

Science Teacher Activism: The Case of Environmental Education

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Responses

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Abstract

Science and technology education has been taught as a neutral and technical subject in, abstract, contextless ways. This state of affairs is not tenable, especially for one who is aware of the controversies surrounding the uses and abuses of science. In this paper, I argue that environmental education should be a topic that science educators teach, and review some of the obstacles and challenges surrounding socially responsible (science) education, with environmental education as an example. Place based education is proposed as a means through which some of these challenges can be faced; and I conclude with some general comments about education.

Introduction

Science and technology education has, for a long time, been taught as a neutral, technical subject largely divorced from its associations with society and its impacts on the environment. While it is with relief that contemporary scholarship has managed to shift the public attention and direct STSE to its current acquisition of mainstream status, many regularities and old forms of relation still exist which threaten the integrity of many implementations, reducing its social liberatory and justice intent into an afterthought that is tacked on the end of the content lessons “if there is time”, as a common refrain would have it. In this paper, I wish to make a curriculum argument advocating for more STSE education, while at the same time advancing limitations that recognise and respect the realities of schooling and societies. Emphatically, this is not meant as a defeatist move, but rather, as a means to ground the project to enhance its real-world effectiveness. Environmental education is chosen as a demonstration case to illustrate some key features of these limitations which pose serious dilemmas to educators.

The questions of curriculum

Perhaps one way to begin any curriculum inquiry is to focus on some of its core questions. Dillon (2008) reminds us that the fundamental curriculum question is not necessarily limited to that of ‘What knowledge is of most worth’: “In point of fact, the question cannot be proven more central than any other basic question—they are equivalent—nor can it be disconnected from the others” (p. 4). For these other questions, several other scholars have constructed perhaps rather unwieldy paragraphs; for example, Brezinka (1997, in Dillon, 2008) writes:

Who (subject) educates whom (object, addressee), to what end (aim) under what circumstances (situation, framework, conditions, context), how (in what manner or form of educational action), and with what consequences (results, effects, side effects)?

Certainly, a well known formulation belongs to Ralph Tyler (1949), focusing on the purposes, experiences, organisation and evaluation, something that has endured almost six decades without a significant reformulation. With regard to this, I am in agreement with Dillon (*ibid.*) as he writes that “[t]hat

fact is not cited in praise of Tyler. It is faced in wonderment over the state of the curriculum field” (p. 10). These questions are as significant as they are useful, and equally so for theorists and practitioners, the latter of whom has to contemplate at least a limited set of these questions before every pedagogical episode. For this project, I would propose to focus on such a limited set, for the sake of practicality and personal significance, and propose to follow the logical sequence of curriculum planning in this order: (i) What is the nature of society that we are educating for? (ii) What possibly different kind of society do we have in mind with the intended curriculum innovation? (iii) What forms of knowledge are in/ex-cluded, and why? As a metaphor for the organisation of this paper, I will start at the level of the social, and ‘zoom in’ to consider to consider the teaching situation in detail.

Neoliberalism and education

To be relevant, any curriculum innovation must have an image of what society is like, and what form society is to become, even if only implicitly. In contemporary efforts of science education reform, some common themes have been: a vision of science education in service of the democratic imperative (e.g. Longbottom & Butler, 1999); for versions of social justice (e.g. Barton & Osborne, 2002; Roth & Désautels, 2002; Tobin, Elmesky, Seiler, Kincheloe & Steinberg, 2005); or for some form of ecological sustainability in the face of a rapidly globalising world (e.g. Carter, 2005). If we were to widen the scope to consider scholars in education more generally, there has been no shortage of intellectuals who have continually reminded us of how different schools and society can be, and how bad the situation is; from idealistic revolutionaries such as Paulo Freire (2000), critical scholars such as Michael Apple (2004, ; 2005), and others (e.g. Dolby & Dimitriadis, 2004; Giroux, 1983; Oakes, 1985).

