Measurement, Metaphor, and Marks on the Page

GEORGINA STEWART

University of Auckland

Abstract:

This paper takes 'measurement' as a will to determine or fix space and time, which allows for a comparison of ontological models of space and time from Western and Māori traditions. The spirit of 'measurement' is concomitantly one of fixing meaning, which is suggested as the essence of the growth of the scientific genre of language that has taken place alongside the growth of science itself, since the European Enlightenment. The Periodic Table is an exemplar of the ideals of the deterministic philosophy of measurement, which underpins both modern English and the philosophy of science. The paper explores how such a philosophy is embedded within modern English, including the language of education, by comparing characteristics of English and Māori language, especially in relation to ideas of measurement, precision, space and time.

Keywords: language of science, language relativity, left-brain/right-brain thinking

Introduction: Mendeleyev's dream and the language of science

> I saw in a dream a table where all the elements fell into place as required. Awakening, I immediately wrote it down on a piece of paper - Dmitri Mendeleyev, 17 February 1869.

One of my favourite stories from science is that of Mendeleyev, working through a wintry night in rural Russia. His dream-inspired Periodic Table would become the central concept marking the coming of age of chemistry as a discipline - joining Newton's mechanics for physics, and Darwin's evolution for biology. Mendeleyev's original insight left gaps in his table for elements that had not yet been discovered. Mendeleyev's 'dream' is an example of literacy of the highest order - an act of pattern-seeking with a complex and incomplete array of words and numerals - that allowed him to 'read' the very blueprint of matter, inaugurating the modern understanding of atomic structure. Mendeleyev's genius demonstrates the closely intertwined nature of literacy and science, a connection obscured by recent educational trends to separate 'literacy' from 'language' in the notion of 'literacies'. The resulting Periodic Table is an exemplar of the manifestation in language and science discourse of what might be termed the 'deterministic philosophy of measurement'. This term reflects the contemporary concept of 'measurement', which ultimately comes down to an exact determination of some aspect of material reality, or space and time, which can be numerically or categorically represented. Here the words 'space and time' (or space-time) represent the physical world in which we live.

Mendeleyev's dream is part of the larger story of the development of the language of science, which is a key aspect of the overall development of modern science to its position today as the most powerful form of knowledge ever known to humanity, and a global network of complex social and technological systems and structures. According to Foucault's notion of discourse, the real-world power of science lends symbolic power to the word 'science', which thus becomes a potent ideological item of significant political interest. This symbolic power is somewhat unrelated to science itself – it takes on a life of its own, referred to as 'discursive power' , which explains why the word 'science' is so widely used in an honorific sense.

Over time, the inter-related development of science and modernity in post-Enlightenment Europe embedded this deterministic philosophy of measurement within language, especially English, which, for historically-contingent reasons, has become globally dominant both as a world language and as a language of science. The

language of science has been influential in all spheres including the development of systematic approaches to education, and of sub-disciplines including curriculum, pedagogy and assessment. These recent fields are emerging at a time when educational discourses are dominated by a cluster of related concepts including evidence, standards, outcomes and accountability. These concepts share this underlying deterministic notion of 'measurement' as a fixing or specifying of some aspect of the phenomenon in question. The facile assumption that standardised testing is an objective 'scientific' way to 'measure' education reflects the influence of neo-liberalism on education policy. Thirty years of neo-liberal re-shaping of national public policy and institutions has entrenched a culture of managerialism and technocratic approaches towards quality assurance, among other basic functions, in education systems. Given the totalizing nature of this neoliberal discourse, non-Western traditions such as Māori offer alternative visions and philosophies of what education, literacy, quality and equity might entail.

Binary models of thought

Debate continues about what is uniquely 'Māori' about 'Māori knowledge' as understood within the contemporary education sector, especially in Māori-medium education. A bipolar debate concerning 'Māori science', and related questions, features in the literatures on which educational research draws for its base of philosophy and theory. For example, the classical Anthropological debate about 'rationality' posited science against indigenous knowledge, in efforts to clarify what science actually is, and how it works. Secondly, the on-going 'science wars' centre on the 'two cultures' in the academy, represented by the question of the status of social science, including education, as science. Thirdly, in work that was influential to educational thought of recent times, Jerome Bruner posited two basic modes of thought: 'narrative' and 'logico-scientific'. Whether the split is made by discipline, culture, gender, politics, or any one of a number of other defining criteria, there are clearly two basic modes of thinking.

