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Reforming the Research and Science System for Māori Innovation

practice theory for policy implementation

Abstract

Te Ara Paerangi proposes multi-year reforms to New Zealand's research, science and innovation system to 'make a greater impact on New Zealand's productivity and wellbeing'. One objective is to 'embed Te Tiriti' and 'advance Māori aspirations in the RSI system'. What does this mean in practice? Using a three-element practice theory framework, we assess the Science for Technological Innovation National Science Challenge's approach to advancing Māori-led or -partnered science and innovation. Our analysis suggests that such frameworks provide a useful lens for assessing how policy can move to practical implementation, particularly to advance Māori innovation aspirations.

Keywords practice theory, Vision Mātauranga, research, science and innovation, interface research, policy interventions

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The largest rethink of New Zealand's research, science and innovation system in 30 years is underway (Morton, 2022). The white paper *Te Ara Paerangi: future pathways* proposes a multi-year programme to 'make a greater impact on New Zealand's productivity and wellbeing' (Ministry of Business, Innovation and Employment, 2022, p.36). *Te Ara Paerangi* sets out the government's direction for reform of the system with four objectives which will tackle long-standing issues. One of these is the objective to 'embed Te Tiriti' and expand the existing Vision Mātauranga policy, which aims to 'unlock the innovation potential of Māori knowledge, resources and people' for the benefit of both Māori and New Zealand (Ministry of Research, Science and Technology, 2007, p.4). However, what does 'embedding Te Tiriti' actually mean? We argue that at a fundamental level it means something both aspirational, and also very practical: aspirational, because Māori partnering in or leading research,

science and innovation delivery has the potential to create beneficial impacts in a way that more generic approaches do not; practical, because experience of the almost 20 years of the Vision Mātauranga policy shows that barriers to Māori participation in and benefit from science and technology still exist. This is particularly the case in terms of research and development and innovation, with expert reactions to the white paper voicing concern about 'how' implementation of Te Ara Paerangi's policy goals would occur (Science Media Centre, 2022).

This article situates itself in the 'how', reflecting on the Vision Mātauranga policy, its practice as exercised through one National Science Challenge – Science for Technological Innovation (SfTI) – and Te Ara Paerengi's reform objectives, including the Tiriti goal. We argue that Science for Technological Innovation's goal 'to unite mātauranga Māori and western science to explore new and exciting opportunities to build a vibrant and prosperous technology-driven economy' (Science for Technological Innovation, n.d.) has provided an evidence-based practical pathway to achievement of that goal. The benefits of this approach, for both Māori and the science and innovation community, are only now being brought to fruition. However, the pathway, and our analysis of this through a practice theory lens, have broader application, including for policymakers.

Our underlying thesis is that the Te Ara Paerangi objective of making a greater impact on New Zealand's productivity and wellbeing will require 'nets of practice-arrangement nexuses' (Schatzki, 2002). By this we mean the need for systems of funding delivery and the infrastructural and relational 'configurations' that will sustain the performance and range of social practices, including those that are conducive to Māori engagement in and benefit from the research, science and innovation system. Such configurations work because a set of three practice elements, in this case materials, meaning and competence, are linked together and transformed through the process of doing (Shove, Pantzar, and Watson, 2012, p.12). We use this three-element framework of analysis to provide insights from practice theory that have potential to enhance the Te Ara Paerangi reform pathway, including to 'advance Māori aspirations in the RSI system'.

Māori submissions on the green paper for Te Ara Paerangi observed that the Vision Mātauranga policy was fragmented, siloed, competitive, and hindered by funding structures that failed to foster Māori researcher capability ...

