Subverting corporate-friendly science education in public schools

The phrase ‘public education’ seems oxymoronic. It implies a system designed to serve the ‘public.’ Many would say it also implies an intention to educate all citizens in the best ways known. Sadly, and paradoxically, these assumptions do not seem warranted — especially more recently, as transnational corporations have gained increased control of public agendas in their battles for global economic supremacy. Indeed, in some countries, concern about economic competitiveness is viewed as worthy of a declaration of ‘war’:

Our Nation is at risk. Our once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world. ... If an unfriendly power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war. As it stands, we have allowed this to happen to ourselves. We have even squandered the gains in achievement made in the wake of the Sputnik challenge. Moreover, we have dismantled essential support systems which helped make those gains possible. We have, in effect, been committing an act of unthinking, unilateral educational disarmament (NCEE, 1983, p. 5; emphases added).

Since then, other jurisdictions have, dutifully, fallen in line with similar messages for profit-motivated reform of public education.
An economic ethic for education is clearly evident in Ontario curricula, for example:

The new Ontario curriculum establishes high, internationally competitive standards of education for secondary school students across the province. The curriculum has been designed with the goal of ensuring that graduates from Ontario secondary schools are well prepared to lead satisfying and productive lives as both citizens and individuals, and to compete successfully in a global economy and a rapidly changing world. (MoET, 1999, p. 3; emphases added)

At risk because of this economic ideology, ironically, is the education of most children. In short, it is apparent public school systems serve as ‘factories,’ manufacturing citizens conducive to efficient production and consumption of goods and services in order to funnel wealth towards the world’s economic elite. With increasing technological innovation, however, most students are being trained to serve as consumers — in both the sense of being passive followers of corporate labour instructions and as active, but unquestioning, consumers of goods and services of business and industry. Such engineering of society in corporate-friendly ways is mediated, to a great extent, by publicly-funded school science. After justification of this claim, elements of an alternative, more just science education are discussed.

Social engineering through public school science

While there are exceptions in many classrooms throughout Western, industrialized nations, school science often is characterized by the following elements:

- Emphasis is placed on teaching and learning of achievements of science (e.g., laws and theories);
- Teaching and learning of these achievements tends to occur at a rapid pace;
- Much of the knowledge taught is abstract, isolated from ‘real-world’ contexts;
- Students are rarely nurtured in development of expertise that would enable them to create their own scientific knowledge;
- Students rarely have opportunities to use scientific knowledge and skills to solve problems relevant to them;
- In the way it is taught, scientific knowledge is made to appear certain, beyond doubt;
- How scientific knowledge is or may be developed is portrayed to be efficient, unbiased and routine;
- Scientific knowledge and ways of developing it are taught with little reference to historical, cultural, economic, social and gender considerations;
- Technological design is, generally, omitted, and, as well, portrayed as dependent on scientific knowledge;
- Learners’ perspectives, abilities, interests, questions, differences, etc. are rarely considered.

Given that these characteristics are undesirable, it must first be made clear that teachers should not feel responsible for this state of affairs. They are — in effect — being used as instruments in complex systems, in which education is engineered to serve purposes of dominant members of society. How school systems get to be this way is a complex matter, beyond the scope of this article. However, how they are structured to engineer societies conducive to production and consumption of goods and services can, I believe, be relatively easily surmised. It is apparent that school science is geared, primarily, to identify and educate a relatively small cohort of potential scientists and engineers, who may serve business and industry as developers and managers of mechanisms of production and consumption of goods and services. As a by-product also useful to business and industry, however, school science produces masses of citizens trained, primarily, to serve as obedient workers and as enthusiastic consumers of goods and services. Each of these functions of school science is elaborated below.
Identifying potential scientists and engineers

Often, rather than an opportunity for enlightenment and empowerment for all citizens, school science is like a 'selection and training camp' for future scientists and engineers. It is a complex testing environment, in which survivors must possess aptitudes for quickly learning and processing abstract, theoretical concepts — such as Bernoulli's Principle, temperature effects on enzymes, Le Chatelier Principle, the electromagnetic spectrum, etc. Students with such aptitudes may, eventually serve as 'symbolic analysers' (Reich, cited in Dobbin, 1998, p. 128) — i.e., those who can analyze and manipulate symbols, including words, numbers and visuals. They are needed by business and industry to work as engineers, scientists, accountants, lawyers, etc. Indeed, in the 'new economy,' such abstractors are extremely important, as businesses attempt to regularly develop new products in ways that enable them to sell to 'niche' consumers (smaller identifiable groups of consumers) (Gee, 2000).

