WALKING TOGETHER

First Nations, Métis and Inuit Perspectives in Curriculum

Traditional Environmental Knowledge

Whose Scientific Knowledge? The Colonizer and the Colonized

by Glen Aikenhead

Government of Alberta

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At a 1982 science teachers' conference in Saskatoon, Canada, Jacques Désautels explained how conventional science teaching, claiming to transmit value-free knowledge to students, subliminally inculcates scientific and societal values. Like the Greek wooden horse during the siege of Troy, a science curriculum plays the role of a Trojan horse by concealing its values when teachers attempt to enculturate students into Western science. These values often take the form of an ideology called "scientism" (Ogawa, 1998; Smolicz & Nunan, 1975; Ziman, 1984). Nadeau and Désautels (1984) identified five ways in which this ideology surfaces in school science. First, there is a *naive realism*, scientific knowledge is the reflection of things as they actually are. Second, there is *blissful empiricism* according to which all scientific knowledge derives directly and exclusively from observation of phenomena. Third, there is *credulous experimentalism*, which holds that experimentation makes possible conclusive verification of hypotheses. Fourth, people committed to *blind idealism* believe that scientists are completely disinterested and objective beings in their professional work. Finally, those subscribing to *excessive rationalism* hold that the logic of science alone brings us gradually nearer the truth. Science teachers tend to harbor a strong allegiance to values associated with scientism, for instance, science is: authoritarian, non-humanistic, objective, purely rational and empirical, universal, impersonal, socially sterile, and unencumbered by the vulgarity of human bias, dogma, judgments, or cultural values (Aikenhead, 1985; Brickhouse, 1990; Gallagher, 1991; Gaskell, 1992). Concealed in a Trojan-horse curriculum, scientism and other values penetrate students' minds when they learn to "think like a scientist" and take on other "habits of the mind"; goals emphasized in recent reform documents (AAAS, 1989; NRC, 1996). These new science curricula attempt to enculturate all students to the same value system.

Towards a Cross-Cultural Science Education

Enculturation is not a problem for a small minority of students whose worldviews resonate with the scientific worldview conveyed most frequently in school science (Cobern & Aikenhead,

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1998). These “potential scientists” *want to* think like scientists (Costa, 1995). They embrace enculturation into Western science (Aikenhead, 1996; Hawkins & Pea, 1987). To them, there is no Trojan-horse curriculum.

But for the vast majority of students, attempts to enculturate them into Western science are experienced as assimilation into a foreign culture. These are the future citizens who will make strategic decisions for themselves and their society increasingly influenced by science and technology (Aikenhead, 1980; McGinn & Roth, 1999). Because they reject assimilation into the culture of Western science, they tend to become alienated from a major global influence in their lives. Alienation reduces their effectiveness at “legitimate peripheral participation” in community matters related to science and technology (Roth & McGinn, 1997).

The problem of alienation is more acute for Aboriginal students whose worldviews, identities, and mother tongues create an even wider cultural gap between themselves and school science (AAAS, 1977; Cajete, 1986, 1999; Snively, 1990; Sutherland, 1998). For centuries, attempts to assimilate Aboriginal peoples into Euro-Canadian society (i.e. colonization) have had disastrous consequences (Battiste, 1986; Buckley, 1992; Deyhle & Swisher, 1997; MacIvor, 1995). Any further attempt to assimilate Aboriginal students into Western science continues this colonization, and raises issues of social power and privilege in the science classroom.

These issues formed the basis of a socio-cognitive model of teaching and learning. Drawing upon the social cognitive work of Delpit (1988), Lave (1988), and Wertsch (1991), O’Loughlin (1992) persuasively claimed:

> To the extent that schooling negates the subjective, socioculturally constituted voices that students develop from their lived experience... and to the extent that teachers insist that dialogue can only occur on their terms, schooling becomes an instrument of power that serves to perpetuate the social class and racial inequities that are already inherent in society. (p. 816)

This model for equity science education is an alternative to the conventional, uni-logical, assimilative, authoritative discourse that transmits scientific knowledge and values to students. O’Loughlin focused on “dialogical meaning making” in the context of social power, thereby sharing the transformative goals of critical pedagogy (Freire, 1970):

> Dialogical meaning making occurs when the learner is influenced by the text, but is also allowed the space to play an active role in developing a personally constructed understanding of the author’s or teacher’s message through a process of dialogic interchange. (O’Loughlin, 1992; p. 813)

The discourse of instruction O’Loughlin proposed involves more than the conventional literacy for comprehension (reading the lines in science textbooks to infer comprehension, usually to pass exams and acquire credentials). His discourse of instruction is more than literacy for critical thinking (reading between the lines to infer hidden assumptions, alternatives, and changes of meaning). For O’Loughlin one learns “to *participate* in the culture of power, while simultaneously learning how to *reflect critically* on the power relations of which they are a part” (p. 807, italics in the original). His discourse of instruction is more like van der Plaat’s (1995) reading between the lines of privileged discourse to infer what ontology has been culturally constructed by that discourse and to understand that ontology in terms of its relationship to one’s own culturally determined ontology. This type of literacy is very much needed by many Aboriginal students (Cajete, 1999; MacIvor, 1995).