We proceed as follows. First, we outline New Zealand's research, science and innovation system, the Te Ara Paerangi proposal and Vision Mātauranga policy. We then draw on the 'science knowledge' debate and distinctions and tensions between Western science and mātauranga Māori to highlight SfTI's approach to 'interface' research that realises the value and role of using dual knowledge and practice systems. We then present practice theory as a lens for policy implementation to embed Vision Mātauranga practice, and our case study as an example of practice change. As the largest National Science Challenge, Science for Technological Innovation aims to 'enhance the capacity of Aotearoa-New Zealand to use physical sciences and engineering for economic growth' (Science for Technological Innovation, n.d.) and includes a Vision Mātauranga theme, with specific Vision Mātauranga projects and researchers. We analyse SfTI activities using the three-element practice framework, which we suggest may have useful application for shaping Te Ara Paerangi's policy settings. We then offer two policy considerations that pay attention to different influences that support or are active barriers to embedding te Tiriti and expanding the Vision Mātauranga policy in the research, science and innovation system.

New Zealand's research, science and innovation system

Unravelling the practice 'architecture' (Spotswood, 2018) that supports New Zealand's research, science and innovation system in its current state is a first step in understanding how to change it for the future. New Zealand's current Research, Science and Innovation Strategy aims to guide priority setting and government investment in research, science and innovation across both the public and private sectors. This ranges from investigator-led research such as research supported by the Marsden Fund and centres of excellence, the mission-led research of the National Science Challenges, supports for business research and development like Callaghan Innovation, to user-led and applied research in the public service. Under the current strategy, New Zealand 'will be a global innovation hub, a world-class generator of new ideas for a productive, sustainable, and inclusive future', with processes that rely on 'fluid connections between the components of the system' (Ministry of Business, Innovation and Employment, 2019, pp.6, [i]). The strategy also has an 'extended Vision Mātauranga' principle to ensure that the research, science and innovation system is open to the best Māori thinkers, researchers and resources and protects mātauranga Māori (ibid., p.37).

The need for a revised approach to the Vision Mātauranga policy has been highlighted in the Te Ara Paerangi proposal. Māori submissions on the green paper for Te Ara Paerangi observed that the Vision Mātauranga policy was fragmented, siloed, competitive, and hindered by funding

Table 1: Te Ara Paerangi vision, objectives and policy framework

Te Ara Paerangi Future Pathways Vision			
A research, science and innovation system that supports wellbeing for all current and future New Zealanders, a high-wage, low-emission economy, and a thriving, protected environment through excellent and impactful research, science and innovation			
Reform objectives and policy directions			
1 Creating new futures	**2 Embedding Te Tiriti**	**3 Valuing our people**	**4 Building system agility**
1.1 Establish national research priorities	2.1 Advancing Māori aspirations in the RSI system	3.1 Attract, develop, and retain talented people	4.1 Clarify roles and responsibilities
1.2 Accelerate innovation, diversify, and scale up impact	2.2 Investing in mātauranga Māori, Māori knowledge	3.2 Supporting diversity at all levels	4.2 Co-ordinating investment in future-oriented infrastructure
1.3 Grow global connectivity	2.3 Crown to lead by example	3.3 Empowering Pacific Peoples	4.3 Designing resilient and adaptable public research organisations
			4.4 Funding mechanisms that support system goals
Implementation Approach			
· Phase 1 (2023)	Introduce RSI workforce policy package; Release RSI Te Tiriti Statement		
· Phase 2 (2024)	Establish new National Research Priorities and funding mechanisms		
· Phase 3 (from 2024)	Undertake institutional reform where required to achieve the vision of TAP		

structures that failed to foster Māori researcher capability (Te Pūtahitanga, 2022). There is a view that the existing system has not sufficiently valued mātauranga Māori, and consequently Māori have not been equal partners, leaders or beneficiaries of science innovation. A recent review by Mead et al. (2022) suggested that there needs to be greater coordination to guide government agencies' interactions with mātauranga Māori through connecting, collaborating and co-creating with Māori. Moreover, as kaitiaki of mātauranga, there needs to be greater provision for Māori to take the lead in determining how and when mātauranga is used in research, science and innovation.