The selection of these professionals is not, however, an equitable process. Students with abilities for dealing with abstractions in the absence of practical applications tend to have advantaged backgrounds. It is apparent, for instance, that our "curricula and teaching methods are ... most closely adapted to the needs of middle- and upper-middle-class, culturally North European-American, fluent speakers of prestige dialects of English" (Lemke, 2001, p. 306). As such, school science is, in a sense, a 'survival of the richest' (Bencze, 2001a). Sadly,

thousands of years of human development and progress are reduced to the pursuit of 'efficiency,' our collective will is declared meaningless compared to the values of the marketplace, and communitarian values are rejected in favour of the survival of the fittest. A thinly disguised barbarism now passes for, is in fact promoted as, a global human objective (Dobbin, 1998, pp. 1-2).

Such elitism is, clearly, unjust — and it needs to be subverted.
Training consumers

To maximize profit, in addition to a small cohort of professionals (such as engineers and scientists), business and industry need 'workers' — with a range of skill levels — who will dutifully follow labour instructions from the aforementioned professionals. Together, professionals and less-skilled workers will be able to produce goods and services tailored to consumers' needs and desires. However, producing goods and services is not, necessarily, enough. Large numbers of people willing and anxious to purchase these goods and services are needed. They should not, as well, be concerned about possible adverse effects of these goods and services on individuals, societies and environments. Accordingly, corporations spend large portions of their budgets on 'creating' desire for their products and services — indeed, often more on marketing than on research and development (Dobbin, 1998). In addition, however, school science seems to contribute to this production of both compliant labourers and enthusiastic purchasers. School science appears to do this in ways in which it trains students to be 'consumers' — that is, those willing to passively accept ideas, strategies, concepts, institutions, etc. In that sense, school science is not — paradoxically — about providing most students with scientific literacy but is, rather, an 'apprenticeship for consumership' (Bencze, 2001a). There are at least six ways such consumerism seems to be promoted through school science, as elaborated below.

Consumerism via conformity: The more people are alike, the easier corporations can market products to them. Such conformity is, indeed, promoted through school science — as it is in most other school subjects — through standardization of curriculum and instruction. Regardless of students' individual needs, interests, perspectives, abilities, etc., they are expected to conform to the same curriculum expectations. In school science, they are all expected to learn — and, apparently, come to believe — Western scientists' conceptions about nature and ways of changing nature (i.e., technologies). This is particularly evident in the experiences of aboriginal peoples in school science, for example. "Around the world ... science students are expected to construct scientific concepts meaning-

fully even when those concepts conflict with indigenous norms, values, beliefs, expectations, and conventional actions of students' lifeworlds" (Aikenhead & Jegede, 1999, p. 270).

Consumerism via passivity: People are more likely to consume ideas, products, services, etc. if they have learned that others can function as their providers. Such passivity often appears to be promoted in school science through the extent to which emphasis is placed on teaching and learning of achievements of science — with few opportunities to foster abilities to develop achievements. The "medium [of school science] is reinforcing the message ... that science education is about remembering the results of other's [professional scientists' and engineers'] research ("facts") rather than developing the ability to conduct one's own" (Claxton, 1991, p. 28). Habituated to consuming products of science, students may leave school expecting others to continue to 'feed' them products and services.

