SCIENCE CURRICULA AND INDIGENOUS KNOWLEDGE

Curriculum can be thought of as what is required to be taught, its scope and sequence. This is usually in the form of documentation prepared by an educational authority to be used in schools and colleges under its auspices. In recent times some of this work has been done at a national level by agreement with state, provincial and local educational authorities (where they exist) which may then modify and enact the curriculum within their domains. In some cases the curriculum may be prepared by recognised external agencies such as the International Baccalaureate. The curriculum differs from individual teacher’s or school-based programs which are interpretations of the curriculum for individual school or classroom contexts. Universities usually prepare autonomous curricula although there are usually processes nationally and internationally to ensure comparability.

A related interpretation of curriculum refers to curriculum resources, a classroom resource which may have been developed by the educational authority, an interested organisation or often by groups of teachers to implement the curriculum. Curriculum resources are usually considered to be a link between the curriculum and classroom pedagogy, however resources may be developed which are not based on the curriculum or reflect a particular interpretation of its meaning. Text books can also be considered as curriculum resources which should reflect the regional curriculum.

There has been some discussion of the inclusion of indigenous knowledge in the science curriculum in recent times, although previously there have been instances of the inclusion of indigenous knowledge in some ways, most frequently in text books. Critiques of this portrayal have focused on stereotypes which denigrate indigenous peoples and their knowledges. There has been advocacy for the inclusion of indigenous science in mainstream science courses primarily since the 1990s and terminologies such as multicultural science and multi-science have been used by the advocates. This has been undertaken by both indigenous and non-indigenous science educators (including Aikenhead, Jegede, George, Kawagley, Cajete, Snively and Corsiglia, Stanley and Brickhouse, Cobern, Pomeroy and Ogawa). Criticism of these approaches has been mainly by a group of science philosophers who make a distinction between the universality of western modern science as core science and the lesser position of indigenous knowledges and indigenous sciences. However this argument has in some ways been circumvented in some countries where educational authorities have
mandated the inclusion of ‘indigenous perspectives’ across the curriculum, including subject science. Other arguments include approaches to redefine western modern science to be inclusive of indigenous knowledge (particularly approaches to science in Africa).

**Science and indigenous knowledge**

Since the Rio Earth Summit in 1992 there has been an increasing recognition by some professional scientists of the role of indigenous knowledge, particularly in areas involving land management and the environment. At the UNESCO Conference in 1999, *Science for the Twenty First Century*, there was a call for a wider use and support for traditional forms of learning and knowledge, as well as cooperation between holders of traditional knowledge and scientists to explore the relationships between different knowledge systems and to foster interlinkages of mutual benefit. As a consequence, in 2002 the International Council for Science (ICSU) prepared a report on science and traditional knowledge. It was pointed out by a subcommittee that traditional knowledge was informing science, particularly in nature management. They recommended that the ISCU and member nations should sustain traditional knowledge systems through active support to the societies that are keepers and developers of this knowledge, promote training to better equip young scientists and indigenous people to carry out research on traditional knowledge, and promote and develop research to better appreciate traditional knowledge. Just prior to the Rio+20 UNESCO conference in June 2012, an ICSU session on Indigenous Knowledge noted that indigenous and traditional knowledge has gained increasing recognition as an essential building block for global sustainability, as well as a change in relationship between scientists and indigenous knowledge-holders. A shift away from the notion of scientific validation of extraneous knowledge and its integration into science was leading towards an approach anchored in the co-design of research and the co-production of new knowledge to address complex emerging challenges. Diverse knowledge systems were becoming more valued because of the benefit of place-based knowledge systems of heightened local relevance.

Areas of knowledge production which have seen the interaction of western scientists and their indigenous counterparts include (to use their western names) ethnobotany and ethnobiology, archeoastronomy and agriculture. These interactions have seen the exchange of knowledge by both groups of people in a variety of ways and including Elders from both groups. This exchange is limited to fields of knowledge where some similarity occurs and varies because of the place-based nature of indigenous knowledge. Often the knowledge is
referred to as indigenous science or a way of knowing or if it is more specifically environmental, as traditional environmental or ecological knowledge (TEK). Occasionally the location of the knowledge will be specified, such as Maori environmental knowledge or the Yupiaq way of knowing. Thus there is an attempt by some professional western scientists to broaden the definition of science to become more inclusive of place-based indigenous sciences.

