Mātauranga Māori and School Science

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The debate whether Mātauranga Māori is science or not is well presented in the last two issues of *New Zealand Science Review*[1] by both Science and Māori Education scholars, philosophers, and science researchers (for example, Mercier 2019; Stewart, Ruru *et al.* 2019). Trying to summarise what they have said so clearly and succinctly is beyond my limited ability. Readers interested in deeper understandings of the debate may find it useful to read their papers in *Science Review*. Moving on from a substantial literature review, I will share my thoughts about Mātauranga Māori and School Science. Gerrard and Kukutai (2019) draw attention to the global issues of environmental, societal, and technological challenges our planet is facing. We can now add the recent pandemic to these issues. I wonder if Rangi *(Ranginui, Sky father)* and Papa *(Papatūānuku, Earth mother)*, Māori Gods, are telling us that our Earth has had enough stress now and needs us all to care for it. I also agree with Gerrard and Kukutai's view that we need multiple ways of looking at the issues and drawing on the best of thinking that all humans and cultures have to offer. We can start with our own, Māori culture. I will return to this later in the article.

I want to draw attention to science education in Aotearoa New Zealand and how the two huge knowledge systems we have can contribute to bringing up the next generations of New Zealanders. Why does what I have to say matter? In New Zealand science education, the National Certificate of Educational Achievement (NCEA) is being reviewed at present. Its focus is on scientific literacy – which is great. The proposed change is providing for Mātauranga Māori and Science to have equal status and to be taught in Year 11 Science. This is a great step forward; however, in this article I will argue that scientifically literate citizens need to understand the scientific ways of thinking and how scientific knowledge is created. I propose that students need to be able to see a connected world and think about their role in such a world. The goals are the same: I am proposing that, instead of including Māori content, we teach the children *Māori ways of thinking*. Then the scientifically literate student that we want at the end of schooling can think both in Māori ways and scientific ways.

In terms of knowledge systems, we can choose to have our two knowledge eyes, to take a *two-eyed seeing and both eyes looking* approach and drawing our perspective. Young children are likely to have 20/20 vision and they may become better Kaitiaki (Guardians) of the Taiao (Environment) then we have been. The two-eyed seeing has been promoted by indigenous science educationalists and scholars, for example, Hogue (2016, 2019) and Hogue & Bartlett (2014). As our children progress to secondary school, so they can see the world through two lenses. The notion of two-eyed seeing is described by Aikenhead and Mitchell (2011) as follows:

> *As two-eyed seeing implies, people familiar with both knowledge systems can uniquely combine the two in various ways to meet a challenge or task at hand. In the context of environmental crises alone, a combination of both seems essential* (p. 114).

As a biologist I have come to understand that humans have two-eyes to the front or monocular vision (as do all predators). The evolutionary benefit it gives us is the ability to judge the distance better, and have improved focus on distant objects. So why not use one eye for each way of seeing, the scientists' way and the Māori way.

I am a learner, teacher, a science educator, and a researcher who has taught in New Zealand for more than 45 years. In this time, I have taught from early childhood through to tertiary level and am currently supervising a science education PhD student who is trying to do all that she can to lift the achievement of her Māori students. In my learning and teaching journey in New Zealand I have had the privilege to teach in mainstream New Zealand schools and to be involved in research and development of a Pūtaiao science programme for primary schools, which is taught in te reo Māori, in a Māori medium kura (school). The primary school programme is embedded in the Māori

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[1] https://scientists.org.nz/resources/Documents/NZSR/NZSR75(4).pdf

https://scientists.org.nz/resources/Documents/NZSR/NZSR76(1-2).pdf

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knowledge and taught in te Reo, with the continuing goal of the children learning to develop a Māori worldview. At the end of the primary school, the children know what *being Māori is* and are fluent speakers of their language.

