sciences and the natural and health sciences. This allowed us to identify a cohort of Māori researchers' key observations on mātauranga Māori and the science, technology and innovation (STI) system (Table 1). The review targeted peer reviewed journal articles, conference papers, book chapters and reports, and included systematic reviews, policy articles, empirical and experimental data, theoretical/conceptual findings, and model development. This helped us present a general picture of the state of knowledge on mātauranga Māori and science, what has changed, what needs to change, and who was writing on the subject.

Our data set is somewhat skewed by the dominance of established research in environmental, ecological and biological sciences versus research in "high-tech" disciplines of engineering, clinical and physical sciences, artificial intelligence, digital and space sciences. This may reflect the limited human and financial capital in the New Zealand economy due to its size and the need to focus our approach on high-tech science and innovation to meet grand challenges. There are real opportunities for Aotearoa in areas of emerging research such as space and aerospace, biotechnology, quantum technology and advanced materials and medical technology (MBIE, 2024).

As Table 1 shows, over the 10-year time frame six themes dominated:

1. Collaboration is viewed as important but requires cultural competency and the engagement of non-Māori scientists.
2. Māori worldviews are holistic, and Māori ways of working essential for Māori

TABLE 1 Key themes derived from our literature review

Theme		No. of outputs	Sample of outputs
Collaboration/ engagement	Collaboration between the science sector and Māori is important to achieving shared technical knowledge and absorptive capacity. Sci-tech projects and research-focused institutions (universities, Crown Research Institutes, government departments) should be collaborative, discussing, sharing ideas and insights. Some researchers find it difficult to engage with Māori due to lack of resources and cultural competency (experience with tikanga and mātauranga) as well as the lack of "bridging" or "brokering", as many projects lacked a Māori researcher (intermediaries).	40	Amoamo & Ruckstuhl, 2021; Kaiser & Saunders, 2021; Kukutai et al., 2021; Martin, 2021; Muru-Lanning, 2012; Ruckstuhl et al., 2019
Holistic worldview	Holistic Māori processes are essential for Māori knowledge, resources and people to contribute to STI. Māori decision-making processes are holistic, based on social, cultural, environment and spiritual indicators. Science needs to be understood from a Māori perspective, using a mātauranga Māori lens to translate science across boundaries.	32	Johnson et al., 2021; Keegan & Cunliffe, 2014; Kukutai et al., 2021; Mika et al., 2017; Ruckstuhl et al., 2019
Science and technology as agents of colonisation	There has been marginalisation of Indigenous knowledge as inferior and as a "pseudoscience" in the shadow of "real science". Western science (WS) has been and continues to be an agent of colonisation, domination, power and control, and a key barrier to increasing the uptake of Māori into science. The paradigms that operate in the RSI sector in Aotearoa do not easily cater for Māori knowledge, excluding Māori from many areas of research and positioning Māori as the "other" for not adopting WS ways. Māori, Pacific and other Indigenous groups experience racism and targeting online and in social media.	20	Broughton & McBreen, 2015; O'Carroll, 2013; Prussing & Newbury, 2016; Ruckstuhl et al., 2019; Ruwhiu et al., 2022; Stewart, 2020
Epistemology/ ontology	There are ontological and epistemological distinctions between Indigenous knowledge/mātauranga and WS. Integration requires examination of the epistemological origins of each knowledge system and the societal drivers that shape them. Mātauranga Māori highlights similarities; WS is analytical and focuses on differences. Both have their own integrity but are different ways of looking at the world.	21	Hikuroa, 2017; Mercier, 2018; Morgan & Manuel, 2020; Rauika Māngai, 2020; Roberts & Wills, 2019; Stewart, 2019
Protection/ control of mātauranga (data sovereignty)	Contention around Māori data and data sovereignty. Māori data should enable self-determination and mātauranga should be protected against misappropriation. Māori communities have to assume responsibility for the governance of data and shift capacity to use mātauranga Māori and Māori data to focus on creating insights and initiatives.	17	Greenwood et al., 2011; Hudson et al., 2017; Kukutai & Taylor, 2016; Sterling et al., 2021
Technology/ context of IT	Technology is being used creatively for particular kaupapa incorporating tikanga to bring Māori together and encourage connection, as well as spread important information about te reo, tikanga and whakapapa. Applying this context to IT is essential for the uptake of technological innovation for Māori and for increasing the number of Māori in leadership roles.	20	Kawharu et al., 2021; Keegan & Sciascia, 2018; Ruwhiu et al., 2022; Whaanga et al., 2021; Wilkinson et al., 2020

NOTE: Drawn from a review of 56 research outputs published during the last 10 years from the fields of engineering; environmental science; digital technologies; medical and health sciences; language communication and culture; physical, chemical and Earth sciences; mathematical, information and computing sciences; and commerce and management.

knowledge, resources and people to contribute to STI.
3. There are ontological and epistemological distinctions between Western science and mātauranga.
4. Science is another agent of colonisation that has affected Māori social, economic, environmental and spiritual wellbeing.
5. The issues around Māori data sovereignty and governance include mechanisms and policies through which Māori exercise control and protection over data.
6. The context of IT and technology is essential for the uptake of technological innovation for Māori.