In respect of these criticisms and recommendations, Te Ara Paerangi sets out to replace the current research, science and innovation system with a new framework (Table 1), with objective 2 – Embedding Te Tiriti (Figure 1) – responding to some of the concerns of Māori and others.

While the 2007 Vision Mātauranga policy has created some positive shifts, its level of impact has been less than intended (Rauika Māngai, 2020), in part due to insufficient funding for Māori-driven and focused research (Ministry of Business, Innovation and Employment, 2023). Te Ara Paerangi presents an opportunity for a more integrated policy approach, with the various components – the macro (government), the meso (research institutions) and the micro (individual scientists) – aligning around the broad objectives, including giving effect to te Tiriti and mātauranga Māori. There are challenges and tensions in such integration, many of which have their origins in the debate as to what constitutes science knowledge. The benefit of drawing from both Western science knowledge and mātauranga Māori, described by Durie (2004) as 'interface research', suggests a way through the debate and highlights the value of both knowledge systems. We examine some of the facets that constrain and support interface research before presenting our case study.

The science knowledge debate: valuing mātauranga Māori within Aotearoa New Zealand's research, science and innovation system

Contests about the validities of the two systems distract from explorations of the interface, and the subsequent

Figure 1: Te Ara Paerangi: embedding te Tiriti design – strategic shift proposal

Source: adapted from Ministry of Business, Innovation and Employment, 2022

> opportunities for creating new knowledge that reflects the dual persuasions. (Durie, 2004, p.2)

The Western science knowledge and mātauranga Māori debate has been conducted across academic, social and political platforms. For example, the New Zealand Association of Scientists council has emphasised the importance of the mātauranga Māori/science relationship for the New Zealand science community (New Zealand Association of Scientists, 2022): the authors suggest that both science and society benefit when systemic biases, such as lack of research workforce diversity or narrow views of what is considered 'science', are addressed. The latter point highlights the epistemological differences between notions of Western and indigenous science.

This difference was brought to the fore in debates over proposed changes to the New Zealand school curriculum to promote mātauranga Māori as a valid body of knowledge (Clements et al., 2021). Discussion juxtaposed the scientific 'value' of mātauranga Māori against the universalism of Western science. While the question of 'what is science' is an infinitely complex one, for many Māori the debate re-emphasised an ongoing colonial mentality full of 'inaccurate and racist tropes' (Leask, 2023), with an unwillingness to share decision making about science priorities and privileging a limited, Western-dominated view of science (New Zealand Association of Scientists, 2022).

This example illustrates how decontextualised philosophical debates can obscure the actual practice of applying different bodies of knowledge to addressing real-world problems. Debates about indigenous knowledge as science are not new, in New Zealand or globally (Broadhead and Howard, 2021; Gorelick, 2014; Whyte, Brewer and Johnson, 2015). Whatever position is taken, this does not necessarily stop relationships forming or action being taken. As Stewart (2023) argues, the debate is more than simply academic jostling: the idea of 'Māori science' has real-world application, whether to address climate change adaptation, manage ecosystems (Fisher et al., 2022) or address geomorphology and natural hazards (Evans, 2020).

Globally, such real-world applications are tackling complex sustainability problems, such as environmental management to reduce disaster risk in forest ecosystems (United Nations, 2015). Similarly, in New Zealand, mātauranga Māori is being used as tactical 'watchfulness' in relation to forest biodiversity, likewise contributing to more effective disaster reduction strategies (Lambert and Mark-Shadbolt, 2021). Geospatial tools like Takiwā digitise and visualise mātauranga Māori alongside science data to support environmental outcomes (Hudson et al., 2020). Mātauranga Māori has also been incorporated into marine monitoring, mapping and management frameworks, contributing to New Zealand's knowledge of the impacts of change on local ecosystems and communities (Paul-Burke et al., 2020). Such examples shift the locus of decision making to a shared problem-solving model.