My kura whanau, not being able to employ teachers who could teach science in te reo Māori, have employed science teachers and in the past three years have had students achieving NCEA level 1 Science and Chemistry and Biology at Level 2 and 3. These students are successful science learners. Yes, the kura would love to have science being taught in te reo Māori, but they have taken a pragmatic approach. Our Māori students in the kura are achieving, so there is something for the mainstream to learn. I must state here that I am neither Pākeha nor Māori, just a teacher who wants the students to learn science and live in a better world than the one we are handing over to them.

My real concern is for the students' learning when we teach. The polarised views of the policies that want Mātauranga Māori to be taught and learnt in schools and science teachers who generally do not know what Mātauranga Māori is, has caused confusion in school science teaching. I was a keen teacher who wanted to 'deliver' the *Science in the New Zealand Curriculum* (Ministry of Education 1993). The curriculum encouraged the use of Māori contexts, and this supposedly was going to grab the attention of Māori students, we would become inclusive, and all would be well. It is not until recently that I have had the opportunity to work alongside experienced Māori teachers and have come to the thinking that I put forward in this article. As I have researched in a kura I have learnt that stories are a good way to communicate. So here is my story.

A teaching story and new learning

In my own experience, being a naïve teacher with little understanding of the Māori ways of doing things, but believing in giving anything a try, I included a unit in the context of a hangi in my accelerated learning programme for Year 10 (In 1995!). This did not ruffle any feathers, and I could do this safely with my class as an extension activity. In the first year, it was a bit clumsy – I was trying to make it work! Then I became brave and included: investigating the effect of size of the pieces of the vegetables and the time it took to cook them (for hangi, vegetable pieces are cut to be about a similar size); and smoking the food by burning some manuka leaves and asking the students to offer explanations as to why they thought these leaves were added. The thoughts offered by one 14-year old were impressive: 'Hey miss, they did not have curry to flavour the food!' Was I to be offended by this quip? No, the child had offered a very sensible reason: manuka gave the food seasoning.

A year later a science organisation was closing and invited local schools to come and take any equipment that they no longer needed. So being a hoarder I got three water-baths. They were put on the side bench in my laboratory. When students asked, we talked about what they were and how they could be used. Next week, Moana [pseudonym] came at lunchtime and asked, 'Miss, can I use one of these?' She explained that she would like to make an electric hangi for the science fair. She asked her father what the best stones were for using in a hangi and brought some along. This was an excellent opportunity to investigate rock types and think why these were more suitable than others. In brief, this wonderful 15-year-old girl made the first electric hangi, cooked food in it, entered the science fair, and won a major prize. This quite possibly was one of the best science investigations that took place in my class. She tried different ways of putting the food in the hangi: Where should meat go in relation to vegetables? How does the food cook in the hangi? New learning for us all was that it is the steam generated by the wet cloths which cover the food that cooks the food. We also learnt that we needed to use small leafy pieces of manuka to generate the smoke to flavour our food.

My recent research was in a kura, and the kura whanau has given me time to be with the kura teachers and students and learn from them. What I should have learnt from the above story was that this lovely girl had seen the water-baths, thought about it, talked to her father about the hangi stones and turned up with a plan. *She was thinking – and making connections*. Something that she had learnt to do from her elders. It has taken me a lifetime to learn that all living things have connections with other living and non-living things. It was not until the present research project that I understood what the kura teachers meant when they talked about tamariki (children) making connections.

Another story

The second story is from my more recent science teaching experience. Consider the following example using the most common material, 'air', that is essential for survival on this planet. I would like to think science ideas about air would be important for students to learn.

In elementary school, students are taught that we breathe in oxygen and breathe out carbon dioxide and that plants breathe in carbon dioxide and breathe out oxygen. The latter is a misconception that often remains beyond primary science education. Then in high school, students learn that air is made up of 78% nitrogen, 21% oxygen, 0.033% carbon dioxide, and the rest is a mixture of other things. They also learn that green plants use carbon dioxide to make food. All these facts are memorised and can be repeated with accuracy by many adults well after their school education.