The theme of the importance of collaboration was strongly emphasised by 40 authors in our sample, including in recent reports like *A Guide to Vision Mātauranga: Lessons from Māori Voices in the New Zealand Science Sector* (Rauika Māngai, 2020) and *Te Pūtahitanga: A Tiriti-led Science–Policy Approach for Aotearoa New Zealand* (Kukutai et al., 2021). According to many of the authors, collaboration requires non-Māori researchers to be open and willing to share findings with Māori and for Māori to be part of the research process. This includes Māori leadership as essential for the uptake of technological innovation for Māori. However, some of the literature explained that non-Māori researchers struggle to interact and collaborate with Māori due to lack of cultural competency (Martin, 2021). Here, SfTI research has found that the role of science intermediaries (Māori and non-Māori) who can guide cross-cultural engagements can be integral to bridging the science–Māori knowledge interface, as articulated through the VM policy (Ruwhiu & Amoamo, 2021; SfTI, 2020).

Twenty-one articles raised the *ontological and epistemological* distinction between science and mātauranga Māori. A predominant theme related to mātauranga Māori as a *holistic knowledge system* (32 articles) based on inter-relationships (whakapapa) and deeply embedded in the ethics, values and obligations of Māori collectives. Many authors (20) noted that mātauranga Māori has been applied and adapted to a variety of contemporary contexts, progressively and creatively adopting and adapting technology for socioeconomic uses in ways that incorporate tikanga (Kawharu et al., 2021; Keegan & Sciascia, 2018; Ruwhiu et al., 2022; Wilkinson et al., 2020). However, there were cautions. Mead (2012) noted that mātauranga Māori is nuanced to its context. Decontextualising mātauranga Māori runs the risk that scientists will view it as a "one-size-fits-all", abstracting and therefore potentially minimising its contribution (Ogilvie et al., 2018). Cherry-picking elements of mātauranga Māori devalues holistic approaches, including the ability to *protect mātauranga Māori* (17 articles) through appropriate mechanisms such as IP laws, with calls for data sovereignty (Hudson et al., 2017). In a world where information appropriation and unethical data use is prevalent (West et al., 2020), authors recognised that current legal tools do not provide adequate protection of mātauranga Māori.

Such issues run into the theme of systemic racism and marginalisation of mātauranga Māori /Indigenous knowledge (Broughton & McBreen, 2015; Prussing & Newbury, 2016; Ruckstuhl et al., 2019; Ruwhiu et al., 2022; Stewart, 2020). This theme, in turn, links to another theme raised in 20 articles, with Western science seen as *an ongoing agent of colonialism*, creating barriers for Māori due to the lack of culturally safe spaces within current institutions for Māori, which is particularly problematic for early career Māori researchers (Kawharu et al., 2021; Ruru et al., 2019; Waiti & Wikaire, 2021).

Analysis of themes against Shove et al.'s (2012) three-element model and mātauranga Māori

Having identified these key themes, we now turn to Shove et al.'s (2012) analytical approach to understand the components of and dynamic relations amongst the elements that are required to form, change or embed the VM policy practice aim of distinctive R&D activities through Māori knowledge, resources and people. Table 2 presents Shove et al.'s (2012) three-element model and identifies the types of influences that either enable or constrain a policy like VM in RSI systems.

Materials

In our analysis, the VM policy falls into the materials category, under a loose definition of policy infrastructure. Shove et al. (2012) describe materials as objects, infrastructures, tools, hardware—generally, the physical and visible "things" deployed in a practice. Materials have a fundamental purpose in determining the lifecycle of a practice and can be viewed as active actors that have a role in enabling, shaping, entrenching or constraining practices (Kadibadiba et al., 2018). For Reckwitz (2002), things can be seen as sites of understanding, or materialised understandings. In this sense, then, a policy that appears

TABLE 2 Analysis of themes against Shove et al.'s (2012) three elements of practice theory

Meanings (Cultural conventions, expectations, socially shared meanings)	**Competences (Knowledge, embodied skills)**	**Materials (Objects, infrastructure, tools)**
Te Tiriti: colonisation, racism, equity, sovereignty.	*Partnership*: Māori leadership/ governance/decision-making, low number of Māori in science and technology.	*Policy infrastructure*: VM policy, funding, application forms, data sovereignty tools, law, IP contracts.
Ontology/epistemology/axiology: holism, mātauranga vs Western science, Māori values.	*Holistic processes*: collaboration, co-creation, co-design, wānanga.	*Embodied mātauranga*: marae, Māori locations, Māori design, pūrākau.
Māori context of IT/science: kaupapa, relevance of R&D to Māori aspirations.	*Cultural competence*: engagement, tikanga, te reo, karakia, waiata, maramataka, mentoring Māori early career researchers, intermediaries, absorptive capacity.	*Research infrastructure*: entities, institutions, safe Māori R&D spaces, data.

on websites can be downloaded as a PDF, and appears in numerous documentary references across government, academic and other locations as a materialised understanding that Māori knowledge, resources and people should have the potential to be key contributors to the economy through distinctive R&D activities. Therefore, the policy can be read as an intent to enable, shape and entrench a new set of practices into the STI system.

However, as Shove et al. (2012) explain, it is the *linkages amongst elements* that entrench a practice. Hence, the VM policy's materiality, whether in the form of application forms for funding, written contracts, IP laws, data sovereignty tools, and so on, requires linkages to other materials, on both the Māori and the non-Māori research institution side (e.g., embodied mātauranga in the context of Māori locations). For Māori, co-creation processes such as wānanga can only happen on-site so that the "context" of the research is understood. Control over Māori data requires more than just legal interventions. Options like digital markers that focus on accurate provenance, transparency and integrity in research engagements around Indigenous data support Indigenous communities' consent processes and the appropriate use of their data.

