POLICY FORUM

EDUCATION

Teach Indigenous knowledge alongside science

Evidence supports the teaching of Indigenous knowledge alongside sciences in the classroom

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Conflict has grown around Indigenous knowledge in education policy. There has been growing acceptance of the value of Indigenous knowledge for promoting ecological resilience, transformational approaches in stewardship, and cultural renewal within global fora such as the Intergovernmental Panel on Climate Change. However, despite increasing acceptance at a strategic high level in science-informed policy, there is often a lack of wider acceptance, application, and policy protections of Indigenous knowledge transmission in more local settings, including opposition by some scientists. We argue that Indigenous knowledge can complement and enhance science teachings, benefitting students and society in a time of considerable global challenges. We do not argue that Indigenous knowledge should usurp the role of, or be called, science. But to step from "not science" to "therefore not as (or at all) valuable and worthy of learning" is a non sequitur, based on personal values and not a scientifically defensible position.

The current state of global systems in an uncertain risk landscape creates an urgent need for many knowledges and approaches to build resilience and prosperity of communities. One attempt to provide policy protections and opportunities for Indigenous knowledge is the Aotearoa–New Zealand government's decision to ensure that Indigenous knowledge (Mātauranga Māori) has equal value with other bodies of knowledge in the school curriculum, after lengthy advocacy from Māori educators to honor the Treaty of Waitangi, Aotearoa–New Zealand's founding document. This policy has precipitated a battle of rhetoric among researchers and scientists; initial condemnation of the policy by a group of academics argued that unlike science, Indigenous knowledge is inadequately equipped to provide empirical evidence of universal truths (*1*), which resulted in a signed open letter by 2000 academics and public figures in support of the policy that includes Mātauranga Māori. Since then, the Royal Society of New Zealand–Te Apārangi (the premiere advocacy and advisory body for science and humanities) has been drawn into the debate, which continues from both sides. Those that support this policy have largely argued on the grounds of ethical responsibilities and moral viewpoints, whereas those that oppose it cite dilution or, at worst, abandonment of science that will lead to poor societal outcomes (*1*). The considerable research effort on innovation, Indigenous knowledge's relationship with science, and its pedagogy have not (to our knowledge) been synthesized to address this discussion, which is also pertinent to efforts beyond New Zealand [such as recent investment into Indigenous knowledge by the US National Science Foundation (*2*)].

We suggest that many of the arguments used to "defend" science by presenting Indigenous knowledge as inferior are themselves rooted in logical fallacies. We also argue that the treatment of all Indigenous knowledge as myth is at odds with the literature, which emphasizes a continuum from empirical and science-like aspects of Indigenous knowledge to philosophical and metaphysical ones (*3*). Teaching sociocultural themes of a Māori worldview is already encouraged in curriculum guidelines, suggesting that objections are not to having these aspects taught at school but rather to giving them value in the context of knowledge. Yet school curricula already include a range of subjects across the arts and humanities that do not meet criteria of science, and it would be senseless to argue that they do not have "equal value" with science.

Moreover, we argue that there is a cost to rejecting Indigenous knowledge, in that framing it with simplistic caricatures misses the potential for complementarity between science and Indigenous knowledge. Concomitantly, we highlight learning benefits that emerge when students are well versed in multiple knowledge systems. Last, we provide evidence that science innovation may be stifled if mainstream science is granted sole dominion over knowledge generation.

COMPLEMENTARY EXPLORATION

Indigenous knowledge is often generated empirically and drawn from local context, complementing and challenging scientifically derived universal "truths." These empirical aspects of Indigenous knowledge (which have been called the "know-how versions of knowledge") that emphasize the method or workability [(*3*), p. 103] align most closely with science but still differ sufficiently from science in their context and underpinning worldview that many (but not all) scholars argue that science and Indigenous knowledge are not the same (*3*).

In addition to the more "science-like" empirical components and their framings that we discuss below, there are components of Indigenous knowledge that are metaphysical or philosophical and entirely unrelated to science. These latter components alone have been emphasized by those who challenge the validity of Indigenous knowledge, with their criticisms likely fueled by recent examples of Creationism being taught in schools in place of evolutionary theory. Yet this framing of Indigenous knowledge as entirely "myth" is an "appeal to extremes" argument, which would benefit from a more mature and nuanced view of Indigenous knowledge.

A key issue is that Western culture discretizes knowledge generation into disciplines, in which science cannot be contaminated by nonscience, whereas such divisions between methods of inquiry are often absent from Indigenous knowledge systems. However, we believe this only becomes a problem when teaching Indigenous knowledge "as" science, but not "alongside" it, as articulated in the Aotearoa–New Zealand policy.

