WALKING TOGETHER

First Nations, Métis and Inuit Perspectives in Curriculum

Traditional Environmental Knowledge

Science and Technology Education from Different Cultural Perspectives

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SCIENCE AND TECHNOLOGY EDUCATION FROM DIFFERENT CULTURAL PERSPECTIVES

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My paper has two purposes:

(1) to explore an alternative to the conventional monocultural science-technology (ST) curriculum in schools narrowly defined by Western science-technology (Western ST); and

(2) to consider the benefits that accrue from a school science that integrates Western ST into the indigenous knowledge of nature (indigenous ST) held by the school's community culture. This alternative is a multi-ST school curriculum.

My exploration begins by considering one of the most memorable events over the past 50 years in Western science-technology (ST): the first visit to the moon by humankind in 1969. What does this event tell us about Western ST? What are the implications for school ST education worldwide?

A Humanistic and Cultural Account of Science-Technology

The Apollo 11 moon landing signified many things, such as the social contract between Western ST and politics (i.e., J.F. Kennedy's Americans would beat the Russians to the moon) and the social contract between Western ST and corporate profits (i.e., the companies contracted to make it happen). This social aspect of Western ST, the "collectivisation of science" during the 20th century as John Ziman (1984) called it, defines a key dimension to Western ST (Bencze et al., 2006).

Another human dimension to Western ST is discovered by observing the astronauts themselves: Who were they? What did they do? What did they say? Both Neil Armstrong and Buzz Aldrin were white male Anglo-Americans. They shared the same race, sex, and culture. Over the years astronauts have become somewhat more diverse, as have the scientists and engineers working for NASA, but there is much room for improvement.

What did the astronauts do? For one thing, they left material on the moon when they returned to earth. Besides a golf ball and an American flag, the material was mostly spacecraft junk (i.e., garbage). When the astronauts' culture is mainstream Anglo-American, this garbage is seen with pride of accomplishment. If the astronauts' culture were instead Aboriginal, for instance, in this case Native American (the original peoples of the continent they call Turtle Island), the words first spoken on the moon would certainly *not* have been, "That's one small step for man, one giant leap for mankind." Instead we would likely have heard, "That's one small step for this astronaut, and one giant responsibility to Mother Earth and all my relations." Most importantly, Native American astronauts would have left a gift of tobacco on the surface of the moon to show their indebtedness and responsibility to Mother Earth.

NASA scientists and engineers whose cultural self-identity is Native American do use the conceptual tools of Western ST but can be guided by Aboriginal values, ideologies and intuition at crucial points in the progress of a project (Cajete, 1999). An Aboriginal perspective, if held by some members of a research and development team, will improve the diversity of decision making and problem solving that propels ST projects forward (Cajete, 2000a; ICSU, 2002; Knudtson & Suzuki, 1992; Snively & Corsiglia, 2001). Western ST benefits from cultural diversity.

I have drawn upon the cultures of Aboriginal peoples to highlight a different cultural worldview to the Eurocentric worldview endemic to most of Western ST. This contrast reveals how modern Western ST is laden with culture-based values and ideologies that have become part of Western ST during its development over the past 500 years.

Before proceeding further in this paper, I need to clarify some key terms. I draw upon Ogawa (1995) to define "science" in a multi-science context. Science is *a rational, empirically based way of describing or explaining nature*. This definition is more encompassing than its Eurocentric meaning associated only with Western ST. (My pluralistic perspective should not be confused with a relativistic one.) The term "technology" in this paper continues its normal generic definition: designing and developing artefacts and processes in response to human and social needs.

The political history of the word "science" in England privileges a very narrow meaning: the canonical Western science content taught in universities. The word "science" was deliberately chosen in 1831 when a few natural philosophers founded the British Association for the Advancement of Science and thereby professionalized natural philosophy into a new social institution, which they called "science" for very political reasons (Aikenhead, 2006; MacLeod & Collins, 1981). Equally political today, we can expand the meaning of "school science" so it is culturally responsive to the indigenous cultures of students.

Because the cultural origin of Western ST is historically Euro-American, Western ST is strongly associated with Euro-American culture, although Western ST is a fairly unique subculture on its own (Pickering, 1992; Ziman, 1984). And as Ogawa (1995) correctly pointed out, Euro-American culture has its own everyday, indigenous, commonsense, knowledge of nature. This knowledge is often at odds with that found in the subculture of Western ST, much to the consternation of science teachers. In order for me to refer to types of knowledge systems different from Western ST, I am guided by Ogawa's (1995, 2002) term "*indigenous science*" to refer in general to systems of knowledge of nature developed by a culture indigenous to a region or country (i.e., indigenous ST). Thus, mainstream Euro-American commonsense about nature is indigenous ST. Traditional Malaysian and traditional Japanese knowledge of nature are also examples of indigenous ST. "Indigenous science is a kind of knowledge and cosmology not 'in the past' but 'of the present'" (Ogawa, 2002, p. 6). For instance, Islamic nationalism today has created several indigenous views within Islamic ST (Irzik, 1998; Sardar, 1997).