There also needs to be clarity about what the VM policy means by "distinctive" R&D activities. For example, leadership models like Takarangi (Kawharu & Tapsell, 2021) can be replicated across both Western and Indigenous systems. Takarangi is novel, grounded in whenua and taonga, and gives expression to rangatiratanga. It is a model that helps address low Māori researcher capacity in the physical sciences as well as maximise the potential of mātauranga Māori in combination with high-tech innovation.

Finally, there needs to be linkages to the capabilities and knowledge of non-Māori scientists and Māori to undertake such activities. Capacity development programmes build competency and engagement with Māori through attendance at events (e.g., the Federation of Māori Authorities annual hui). Attendance at such hui brings critical reflection on the purpose of research, changing assumptions about Māori needs, and influences how grant applications are written for research that incorporates new methodologies.

Moreover, the connections between materials, competences and meanings must be renewed time and again. Therefore, as a material intervention tool, the VM policy in its R&D innovation intent is only one part of one element.

Competences

While Shove et al.'s (2012) framework focuses on how elements are linked, unlinked and then relinked in new configurations to create new practices, this is not to say that individuals are rendered

invisible. As many authors in our literature review argue, Māori values, worldviews, knowledge practices and kaupapa cannot be instigated without Māori people. In Shove et al.'s (2012) analysis, however, it is not individuals that are the principal unit of enquiry. Rather, individuals as "carriers of practice" have the skills or competences that constitute the embodied knowledge required for the carrier to succeed at the performance of a practice.

The findings of our literature review show that most authors argue for collaboration and engagement between scientists and Māori as key to realising the contribution of Māori knowledge, resources and people. The competences for collaboration and engagement, however, fall into different categories. From a partnership perspective, Māori leadership needs to be assured often at a governance level, so that decisions about science, whether system-wide or project-level, have equal input from Māori—an extension of the te Tiriti aspiration. Thus, specific Māori models of leadership appropriate to the sci-tech and entrepreneurship disciplines, such as the Takarangi model (Kawharu & Tapsell, 2021), try to tease out and then point to potential implementation practices. The Takarangi model guides Western and Māori science cooperation in areas including leadership foci, risk management, leadership practices, and complementary but different guiding values (Kawharu & Tapsell, 2021, p. 20).

Partnership and equal decision-making with Māori in the context of science and R&D are not intuitive. New collaborative processes are needed, often couched in terms such as *co-creation* or *co-design*, to draw together Māori and non-Māori understandings around a particular R&D topic. This points to "distinctive R&D" activities being novel, systematic, transferable and reproducible. Our literature review highlighted case studies that explore particular approaches to such co-creation, often taking place on marae or in Māori-controlled spaces, which we describe as the infrastructure of "embodied mātauranga". Science R&D co-design, co-creation and wānanga, as the case studies and some of the more theoretical articles show, require new competences, on both the Māori and the non-Māori sides. Collaborative practices require "matching the levels of preconditions between partners" with individual actors bringing their own views to such collaborations, including specific representations (meanings) of science and innovation (Cirella & Murphy, 2022, p. 358). As we have argued using ideas drawn from theories of how firms absorb and then apply R&D knowledge to create new products or processes, science teams absorbing Māori approaches to science requires not just engaging intellectually with a Māori worldview (meaning), but also experiencing it through mātauranga embodied in things or places materially meaningful to Māori.

Cirella and Murphy (2022) also note that there needs to be sufficient number of "carriers" of a practice if it is to become an ongoing, routinised and recurrent accomplishment. Many of the authors in the literature review argue that there needs to be a higher degree of cultural competence amongst scientists if Māori, and by extension Aotearoa, are to benefit from distinctive R&D. As Table 2 reflects, such competency includes practices that appear adjacent, irrelevant, or even oppositional to sci-tech, such as te reo Māori, karakia, waiata, maramataka. Often the science sector relies on intermediaries, whether non-scientist Māori engagement brokers or Māori researchers, and in particular Māori early career researchers, to be the carriers of these practices. However, given the low number of Māori in sci-tech disciplines, and that such competences appear as not "core" to R&D, it is not surprising that there is difficulty in recruiting a sufficient number of carriers, leading to non-Māori scientists' feelings of cultural inadequacy and fear of engagement (Ruwhiu & Amoamo, 2021) and for Māori, needing culturally safe environments, and mentoring or advocacy—particularly for early career Māori researchers (Waiti & Wikaire, 2021). Policies designed to increase the number of Māori engaged or trained in sci-tech disciplines are recognition that without a sufficient number of carriers VM's aspiration for distinctive R&D is merely tokenistic—the "levels of pre-conditions" on both the science sector and Māori sides do not match to a sufficient degree.

Meanings

As our literature review shows, the VM policy, as a tool of the science sector, comes with significant preconceptions and a lack of socially shared meaning between the science and Māori communities. Practice theory alerts us that symbolic meanings, aspirations and ideas associated with a practice are vital for recruiting, retaining or disengaging practitioners (Baker, 2022). This is reinforced by our literature review, which found that many authors refer to the science sector as an agent of colonisation, both in the past and in the present through lack of equity in research institutions and ongoing racism in communication technologies. That data is being seen as an issue of Māori sovereignty reinforces that what was promised in te Tiriti—authority to control and protect

taonga—has failed to be delivered. Therefore, policy recommendations from Māori such as a Tiriti-led science–policy approach (Kukutai et al., 2021) are a documentary reminder that te Tiriti and its place in the RSI sector are still not shared from a common framework of understanding and therefore linkages to other elements are tenuous.