O'Loughlin's (1992) socio-cognitive model of meaning making addresses social power and privilege in the classroom, but it does not explicitly treat meaning making from a cultural perspective. A cultural perspective on science education is founded on such assumptions including the following. First, Western science is a cultural entity itself, a subculture of Euro-Canadian society. Second, people's cultural identities may be at odds with the culture of Western science. Third, science classrooms are subcultures of the school culture. Fourth, most students experience a change in culture when moving from their life-worlds into the world of school science. Fifth, learning science is a cross-cultural event for these students (Aikenhead, 1996; Aikenhead & Jegede, 1999). These assumptions help to define a cultural approach for school science, one that tends to privilege science for all.

This approach to teaching and learning engages students in cultural negotiations in a context in which learning science is experienced as "coming to knowing," a phrase borrowed from Aboriginal educators (Ermine, 1998; Peat 1994). Coming to knowing is reflected in participatory learning: "If the living, experiencing being is an intimate participant in the activities of the world to which it belongs, then knowledge is a mode of participation" (Dewey, 1916, p. 393). The world in which most Aboriginal students participate is not a world of Western science, but another world increasingly influenced by Western science and technology.

Coming to knowing engages Aboriginal students in their own cultural negotiations among the several sciences found within their school science, in which students become more aware of four aspects of their lifeworlds. First, students reflect on their own understanding of the physical and biological world. Second, students come to know the Aboriginal commonsense understanding of their community. Third, they may encounter ways of knowing of another culture, including those of other First Nations peoples. Fourth, they are introduced to the norms, beliefs, values and conventions of Western science. This is known as "multi-science education" (Ogawa, 1995). Coming to knowing is also about developing cultural identity and self-esteem.

As mentioned above, a cultural approach to science education recognizes that learning Western science for most Aboriginal students is a cross-cultural event. Students move from their everyday cultures associated with home to the culture of Western science (Aikenhead, 1997; Phelan, Cao, & Davidson, 1991). These transitions, or border crossings (to use Giroux's [1992] metaphor), are smooth for "Potential Scientists," are manageable for other "Smart Kids," but are most often hazardous or impossible for everyone else (Costa, 1995). Success at learning the knowledge of nature of another culture for the purpose of coming to knowing depends, in part, on how smoothly one crosses cultural borders. Too often students (Aboriginal and non-Aboriginal alike) are left to manage border crossings on their own (Phelan et al., 1991). Most students require assistance from a teacher, similar to a tourist in a foreign land requiring the help of a tour guide. In short, a science teacher needs to play the role of a culture broker (Aikenhead, 1997).

Such a culture broker understands that Western science has its own culture, given that scientists generally work within an identifiable set of cultural attributes: "an ordered system of meanings and symbols, in terms of which social interaction takes place" (a definition by cultural anthropologist, Geertz, 1993, p. 5). More specifically, the scientific community generally has its own language, beliefs, values, conventions, expectations, and technology. These attributes define a culture (Aikenhead, 1996). For Western science, these attributes are identified as "Western" because of the fact that the culture of Western science evolved within Euro-American cultural settings (Pickering, 1992; Roshed, 1997). The culture of Western science today exists within many nations, wherever Western science takes place.

A culture brokering science teacher makes border crossings explicit for Aboriginal students by acknowledging students' personal preconceptions and Aboriginal worldviews that have a purpose in students' everyday culture. A culture broker identifies the culture in which students' personal ideas are contextualized, and then introduces another cultural context, for instance the culture of Western science, *in the context of* Aboriginal knowledge. At the same time, a culture broker must let students know what culture he/she is talking in at any given moment (e.g. Aboriginal science or Western science), because teachers can unconsciously (implicitly) switch between cultures, much to the confusion of many students. (Some specific strategies to accomplish this are described elsewhere [Aikenhead, 1997; Cajete, 1999; Jegede & Aikenhead, 1999].)