Indigenous ST *includes*, but should not be equated with, "Indigenous knowledge," a term that conventionally refers to the knowledge of nature held by the *original* peoples of a land (Battiste, 2000); for example, the Ainu of Japan (Suzuki & Oiwa, 1996), Native Americans, Yupiaq and Polynesians of the USA (respectively: Cajete, 1999; Kawagley, 1995; Chinn, 2004), the MŠori of Aotearoa New Zealand (McKinley, 1996), and Aboriginal peoples of Australia (Christie, 1991) and Canada (Aikenhead, 2001).

Indigenous ST is place-based in that its validity depends upon the place in which it is learned and used (Hammond & Brandt, 2004). Thus, indigenous ST is invariably plural. The foundation to indigenous ST is comprised of worldviews dramatically different from the worldview endemic to Western ST, yet both STs employ empirical data and rational ways of knowing in creative and intuitive ways (Cajete, 2000b), although each has a culture-laden rationality and intuition that differ in several ways and to varying degrees (Aikenhead, 1997). As Ogawa (2002) pointed out (in the quotation just above), indigenous ST is present day knowledge, not old traditional knowledge, yet it may have been formed out of the synthesis (acculturation) of several knowledge systems prominent in the past. Thus, Ogawa (2004, p. 1) described present day Japanese indigenous ST as "a body of stratified and amalgamated knowledge and cosmology with several different kinds of precedent cultures or civilizations."

Just as biodiversity is crucial to survival in the biological world, cultural diversity in ST will be crucial to sustainable development, empowerment, peace, and ethics in the 21st century (a major focus of this Symposium). A Eurocentric dominated ST is an ontologically impoverished ST. A United Nations authority on Aboriginal knowledge of nature ("Indigenous knowledge") wrote, "Indigenous knowledge fills the ethical and knowledge gaps in Eurocentric education, research, and scholarship" (Battiste, 2002, p. 5). Thus, future scientists and engineers need a foundation in a rich, culturally diverse ST education because if they continue to try to solve today's problems with the same kind of thinking that caused the problems in the first place, the quality of life on this planet is in jeopardy (Cajete, 2000b; Suzuki, 1997).

What does the Apollo moon landing tell us about ST? It illustrates a global mono-culture type of ST imbued with Eurocentric values and ideologies (Ogawa, 1996). For instance, Neil Armstrong did not have sufficient indigenous scientific literacy to leave a gift of tobacco on the moon.

When non-Western cultures influence the culture of Western ST (an influence not to be confused with Western science's conventional appropriation of other cultures' knowledge of nature), the other cultures' differing values, ideologies and intuition will help ensure sustainable progress if business, industry, resource management and health sectors embrace a multi-science type of ST (Snively & Corsiglia, 2001). Even white, male, Anglo-American scientists and engineers can expand their perspectives on nature and on problem solving by learning the knowledge of nature (indigenous ST) held by another culture. In addition, they will be able to appreciate the ontology, epistemology and axiology of their own Western ST when they contrast it with an indigenous ST of another culture.

Different cultures often have diverse ways of describing or explaining nature, and they often have unique ways of designing artefacts and processes for human use (Ogawa, 1995; Semali & Kincheloe, 1999). ST knowledge systems are indigenous to particular cultures, as historians of ST have documented (Ogawa, 2002). Euro-American cultures have privileged a particular ST

(Western ST) and have exported it as an icon of prestige, power, and progress (Mendelsohn & Elkana, 1981). Eurocentric Western ST is a powerful predictor of events in several contexts of natural phenomena, which makes it an attractive tool for medical, industrial, corporate, and military interests. But equally important, European nations have had a habit of colonizing the world and appropriating or obliterating local knowledge systems (indigenous ST) in ways that advanced the European ideology of human power and dominion over nature (Kawada, 2001; Mendelsohn & Elkana, 1981), and these European nations have held an ideology that equated materialistic growth with progress (Suzuki, 1997). This cognitive imperialism (Battiste, 2000) by industrial nations continues today as neo-colonialism (Ryan, 2006).

Science and Technology Education in Schools

Science educators themselves are not immune from neo-colonialism, as I discovered in Seoul, South Korea, at an international conference with the theme "Moving toward Worldwide Science Education Standards" (Korean Educational Development Institute, 1997). It became quite clear to most participants that major sponsors of the conference (e.g., ICASE and UNESCO) expected us to reach a consensus on one set of standards for school science for all countries; a neo-colonial stance to be sure. At the final plenary session scheduled to articulate this global reform to science education, the tables turned. Participants from many countries critically assessed the conference's intended outcome and persuasively argued that school science is best taught when responsive to the local culture. As a result, a position opposing global reform was reached at the conference when a majority of participants affirmed a culturally sensitive perspective on science education. Neo-colonialism had failed in this instance, but often it does not.