The problem with most such models of thinking is the tendency to assign logic to one side of the binary, thereby leaving it out of the other. Anthropology showed that logical coherence is characteristic of all cultural knowledge bases, Western and indigenous alike. Yet, although Eurocentrism has been officially expelled from the academy, the association of science with modern Western culture as 'proof' that Euro-Americans are more 'advanced' and 'intelligent' than 'primitive races' remains a powerful subterranean message in social discourse, hence retaining influence even within academic circles. It makes little sense to assign logic to 'scientific' thought since narrative power also depends upon logical coherence. It is important, however, to uncouple logic from naturalism, to which science, but not narrative, is committed.

The two modes of thought are perhaps better known today as 'left-brain' and 'right-brain' thinking. Given its universal applicability as part of the biological heritage of humans, the left-brain/right-brain model of thinking is more useful than Bruner's in domains such as science education, where Bruner's influence, one step away from Eurocentric, is still evident in the dominant pedagogical metaphor that 'science is a special way of thinking'. Cognitive science and brain medicine have established that left-brain thinking is analytical in nature, while right-brain thinking is holistic (in most healthy human brains). These two modes of thought are reflected in the two basic modes of language that can be termed 'measurement' and 'metaphor'. This view understands logic as inherent both modes of thinking, and therefore in both modes of language. Not involving logic in the criteria by which to categorize thought eases the longstanding debates about rationality, including multicultural science education research, epistemological diversity and incommensurability.

The link between knowledge, culture and language has been known since the 1930s as the Sapir-Whorf hypothesis. Though best known for his work on Hopi and other indigenous American languages, Benjamin Whorf was a chemist by training. His interest in what he called 'configurative linguistics' was fuelled by his work as an industrial insurance assessor, finding that the meanings understood by words such as 'empty' sometimes explained why workplace accidents occurred. The Sapir-Whorf hypothesis was later sub-divided into 'weak' and 'strong' versions (also called W1 and W2, respectively) by Joshua Fishman. Strong Sapir-Whorf is the idea that language determines thought, i.e., language determinism, a concept that has been thoroughly investigated and rejected, along with the emergence of the notion of a 'universal grammar'. So-called 'weak Sapir-Whorf' (or W1) is the idea that language and knowledge are inter-related and influence each other, termed

'language relativity'. Whorf's idea of language relativity was a forerunner of the concept of 'world-view' , and his approach to languages and cultures has been recognised as an early form of poststructuralism.

Scientific English is a form of language that reflects the development of the modernist, deterministic philosophy of science. Research into the language of science has identified certain 'syndromes' of characteristics in scientific English, in particular the combination of a syntactical feature called 'grammatical metaphor' along with a much higher lexical density than everyday language, measured by the number of lexical words per sentence. These syndromes developed and became characteristic of scientific English in the era following the switch from Latin to English (and other European languages, but for simplicity this discussion refers only to English) as language medium of science, which took place in the post-Enlightenment period. The purpose of these characteristics of scientific English was to allow for the delineation of a step-by-step argument or chain of reasoning.

As developments in technology continue to enable measurement to become more and more precise, so the lexicon of science expands correspondingly. More significantly, the syntactical change to allow the step-by-step reasoning of science discourse occurred quickly in the Enlightenment period, once English became a language of science. Both specialised vocabulary and step-by-step chains of argumentation reflect the basic 'measurement' mode of the scientific genre of English. In science language, word and sentence meanings are precise and stable, adhering to the universalist commitment that time and space are always and everywhere the same, with only one meaning being possible. The language of chemistry demonstrates this powerful precision, whereby internationally-agreed rules of nomenclature provide unique names for each of the many thousands of organic chemical substances, even down to unique names for the so-called left- and right-handed pair of substances that differ only in their effect on polarised light, a difference produced by changing the *order* of the four bonds from a key carbon atom in the molecular structure to four different chemical species.

Science discourse requires that words and sentences have unambiguous meanings. Thus, though rich, messy stories from the history of science are preserved within science words, such as the names of the elements, in operation science language is profoundly non-metaphorical: nouns, verbs and adjectives have stable, precisely-defined meanings; and statements are intended to be understood literally, not metaphorically. Scientific English sacrifices richness of meaning in favour of precision: words and statements have single-layered meanings (which is not to be confused with the idea of simple vs. complex meanings).

Te reo Māori: favouring right-brain thinking?

Speakers of Māori will immediately recognise that the above language descriptions are foreign if not antithetical to the workings of te reo Māori. In contrast to scientific English, te reo Māori can be characterised as a language in which even very small words carry many levels and nuances of meaning, within an overall worldview built from the large tropes and metaphors of traditional Māori culture. The term 'worldview' is understood as a personal-cultural ontological, epistemological and ethical paradigm. Using in-depth investigations of both traditions and language features, Anne Salmond characterised the traditional Māori worldview as structured by a series of large interlocking bipolar opposites at many levels, from psychological to cosmic.