Some researchers in science studies have considered that although indigenous knowledges had lacked “the same authority and credibility as science because their localness restricts them to the social and cultural circumstances of their production” (Watson-Verran and Turnbull 1995, p 116), there was now an explicit focus on the local as an implicit basis of scientific knowledge. It has been suggested that the ways of understanding the natural world that have been produced by different cultures and at different times should be compared on an equal footing. Such epistemological relativism was rejected by other science studies researchers. Although western science could be considered to be a localised knowledge system, as are other ethnosciences, the notion that they are equally defensible was rejected. The standpoint approach was that different cultures’ knowledge systems have different resources and limitations for producing knowledge.

Others who were researching indigenous knowledge and education considered that it was possible to produce a transformative science which would highlight the differences and complementarities between western science and indigenous ways of knowing. Some wished to initiate “a conversation resulting in a critique of Western science that leads to a reconceptualization of the Western scientific project around issues of multiple ways of seeing, justice, power, and community” (Semali and Kincheloe 1999, p 45). Their idea of an indigenously-informed transformative science is not simply an addition of knowledge but “challenges the epistemological foundations of ethnoknowledge known simply as science” (p 45). They also suggested that indigenous knowledge could transform education, that its inclusion in the curriculum leads to a needed interaction with ‘difference’ for westerners, leading to a heightened consciousness which is more empowering than “a narrow focus on homogeneous cultural traditions” (Semali and Kincheloe 1999, p 47).

**Science education and indigenous knowledge: multicultural science education**
In the past twenty-five years there has been much research in education in general and in science education in particular into indigenous ways of knowing. Multicultural science educators questioned whether the western knowledge base was appropriate or culturally biased, specifically questions such as: “Whose culture are we teaching? Whose knowledge is of most worth? Who benefits and who is harmed by current approaches to curricula?” (Stanley and Brickhouse 1994, p 387). It was suggested that holding a universalist position with regard to scientific knowledge gave a feeling of omniscience to scientific knowledge and has led to the destruction of other knowledge systems regarded as inferior by western standards. What was advocated was a community of learners with “the capacity to generate and consider various possibilities for understanding and determining knowledge” (Stanley and Brickhouse 1994, p 394). This was seen to lead to a science education from multiple perspectives rather than one perspective, although these other perspectives should not be given equal weight in the curriculum. Later, concern was expressed that universalist western modern science could be taught as if it was neither controversial nor problematical, that multicultural education introduced students to new ways of thinking about the natural world helping them not only to understand other ways of thinking but also some of the fundamental understanding of western ways of thinking.

The relationship between western modern science and indigenous science, particularly traditional ecological knowledge, has been discussed in the context of science education. The local nature of traditional ecological knowledge and its transmission were considered as an oral narrative, and its place related to sustainable development. The relativist nature of indigenous science is a reflection of its local applicability, in contrast to the universalism of western modern science. The spiritual element of traditional ecological knowledge is also seen as an impediment for it being considered as science by many western scientists. What seems to be forgotten is that most indigenous sciences are accumulations of observations, refined over time, what is referred to often as ‘the wisdom of the Elders’. Other science educators suggested that western science could be defined with sufficient clarity so as to maintain a coherent boundary for the practical purposes of school science curriculum, using the Standard Account for science, and that the boundary would exclude indigenous knowledge as well as other domains of knowledge. It was suggested that it would be better considered as a different kind of knowledge, valued for its own merits. From such a position it could maintain its independence from which it could critique the practices of science rather than be co-opted into a universalist science.
Some Indigenous science educators have seen the inclusion of indigenous education as being important, particularly in providing a more culturally relevant frame of reference for teaching science to Indigenous students. Others, noting that teaching of science is mostly by western teachers, were concerned that the treatment of indigenous knowledge would be oversimplified and essentialised to the point of becoming a caricature of its reality (McKinley and Stewart 2012). Science educators working in this area advocate that non-indigenous teachers work in partnerships with indigenous peoples to include indigenous knowledge but it is acknowledged that this is often not possible.