In relation to the ontological, mātauranga Māori is holistic, grounded in whakapapa and relationality between the human and not human. In terms of epistemology, how Māori understand what is and is not knowledge reinforces that mātauranga Māori and the science sector have different frames of reference. Many authors emphasise that these different frames of reference are founded upon particular values that may sit uneasily within a "strict" sense of what science is. For example, Kukutai et al. (2021) argue that a value such as manaakitanga, which has its roots in caring for Māori community, has an overall benefit to the STI system because it can be applied to the system as a whole. However, unless manaakitanga can be materialised in some way—materially or through a skilled action—then such values remain as unlinked elements. Given the historical precedent accompanying lack of te Tiriti partnership, many of the authors lay out instances of where and why Māori knowledge has been minimised as not "real science", as well as instances of its physical or intangible form being appropriated without acknowledgement or recompense. These instances underlie calls for more appropriate and tangible policy infrastructure in the form of changes to IP processes or particular tools like digital markers that protect mātauranga Māori.

A third area where the meaning of the VM policy has failed to be shared relates to how the contribution of Māori knowledge, resources and people must be framed within the context or kaupapa of Māori aspirations for themselves. As some authors noted, Māori use sci-tech tools for many kaupapa Māori purposes, such as revitalisation of te reo Māori (Keegan & Sciascia, 2018), Māori culture (Greenwood et al., 2011), e-health (Henry et al., 2017) or to embed Māori values into an industry such as fisheries to protect the environment (Ogilvie et al., 2018). Therefore, the linking of Māori values, frames of reference and, as Schatzki (2009) describes it, the "timespace process" whereby everything that people do has a history and a setting, are fundamental to achieving the VM policy's aspirations.

Conclusion

We have previously argued (Ruckstuhl et al., 2019) that there are no VM implementation methods within the sci-tech sector and particularly not in the high-tech disciplines that are the focus of our literature review. Rather, implementation has been case by case and ad hoc. We noted the relative infancy of Aotearoa's high-tech R&D sector, and that its underpinning "hard" sciences have been some of the last to implement the VM policy. The still low capacity of Māori scientists in these disciplines plays a factor vis-à-vis the more established cohort of Māori researchers in the biological and environmental sciences. Over the last decade, and as indicated in the proposed Science System Advisory Group review (MBIE, 2024), Māori knowledge, leadership and approaches are increasingly being accepted as a necessary component of the science sector. However, there is still some way to go before the materials, competences and meanings of these approaches are routine or a practical accomplishment (Cirella & Murphy, 2022). Hence, this analysis, based on our own and others' experience as captured in the literature review, provides an opportunity to focus on the elements necessary to truly embed the ambitions of the VM policy as it pertains to the creation of distinctive R&D activities.

As noted in *A Guide to Vision Mātauranga* (Rauika Māngai, 2020) and *Te Pūtahitanga* (Kukutai et al., 2021), the material traces of past practices stemming from colonialism and lack of partnership has resulted in Māori having limited opportunities to influence the science–policy interface. However, as these reports also advocate, including local, culturally situated and contextualised knowledge about complex problems can help solve real-world social, economic and environmental challenges. From a Māori context, and as Shove et al. (2012) identify, to achieve this will require new configurations of existing elements along with new elements in conjunction with those that already exist. As part of sci-tech innovation practices, VM policy is not just a communicator of symbolic meaning, status or identity; its value lies in the integration of forms of material, competence *and* meaning. All three elements must exist for the performance of the practice (Spotswood et al., 2015), and practices have to be performed to be sustained (Blue, 2019). If VM is to be fully realised, people have to enact it—successful implementation depends on who practises it and when, where and how it is practised. For Schatzki (1996), the actions and causally linked doings and sayings enacted in the performance of a practice collect

into various sorts of spatiotemporal networks that run through and connect different practices into "institutions", "groups" and "systems" (p. 89). While entities like MBIE, SfTI and institutions can make VM "happen"—they cannot succeed without the carriers of practice and the competences and meanings required to constitute and reproduce the *practice* of VM. The practice of "distinctive R&D" is further challenged by bias against novelty, lack of diversity, too much focus on the technical, the timing of decisions, and decision-making processes themselves. While it is sometimes thought that practices as entities are closed blocks or patterns that are then filled out by performances that maintain or change the social order, for Schatzki (2016) their enactment in context-specific situations forces a reinterpretation and therefore an innovation that represents more than pure reproduction (p. 25).

Taking a cue from Schatzki's and Shove et al.'s works, we can attempt to understand social phenomena in sci-tech innovation through the life-cycle of practices, activities, bundles and arrangements. The practice of the VM policy in the RSI system as a phenomenon occurs within "a field of practices" that includes "knowledge, meaning, human activity, science power, language, social institutions and human transformations" (Schatzki et al., 2001, p. 2). Competency needs appropriate materials and tools to perform the intended practice (VM), while individuals draw on specific meanings to perform practices.