… contestation over validity distracts from opportunities to create new knowledge and practice at the interface and becomes entangled with deliberate philosophical attacks on Māori knowledge.

As Durie (2004) states, contestation over validity distracts from opportunities to create new knowledge and practice at the interface and becomes entangled with deliberate philosophical attacks on Māori knowledge. Such distraction serves a very narrow and limiting conception of scientific 'truth' (Stewart, 2023). In their submission on the Te Ara Paerangi green paper, Māori submitters argued for changes to institutional mechanisms, processes, behaviours and power structures. Such change requires respect for Māori knowledge across multiple domains and the creation of a dialogic space for enquiry and equity.

To summarise: how will the research, science and innovation system orchestrate its initiatives to enable productive dialogic spaces for interaction with Māori; and what changes to institutional mechanisms, processes and behaviours are required? We now look to practice theory and our case study to identify enablers and barriers to implementing the Vision Mātauranga policy in the current research, science and innovation system, and discuss practice theory as a theoretical and practical step towards achieving Te Ara Paerangi's policy outcomes for Māori.

Practice theory as a framework for policy implementation

Theories of practice are seen as a potential approach to explain and then implement systemic and cultural change (Nicolini, 2012; Spaargaren, 2011). Briefly, theories of practice take a wide view of the 'landscapes' in which practices do and do not take hold (Hui, Schatzki and Shove, 2016), and therefore policymakers' capacity to actively configure or intervene in this terrain. Social practices, such as Māori engaging in a research, science and innovation system, involve shared understandings of how 'things are done' (Schatzki, 2002). Therefore, practice theory is a way to understand how behaviours emerge from the way society is organised.

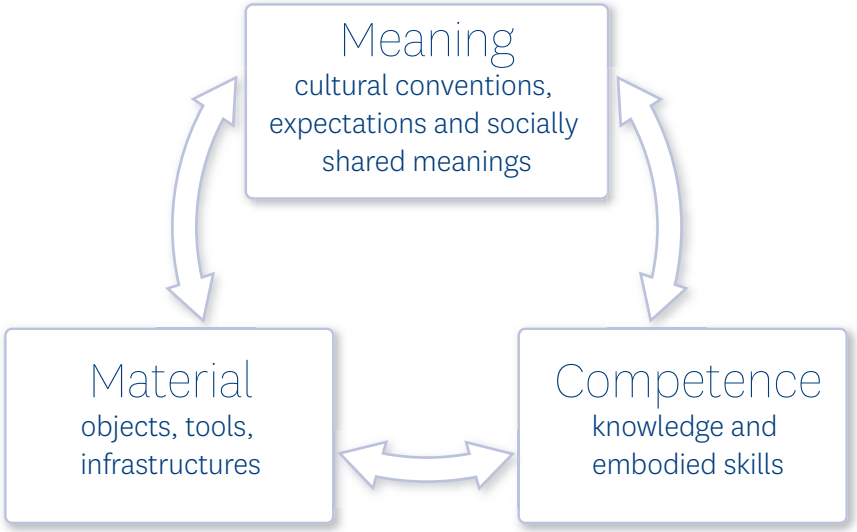
Practices are discrete 'entities', made up of 'elements', which are performed routinely, collectively and repeatedly (Spotswood, 2018). The 'elements' of social practices are materials, meaning and competence (Figure 2). Materials include 'things' such as technologies, tangible physical entities, and

the stuff of which objects are made. Meanings encompass symbolic meaning, ideas, aspirations and expectations. Competence includes skills, knowledge and technique. It is the combination of elements and their changing configurations over time that are important (Shove, Pantzar and Watson, 2012). Linkages among elements are central to understanding how practices are maintained or changed. This is because changing practice requires breaking or challenging the links among interrelated elements.