The incommensurability of multiculturalism and universalism was examined in the context of traditional ecological knowledge and western science. It was pointed out that “the reduction of local contexts [of TEK] to scientific praxis is inherent to the transcendent nature of scientific knowledge and includes a loss of local heterogeneity, dynamic, and plurality; and transcendent scientific knowledge is useless unless local contexts are reduced to the conditions of scientific laboratories rather than remaining contexts in their own right” (van Eijk and Roth 2007, p 18). It was concluded that traditional ecological knowledge and western science were different but were useful in specific local contexts and that traditional ecological knowledge could relate to students learning to solve local problems.

On the other hand there has been a negative response from a group of western scientific philosophers critical of multicultural science, including traditional and indigenous sciences, and its influence on the science curriculum. The universalist position advocated mainstream western science and was critical of multicultural science, particularly a form referred to as ‘robust’ or ‘noninterventionist multiculturalism’. Robust multicultural science was considered by these critics to be relativist and promoting equally validity with universalist western science. A version of multicultural science termed ‘epistemic multiculturalism’ was also considered incompatible with universalist science. Here multiculturalists were criticised in particular for attempting to broaden the notion of science to include ethnosciences, traditional ecological knowledges and indigenous knowledges. In considering whether indigenous knowledge or traditional ecological knowledge should be included in the school science curriculum, a version termed ‘limited compatibilism’ was proposed. By this was meant whether there were sufficient similarities between the indigenous knowledge and western science, normally judged against western science.
What is notable in the discussions of both the scientists and the science educators who are involved is the emphasis of place-based and local knowledge in the indigenous sciences and traditional ecological knowledge. How to implement this sense of the local through the curriculum and then into pedagogy is one of the difficulties being addressed by some multicultural science educators.

**Science curricula and indigenous perspectives**

In the later part of the 20th century, many countries reappraised their school curricula and developed national goals for education. In several of the settler states – those countries which had been colonised particularly by European countries but which had since become independent – the national goals included references to the original indigenous inhabitants. This occurred both in countries with a majority population of mostly European origin such as Australia and Canada, as well as those with a native majority such as South Africa. An outline of the Australian experience in endorsing indigenous perspectives is summarised here.

The first attempt to develop national goals for school education in Australia was at the end of the 1980s and was called the Hobart Declaration. Although education in Australia is controlled at the state or territory level of government, the federal (national) government is concerned with issues of quality of education across the nation. In a national project funded by the Ministerial Council of education ministers, a series of agreed goals of education – the Hobart Declaration – was reached. These included development of national curricula across the eight identified curriculum areas, including science, as well as identifying a number of cross-curriculum perspectives. Item 8 read: “To provide students with an understanding and respect for our cultural heritage including the particular cultural background of Aboriginal and ethnic groups”. The reference to Aboriginal culture was interpreted as applying in the teaching and learning of science and needed to become evident in science curricula developed nationally; it became commonly referred to as the ‘indigenous perspective’.

The Hobart Declaration has been updated on two occasions, as the Adelaide Declaration (1999) and the Melbourne Declaration (2008). The Melbourne Declaration included providing students with an understanding and respect for their cultural heritage including the particular cultural background of Aboriginal and ethnic groups and giving all students the opportunity to access Indigenous content where relevant. As well, within the goal of promoting equity and excellence it included ensuring that schools build on local
cultural knowledge and experience of Indigenous students as a foundation for learning, and work in partnership with local communities on all aspects of the schooling process, including to promote high expectations for the learning outcomes of Indigenous students. This represents a shift through the Declarations from solely consideration of indigenous knowledge to ensuring inclusion of Indigenous peoples in all aspects of the schooling process.

There have been attempts to develop a national curriculum including science in Australia since the 1990s, and although its implementation by the various states and territories has been varied, these attempts have influenced the science curriculum in all jurisdictions. Its latest form is the National Curriculum: Science released by the Australian Curriculum Assessment and Reporting Agency in 2011, which covers the years from Foundation to Year 10. A cross-curriculum priority in the national curriculum, including science, is termed ‘Aboriginal and Torres Strait Islander histories and culture’, although it is commonly referred to as the indigenous perspective. Indigenous perspectives in the science curriculum are incorporated as possible elaborations in the Science as a Human Endeavour strand rather than the Science Understanding strand. This has been seen by some commentators as continuing to treat indigenous knowledge as inferior to western science knowledge. Some science educators have suggested that the discussion regarding the nexus between indigenous science and western science could be treated as relating to the Nature of Science, which is implicitly within the realm of Science as a Human Endeavour strand in the Australian curriculum.