Not only are Māori words and phrases multi-levelled in meaning, but a great deal of the meaning of Māori words and statements rests in exactly *how* they are said by the speaker. Thus oratory is far more important in Māori culture than in modern Western culture. Sacrificing precision for richness of meaning is associated with this performativity aspect of language in te reo Māori, which is absent from modern scientific English. The need to modernise te reo Māori for its survival has led to many arbitrary decisions in recent decades, 'fixing' the meaning of certain traditional Māori words by aligning them to English words, in ways that reflect dominant contemporary understandings, sometimes obscuring the original richness of imprecision. One way this 'richness of imprecision' works is when a Māori word takes two meanings seen in English as opposites, such as the example commonly cited in education: the word 'ako' can mean either 'to teach' and 'to learn'. However the 'mainstream' version of this idea is that ako means both at once, when in reality the context (including non-linguistic features such as performativity) determined which meaning was being invoked in a speech act. These differences and richness in meaning are not conveyed by the written words alone.

Perhaps traditional Māori language reflects a culture operating as much or more by metaphorical right-brain thinking as the precise analytical left-brain mode. Modern English is influenced by the scientific genre, reflecting the dominance and leadership of analytical left-brain thinking, using precise, stable, literal meanings, which can be represented in written form without loss of content. In traditional Māori language, however, lexical words play a far lesser role in carrying meaning, which has more to do with how lexical words are arranged along with many other small words. Over and above the words themselves, much of the meaning of a Māori utterance rests in the pacing and emphasis each word is given, along with facial expression, gesture, and the use of other language devices, such as repetition, or extra non-lexical words added in for emphasis.

It is widely accepted that Western and Indigenous worldviews tend to be characterised by opposing binaries, but this does not make these ways of thinking mutually exclusive, in the sense of unable to be understood by someone brought up within the other culture or way of thinking. Worldview is a more up-to-date expression of the idea expressed as weak Sapir-Whorf, W1 or language relativity. Drawing these links helps explain why bilingualism, including Kaupapa Māori education, draws fire from 'social realists' such as Elizabeth Rata. Bilingualism is necessarily committed to some degree of philosophical relativism, but Rata understands the postcolonial Māori *critique* of universalism as *denial* of universalism.

From the perspective of the modern scientific worldview, Māori knowledge has no explanatory power about the natural world, and therefore no value. The scientific view is that Māori knowledge does exist in some scientific domains such as astronomy and taxonomy, arising from 'detailed observations' of nature , but that this knowledge is a mere shadow of modern science knowledge in those areas. Science considers Māori knowledge to be underpinned not by working models of reality, but by 'stories'. The question of whether or not Māori knowledge is science (or a science, or anti-science) is really a question about how the word 'science' is being understood – Māori knowledge is merely the 'provocateur' in this version or iteration of the old debate over what counts as science. The dramatic answer is to say that Māori knowledge *is* a science, a claim that is usually justified by pointing out all the 'true' information that traditional Māori knowledge includes about the natural world. Rebuttals invariably focus on the obvious flaws in this claim. Following the above argument, however, the value of Māori knowledge (assuming there is such a thing) lies in it being different from science.

Might the concept of worldview, and the claims about epistemological diversity, be explainable in terms of (among other things) relative balance between these two modes of thinking, left-brain and right-brain thinking, which could, for this discussion, be re-labelled 'measurement vs. metaphor thinking'? This idea follows Sydney Lamb , who maps 'left-brain' and 'right-brain' thinking to 'philosophical differences' he terms 'splitter-thinking' (associated with absolutism, universalism and reductionism) and 'lumper-thinking' (associated with relativism and holism), respectively. One of the key concepts of Māori knowledge, namely 'whakapapa', may be used to explore this distinction. The dictionary translation of this important Māori word is 'genealogy' or 'family tree', but whakapapa is far more than this: it is a central trope in Māori cosmology, thought and knowledge, termed a 'cognitive gestalt' ; a 'way of thinking' , p.59), a value and a concept, 'both a noun and a verb'. Māori knowledge and worldview are considered as being intrinsic within te reo Māori, a position that accepts language relativity, while paying due regard to the limitations of relativism. Anne Salmond identified this approach, taking Māori language as the key to understanding Māori worldview and Māori knowledge, as key in semantic anthropology : it is also aligned with Kaupapa Māori research principles, and with the 'diffraction methodology' approach of reading two traditions 'through' each other , in the sense of seeking explanations that 'work' from both a Māori and a scientific perspective.