Consumerism via confusion: Those with poorly-developed conceptions about nature — that is, understandings of laws and theories — are less likely to be inclined to develop their own knowledge and, as well, to critique knowledge developed by others. Conceptions about nature are critical to survival in a science-based world. Because teachers often feel compelled to 'cover' the teaching and learning of scientific laws and theories rapidly (often because of the sheer volume of information in curricula), students have few opportunities to fully understand this information before a new subject is started. As a student in the UK said, for example, "You just get to know what you're talking about and [teachers] change [the topic] ... you forget everything that you know ... in the end you do not know what you are doing" (Claxton, 1991, p. 24). Indeed, Millar (1996) claimed that most studies of students' (by the age 16) understandings of fundamental laws and principles of science — including the particle theory of matter, the model of the solar system, and ideas about animal and plant gas exchange — are either simplistic or quite different from those of scientists. Similar results are obtained for lay adults.
Consumerism via na"ivity: If people believe science and technology to be highly efficient, unbiased and unproblematic with respect to possible negative effects on individuals, societies and environments, they are more likely to feel comfortable consuming products of business and industry — given that corporations control most of the word’s science and engineering activities. School science often does ‘sanitize’ professional science in a variety of ways, perpetuating various “myths” (Hodson, 1999). For example, through use of guided ‘experiments’ (sometimes called, ‘cookbook labs’) carried out in similar ways by all students in a class, students may be mistakenly led to believe that scientific conclusions arise strictly on the basis of empirical findings — without involvement of pre-conceived notions or theories and, as well, without debate.

Consumerism via incapability: If citizens are incapable of developing products and services for themselves, corporations will only be too happy to make these available for consumption. For a variety of complex reasons, teachers of science often limit students’ opportunities to develop skills and attitudes they could use to develop their own knowledge. Through excessive use of the aforementioned guided science experiments, for example, students make few decisions surrounding and become ‘de-skilled’ with respect to fundamental aspects of scientific inquiry — including problem-posing, problem-solving and peer-persuasion. Even with constructivism-informed teaching approaches, through which students might believe they are freely constructing knowledge, coercion often occurs. Students’ thoughts and actions are ‘attacked’ in ways ensuring their conclusions match those of Western science, including by: i) maligning their pre-instructional ideas (e.g., calling them ‘naïve.’), ii) engineering their scientific inquiries (e.g., determining their experimental methods) and iii) regulating their conclusions (Benecke, 2000a).

Consumerism via isolation: While businesses clearly value collaboration amongst workers for the sake of production, competition amongst individuals also is a core business ethic. There is strength in numbers for people. A group of collaborating people can accomplish more than the same numbers of individuals working independently. In many ways, such group strength is bad for business. Communities of people can, collaboratively, organize themselves in ways that may challenge the need for products and services provided by business and industry. Consequently, corporations tend to promote individualization and competition. This can be seen in school systems in the form of students’ individual competition for marks — along with the social success that are associated with such school achievement. Through standardization and monitoring (assessment) of curriculum and instruction, along with excessive curriculum content loading, an ethic of competitiveness is fostered, as students struggle to achieve authorities’ recipes (i.e., curriculum expectations) for citizenship in science. Teaching [such] values of individual free enterprise prepares the students to adopt corporate loyalty. ... In such an environment, a student learns that when the boy seated next to her drops out of school, he is solely responsible for the decision. In the words of the Conference Board of Canada, he has ‘apparently ignored’ the tremendous cost to himself and society.’ What happens to him is of no concern to her. She is learning to blame the unemployed for their condition ... (Barlow & Robertson, 1994, p. 82).

Where such mind and action control exists in schools, it is, clearly, unjust. Certainly in a democracy, and anywhere else for that matter, schooling should not be serving as a mechanism for such social engineering — for creating a society geared towards production and consumption of goods and services for the benefit of the economic elite. Such corporate-friendly school science needs to be subverted.

Subverting corporate-friendly school science

It is unconscionable that school science could be used, in effect, to engineer societies in ways serving needs and interests of a small fraction of the world’s population. It is, clearly, undemocratic.
Citizens worldwide deserve the right to determine their own thoughts and actions, as well as to gain access to the intellectual riches of societies. In other words, curriculum principles and practices are needed that include not only what adults think is important, but also the questions and concerns that young people have about themselves and their world. [It] invites young people to shed the passive role of knowledge consumers and assume the active role of 'meaning makers.' It recognizes that people acquire knowledge by both studying external sources and engaging in complex activities that require them to construct their own knowledge (Beane and Apple, 1995, p. 15-16; emphases added).