The relation between schools and society is such that, far too often, education has been called upon to fix the various ills of society that there is hardly any humour left in the observation made by Cuban (2003), that: “When the nation has a cold, public schools sneeze.” It should come as no surprise that at least in the US, some of the more significant changes in public education have been brought about as responses to: the rapid industrialisation of the US economy at the turn of the 20th century; the sociopolitical rhetoric surrounding the launch of Sputnik in the 1960s and 1970s (Cochran-Smith & Fries, 2008), and the economic ‘threat’ posed by the rise in economic strength of the East Asian states (Bracey, 2003; National Commission on Excellence in Education, 1983). Rather than approaching socioeconomic difficulties with economic and other political policies, Cuban (2004) notes that the US government has had a long history of deferring problem solving by foisting blame on the education system and expecting schools to take on additional responsibilities while underlying causes persist unchecked. Here, it is probably appropriate to allow the disclaimer that Cuban writes specifically about the US education system. However, given the influence that the US has on policy rhetoric throughout the world, especially through the economic influence it wields through the World Bank and the International Monetary Fund, it is not surprising that many other states have acquiesced and accepted, if not wholesale, localised versions of US policy logic, most notably, the set of ideas identifiable as the neo-liberal agenda.

Tracing its development, Klees (2008) points out that the Thatcher and Reagan administrations in the early 1980s managed to make sweeping changes to national and international rhetoric and policy, thus beginning what was called the ‘Great Experiment’ on a global scale through the auspices of conditional international aid managed by the World Bank and the International Monetary Fund. In education, Klees argues that there have been three directions in which neoliberal thinking, based on poorly supported and misleading analyses, which have resulted in failed policies; specifically, (i) the increased use of user fees and cost recovery methods; (ii) the privatisation of educational activities; and (iii) the direct connection of management and financing of education to measurable output. Neoliberal advocates possess a strong faith in the metaphor of the ‘invisible hand’ of the market bringing progress to schools; however, the ‘invisible hand’ is just a metaphor, with little denotative value, instead relying on related ideas such as the ideal of ‘meritocracy’ at the core for what it stands. As such, one of the possible moves to steamroll opposition

would be to accuse opponents of rejecting effort and merit; in addition, neoliberal systems are said to be “grounded in the rational choices of individual actors. Thus, markets and the guarantee of rewards for effort and merit are to be coupled together to produce ‘neutral’, yet positive, results” (Apple, 2001, p. 413).

Perhaps most significant among the neoliberal initiatives in education from the perspective of curriculum scholarship is the effort to quantify educational achievement and to incentivise or sanction accordingly via economic means. Klees (2008) points out many problems with such attempts, the most significant of which is the reliance on standardised tests as the only accepted measure for educational attainment. Without a doubt, this has led to well documented cases globally of teaching for the test; reduction in time spent on untested subjects (e.g. art, music, physical education); time, effort and resources spent on test preparation at the expense of other learning; the drastic reduction of recreation time for primary school students; increased anxiety and mental and behavioural problems; and even teachers cheating or aiding student cheating. In Alberta, Canada, Graham and Neu (2004) report on the imposition of a new standardised testing regime in the province, noting that the variety of public reactions to the annual release of the test results in the newspaper front pages ranged from debates over the legitimacy and ability of the measurements to capture the essence of learning, to others eagerly awaiting the results so as to be able to compare, as sports fans might, the performance of their favourite school or school board on the league tables. As a means to understand the effects of standardised testing, Graham and Neu (*ibid.*) make use of the Foucaultian concept of governmentality and the construction of governable persons, which in essence, describe and explain how regimes of power maintain and exercise their authority in our contemporary era where overt exercise of power via sanctions and harsh punishments are no longer acceptable. A brief discussion of governmentality follows.