Practice theory is not one, unifying theory. However, given its limited application in high-tech innovation, its usefulness is under-researched. Through a practice theory lens, the ways in which "things" (encompassing materials, competencies and meanings) are acquired, appropriated and used routinely lead us to conclude that there is scope for relating the results and insights of sci-tech studies to a more extensive analysis of how practices evolve. In this, the elements of material, competence and meaning are rearranged to foster the best science most relevant to Aotearoa. For Māori to benefit and participate requires a conscious and very deliberate set of practices that resonate with and align to Māori innovation aspirations (Ruckstuhl et al., 2019). This will set the scene to design and enhance processes as iterative, interactive, ongoing, routinised and recurrent accomplishments that create a pathway to normalise VM engagement.

If we are to take these ideas forward, we need to conceptualise practitioners (i.e., scientists) as but one dimension of the reproduction of practice. The elemental approach provides a lens to examine configurations—or practices—that work because material elements and those of meaning and competence are linked together and transformed through *the process of doing*. Practice theory goes beyond describing what people do. Practices are, in fact, meaning-making, identity-forming and order-producing activities (Chia & Holt, 2008; Nicolini, 2009). This raises fundamental questions concerning how collaborative innovation is done, the meaning of that which is done, and how practices constitute and shape the collaborative space between Western science and mātauranga Māori. While the template for the enactment of VM is still a work in progress, we suggest that practice theory provides a powerful tool in shaping the trajectory of VM practice necessary to meet the scale of STI in Aotearoa.

Glossary

hui	meeting
karakia	ritual chants, prayers
kaupapa	topic
manaakitanga	hospitality, generosity
marae	open space or courtyard where people gather, generally in front of a main building or meeting house
maramataka	Māori lunar calendar
mātauranga	knowledge
pūrākau	narratives
rangatiratanga	self-determination
taonga	treasure, anything prized
te reo Māori	the Māori language
te Tiriti	the Treaty (of Waitangi); New Zealand's founding document
tikanga	custom, protocol
waiata	songs
wānanga	learning space
whakapapa	genealogical links, lineage/ancestry
whenua	land

References

Alpenberg, J., & Scarbrough, D. P. (2021). Practice theory in a collaborative context. *Journal of Business Research, 123*, 415–422. https://doi.org/ghjcxc

Amoamo, M., & Ruckstuhl, K. (2021). Kāhui Māori: Distinctive leadership in science and technology. In M. Amoamo, Ruckstuhl, K., & Kawharu, M. (Eds.), *He pou hiringa: Grounding science and*

technology in te ao Māori (pp. 35–54). Bridget Williams Books. https://doi.org/mxk2

Amoamo, M., & Ruckstuhl, K. (2023). Reforming the research and science system for Māori innovation: Practice theory for policy implementation. *Policy Quarterly, 19*(4), 77–85. https://doi.org/m3wf

Ardito, L., Ferraris, A., Petruzzelli, A. M., Bresciani, S., & Del Giudice, M. (2019). The role of universities in the knowledge management of smart city projects. *Technological Forecasting and Social Change*, *142*, 312–321. https://doi.org/gf3w9r

Baker, B. (2022). *An examination of changing sustainable business practices in New Zealand* [Master's thesis, Lincoln University]. Research@Lincoln. https://hdl.handle.net/10182/15829

Barcham, M. (2012). Thinking about Māori development in terms of the capability approach: The shift towards the adoption of the Māori potential approach. In F. Panzironi & K. Gelber (Eds.), *The capability approach: Development practice and public policy in the Asia-Pacific region* (pp. 55–67). Routledge.

Blue, S. (2019). Institutional rhythms: Combining practice theory and rhythm analysis to conceptualise processes of institutionalisation. *Time & Society*, *28*(3), 922–950. https://doi.org/gnszdr

Bourdieu, P. (1977). *Outline of a theory of practice* (R. Nice, Trans.). Cambridge University Press. https://doi.org/gjqwx3

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. https://doi.org/gjt5ck

Caccamo, M. (2020). Leveraging innovation spaces to foster collaborative innovation. *Creativity and Innovation Management*, *29*(1), 178–191. https://doi.org/ggvfgc

Cardinale, I. (2019). Microfoundations of institutions and the theory of action. *Academy of Management Review*, *44*(2), 467–470. https://doi.org/gfgs2w

Chesbrough, H. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Harvard Business School Press.

Chia, R., & Holt, R. (2008). The nature of knowledge in business schools. *Academy of Management Learning & Education, 7*(4), 471–486. https://doi.org/b8ftzq

Cirella, S. (2021). Managing collective creativity: Organizational variables to support creative teamwork. *European Management Review*, *18*(4), 404–417. https://doi.org/gmm7kc

Cirella, S., & Murphy, S. (2022). Exploring intermediary practices of collaboration in university–industry innovation: A practice theory approach. *Creativity and Innovation Management*, *31*, 358–375. https://doi.org/mxk3

Echeverri, P., & Skålén, P. (2011). Co-creation and co-destruction: A practice-theory based study of interactive value formation. *Marketing Theory*, *11*(3), 351–373. https://doi.org/fm5ngn

Foucault, M. (2002). *Archaeology of knowledge* (A. M. Sheridan Smith, Trans.). Routledge. (Original work published 1969)

George, G., Howard-Grenville, J., Joshi, A., & Tihanyi, L. (2016). Understanding and tackling societal grand challenges through management research. *Academy of Management Journal*, *59*(6), 1880–1895. https://doi.org/gc8svm

Giddens, A. (1979). *Central problems in social theory: Action, structure, and contradiction in social analysis*. University of California Press. https://doi.org/gtgqqg