The focus on the elements of practice and their changing configurations over time orients attention away from individual actors and their behaviours and dispositions (ibid.). This understanding emphasises that practice elements exist before and after individuals or organisations integrate them into a particular set of activities or routines. As stated, practice theory shows us how behaviours emerge from the way society is organised, with specific interest in societal patterns (Spotswood, 2018), including temporal patterns, like experiences of colonisation or racism. The proposition here is that forms of competence and the meaning of participation evolve as practices are reproduced time and again, and as they are adopted by new or different 'carriers' – whether individual, group or organisation (ibid.). Analysis of which competing or complementary practices prevail opens a route to understanding and then addressing the complex sociocultural context which locks us into certain patterns of behaviour, including the way we conceive of and organise systems of science and innovation.

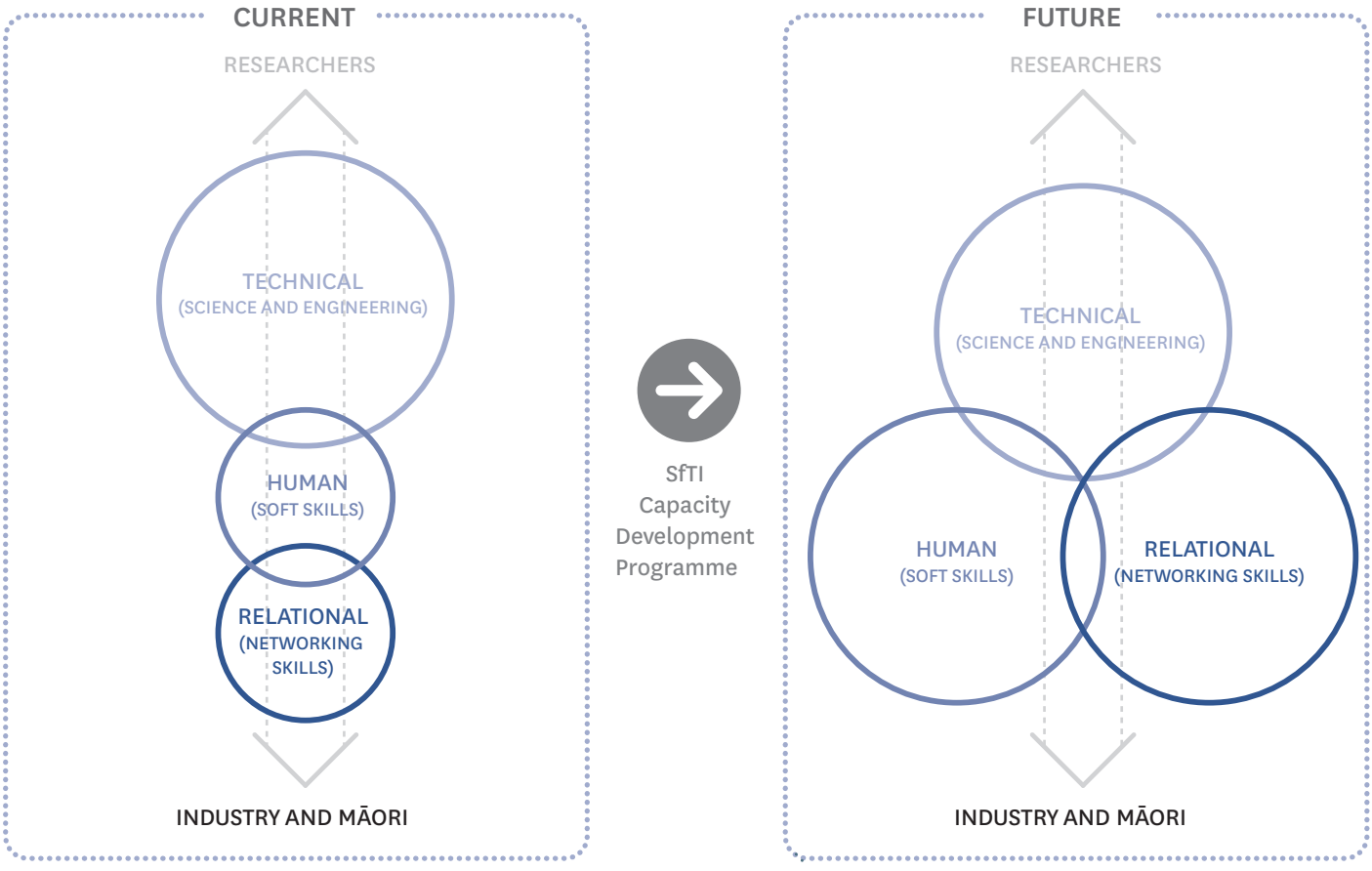
As such, practice theory as an approach to framing a change problem has potential