Neoliberalism and governmentality

Arising out of an analysis of the ways in which citizens were punished, and considering the larger context of modes of governance, Foucault (1977, 1991) traced the development from regally sanctioned public displays of extreme bodily violence to modern-day forms of incarceration which in contrast sequester and monitor criminals through one-way forms of observation in order to punish their ‘souls’. Foucault notes five key features of the modern ‘art of punishment’, whose effects are not limited to transgressors of the dominant order, but are instead applied to the population at large: (i) constructing a field of comparison, in which individual actions can be gauged against a rule to be followed; (ii) differentiation of individuals from one another; (iii) quantification and hierarchicalisation in terms of values and abilities; (iv) introduction of constraints of conformity that must be achieved by the population; and (v) defining, overtly or covertly, the boundaries of the normal. In contrast to the ‘memorable man’ of the Ancien Régime (the regicide), in which what was important was to secure for the sight of many the total destruction and annihilation of one criminal, modern day punishment renders populations into the ‘calculable man’, groups which are available for the scrutiny and examination of a small group or an individual. These practices are now so much a part of our modern culture that it is almost rhetorical to ask: “Is it surprising that prisons resemble factories, schools, barracks, hospitals, which all resemble prisons?” (Foucault, 1977, p. 228).

In the neoliberal context, Foucaultian governmentality has been productively applied by diverse authors (see, e.g. Davies & Bansel, 2007; Olssen, 2004; Robertson & Dale, 2002). While this approach is often critiqued for leaving very little ‘wobble room’ for personal agency and can often seem pessimistic, key features of these new modes of governance match very closely the realities of schooling in contemporary societies; this is quite clear in the case of standardised testing in Alberta. In Ontario, for a study seeking to understand how teachers positioned themselves amidst the turmoil and political pressure of neoliberal motivated changes of education, Dehli and Fumia (2008) interviewed twelve teachers to discover how “notions of effectiveness, improvement, and accountability shape images of the good teacher in reform discourses, and how these notions are woven into teacher talk as they ‘account for themselves’ in interviews” (p. 143). In one of the contradictory locations in which teachers were placed, the rhetoric espoused by the Deputy Minister of Education for Ontario encouraged teachers to “be the change you wish

to see”, while at the same time, government interventions undermined possibilities for teachers’ abilities to do so; for example, targets and achievement outcomes were strongly dictated; notions of what counted as learning were limited; and students’ and teachers’ performance were more frequently measured; student report cards and tests had to be standardised, with exceedingly precise specifications that took up a lot of teachers’ time. In many cases, teachers found themselves having to resort to traditional teacher-led pedagogies just to complete the syllabus in time for evaluation. Significantly, the neoliberal governance strategies at work here are similar to that in other countries (see e.g. Marginson, 1997; Tan & Mok, 2004): ‘steering at a distance’ with policy makers emphasising the responsibility, accountability and autonomy of the ‘enterprising professional’ who delivers ‘educational goods’ to students, the ‘consumers’ of educational products, all the while being continually constrained by narrowing, non-negotiable standards of achievement. Teachers were ‘freed’ to “pursue appropriate strategies to ensure that students in the classroom, no matter their circumstance or the resources of the school and community, meet the targets established by centrally determined curricula, tests and reporting tools” (Dehli & Fumia, 2008, p. 147).

Science, technology, and its effects on the world

At six billion (UN Secretariat, 1999), we certainly have grown to proportions that strain the capacity of our biosphere to cope. To a great extent, science and its associated technologies have been the enabling factors that allow us growth; one does not have to think too hard to surface such innovations as the green revolution, the invention of concrete and associated building technologies, internal combustion engines, refrigeration, electricity, and many others, which allow us the possibility of so many of us living in dense quarters in relative comfort. Yet, at the same time, science and technology have enabled such spectres as the Cold War concept of mutually assured destruction, environmental hazards such as the loss of stratospheric ozone, climate change due to the release of greenhouse gases, and massive species loss associated with landscape clearing and mining (McMurtry, 1999).