Similar processes incorporating indigenous perspectives into the science curriculum can be noted in the recent curriculum development in a number of countries, particularly Australia, New Zealand, Canada and South Africa. Thus it can be seen that the imperative to be inclusive of indigenous culture and knowledge has been taken up by curriculum authorities.

It has been advocated that indigenous science should be included in the science curriculum, for a number of reasons. Indigenous science could be seen as part of the way we can understand the world. Secondly, indigenous science could tell us something about western science and science education. Finally, it was a way of achieving reconciliation between Indigenous and non-indigenous peoples and a vehicle for social justice. Earlier, indigenous perspectives were perceived primarily as impacting on non-indigenous students.
However, as seen in the commentary on the Melbourne Declaration, they have evolved to impact on the education of Indigenous students. This included trying to reconnect Indigenous learners with their roots and developing cultural citizenship, as well expanding our knowledge base in a knowledge society.

The new South African science curriculum prescribes the inclusion of Indigenous Knowledge, allowing for localised content and accommodating different ways of learning although it is not apparently always clear what this means. In common with curriculum documents in other countries, what is often described as indigenous knowledge are fragments which fit with western science, compatible with the notions of oversimplification, caricature and essentialising treatments suggested by some science educators but perhaps a pragmatic implementation of limited compatibilism also. However, there has been a call for indigenous knowledge to be included in western science in several parts of Africa by a number of African science educators, both indigenous and non-indigenous (including Jegede, Ogguniyi, Semali, Okebukola, Gitari, Keane and Malcolm), a call which resonates with that made by African scientists as well.

The development of a Maori science curriculum, Putaiao, in Aotearoa New Zealand in the 1990s, has offered a precedent for similar curriculum development elsewhere. In writing the Maori science curriculum, the western science curriculum was reconstructed to match up with Maori understandings of the world, much of the Planet Earth and Beyond strand, in the Maori version, has gone into the Biological World strand, which was renamed Mataora. What is important for Maori is that this represents the joining of Papatuanuku (earth) with the rest of living things (as defined through science). However, there are a number of conditions imposed which limited the accessibility of students to the curriculum. Firstly, the document is written in Maori, for students who are learning through the medium of Maori. Secondly, there were issues regarding language at two levels. At one level there were differences which are apparent with the syntax construction between native speakers and second language learners of Maori. Then there were issues of a ‘standardised’ Maori language in a country made up of various tribal groups with differing dialects.

From time to time indigenous influences on science curriculum have been discarded. In Hawaii a science standard called Malama I Ka ‘Aina was adopted in 1994. It incorporated an awareness of Native Hawaiian phenomena and supported culturally-responsive, place-based curriculum. However, it was removed in 2005 on the recommendation by out-of-state
consultants because it was seen as being too limited to Hawaiian culture, suggesting the political challenges to forms of multicultural science education were not completely aligned with mainstream perspectives.

There appears to have been little criticism of the role of the education authorities in implementing indigenous perspectives through the curriculum. The first criticism would come about from the assumption that Indigenous and western knowledges run parallel, when it has been shown by numerous scholars that they have different epistemologies. A second related criticism would apply because the educational authorities subdivide indigenous knowledge according to the western fields of knowledge, including science. As noted about, in school science curricula there has been a tendency to fit the indigenous perspectives into the western science curriculum structure. This has led to a simplification of the indigenous knowledge often to the point of caricature.

Conclusion

There have been two approaches to the inclusion of indigenous knowledge in the school science curriculum. The first of these is by scientists working close to indigenous peoples who see indigenous knowledge as valuable, particularly as local knowledge. One of their strategies is to expand the definition of western science so that it can include indigenous knowledges in a respectful way. They are supported by a group of multicultural science educators who also wish to be respectful of indigenous students’ prior knowledge. The idea of expanding the definition of science and inclusion of indigenous knowledge in the school science curriculum is opposed by some philosophers of science. Separate from this and somewhat pre-emptive of the work by scientists and science educators is a move by many educational authorities to include indigenous knowledge across the curriculum, often referred to as indigenous perspectives. This includes in the science curriculum although it seems that often it is not clear what an indigenous perspective means. What is becoming clear from investigations in science, science studies and cultural studies in science education is that indigenous knowledge incorporates a local perspective that complements the western science one.

References