Figure 2: Elements of a practice



Adapted from Shove, Pantzar and Watson, 2012

Figure 3: Relationships between the three practice capacities – current and future trajectory



Source: Science for Technological Innovation, 2022a

Table 2. SfTI Practice Elements

Practices	Elements embodied in SfTI practices
Mission lab design	SfTI has redesigned how science teams are brought together through mission lab design. In the upstream stage of innovation, mission labs are designed to counter ill-preparedness to work within an industry of Māori framework (*competence*). This approach was based on the observation that scientists' strong ties to their pre-existing networks would not necessarily lead to crossing disciplinary or organisational boundaries towards innovation. The mission lab process occurs prior to science input, with industry and Māori defining the research they want to see. Thus, projects are co-designed (*competence*) with industry and Māori to generate collaborative paths to impact. Mission labs assembled 'best teams' formed outside established science team networks, including Māori people and concepts (mātauranga) as part of research design (*meaning*). This means greater diversity of views, experience, and willingness to move outside science-focused metrics of 'best'.
Māori locations as sites of innovation	Science teams absorbing Māori approaches to science requires not just engaging intellectually with a Māori world view (*meaning*), but also experiencing it through mātauranga embodied in things or places material to Māori. Moving 'out of the lab' allowed SfTI researchers to better canvass needs and community values, generate practical scientific insights more rapidly, enhance trust, and shift mindsets to understand and welcome different world views. Embedding research in places of significance to Māori (e.g., marae, natural environment) enabled better understanding of Māori contexts and practices. Particular geographic localities with their culturally situated conditions and interconnectedness have thus influenced how projects are undertaken.
Innovation Intermediaries: Kāhui Māori	SfTI's Kāhui Māori acted as innovation intermediaries (*competence*) and to ensure that te ao Māori innovation pathways (*meaning*) are embedded appropriately. Drawn from Māori business, community and academia, the kāhui provided advice and guidance and developed new processes and tangible materials to accelerate research and development and innovation to Māori and science communities. For example, one material output was a small booklet which included traditional Māori songs, invocations and protocols, to encourage a shared sense of meaning and purpose across all researchers. Another was an assessment protocol that rigorously interfaced Māori resources, knowledge and talent and high-quality science at project initiation. In some cases such projects have gone on to commercialisation pathways, while others are being applied more directly with Māori communities.
Redesigned competencies through Capacity Development programme	SfTI's Capacity Development programme aimed to build competency and engagement with Māori through attendance at events (*materials*), science leadership programmes, and entrepreneurial development (*competence*). For many researchers, attendance at hui has brought critical reflection on the purpose of research (*meaning*), changing assumptions about Māori needs (*meaning*), and influencing how grant applications are written (*competence*) to incorporate new methodologies like wānanga (*materials*). For Māori researchers, participating in leadership or commercialisation programmes developed new competence able to be applied to innovation projects with Māori communities and increasing Māori capacity in research and development.

utility for policymakers, with relevance for understanding processes in areas of complexity such as economics, environmental politics, or complex global problems (Shove, 2017). A New Zealand example of where practice theory can be applied to investigate and encourage energy transitions is Stephenson's 'cultures framework' (Stephenson, 2023). It uses cultural ensembles and patterns of associated motivators, activities and material as a diagnostic to respond to the crises of climate change and sustainability. As an analytical approach it offers advice to policymakers and researchers on the use of the framework.