Greenwood, J., Te Aika, L. H., & Davis, N. (2011). Creating virtual marae: An examination of how digital technologies have been adopted by Māori in Aotearoa New Zealand. In P. R. Leigh (Ed.), *International exploration of technology equity and the digital divide: Critical, historical and social perspectives* (pp. 58–79). Information Age Press. https://doi.org/fdvcz9

Hampton, S., & Adams, R. (2018). Behavioural economics vs social practice theory: Perspectives from inside the United Kingdom government. *Energy Research & Social Science*, *46*, 214–224. https://doi.org/ggfgft

Hargreaves, T. (2011). Practicing behaviour change: Applying social practice theory to pro-environmental behaviour change. *Journal of Consumer Culture*, *11*(1), 79–99. https://doi.org/bnwdhr

Hemphälä, J., & Magnusson, M. (2012). Networks for innovation—but what networks and what innovation? *Creativity and Innovation Management*, *21*(1), 3–16. https://doi.org/f235jd

Henry, E., Newth, J., & Spiller, C. (2017). Emancipatory Indigenous social innovation: Shifting power through culture and technology. *Journal of Management & Organization*, *23*(6), 786–802. https://doi.org/ghzpxr

Hikuroa, D. (2017). Mātauranga Māori—the ūkaipō of knowledge in New Zealand. *Journal of the Royal Society of New Zealand, 47*(1), 5–10. https://doi.org/gnkk95

Hudson, M., Anderson, T., Dewes, T. K., Temara, P., Whaanga, H., & Roa, T. (2017). "He matapihi ki te mana raraunga"—Conceptualising Big Data through a Māori lens. In H. Whaanga, T. Keegan, & M. Apperley (Eds.), *He whare hangarau Māori—Language, culture & technology* (pp. 64–73). University of Waikato.

Hui, A., Schatzki, T., & Shove, E. (Eds.). (2017). *The nexus of practices: Connections, constellations, practitioners*. Routledge. https://doi.org/gjchjx

Johnson, D., Parsons, M., & Fisher, K. (2021). Engaging Indigenous perspectives on health, wellbeing and climate change. A new research agenda for holistic climate action in Aotearoa and beyond. *Local Environment*, *26*(4), 477–503. https://doi.org/mxk5

Kadibadiba, T., Roberts, L., & Duncan, R. (2018). Living in a city without water: A social practice theory analysis of resource disruption in Gaborone, Botswana. *Global Environmental Change*, *53*, 273–285. https://doi.org/gn5zf2

Kaiser, L. H., & Saunders, W. S. A. (2021). Vision

Mātauranga research directions: Opportunities for iwi and hapū management plans. *Kōtuitui: New Zealand Journal of Social Sciences Online*, *16*(2), 371–383. https://doi.org/mxk6

Kawharu, M., Jones, L., & Tapsell, P. (2021). Where tikanga meets technology: Connecting hau kāinga to whenua ora. In M. Amoamo, K. Ruckstuhl, & M. Kawharu (Eds.), *He pou hiringa: Grounding science and technology in te ao Māori* (pp. 55–74). Bridget Williams Books. https://doi.org/mxk7

Kawharu, M., & Tapsell, P. (2021). Expanding Takarangi: Applying a Māori values-led model of team leadership in science and technology. In M. Amoamo, K. Ruckstuhl, & M. Kawharu (Eds.), *He pou hiringa: Grounding science and technology in te ao Māori* (pp. 17–34). Bridget Williams Books. https://doi.org/mxk8

Keegan, T. T. A. G., & Cunliffe, D. (2014). Young people, technology and the future of te reo Māori. In R. Higgins, P. Rewi, & V. Olsen-Reeder (Eds.), *The value of the Māori language: Te hua o te reo Māori* (Vol. 2, pp. 385–398). Huia Publishers.

Keegan, T. T. A. G., & Sciascia, A. D. (2018). Hangarau me te Māori: Māori and technology. In M. Reilly, S. Duncan, G. Leoni, L. Paterson, L. Carter, M. Rātima, & P. Rewi (Eds.), *Te kōparapara: An introduction to the Māori world* (pp. 359–371). Auckland University Press.

Kohtamäki, M., Heimonen, J., Sjödin, D., & Heikkilä, V. (2020). Strategic agility in innovation: Unpacking the interaction between entrepreneurial orientation and absorptive capacity by using practice theory. *Journal of Business Research, 118*, 12–25. https://doi.org/ghfqxr

Kukutai, T., McIntosh, D. T., Boulton, A., Durie, M., Foster, M., Hutchings, J., Mark-Shadbolt, M., Moewaka Barnes, H., Moko-Mead, T. T., Paine, S. J., Pitama, S., & Ruru, J. (2021). *Te Pūtahitanga: A Tiriti-led science–policy approach for Aotearoa New Zealand*. https://resiliencechallenge.nz/wp-content/uploads/CB_TePutahitanga_A4_2021_inner_Digital_final.pdf

Kukutai, T., & Taylor, J. (Eds.) (2016). *Indigenous data sovereignty: Toward an agenda*. ANU Press. https://doi.org/gmh4nm

Maller, C. J. (2015). Understanding health through social practices: Performance and materiality in everyday life. *Sociology of Health & Illness*, *37*(1), 52–66. https://doi.org/f6zsg5

Martin, W. J. (2021). Building Māori capacity: Accelerating access to physical sciences and engineering research. In M. Amoamo, K. Ruckstuhl, & M. Kawharu (Eds.), *He pou hiringa: Grounding science in te ao Māori* (pp. 100–118). Bridget Williams Books. https://doi.org/mxk9