The role of science and technology in all of these has been well studied; authors such as Marcuse (1991) criticise the advent of advanced industrial societies and their role in the increasing ‘unfreedom’ experienced by citizens; while Beck (1992) reminds us all of how products are being quickly brought into market, often insufficiently tested for their potential harm. Worse still, the risks that we are exposed to are not fairly distributed, with the dominant groups being able to mitigate their exposure by either moving or influencing the siting decisions of hazardous facilities. In the catastrophic accidents of Bhopal and Chernobyl, we see examples of differential exposure to risk, while in the case of Vioxx and Thalidomide, the effects of a rush to market and the use of consumers as effectively long-term pharmaceutical safety testers. These matters should not be taken as an outright indictment of science, technology, scientists and engineers; after all, science and technology develop within a social milieu and the products of research and investigation are always guided by the social desire for knowledge and bound by societal norms. To illustrate this last point, one only need to look at the history of phrenology and intelligence testing in the last one and a half centuries (Gould, 1981); the best and the brightest scientists of their time were occupied with investigations into the relative intelligence and worthiness of different races. Utilising what were then the cutting edge technologies of their time, well respected scientists, in all their earnestness, repeatedly demonstrated the superiority of the Caucasian race over the ‘Negro’ or the ‘Mongoloid’. In many cases, even when empirical evidence was contrary to the socially accepted order of things, the results were dismissed as experimental error or on the grounds that the test was not accurate, maintaining socially held ‘truths’. If these findings were limited to the quaint little world of scientists, it would have been ideal. Unfortunately, these results were used to justify many, if not most of the racially motivated policies, including those that caused the closing of migration opportunities of people from territories undergoing oppression on the grounds that they were intellectually inferior; the exclusion of racial groups from particular professions, and the general condition of racial discrimination in places like the U.S (Gould, 1981). Of course, with the luxury of hindsight, we can say that there have been cases in which scientists acted on bad faith, and that there is, after

all, progress in scientific knowledge, hence some of the past actions could be excusable. Still, perhaps the valuable lesson to learn from all of this is the importance of a position of critical scepticism, and the epistemological issues surrounding science and its relation to forms of power in society, something that most conventional science curricula do not deal with, preferring instead to portray scientific knowledge as unproblematic and straightforward (e.g. Lederman, 1999; Matthews, 1994; McComas, 1998).

Environmental education

As a science educator with a commitment to the theoretical commitments and viewpoints expressed above, an almost natural context for research would be the environmental education curriculum. Putting aside for the moment important definitional questions, there are several important reasons for science educators to be interested in the environment. Firstly, environmental degradation has been the ‘collateral damage’ of the progress of science and technology; educators need to acknowledge at least the intellectual responsibility (but not necessarily culpability) and refuse to participate in ‘business as usual’. Secondly, for educators interested in social justice, it must be remembered that it is often the subordinated groups that are saddled with the burdens of a degraded environment, due to their inability to affect the political process or move out of the way. Thirdly, as a focal point for localised action, few causes present such readily actionable opportunities as the environment; such is the unfortunate status of the environment. Fourthly, from a Foucaultian perspective, there is much reason to be sceptical about environmental education efforts, which barely bother to disguise their commitment to a neoliberal governmentality. While we cannot therefore conclude that environmental education is not achieving its ostensible aims, we should really question what other unspoken aim or inadvertent consequences exist. Lastly, environmental issues are an ideal nucleus to focus the teaching of science, technology, and society; providing an ‘ultimate cause’ for the curriculum project; specifically, learning about the science, technology and societal aspects of an issue because they are needed to understand and take action. Specific to the Ontario context, the science and technology curriculum has recently been revised in 2007, with a renewed emphasis on the environment; clearly in its introduction, the curriculum guide (Ontario Ministry of Education, 2007) spotlights one of the three goals of the elementary science program as “to relate science and technology to society and the environment” (p. 3). Since these changes are mandated from a ministry level, there is then an added dimension of theoretical interest in finding out how teachers handle change.