Both the cultures framework and Shove, Pantzar and Watson's three-elements framework have practical relevance for policy intervention and identifying the types of influences that either enable or constrain a policy like Vision Mātauranga in research, science and innovation systems. We now turn to our case study analysis.

Case study: Science for Technological Innovation as Vision Mātauranga policy implementation practice

Science for Technological Innovation is one of New Zealand's National Science Challenges, with a mission 'to enhance the capacity of New Zealand to use physical and engineering sciences for economic growth and prosperity' (Science for Technological Innovation, 2022b, p.7). Areas of research have included sensors, robotics and automation; data science and digital technologies; and materials, manufacturing technology and design. SfTI's Building New Zealand's Innovation Capacity programme is a longitudinal programme researching the enablers and barriers of collaborative, mission-led, 'blue skies' science, with a particular focus on how the research, science and innovation system responds to Māori in the context of high-tech innovation (Science for Technological Innovation, 2020, 2022b). To achieve its mission, SfTI developed approaches to enable scientists to collaborate and engage with industry and Māori, conceptualised as a set of three intersecting capacities: technical science, human competencies and attributes like entrepreneurialism, and relational networks (Figure 3).

Table 3: RSI system shifts to embed VM policy as integrated science practice

From	To	Barrier	Priorities	Element
A closed, competitive system	A collaborative system with networked open innovation (OI)	Funding incentives IP laws and practices Policy settings Contracting arrangements	· Invest in innovation intermediaries (e.g., Kāhui Māori) · Provide policy and resourcing to encourage or mandate engagement · Build long-term, authentic high-trust connections among Māori, industry and scientists through structured collaboration methodologies · Standardise Māori IP contracting clauses, including Māori data protection	Materials/Competency Materials Meaning Materials
Western science only	Western science and mātauranga Māori	World views about 'what science is – and isn't'	· Dedicated funding for Māori science research priorities · Increase scientists' understanding of te ao Māori and cultural competency · Mentor Māori researchers into research and development/innovation roles – particularly early-career researchers (whanaungatanga approach)	Materials Competency Competency/meaning
Technical science only	Technical and entrepreneurial / cultural skills	Individual and institutional incentives	· Improve role clarity (including connections) · Address Māori innovation incentives · Invest in professional support and development for scientists to develop entrepreneurial and cultural capabilities	Competency/meaning Meaning/materials Materials / Competency

This model necessitated the development of new and modified configurations of routines and particular types of materials and tools, with individuals needing to draw on specific meanings and understandings to perform these new practices and routines (Science for Technological Innovation, 2020). Table 2 identifies some of these routines, materials, tools and meanings as they pertain to Māori.

Science for Technological Innovation's Vision Mātauranga policy implementation evolved over time as it was actualised through specific materials, meanings and competencies, and as its practice was adopted by new carriers – researchers, partners, administrators, students, businesses. While individuals came and went over the period of our research, diverse elements associated with how the Vision Mātauranga policy was practised continued to circulate within and among many different practices and practitioners beyond SfTI. Accordingly, rather than focusing on the 'frontlines of behaviour change' – whether at the individual or organisational level – a practice theory lens places the practice configuration at the centre of analysis (Hampton and Adams, 2018).

Our case study sample of findings shows how analysing competing or complementary practices can effect certain patterns of research, science and innovation behaviour, and as such is an exemplar that might inform implementation of Te Ara Paerangi objectives.