MartinJenkins. (2023). *Exploring the use of government RSI funding for Māori*. https://www.mbie.govt.nz/assets/government-investment-in-maori-research-science-and-innovation.pdf

Mead, H. (2012). Understanding mātauranga Māori. In Haemata Ltd., T. Black, D. Bean, W. Collings, & W. Nuku (Eds.), *Conversations on mātauranga Māori* (pp. 9–14). NZQA. https://www2.nzqa.govt.nz/assets/Maori/Our-focus-on-Maori/Conversations-Matauranga-Maori.pdf

Mercier, O. (2018). Mātauranga and science. *New Zealand Science Review*, *74*(4), 83–90. https://doi.org/mxmb

Mika, J., Warren, L., Foley, D., & Palmer, F. (2017). Perspectives on Indigenous entrepreneurship, innovation, and enterprise. *Journal of Management & Organization*, *23*(6), 767–773. https://doi.org/gndggj

Ministry of Business, Innovation and Enterprise. (2024). *Terms of reference for the Science System Advisory Group*. https://www.mbie.govt.nz/science-and-technology/science-and-innovation/agencies-policies-and-budget-initiatives/science-system-advisory-group/tor/

Ministry of Research, Science and Technology. (2007). *Vision Mātauranga*. https://www.mbie.govt.nz/dmsdocument/1269-vision-matauranga-unlocking-the-innovation-potential-of-maori-knowledge-resources-and-people

Moewaka Barnes, H. (2006). Transforming science: How our structures limit innovation. *Social Policy Journal of New Zealand*, *29*, 1–16.

Morgan, K., & Manuel, R. (2020). Western science and Indigenous wisdom: Is integration possible, practical, plausible? *New Zealand Science Review*, *76*(1–2), 6–12. https://doi.org/mxmc

Muru-Lanning, M. (2012). Māori research collaborations, mātauranga Māori science and the appropriation of water in New Zealand. *Anthropological Forum, 22*(2), 151–164. https://doi.org/mxmd

Nicolini, D. (2009). Zooming in and out: Studying practices by switching theoretical lenses and trailing connections. *Organization Studies*, *30*(12), 1391–1418. https://doi.org/cbs99r

Nicolini, D. (2012). *Practice theory, work, and organization: An introduction*. Oxford University Press.

O'Carroll, A. D. (2013). An analysis of how rangatahi Māori use social networking sites. *MAI Journal*, *2*(1), 46–59.

Ogilvie, S., Major, R., McCarthy, A., Paine, G., Paine, R., Connor, G., Connor, S., Taylor, D., Jeffs, A., Heasman, K., Batstone, C., Chambers, B., & Allen, W. (2018). Mātauranga Māori driving innovation in the New Zealand scampi fishery. *New Zealand Journal of Marine and Freshwater Research*, *52*(4), 590–602. https://doi.org/mxmf

Ollila, S., & Yström, A. (2016). Exploring design principles of organizing for collaborative innovation: The case of an open innovation initiative. *Creativity and Innovation Management*, *25*(3), 363–377. https://doi.org/f3s9s4

Prussing, E., & Newbury, E. (2016). Neoliberalism and Indigenous knowledge: Māori health research and the cultural politics of New Zealand's "National Science Challenges". *Social Science and Medicine*, *150*, 57–66. https://doi.org/f8b49d

Rauika Māngai. (2020). *A guide to Vision Mātauranga: Lessons from Māori voices in the New Zealand science sector*. https://www.

rauikamangai.co.nz/wp-content/uploads/2021/05/Rauika-Ma%CC%84ngai_A-Guide-to-Vision-Ma%CC%84tauranga_FINAL.pdf

Reckwitz, A. (2002). Toward a theory of social practices: A development in culturalist theorizing. *European Journal of Social Theory*, *5*(2), 243–263. https://doi.org/d9rjhn

Ritala, P., & Stefan, I. (2021). A paradox within the paradox of openness: The knowledge leveraging conundrum in open innovation. *Industrial Marketing Management*, *93*, 281–292. https://doi.org/gjch6r

Roberts, R. M., & Wills, P. R. (2019). Understanding Māori epistemology: A scientific perspective. In H. Wautischer (Ed.), *Tribal epistemologies: Essays in the philosophy of anthropology* (pp. 43–78). Routledge. https://doi.org/mxmg

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*(Suppl. 1), 72–88. https://doi.org/gpjvbk

Ruru, J., Nikora, L. W., McIntosh, T., Patrick, D., & Kukutai, T. (2019). Whāia ngā pae o te māramatanga: our horizons of pursuit. *New Zealand Science Review*, *75*(4), 74–79. https://doi.org/mxmh

Ruwhiu, D., & Amoamo, M. (2021). An uncertain journey research at the science–Vision Mātauranga interface. In M. Amoamo, K. Ruckstuhl, & M. Kawharu (Eds.), *He pou hiringa: Grounding science and technology in te ao Māori* (pp. 88–99). Bridget Williams Books. https://doi.org/mxmj

Ruwhiu, D., Arahanga-Doyle, H., Donaldson-Gush, R., Bragg, C., & Kapa, J. (2022). Enhancing the sustainability science agenda through Indigenous methodology. *Sustainability Science*, *17*(2), 403–414. https://doi.org/mxmk

Schatzki, T. R. (1996). *Social practices: A Wittgensteinian approach to human activity and the social*. Cambridge University Press. https://doi.org/b34zts

Schatzki, T. R. (2002). *The site of the social: A philosophical account of the constitution of social life and change*. Pennsylvania State University Press. https://doi.org/mxmm

Schatzki, T. R. (2009). Time, consumption and everyday life. In E. Shove, F. Trentmann, & R. Wilk (Eds.), *Time, consumption and everyday life: Practice, materiality and culture* (pp. 35–48). Routledge.