There are likely many ways such self-determination, along with enlightenment (in terms of access to intellectual riches), may be achieved. A few general guiding principles can be provided, each of which likely will require government action. These are elaborated (with relevant internet Web links) below.

**Students need to learn less, but learn it better.** 'Content loading' — i.e., saturation of curricula with expectations for student learning, most of which deals with achievements of science — continues to be a fundamental reason for the inability of science teachers to address a breadth of learning outcomes, including learning about the nature of science and abilities to do science. As well, it causes teachers to have to 'cover' concepts so rapidly, and with few opportunities for students to apply their learning in meaningful problem solving contexts, that most students end up only memorizing (and later forgetting) what they could be learning well. As recommended several years ago, school systems need to 'do more with less'; that is, "schools do not need to be asked to teach more and more content, but rather to focus on what is essential to science literacy and to teach it more effectively" (AAAS, 1989; emphasis added). Towards that end, for example, the AAAS has identified four themes for science literacy: systems, models, constancy and change and scale. Identifying just what is 'essential' for science literacy for each jurisdiction (like Ontario) will require government action. Progress in that direction has been made by the Peel District School Board, with their recent publication of the document, "Enduring Understandings" (PDBS, 2001). Once essential outcomes for science literacy have been decided upon, teachers will be able to allow more time for students to consolidate their understanding of each of the concepts, skills, etc. — through using these concepts, skills, etc. in science project work, for example. Without determining these essential Learnings, the following recommendations (and other possibilities for school science) will be much more difficult. Some useful Web resources along these lines are at:

- [http://www.project2061.org/tools/sfaaol/Intro.htm](http://www.project2061.org/tools/sfaaol/Intro.htm)

Learning needs to be based, to a greater extent, on learners' pre-instructional conceptions. Learners tend to begin science lessons already possessing ideas, skills, etc. about which teachers intend to teach. Often, these pre-instructional conceptions are, however, different from what teachers intend to teach. Moreover, they tend to be entrenched in students’ minds, and are more difficult to change as students get older. Claxton (1991) reported, for example, that elementary age children often believe the following from their everyday experiences: weeds are not plants, because plants have to be nurtured; steam turns into ‘air’ once it disappears into the air; light beams travel farther at night than during the day; objects can only move if there is a force on them; cold water freezes faster than hot water; the sun revolves around the Earth, thus explaining sunrise and sunset. Students from different cultures also will have different conceptions of nature (and how to go about investigating it). All of these ideas, skills, etc. need to be honoured, despite the extent to which they may differ from conclusions of Western science. Telling students their pre-instructional ideas are 'useless,' 'naive' or 'wrong' can be damaging for their self-esteem. As well, it is possible that students' ideas, skills, etc. may be better than those of Western science or, as is often the case, more useful for students' particular interests.
While students tend to hold such pre-instructional views, they often are unaware that they hold them. Often, their views, skills, etc., are subconscious. Accordingly, teachers need to use activities that will help students to make their pre-instructional conceptions conscious. Teachers intending to teach students about photosynthesis (chemical reactions in plant cells that convert simple chemicals like carbon dioxide and water into sugar and oxygen), could, for example, simply ask students to make observations about seedlings at different stages of growth and explain what they observe. Students also could be asked to predict and explain what would happen to the plants under different circumstances; e.g., with more or less light or water. To help students (and the teacher) organize and keep track of these pre-instructional ideas, students could be taught to use various visual organizers — such as concept maps, mind maps, fish bones, KWL charts, etc. Some useful Web links along these lines are at:

- http://www.broward.k12.fl.us/ci/whatsnew/strategies_and_such/teachingstrategies.html
- http://www.graphic.org/goindex.html

Teaching needs to be more direct, to avoid discriminatory practices. All too frequently, ‘discovery’ or ‘inquiry’ lab activities are used in school science, under the assumption that it is best for students to learn science by doing science. However, unless students already have conceptions similar to what are supposed to be ‘discovered’ through the lab activities, they are unlikely to discover them. Generally, the students who do not have these conceptions in their heads tend to be the ones from disadvantaged backgrounds — who tend to lack the cultural capital (richness of intellectual and material resources) through which they might already acquire these ideas. Such activities, therefore, discriminate against less advantaged students. It also seems ludicrous to expect students to ‘discover what it sometimes took scientists years to figure out. Invariably, when students do not discover what the lab activities are designed to indicate, teachers may — and often do — guide students or tell them what they should have discovered. As discussed earlier, such ‘guidance’ tends to compromise students’ self-esteem and, as well, their understanding of the nature of scientific knowledge building.