Considerations for Te Ara Paerangi policy directions

Standard policy interventions generally seek to alter one 'element', such as funding mechanisms for targeted Māori projects, or Māori-led and community-led programmes. Showing how all three of Shove, Pantzar and Watson's elements are interconnected draws policymakers' attention to how a change in any one of these elements can affect other elements. This has clear implications for policy design and intermediary activities like investment in capability. While the Vision Mātauranga policy, and likewise Te Ara Paerangi's Tiriti objective, can be viewed as a material tool, made visible via websites, or downloaded as a pdf, in its research and development innovation intent it is only one part of one element. Table 3 illustrates potential shifts in the research, science and innovation system that, from our case study, align to practice elements to accelerate Māori science, technology and innovation.

We suggest that to design and enable the scale of research, science and innovation interventions, particularly in the high-tech area that is the focus of Science for Technological Innovation's activity, practice theory has much to offer. Shove, Pantzar and Watson's three-way framework offered a useful insight into the constellations of SfTI's practices that 'worked'. Cultural stasis and cultural change are often the result of inter-element dynamics being either supportive of the status quo and therefore resistant to change, or weak and easily disturbed. Change is not solely a matter of choice of individuals or organisations; it is a result of the different infrastructures, skills and shared ideas that inform what makes something 'the norm'. It will require new constellations of practice that build knowledge of te ao Māori; develop new capabilities in government and research entities, along with more substantial roles for Māori in research, science and innovation policies and structures; and target material shifts,

including funding. Such a process includes Te Ara Paerangi's proposed policy to create research, science and innovation frameworks that recognise, value and fund Māori governance, world views, priorities and management approaches.

Returning to Stephenson's cultures framework, policy intervention is viewed as 'a purposeful change to an external influence', whether existing policies and laws, institutions, technologies, shared beliefs or ideologies. As part of policy design, it is important to identify how these influences support or constrain practice change. Some may be apparent from the outset, while others may be obscure. The latter can be elucidated through deeper engagement with actors, such as organisations like the Ministry of Business, Innovation and Employment, businesses, or iwi and hapū. Therefore, we suggest that in relation to Te Ara Paerangi's objectives, rather than the behaviour of the individual or organisation as the unit of analysis, there needs to be a shift towards an emphasis on practice. In turn, this will (1) require an analysis of external influences that are already supporting policy outcomes like Te Ara Paerangi's Tiriti objective, and that should be sustained; and those (2) that are barriers that should be removed. Potentially this may involve dismantling or revising existing misaligned policies as opposed to creating new ones.

Incorporating practice theory in policy requires focusing on those elements necessary to truly embed te Tiriti into the research, science and innovation system. Attaching or detaching various elements in an ongoing, routinised way has potential to transform the terrain.

Conclusion

As we argue in our introduction, we view Te Ara Paerangi's Tiriti objective as an aspiration to achieve impact from science-based innovation for Māori specifically, and, in line with the almost 20 years of Vision Mātauranga policy, for New Zealand more broadly. Creating practices that position Māori as partners in and leaders of research and development delivery has accelerated innovation impact in a way that previous approaches have not. Hence, we support Te Ara Paerangi's aim to build Māori research capacity and capability, and embed Māori aspirations through a planned strategic shift from the current to a future state that is more reflective of and responsive to te Tiriti o Waitangi.

Our analysis indicates that Science for Technological Innovation's focus on integrating components of practice can create real gains in science-based innovation, pointing towards how to achieve Te Ara Paerangi's objective of greater impact on New Zealand's productivity and wellbeing. This has been especially true for the Māori researchers, partners, leaders and communities who have been involved in SfTI's research and development projects and capacity development programmes. However, such benefits could only be derived once a host of materials, meanings and competencies had been developed, reformulated or cast aside to create new constellations of practice. Practice theory can, therefore, provide a guiding policy framework that pays attention to the various elements that require routine, collective and repeated performance to create the transformations Te Ara Paerangi envisions, including the transformations to embed and accelerate Māori innovation.

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