By analogy, philosophy is not science and includes inquiries around existence, knowledge, and the self. Both the questions asked and the methods of enquiry frequently depart from what could be called science. Moreover, philosophy can reflect on the nature of science in a way that science is unable to reflect on itself. For this reason, students who study philosophy alongside science can improve

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their learning both of science concepts and concepts about science (*4*). Attributing greater "value" to science than philosophy (or other nonscience endeavors such as art or the humanities) would make little sense and be an opinion based on values rather than scientific evidence.

Similarly, we argue that teaching Indigenous knowledge alongside science should not seek to usurp science (in the way that, for example, creationism seeks to undermine evolutionary theory because they are incompatible with one another), but rather it "provokes science, and can act as a mirror for science to see itself more clearly, reflected in a philosophically different form of knowledge" [(*5*), p. 87]. A parallel understanding of science and Indigenous knowledge systems would be complementary, emphasizing their similarities and cultural differences; the separation versus connection of empirical and philosophical subjects would be one example of those differences. Another example specific to Aotearoa–New Zealand would be that Te Ao Māori (Māori worldview) uses an intergenerational lens inclusive of the observer that gives cultural integrity to questions and generated outcomes, whereas the scientific method strives to be disconnected from that which it observes.

The timescales of knowledge generation are also complementary. For example, short-duration scientific research funding cycles can create institutional barriers to long-term data acquisition and study of large-scale (such as environmental) problems. By contrast, Indigenous knowledge can and has contributed empirically generated, intergenerational knowledge, making it an increasingly valuable tool in environmental management, particularly around rare but increasingly frequent natural events such as large-scale deadly bush fires that plague Australia and parts of North America. For at least 40,000 years, Indigenous Australians have been managing the landscape, leaving a deep human imprint, one that has been nearly erased from living memory. However, in parts of Australia, local authorities, scientists, and Indigenous communities are now coming together to revisit Indigenous fire management and reframing science through Indigenous knowledge to better understand these modern environmental dilemmas (*6*).

This example highlights how knowledge and its cultural context have a place in education because local context matters, particularly when Indigenous communities with their knowledge drive questions or request the support of science tools such as genomics to generate codeveloped conservation solutions. We hope that viewing Indigenous knowledge as complementary to science, without replacing nor being science, may lead to more nuanced and fruitful conversations around policy in this space and to maximizing the benefits of such policy.

Yet despite all of this, the false dichotomy between the validity of Indigenous knowledge and science-generated knowledge persists and is frequently based on a straw person. Science and Indigenous knowledge systems comprise distinct perspectives of understanding the world because they differ in methodologies, philosophies, worldview, and modes of transmission. The knowledge produced through traditional science methods has resulted in many game-changing outcomes, such as the eradication of smallpox and the production of life-saving vaccines. However, it has also proven itself wrong (for example, phlogiston, aether, and phrenology) and produced catastrophic outcomes for humanity (such as the atomic bomb), while failing thus far to solve the most pressing challenges of our time (such as climate change). As scientists, we accept such scientific shortcomings on the basis that they are corrected as part of the scientific process, in which knowledge is updated as new information becomes available.

Yet although Indigenous knowledge is also well known to be dynamic and continuously updated (*7*), critics do not afford it an equal right to correct itself. For example, "pity the moas were all eaten" (*1*) is commonly used rhetoric to imply the failure of Māori knowledge around conservation of a giant endemic New Zealand bird in the 15th century. Yet this reasoning mistakenly conflates the validity of present-day Indigenous knowledge with 15th-century knowledge and decision-making. By comparison, this extinction was two centuries before British colonization would produce such mass environmental devastation in its colonies that the Western conservation paradigm would be born. In fact, evidence has shown some present-day Indigenous managed lands to have much higher biodiversity than some Western Conservation managed lands (*8*), and this can likely be attributed in part to the nuanced relationships that are encoded within Indigenous knowledge. Thus, the argument that Indigenous knowledge

Taxonomic plant identification is taught alongside Indigenous knowledge of the use of these plants to Indigenous students from various tribes around Tamaki Mākarau (Auckland) New Zealand.

PHOTO: DR. LAUREN WALLER

only includes historical, precolonization learnings, whereas mainstream science can continuously learn from its mistakes, is both a straw person and a circular argument because it defines Indigenous knowledge using the exact criteria (outdatedness) for which it is criticized.

Some societies, such as many Indigenous groups, lack traditional written communication and thus transmit knowledge within memorable framings, such as stories or myths, to ensure their longevity (*9*). A superficial interpretation of these framings is often used to depict Indigenous knowledge as purely metaphysical—an example of the appeal to extremes fallacy—justifying its displacement by science (*9*). Yet this false dichotomy ignores evidence that, like Indigenous knowledge, science also uses abstractions and stories (such as models) to facilitate knowledge transmission and illustrate concepts or key messages. For example, both simulation and statistical models can require simplifications that are known to be false. Bohr's model of the atom and Newtonian physics are still widely taught in schools as easily understood approximations, despite their limitations with respect to quantum mechanics. By analogy, dismissing Indigenous narratives on their verbatim interpretation risks missing considerable opportunity to learn from the knowledge and experience encoded within them (*10*, *11*).