Schatzki, T. R. (2010). Materiality and social life. *Nature and Culture*, *5*(2), 123–149. https://doi.org/bcc5vm

Schatzki, T. R. (2012). A primer on practices: Theory and research. In J. Higgs, R. Barnett, S. Billett, M. Hutchings, & F. Trede (Eds.), *Practice-based education: Perspectives and strategies* (pp. 13–26). Brill.

Schatzki T. R. (2016). Crises and adjustments in ongoing life. *Österreichische Zeitschrift für Soziologie*, *41*(Suppl. 1), 17–33. https://doi.org/mxmn

Schatzki, T. R., Knorr-Cetina, K., & Von Savigny, E. (Eds.). (2001). *The practice turn in contemporary theory*. Routledge.

Science for Technological Innovation. (2020). *Building New Zealand's innovation capacity: Phase 1 insights*. Callaghan Innovation.

Shove, E. (2010). Beyond the ABC: Climate change policy and theories of social change. *Environment and Planning A*, *42*(6), 1273–1285. https://doi.org/cj9fjq

Shove, E. (2017). Matters of practice. In A. Hui, T. Schatzki, & E. Shove (Eds.), *The nexus of practices: Connections, constellations, practitioners* (pp. 155–168). Routledge.

Shove, E., Pantzar, M., & Watson, M. (2012). Making and breaking links. In E. Shove, M. Pantzar, & M. Watson (Eds.), *The dynamics of social practice: Everyday life and how it changes* (pp. 21–42). SAGE Publications. https://doi.org/mxmp

Spotswood, F., Chatterton, T., Tappa, A., & Williams, D. (2015). Analysing cycling as a social practice: An empirical grounding for behaviour change. *Transportation Research Part F*, *29*, 22–33. https://doi.org/f67x87

Sterling, R., Riddle, K., Brooks, R. T., & Hudson, M. (2021). *Understanding Māori rights and interests in intellectual property arising from research and innovation*. Te Kotahi Research Institute, University of Waikato.

Stewart, G. T. (2019). Mātauranga and putaiao: The question of "Māori science". *New Zealand Science Review*, *75*(4), 65–68.

Stewart, G. T. (2020). Mātauranga Māori: A philosophy from Aotearoa. *Journal of the Royal Society of New Zealand*, *52*(1) 18–24. https://doi.org/mxmq

Te Puni Kōkiri. (2007). *Annual report for the year ended 30 June 2007: Māori potential approach*. https://www.tpk.govt.nz/en/mo-te-puni-kokiri/corporate-documents/corporate-publications/annual-reports/tpk-annualreport-2007

Vunibola, S., & Scobie, M. (2022). Islands of Indigenous innovation: Reclaiming and reconceptualising innovation within, against and beyond colonial-capitalism. *Journal of the Royal Society of New Zealand, 52*(Suppl. 1), 4–17. https://doi.org/gtvv8b

Waiti, J., & Wikaire, E. (2021). Acknowledging Te Whare Tapa Whā: Health and wellbeing of Māori early career researchers. In M. Amoamo, K. Ruckstuhl, & M. Kawharu (Eds.), *He pou hiringa: Grounding science and technology in te ao Māori* (pp. 119–141). Bridget Williams Books. https://doi.org/mxmr

Welch, D., & Yates, L. (2018). The practices of collective action: Practice theory, sustainability transitions and social change. *Journal for the Theory of Social Behaviour*, *48*(3), 288–305. https://doi.org/gd77ks

West, K., Hudson, M., & Kukutai, T. (2020). Data ethics and data governance from a Māori world view. In L. George, J. Tauri, & L. T. A. o. T. MacDonald (Eds.), *Indigenous research ethics: Claiming research sovereignty beyond deficit and the colonial legacy* (pp. 67–81). Emerald Publishing. https://doi.org/mxms

Whaanga, H., Mato, P., & Keegan, T. T. (2021). Project Ātea: Designing and developing Māori digital space. In M. Amoamo, K. Ruckstuhl, & M.

Kawharu (Eds.), *He pou hiringa: Grounding science and technology in te ao Māori* (pp. 75–87). Bridget Williams Books. https://doi.org/mxmt

Whittington, R. (2006). Completing the practice turn in strategy research. *Organization Studies*, *27*(5), 613–634. https://doi.org/b8psbh

Whittington, R. (2018). Greatness takes practice: On practice theory's relevance to "great strategy". *Strategy Science*, *3*(1), 343–351. https://doi.org/gcv96q

Wilkinson, C., Hikuroa, D. C., Macfarlane, A. H., & Hughes, M. W. (2020). Mātauranga Māori in geomorphology: Existing frameworks, case studies, and recommendations for incorporating Indigenous knowledge in Earth science. *Earth Surface Dynamics*, *8*(3), 595–618. https://doi.org/gg6rdv

Ystrom, A., & Agogué, M. (2020). Exploring practices in collaborative innovation: Unpacking dynamics, relations, and enactment in in-between spaces. *Creativity and Innovation Management*, *29*(1), 141–145. https://doi.org/gjbqgg