Amongst its other uses, the whakapapa concept is also a record of the passage of time, based on the imprecise unit of a generation. In a society organised along communal kinship lines, knowledge of whakapapa was of both social and economic value. Whakapapa is usually portrayed diagrammatically using 'descending vertical lines', but Salmond's research showed that in traditional Māori thought, whakapapa was graphically represented in carvings 'as a double spiral marked by chevrons to show successive epochs'. If whakapapa measured time, the spiral representation of whakapapa reflects a Māori notion of time as cyclic, rather than the Western concept of linear time. A cyclic concept of time (such as the Mayan wheel of time) is a well-established

characteristic that distinguishes indigenous from Western (or ancient from modern) thought. In the case of Māori notions of space-time, the cosmological dualities are like the spokes of time's wheel.

Like whakapapa, the Periodic Table is also conventionally represented in linear form, comprising straight lines dividing the array of elements into rows and columns. Yet prior to Mendeleyev's dream, in 1862 the French geologist Alexandre-Émile Béguyer de Chancourtois proposed the Telluric Helix model in which the elements were arranged in a continuous spiral around a cylinder. Spiral representations of the Periodic Table abound, though not in science education. These two pairs of linear/spiral forms are possible examples of left-brain/right-brain representations. They form a suggestive link with 'Kaplan's Contrastive Rhetoric Doodles', a diagram first published in 1966 by Robert Kaplan that was 'intended to demonstrate a variety of paragraph movements that exist in writing in different languages' in a paper for teachers, titled 'Cultural thought patterns in intercultural education'. The Doodles diagram showed the patterns of English as a straight line, Oriental as a spiral. The word 'rhetoric' in the diagram's title seems to mean something very like what would today be termed 'discourse'.

Conclusion

Thinking about recording the Periodic Table, or whakapapa, in a spiral, rather than linear form, is like a heuristic thought experiment for better understanding the difference between left- and right-brain ways of structurally conceptualizing complex arrays of information. We can 'understand' how either representational form works; but on the other hand, not many of us would independently think of transforming the conventional form of the Periodic Table, or common written forms of whakapapa, into a spiral-form representation. This paper has attempted to advance the philosophical argument presented in , where the relevance of Sapir-Whorf and Kaplan's Doodles to the 'Māori science' debate was suggested in terms of epistemological diversity at the level of discourse.

Cognitively speaking, the straight line and the spiral form another cosmological duality, but one that is overcome by changing perspective – zoom in up close on one part of the spiral and you will see a straight line. Lamb (2004) is interested in mapping the working of each hemisphere of the brain to the various language functions taken care of by each side. This paper applies Lamb's idea to the question of how left- and right-brain modes of thinking may work together, or in opposition, in representations of science – both in the characteristics of scientific English, and in 'school science' (i.e. curriculum representations of the nature of science). The development of scientific English in the period of the European Enlightenment is likely to have reflected an increased relative importance of left-brain or 'measurement' thinking, taking advantage of burgeoning new technologies to observe nature to previously unimaginable levels of detail and precision, and a concomitant relative decrease in language performativity and other language functions aligned more closely with right-brain or 'metaphor' thinking.

In practice, of course, working science is highly diverse and multilingual; it relies on reciprocal relationships between metaphor and measurement, and on the engagement of all available cognitive resources. Scientific thinking cannot therefore be equated with left-brain thinking, but this paper suggests that science discourse, especially as presented in the school curriculum, may reflect a different relative balance, with more emphasis on left-brain and less on right-brain thinking, by comparison with the indigenous discourse of a non-Western culture such as Māori. It seems reasonable to suggest that this difference may contribute to the documented alienating effect of secondary science education on Māori and other indigenous students, to an even greater extent than students in general. In school science education and beyond, the characteristics of left-brain thinking (as described by Lamb, above) have invalidly come to be associated with the nature of science, in a way that supports forms of scientism (i.e. ideological distortions of science) including the claims made by neoliberal economics to include 'scientific' approaches to social policy. The imbalance between 'measurement' and 'metaphor' modes of thinking and language seems characteristic of neoliberal discourse – lots of information but no wisdom, a checklist approach that misses the 'bigger picture'.

The discourses, worldviews and epistemologies associated with indigenous cultural cosmologies, and the languages in which they are expressed, may differ most importantly from those of modern Western science in

terms of this balance between the two great psychological modes of operation. This model supports the assertion of a coherent form of epistemological difference between 'Māori knowledge' and (say) traditional curricular knowledge, while also clearly showing continuity between the two, and a way of explaining how the differences are not captured in language by single words, but at the level of the paragraph, central metaphor or discourse. The ideas brought together in this paper suggest new approaches to future investigations into the role of language in multicultural education, and interculturalism more widely.

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