Recently, I asked prospective science teachers what gas they breathe in? The standard answer was oxygen. I challenged, what about the 78% nitrogen in the air, and why did you not mention nitrogen? Is there some way that our nose filters out all else and allows us to breathe in oxygen? Clearly, they had not thought about it. The next question was, what do we breathe out? Again, the standard response was carbon dioxide. Further exploration confirmed that this was the general belief. We continued this exploration further by saying: 'All right then, if we only breathe out carbon dioxide, how come we give mouth-to-mouth resuscitation to save someone's life or blow at embers to make fire?' I wondered if they had ever considered that the 0.033% of the carbon dioxide was used by plants for photosynthesis and is responsible for the entire food production on our planet, and it was clear that they had not. Finally, 0.033% of carbon dioxide concentration has now reached 0.04% and its impact on our planet is leading to climate change. This was all new to our class of would-be science teachers – who all have science degrees.

What is missing is a general understanding of the *disciplinary connectedness*. Disciplinary connectedness here means an understanding of the physical and biological concepts and how they interact with each other.

Historically in New Zealand schools, biological science was taught as nature study (Figure 1), then discreet subjects Zoology and Botany, and later, Ecology, which acknowledged the

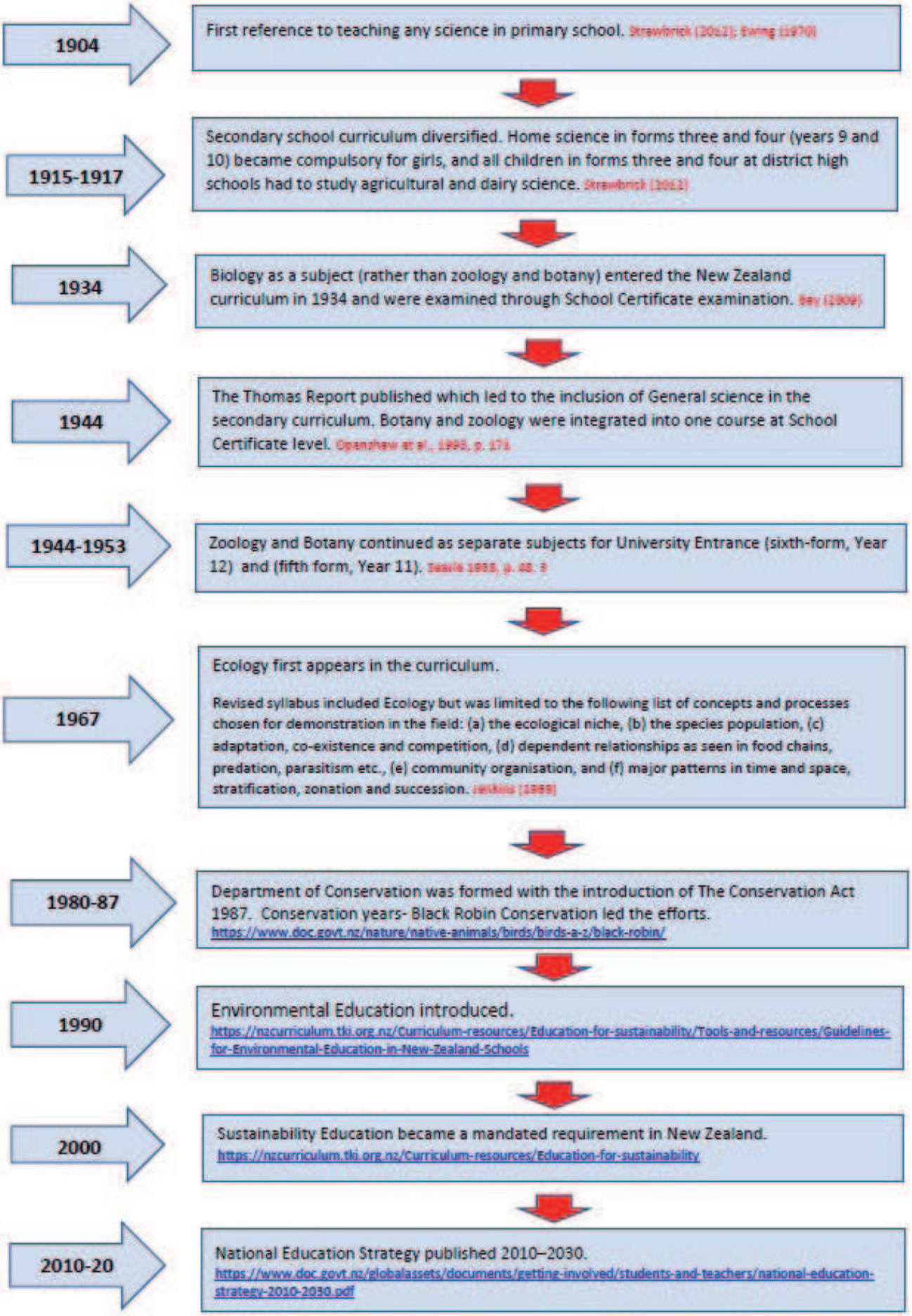

Figure 1. History of science and biology education in New Zealand.

relationship and interdependence of animals and plants. Figure 1 is a flow chart that shows the history of biological science teaching and learning. This was followed by a raised awareness of conservation in the 1980s, then the environment in the 1990s, and biodiversity and sustainability in the 2000s. More recently, we have turned our attention to climate change.

It appears that the knowledge passed down to the Māori from their ancestors shows a nuanced understanding of the interconnectedness of all the living and non-living things in the environment, and how to conserve natural resources and live sustainably. Unfortunately – in my view – not having a Māori medium schooling system in New Zealand, these wisdoms from the ancestors have not been passed down. At the same time biological science education went from learning the taxonomy, form, and function, then moving to ecology, and learning about the relationship between these. We brought in conservation education when species were threatened, environmental education when the environment started to suffer from human demands, and sustainability education when our modern ways of living have become no longer sustainable. We did not look *the other way* that was in front of us, the Māori way of understanding, interdependence, conservation, environmental guardianship, and sustainability. The Māori students we are teaching now, and perhaps their parents educated in the mainstream, have not had the opportunity to learn these ideas.