Returning to definitional issues, the work of Sauv  (2005) informs us of fifteen approaches to environmental education, which she terms ‘currents’, that inform approaches to pedagogy. She describes each current by its dominant conception, primary aims, approaches and strategies, some example activities, and poses critical questions. Of the fifteen, perhaps the forms most recognisable and commonly practised are that of the naturalist, problem-solving, and scientific currents. The naturalist current is interested in reconstructing a link with nature, and typically employs strategies that ‘immerse’ students into nature with sensorial games and discovery activities. The problem-solving current conceives environment issues as problems that need solutions, and is oriented toward guiding students’ development of skills from diagnosis to action. Problem solving activities tend to have a cognitive, pragmatic approach, and example activities include case studies, issue analysis or problem-solving projects. The scientific current views the environment as just another object of study, with the aim for students to develop competence in the environmental sciences, using issues “as a hook”. To me, this latter approach is somewhat repugnant, not only because of the metaphor of a hook as a device that holds its creature against its will, but also because of the implication that the sciences do not have any intrinsic value for learning in itself. While Sauv  does not indicate any preference for one current over another, in the context of this study, perhaps the current most compatible to the overall philosophy of this project would be the praxic current, in which the environment is conceived as a locus of action and reflection, and as the site where students learn about (environmental) action.

Another term that deserves explication, if only because of its widespread use, is that of sustainability. As a concept, it has worked itself deeply into the mainstream discourse, despite opposition to its all-

encompassing vagueness (Jickling & Wals, 2008; Palmer, 1998); for example, Bonnett (2006) queries: “precisely what is to be sustained under the aegis of sustainable development, and at what level and over what spatial and temporal scales” (p. 267)? Bonnett rightly surmises that the difficulties we have over these issues are indicative of the undertheorised nature of our fundamental relationship with nature (see also Bonnett, 2007); of which the sustainable development movement is just one response. In a careful deconstruction, Bonnett reveals contemporary eco-centric philosophies (e.g. the ‘deep ecology’ movement) as fundamentally anthropocentric, and ultimately eschews the binary dualism to locate the essence of sustainability in the nature human consciousness itself, proposing conservation as a concern to “let things be (as they are in themselves — to safeguard, to preserve, to conserve”, different from “the sense of sustainability in order to have ready to hand a resource required for some further purpose (such as economic growth)” (Bonnett, 2006, p. 275).

Stevenson’s gap

In a book chapter of sufficient importance that merited a reprint in a journal twenty years on, Stevenson (2007) proposed the existence of the gap (now named after him) between the rhetoric of environmental education and the reality of schooling. In his analysis, orientations toward anthropogenic environmental degradation could be of two fundamental types, conservative or radical, each further divided into different approaches. If our aim is to further the democratic imperative and offer students choices unto their own destinies, their exposure to different perspectives is important to ensure their rational, defensible decision making. Further, action competence is necessary if we are truly serious about offering them choice as it would be highly ingenuous to offer choice but no way to act on it. If these premises are agreed upon, Stevenson goes on to propose that a political competency would be necessary in order for successfully encounters with the *status quo*. Stevenson proposed that this is far more challenging than schools can take, and considered four regularities of schooling that formed contradictions for environmental education: (i) in terms of philosophical intent, schools have had a stable structure almost globally for over two centuries of social reproduction, whereas environmental education demands a (politically) revolutionary approach; (ii) the classroom pedagogy of schools is biased toward individualistic, lecture-styled approaches of synthetic material, while what is required is a focus on co-operative, real-world problem solving of current situations; (iii) school organisation is biased toward mass credentialing and the efficient processing of students, which is anathema to problematic inquiry, ambiguity, contradictory stances and associated psychological unease; and (iv) curriculum ideologies, where the high status, ‘public’ knowledge being taught in schools is at odds with the ‘private’ knowledges like aesthetic appreciation and other intangible emotional connections to nature.

What can (science) education do?