To facilitate students' border crossings, teachers and students both need to be flexible and playful, and feel at ease in the less familiar culture (Lugones, 1987). This will be accomplished differently in different classrooms. As O'Loughlin (1992) argued, it has a lot to do with the social environment of the science classroom, the social interactions between a teacher and students, and the social interactions among students themselves. Thus, a teacher who engages in culture brokering should promote discourse (Driver, Asoko, Leach, Mortimer, & Scott, 1994) so students are provided with opportunities to engage in the following three activity types. First, students should have opportunities for talking within their own life-world cultural framework without sanctions for being "unscientific." Second, students should have opportunities for being immersed in either their everyday Aboriginal culture or the culture of Western science as students engage in some activity (e.g. problem solving or decision-making in an authentic or simulated event). Finally, students should be know in which culture they participate at any given time.

Effective culture brokers substantiate and build on the validity of students' personally and culturally constructed ways of knowing (Pomeroy, 1994). Sometimes bridges can be built between cultures, other times ideas from one culture can be seen as fitting within the ideas from another culture. Whenever apparent conflict between cultures arises, it is dealt with openly and with respect. (Aikenhead and Jegede [1999] describe cultural conflict in terms of "collateral learning.")

For Aboriginal students, it will be helpful to deal with Western science's social, political, military, colonial, and economic roles in history. Smooth border crossings cannot occur if a student feels that he or she is associating with "the enemy" (Cobern, 1996). By acknowledging Western science's historical roles in the colonization of Aboriginals on Turtle Island (North America), a teacher can address Aboriginal students' conflicting feelings towards the culture of Western science, thus making a student feel more at ease with learning that culture without accepting its values and ideologies. In short, a culture brokering science teacher identifies the colonizer and the colonized, and teaches the science of each culture (Snively & Corsiglia, in press).

Cross-Cultural Science Education as Praxis

Allen and Crawley (1998), Cajete (1986), Kawagley (1995), MacIvor (1995) and Snively (1995) provided specific recommendations for teaching school science to Aboriginal students. Based on these recommendations, a collaborative team of Saskatchewan science teachers, university personnel, and people in the teacher's local community are currently developing instructional strategies and units of study to support teachers wishing to become culture brokers for grade 6 to 11 Aboriginal students (Aikenhead, 2000). One product of this research and development activity will be a set of cross-cultural science and technology units (CCSTUs). The units bring Western science into the student's world, rather than insisting that students go into a scientist's world (the conventional way of teaching science as assimilation).

A cross-cultural science and technology unit will first create an Aboriginal framework into which Western science and technology can be placed. This introductory content is drawn from appropriate Aboriginal knowledge and may take the form of practical action relevant to a community (e.g. listening to an elder, going on a snowshoe hike, or assisting a local wild rice harvest). The choice depends on the unit.

If the objective was to teach Western science's systems of the body (e.g. the circulatory, nervous, and immune systems), we might begin with the topic "Healing." In most Aboriginal cultures, healing is conceptualized into four aspects: emotional, physical, mental, and spiritual. Instruction will establish an Aboriginal view of healing in the science class, appropriate for the age group and sensitive to the local culture.

The community's Aboriginal knowledge has a valid place in this curriculum. For instance, traditional ecological knowledge (TEK) can be combined with various fields of Western science (e.g., ecology, botany, biology, medicine, or horticulture) to give students an enriched understanding of nature in line with sustainable development (Snively & Corsiglia, in press). Some students will discover that they already possess some Aboriginal knowledge, while others will learn it for the first time. Students' Aboriginal knowledge is given voice in the science classroom, in the dialogic sense of voice described by O'Loughlin (1992) as involving both the speaker and the listener in mutual respect. Thus, a CCSTU begins by validating "the ways of knowing students bring to school by grounding the curriculum in their voices and lives" (p. 814). A dialogic voice means that a teacher learns from students and people in the community. A teacher models successful border crossing with his/her students. In this context, students' Aboriginal identity has a legitimate place in classroom instruction. The discourse of power no longer resides with the teacher, power is more evenly shared.

The introduction to a CCSTU constitutes a framework for the whole unit. Throughout the unit, students will return to this familiar framework as needed. The actual time to establish an Aboriginal framework could be as short as a 15 minute review or as long as a several day experience.

Values are particularly salient in Aboriginal cultures (Cajete, 1999). The introductory framework to a CCSTU will identify values that elders expect students to learn. The Saskatoon