Today school science worldwide generally privileges only one of the cultural knowledge systems discussed above, Western ST. Indigenous sciences and technologies are rejected or marginalized in most school curricula. This has negative consequences for the success of science education worldwide because it sustains the under-representation in science and engineering of people who think in a culturally different way than traditional Western scientists and engineers.

The success of science education will be measured, in part, by the number of non-Western students who have avoided indoctrination or assimilation into a Eurocentric way of thinking, but who have learned to appropriate the tools of Western ST for their everyday lives (Aikenhead, 2006; Layton et al., 1993). We need to strengthen students' cultural self-identities as they learn to master and critique Western scientific, technological and mathematical ways of knowing without, in the process, sacrificing their own culturally constructed ways of knowing, that is, their indigenous ST. We must eschew tokenism, indoctrination, and neo-colonialism. Our aim is to nurture students' scientific literacies (the plural is intended) so students can successfully walk in at least two worlds: their village's indigenous culture and the global village's Western ST (Battiste, 2002; Cajete, 1999; Ogawa, 1996).

Conventionally, school science has attempted to enculturate students into taking on a Western ST way of knowing, replete with its canonical knowledge, techniques, and values. In short, many science teachers want students to think like a scientist (AAAS, 1989). This often means that positivistic notions of scientific knowledge are combined with ontologies of realism and Cartesian duality, to feed on reductionistic and mechanistic practices in order to celebrate an ideology of power and dominion over nature. Western ST is not value neutral.

To participate in school science, students are often expected to set aside their indigenous way of knowing, including its alternative notion of knowledge as action and wisdom. Their indigenous ST likely, but not necessarily, combines the ontology of spirituality with holistic, relational and empirical practices in order to celebrate an ideology of harmony with nature for survival. When school science does not nurture students' cultural identities or strengthen their resiliency, most students are not inclined to participate or achieve in these courses (Cajete, 2000a; Lyons, 2003, 2004; Sutherland, 2005). The culture clash between indigenous identities and Western science ideologies is severe for students whose worldviews, cultures, and home languages differ from those found in science classes (Cajete, 2000b; Kawagley, 1995; McKinley, 2005; Nieto, 2002; Rowland & Adkins, 2003). Many feel unwelcome in school science. This happens in spite of supportive influences on student learning. Discordant worldviews create an incompatibility between, on the one hand, students' self-identities, and, on the other hand: students' views of Western ST, of school science, or of their teachers (Aikenhead, 1996; Cobern & Aikenhead, 1998; Kawagley et al., 1998; McKinley et al., 2004); students' views of the kind of person they think they must become in order to engage in mathematics and Western ST (Carlone, 2004; Gagné, 2003).

A case in point concerns Papua New Guinea. Ryan's (2006) participant observer research documented how a group of Australian educators, backed by globally powerful institutions (the World Bank, for one), recently denied Papua New Guinea students a school science program that would have given them the intellectual space to discuss their village's indigenous ST and strengthen their cultural identities. "The [neo-colonial] science syllabus continues to support scientism at the expense of Papua New Guinea understandings of the world, thus denying students the opportunity of naming their own place and thus of contributing to their future on their own terms" (Ryan, 2006, p. 209).

The key educational issue in Papua New Guinea and other countries worldwide is whether or not indigenous ST is recognized and valued in the curriculum. The *educational* value of indigenous ST in school science is supported by decades of empirical evidence; however, the *political* value of indigenous ST in school science goes against global economic interests in having a narrowly defined Western ST school science curriculum (Aikenhead, 2006; Fensham, 1993; Ryan, 2006).

Conclusion

Some science educators who favour a multi-ST approach to school science tend to relegate indigenous ST to a kind of "curriculum emphasis," that is, to be added to the list of 10 emphases proposed by Roberts (1982) and Fensham (2000). (These curriculum emphases are: everyday coping; structure of the discipline; science, technology, and decisions; scientific skill development; correct explanations; self as explainer; solid foundations for the next level of schooling; science in application; science as nurturing; and science through technology.) In my paper, I have presented a rationale for doing much more than adding a curriculum emphasis to an already crowded list of curriculum emphases. The present school science program, monopolized as it is by a mono-culture Western ST and by the ideology of scientism (Ogawa, 1998; Smolicz & Nunan, 1975; Ziman, 1984), needs to be changed to a multi-ST program in which at least one indigenous ST is taught integrated with Western ST in a way relevant to students, that is, by grounding Western ST in students' home culture (Aikenhead, 2001, George, 1999).

This is what I mean by "science and technology education from different cultural perspectives." A school program framed by different cultural perspectives aims to develop students' capacities to function as life-long, responsible, savvy participants in their everyday lives. Their lives are comprised of complex combinations of cultural self-identities, of which most lie outside the domain of Western ST but are increasingly affected by the enterprise of global Western ST. At the same time, a school program framed by different cultural perspectives promises to improve the quality of the Western ST accomplished by future scientists and engineers who are not imprisoned by Eurocentric mono-culturalism.

My aim for ST education is a multi-ST school science that highlights the 12^{th} IOSTE Symposium's emphasis on sustainable development, empowerment, peace, ethics, and international understanding.

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