Most definitely, some of these large sociopolitical issues that confront us require us to take action in our roles outside of who we are as curriculum scholars and advocates; one has to be wary of the charge of indoctrination in schools. We need to be active citizens in participatory democracies, and for that, good science curriculum has much to offer. For example, Longbottom and Butler (1999) argue that some of the prime attributes that enable democratic citizenship is the existence of a critical and rational mindset, science, with its “quintessentially rational character” is ideally suited for this venture among the subjects taught in school. To be certain, they do not advocate a form of scientism or over-reliance on rationalism: “not that we believe that the production of a rational population will automatically eliminate violence, disempowerment, or poverty, but without rationality and critical skills people may never thoroughly question the origin of such evils” (ibid., p. 486). Ultimately, they argue for a version of science education that is tempered against the worst excesses of relativistic perspectives emanating from recent postmodern attacks on science, but on the other hand, is also protected from positivistic, scientific caricatures of itself.

In attempts to foster informed nature of science (NOS) views in science education (see e.g. Abd-El-Khalick & Lederman, 2000; Akerson, Buzzeli & Donnelly, 2008; American Association for the

Advancement of Science, 1993; Lederman, 1992), one can detect attempts to ‘correct’ the public perception of science, and redefine what it means to be scientifically literate. Indeed, that very idea is emblazoned as the title of the book from Roth and Barton (2004) (*Rethinking Scientific Literacy*), which argues, among other things, that a thoughtful reconsideration of the science that we teach in schools today is necessary if we do not wish to reproduce forms of oppression based on current inequitable capitalist forms; and that social and political literacies are inextricably linked to scientific literacy if social responsibility is recognised as a worthwhile goal for education in general. Significantly, science curriculum projects promise much, and as I have summarised in a prior section, have delivered significant gains. Still, considering a more general perspective, there is value in questioning the overarching aims of curriculum intervention projects and ask if there are theoretical limitations to what such projects are capable of.

Writing a retrospective on the sociology of curriculum, the field he helped found in the 1970s, Michael Young (2008) offers an interesting insight to the possibilities and pitfalls of attempts at politicising the curriculum. These efforts, he writes, were borne of the realisation in the 1970s that the selection of knowledge for the curriculum were by no means neutral and unbiased. In fact, scholars such as himself (1971), Michael Apple (1979/2004), Bowles and Gintis (1976), Basil Bernstein (1977), and Paul Willis (1977) were able to demonstrate that, for the most part, school knowledge and practices privileged certain class, race and gender groups, and that the “curriculum was not something given but a social and political construct reflecting particular sets of interests, beliefs and values” (Young, 2008, p. 2). Unfortunately, the movement never really had much influence on teacher education or education policy in general, in part due to its never really moving beyond offering a critique of the *status quo*, and relatedly, because they did not have a well thought-out theory of knowledge. Much critique by members of the movement was focused on the constructivist notion that since knowledge was a social arbitrary, it could always be re-made to better suit the oppressed classes; to this, Young acknowledges a *mea culpa* in accepting that there are limits to which one can construct the world differently, and that “the world (both natural and social) of which we have knowledge is itself structured and not arbitrary, even if we can never be absolutely certain what those structures are” (p. 5). Further, he acknowledges the insight of Durkheim, who recognised that simply because knowledge is socially constructed does not mean that all knowledge is biased and therefore cannot be objective. These ideas have significant implications; scholars have to be clear about the distinction between school and non-school knowledge, and move beyond a simple critique of political nature of the curriculum to offer alternative systems that discriminate less against subordinated groups.