Accordingly, teachers need to use more direct teaching approaches to ensure all students have access to ideas, skills, etc., in the curriculum. Before mentioning what kinds of direct approaches to use, however, it is worth noting that these should be used in concert with activities in which students have opportunities to apply the taught concepts, skills, etc. Teachers could, for example, engage students in an interactive (with questions and answers) demonstration of a particular kind of chemical reaction (e.g., displacement of hydrogen from an acid by a metal). Students could, then, be engaged in a somewhat less teacher-directed activity intended to enable students to experience these sorts of reactions and, as well, explore effects on them of various factors (e.g., concentration of acid, type of metal, temperature, etc.). Similarly, teachers could show students a film, video or multi-media presentation on the internet and, then, have them practise using the ideas, skills, etc., seen through these sources in practical activities in class. Some useful Web links along these lines are at:

- http://library.thinkquest.org/C005704/content_teaching_it.php3
http://www.teach-nology.com/teachers/methods/models/direct/A more representative kind of scientific literacy needs to be promoted. The science knowledge, skills, attitudes, etc. that children learn should go beyond that developed by Western science. Many of these will surface from students themselves, depending on the diversity in the classroom, if teachers build activities into their programmes in which students express and explore their pre-instructional ideas (discussed above). However, that likely will not be enough. Teachers will have to be proactive in ensuring students gain access to scientific ideas, skills, etc. developed by other cultures. Generally, the techniques for teaching these are the same for any other concepts, skills, etc. Teachers will need, however, various resources for teaching in this area. Some useful Web links along these lines are at:

- http://www.upei.ca/~xliu/multi-culture/home.htm
- http://capes.usask.ca/csstn/welcome.html
- http://www.ncrel.org/sdrs/areas/issues/content/ntareas/science/sc200.htm

Professional sciences need to be portrayed realistically. Students need to learn negative, as well as positive, aspects of the nature of science. This will enable them, as future participants in democratic processes, to make decisions about public and private matters relating to science. Students can, to some extent, learn about the nature of science by participating in authentic scientific problem solving activities. They may, for example, design and conduct their own experiments and attempt to develop — like scientists — scientific knowledge from these activities. This can be aided by asking students to reflect on what they did, how it worked out and how they might improve their investigative activities. However, again, it will be difficult for students to 'discover' many aspects of the nature of science through such implicit (a kind of learning 'by osmosis')
activities. They may not, for example, consider negative relationships amongst science, technologies, societies and environments. So, again, teachers need to explicitly (directly) teach the nature of science ideas, concepts, etc. One approach that has been very successful is use of case studies of science in action. Students can read historical accounts, participate in role-playing activities and debate various issues surrounding approaches to and effects of science. Some useful Web links along these lines are at:

- http://www.utmem.edu/~thjones/hist/hist_mic.htm
- http://www.science.ca/
- http://www.oise.utoronto.ca/~lbencze/resources/NofSandT.html#NofSandT
- http://ublib.buffalo.edu/libraries/projects/cases/ubcase.htm

Learners need opportunities to construct their own knowledge. In every science course, it makes sense that students learn how and have opportunities to do science. Just as in professional science, however, there is seldom someone who can tell scientists how to conduct their investigations or what to conclude. Accordingly, these activities must be student-directed (in terms of procedures) and open-ended (with no pre-set conclusions) (Lock, 1990). That means that their purpose is not to teach ideas, skills, etc. in the curriculum — suggestions for teaching of which has been discussed above. Some student-directed, open-ended investigations that students may decide to conduct are, for example: Effects on bacterial growth of changes in pH of media (and explanations for this); Approaches to protecting public statues from erosion by acid precipitation; Effects of various amounts of electro-magnetism on time-keeping accuracy of clocks (and possible explanations for apparent effects). Through such projects, students can become much more skilled in and confident with problem solving in science, they can learn some things about the nature of science and they can develop knowledge and skills unique to their needs interests, perspectives (including culturally and by gender, for example) and abilities.