Here is what I think is important: the students need to learn to make connections in the knowledge they are gaining. Whether we are teaching science or Mātauranga Māori, whether we agree or disagree, we owe it to our children that they learn to think of their world as a connected place where, when you manipulate one thing, it has both intended and unintended implications.

Here I will put to you a simple example often used in school science. Two forces are working on a boat in opposite directions. Which way will the boat move (Figure 2)?

Figure 2. Forces working on a boat.

The answer is simple, and the student gets it right. But when the question was put to a child from the kura, habituated to thinking in a connected way, she wanted to know: Who was in the boat? Which direction they were paddling in? Was the boat in the river or in the sea? Was the tide coming in or going out?

I understand that our country needs the best scientists, who have deep understanding of their discipline, and can innovate and collaborate with others. So, specialisation is a good thing for the 10% of the students who go to school and will take up a career in science. But all students need to be scientifically literate and be able to see what is presented to them in a connected way, and try to look for evidence of what is being said and by whom. Then they can make informed decisions in their everyday life.

We have had a one-eyed way of looking, perhaps naïvely or thinking that science had all the answers, and we did not look at what the other eye could already see. In my view, it is important that the students learn science, but it is just as important to know that there are other ways of looking at the world. To start with, what I personally take from Mātauranga Māori is to understand the connectedness of all things living and non-living. If we take the children with us and help them to understand how science ideas are connected and relevant to them, and teach them to look for the connections, then science may well be a way to understand the world for all students, including those who do not engage with it at present.

The issues of students not staying in science and the achievement of Māori students in science are well documented in the literature (see Moeed & Kaiser 2018). A plea to the policy makers: if you are going to ask teachers to teach Mātauranga Māori, you need to provide the professional development that helps the teachers understand what is it that we want the children to learn. And when providing professional development, conferences in big cities are not the answer. We need to remember the teachers in Taihape and Alexandra – they teach our children, too.

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