Tribal Council, for instance, developed an informal academic program for school-aged children ("Super Saturday") which draws explicitly upon the values associated with the 15 tipi poles. Each Saturday is devoted to a different value. The value becomes one of the themes for university instructors to convey to the young people who visit them on Saturdays. In a school science unit "Healing," for example, a key value may be *harmony with nature*. This establishes the habit of identifying values that underlie Western science when that content is studied later in the CCSTU. When scientific values are made an explicit topic of discussion, they are clarified and critiqued, thus circumventing the indoctrination endemic to assimilative conventional science teaching. Students learn to identify vestiges of scientism in the text and verbal discourses of their everyday lives. The ontology of the Western colonizer (the mathematical idealization of the physical world) becomes more apparent, freeing students to appropriate Western knowledge and technique without embracing Western ways of valuing nature. (See Ogawa's [1996] four-eyed fish metaphor for a Japanese description of such an appropriation, and Krugly-Smolska [1994] for other cultures.) The value of developing scientific knowledge is fundamentally different for the two cultures. While Western science values "revealing nature's mysteries" for the purpose of gaining knowledge for the sake of knowledge and material growth, Aboriginal science strives for living with nature's mysteries for the purpose of survival (Aikenhead, 1997; Simonelli, 1994; Snively & Corsiglia, in press). Thus, each value system orients a student differently towards nature (Ermine, 1995).

Having established an Aboriginal framework and identified key values, the next step in a CCSTU is a border crossing event in which teacher and students cross the cultural border into Western science, *consciously* switching values, language conventions, conceptualizations, assumptions about nature, and ways of knowing. As a culture broker, the teacher clearly identifies the border to be crossed, guides students across that border, and helps students negotiate cultural conflicts that might arise. Because values are very important to Aboriginal communities, a teacher identifies a key value that underlies the Western science in the unit. For instance in the unit "Healing," one value that underlies the science of body systems is "power over nature." The pharmaceutical industry is a case in point.

One feature that often emerges from comparing Aboriginal and Western science is the recognition that Western science can powerfully clarify one small aspect of Aboriginal science. For instance in the "Healing" unit, Western medicine deals predominantly with the physical aspects of healing, and so Western science is seen as informing a small slice of the Aboriginal framework (with its four aspects of healing). When values are made explicit, students are only expected to recognize those values, not to adopt them for their own. The foreignness of Western science begins to feel less threatening. Social power and privilege in the classroom increases for students who sense genuine respect for their Aboriginal values.

As various topics in Western science are studied within the unit, it will make sense to include more Aboriginal content (more than in the introduction). This is easy to do because the unit already has a framework for that content. The Aboriginal content is not just tacked on for the sake of creating interest. It frames the unit in a way that nurtures the enculturation of Aboriginal students into *their community's* culture (Casebolt, 1972). This discourse of Aboriginal knowledge is very different from the discourse of Western science. Both have a function in the classroom. Students share their coming to knowing with their teacher in a dialogic manner.

Students bring their community's knowledge and values into the classroom. New power relationships replace the conventional colonizer-colonized hierarchy.

During any lesson within a CCSTU, students should be able to state which culture they are speaking in (Aboriginal or Western science). Culture brokering teachers can make this explicit, for example, by using two different black boards -- one for Aboriginal science, another for Western science. One is used to record ideas expressed in the discourse of the community's Aboriginal knowledge, while the other board is used to express the culture of Western science. By switching from one board to the other (cultural border crossing), students switch language conventions, conceptualizations, values, assumptions about nature, and ways of knowing. It is up to the teacher to assess the quality of students' learning associated with both boards; both have a place in the assessment. A concrete approach like this helps students gain access to Western science without losing sight of their cultural identity. In fact their cultural identity is cultivated by the classroom's emphasis on coming to knowing.

Nelson-Barber and colleagues (1996) have mapped out the assessment of student achievement within a cross-cultural science classroom. They offer guidance and specific recommendations for developing a culturally responsive assessment system, beginning with the recommendation to treat linguistic and cultural diversity as strengths. An example from the Navajo (Diné) Nation demonstrated the fruitfulness of portfolio assessment. Portfolios were shown to promote student autonomy and reflected the *context* of learning, not just the process and product of learning. The international recognition of the efficacy of student self-assessment (Black & Atkin, 1996) lends credence to negotiating with Aboriginal students how school science will be assessed. Without such a negotiation, the balance of social power and privilege reverts back to the colonizer-colonized hierarchy.

In summary, culturally sensitive CCSTUs will help Aboriginal students feel that their school science courses are a natural part of their lives. CCSTUs will give students access to Western science and technology without requiring them to change their own cultural identity. They will not be expected to adopt the worldview endemic to Western science. However, for those students who have a gift for Western science, a CCSTU lays the foundation for further education in science and engineering.

In either case, cross-cultural science and technology units represent one form of science education for/as social action. The units encourage a change in the power relationships between a teacher and her Aboriginal students in ways that promote mutual respect, coming to knowing, and the ethic of survival for humankind. As a result, teachers and students will become better critical social actors in a Canadian society enriched by cultural differences but challenged by risks to human survival. Whose scientific knowledge will be taught in school science? The cultural capital of Aboriginal peoples can effectively contribute to ameliorating the colonizer/colonized hierarchy in science education to the benefit of both groups.

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