Students asked to 'sink or swim' when conducting their own science projects often may sink, however. Frequently, they lack expertise enabling them to conduct projects independently. Consequently, it is necessary for teachers to provide students with an 'apprenticeship' (Bence, 2000b). Teachers can, for example, model certain techniques — such as how to develop cause-result questions, how to design controlled experiments, how to construct appropriate graphs, how to critique their own methods, how to carefully draw conclusions, or how to debate conclusions with peers. After such modeling, teachers could give students more independence with similar activities. Teachers would act as 'guides,' 'mentors' or 'facilitators' in these situations. These activities would be partly teacher- and partly student-directed. However, they should still be open-ended, so that they mimic what happens in professional science — where appropriate conclusions are not known ahead of time. Teachers could, for example, give students some materials and equipment — such as yeast, sugar, water, a heat source, etc. — and, then, ask them to design and conduct their own experiments using variables of interest to them (e.g., changes in sources of sugar as they effect yeast carbon dioxide production). Once students gain sufficient expertise and confidence, they can be encouraged to conduct student-directed, open-ended science and invention projects. Some useful Web links along these lines are at:

The selection of these professionals is not, however, an equitable process. Students with abilities for dealing with abstractions in the absence of practical applications tend to have advantaged backgrounds.
Summary and conclusions

Unfortunately, it is apparent societies worldwide are experiencing government, not by ‘the people,’ but by large corporations. It is as if government constitutions have been occluded by a sort of ‘corporatist manifesto’ (Bencze, 2001a), a set of guiding principles designed to maximize corporate profit, including

- commitment to market-based provision of services; encouragement of an individualized consumerist ethos; and a derisory view of the ‘nanny state.’ The result: a contraction of state funding for activities once thought of as ‘public’; a greater reliance on various forms of ‘user pays’ for services once funded through (progressive) tax systems; and the corporatisation or privatization of formerly public utilities. In this contemporary meaner and leaner state, new forms of governance have emerged in which consumer-citizens inhabit efficient, generically managed, performance-based institutions oriented towards the imperatives of the global market-place (Henry et al., 1999, p. 88).

Among the “institutions oriented towards the imperatives of the global market-place” is, apparently, school science. It seems to function like a factory, manufacturing a society conducive to production and consumption of goods and services. It appears to do this, primarily, through its emphasis on selection and education of a few potential engineers and scientists — who may work to develop and manage mechanisms of production and consumption of goods and services for business and industry. As a side-effect convenient to business and industry, the preoccupation with generating engineers and scientists tends to create a mass of people oriented towards consumerism — who may become compliant workers and enthusiastic purchasers of goods and services. Where school science is being used for such social engineering, it must be subverted.

In this article, some suggestions for a more just science education have been discussed. Specifically, government must take action to:

- determine fewer essential outcomes for science education, so that students may do more with less.
- ensure learning is based, to a greater extent, on learners’ pre-instructional conceptions.
- ensure teaching of curriculum conceptions and skills is more direct (although with practice activities), to avoid discriminatory practices.
- ensure a more representative (i.e., inclusive) kind of scientific literacy is promoted.
- ensure professional sciences are portrayed realistically.
- ensure learners have opportunities to learn how and have time to construct their own knowledge.

When these and other recommendations are realized, perhaps science education will be more about enlightenment and empowerment.
for all students, rather than about wealth concentration for the few controlling public education.

ENDNOTES
1. While science and technology often are considered different but interacting, they also may be viewed broadly, as one field — perhaps called 'technoscience' (Bencze 2001). Nevertheless, for simplicity, the more common term 'science' is used throughout this article.

REFERENCES


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