The argument "True science is evidence-based not tradition-based" (*1*) ignores considerable research demonstrating that false representations of both science and Indigenous knowledge have unnecessarily polarized this debate. We argue that it would be more fruitful to undertake it in an informed and nuanced way.

KNOWLEDGE TRANSMISSION

In addition to a suite of known benefits to Indigenous students (*12*), we see the potential for all students to benefit from exposure to Indigenous knowledge, alongside a science curriculum, as a way of fostering sustainability and environmental integrity (*13*). For science learning, connecting science with student values and fostering understanding of the role of social and cultural context can lead to the production of ethically sourced scientific knowledge (*14*). In addition, the generation and transmission of Indigenous knowledge are both closely connected to practice: experiencing and doing. Such experiential learning is known to benefit learning in general (*14*), and the broader range of contexts provided by place-based Indigenous knowledge allows students to connect learning with their local environment, which may result in more affective and authentic engagement, leading to greater acceptance and uptake of new knowledge (*14*). Given the societal and environmental issues facing the planet, providing an intercultural understanding that leads to a more balanced and connected worldview can result in positive outcomes, including effective science education.

INNOVATION DRAWS FROM DIVERSITY

Innovation, like evolution, draws from diversity, so that diversity of knowledge sources and transfer among them are known to positively influence innovation (*15*). This value is exemplified by the move toward cross-disciplinarity, in which science can draw on inductive fields of research for hypothesis generation. Given this value of diversity, global challenges faced by humanity could benefit from inclusive science and maintenance of knowledge diversity more generally rather than insisting on assimilation into a single culture of knowledge generation. One path to preventing the extinction of Indigenous knowledge is its dissemination in classrooms, under Indigenous governance and management (supported by the International Bill of Rights and, specifically in New Zealand, the Treaty of Waitangi Act 1975 and the Waitangi Tribunal). Not only will this help to protect Indigenous knowledge holders and their culture, it has the potential to generate innovation more broadly.

Learning about the biological structures of plants used in tradtional practices

PHOTO: A. BLACK AND J. TYLNIAKIS

EVIDENCE, NOT CARICATURES

Indigenous knowledge can complement science-generated knowledge in the pedagogy landscape by providing acceptance and understanding and by contributing to the addressing of global challenges. We urge both education policy analysts and scientists engaging in this debate to draw on evidence rather than caricatures of Indigenous knowledge and a partisan approach to knowledge generation. Knowledge is produced in many traditions. The scientific method is one of those, Indigenous approaches are others, and these are not necessarily mutually exclusive. We need to respect Indigenous knowledge for its inherent value and the philosophical reflections it can provide science to improve outcomes, irrespective of how Indigenous knowledge is contextualized. Much of our time as researchers is spent challenging scientifically derived universal truths through work in local contexts, and Indigenous knowledge does the same but with a higher degree of connectivity between the researcher and what is "researched." Arguably, the ignorance toward Indigenous knowledge and its application is only slightly greater than ignorance to science methodology. We think this is the strongest rationale for teaching them both in schools. ■

REFERENCES AND NOTES

1. R. Dawkins, "Why I'm sticking up for science," The Spectator, https://www.spectator.co.uk/article/why-im-sticking-up-for-science (2023).
2. J. Tollefson, *Nature* **621**, 454 (2023).
3. C. Mika, *J. World Philos.* **7**, 101 (2022).
4. M. Monk, J. Osborne, *Sci. Educ.* **81**, 405 (1998).
5. G. Stewart, *New Zealand J. Teach. Work* **19**, 84 (2022).
6. M. S. Fletcher, T. Hall, A. N. Alexandra, *Ambio* **50**, 138 (2021).
7. R. Tang, M. C. Gavin, *Conserv. Soc.* **14**, 57 (2016).
8. S. T. Garnett *et al.*, *Nat. Sustain.* **1**, 369 (2018).
9. G. Snively, J. Corsiglia, *Sci. Educ.* **85**, 6 (2001).
10. S. M. Sidik, *Nature* **601**, 285 (2022).
11. C. H. Trisos, J. Auerbach, M. Katti, *Nat. Ecol. Evol.* **5**, 1205 (2021).
12. F. Duckworth, M. Gibson, S. Macfarlane, A. Macfarlane, *Alternative* **17**, 3 (2021).
13. R. Zidny, J. Sjöström, I. Eilks, *Sci. Educ.* **29**, 145 (2020).
14. S. Jose, P. G. Patrick, C. Moseley, *Int. J. Sci. Educ.* **7**, 269 (2016).
15. J. De Beer, *J. New Gener. Sci.* **14**, 34 (2016).

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