Most powerfully, Young distinguishes between what he terms the knowledge of the powerful, and powerful knowledges; the former “has its roots in Marx’s well-known dictum that the ruling ideas at any time are the ideas of the ruling class”, while the latter are ideas that “provide more reliable explanations and new ways of thinking about the world [that] provide learners with a language for engaging in political, moral and other kinds of debates” (p. 14). Young argues that it is certainly for the sake of acquiring powerful knowledge that families make sacrifices when they send their children to school. While it can be seductive to simply validate the experiences of subordinate groups in the name of providing schooling that is less discriminatory, surely that move represents a dereliction of our duties as educators, especially since context-independent, powerful knowledges usually cannot be acquired from home environments. To put it in quite blunt terms, if we are interested in improving the lot of subordinated groups, it is a high quality science education, foreign as it may be to their cultures, that will allow them access to high paying jobs.

The implications for researchers trying to correct social injustices with schooling are immense. Curriculum scholars are apt to propose interventions to correct for the *symbolic violence* (Bourdieu & Passeron, 1977) of schooling, yet they do not pause to consider if their actions or recommendations necessarily constitute an improvement on the state of affairs, or are as similarly impositional (Young, 2008). It is possible to over-politicise the curriculum, lose sight of the technical demands required for education, and hurt the people we ostensibly claim to help. This is something that needs careful attention.

Discussion

Returning to our limited set of curriculum questions, my position should be quite clear. There are significant obstacles standing in the way of a more just society, and much of these obstacles are so deeply ingrained into our ways of life that we seldom, if ever, pause to question the very foundations upon which our society is built. For example, faith in the ability of schools to stand up and deliver answers for all manner of social ills may even be said to be the unspoken assumption behind a journal such as this. To be sure, I am not denying the transformative potential of schools, but rather, I am proposing that a honest and critical examination of what schools are really capable of, given the many structural impediments and the strength of the reproduction function, is needed, at least on an occasional basis. In many cases, the solution to social issues belongs outside the realm of the classroom; at the risk of sounding defeatist, there are actions that need to be done at levels that students are simply not prepared for. There is always the risk that students become overly radicalised, and gain tactics but do not develop a sufficiently strong strategy to guide their actions, a sure way toward disillusionment (Andersen, 2004). Perhaps, if we consider the apocryphal story of the old man tossing the starfish back into the sea at the receding tide, we may be doing more harm than good: by 'saving' the starfish, we may inadvertently be overpopulating the reef with coral destroying starfish. The point here is made not in support of social Darwinism, but for the frank realisation that whatever we do must be considered no less than an interference in our students' lives; we can only imagine that we are doing good, but whether we can actually do so is something else altogether, and not something that we can decide. Metaphorically, how can we be sure that the tossing of the starfish does not harm them when they land into the water with a splash. We claim to be helping our students when we interfere with their lives, but, like Anna Frued's case of the governess who lavished love and care upon her failing charge only to leave him when he began to succeed, to what extent are we engaged in activism as a 'rescue fantasy' (Britzman, 1998), saving our own image of ourselves in the process?

If we are allowed to extend the metaphor a bit further, perhaps the problem lies with an inappropriate scale at which a solution is attempted; if the receding tide is a problem, perhaps the solution should not be a manual re-introduction of the species to water, but rather a change of the gradient of the beach made with earth moving equipment, or maybe even a change to the orbit of the moon around the earth? In parallel, we should ask: where should our efforts take place for maximal effect on the problem at hand? On the one hand, if we were to focus on the individual teacher and her classroom, the chance of success would be fairly high, but the reach of such a project would be relatively narrow. On the other hand, taking the 'earth-moving equipment' approach, how are we to account for the countless individuals who will inevitably be crushed by our equipment tracks?

If these arguments sound especially vexatious, they are not meant to be so for purely rhetorical reasons; these questions are also not meant to trigger off a panicked inaction arising from over-analysis. What is important is that we act, but we must do so keeping in mind the eternal balancing act, never acting without thought, nor think without action. And, just like the way the high wire-walker stays on his narrow path by continually responding to the dynamic conditions of the wind and the undulating wire beneath his feet, we must not waver from our mission, all the time being conscious of and responding to the social environment and context, responding to them in appropriate ways.

Place based education?

Now with these weighty considerations in the background, what would a feasible solution look like? One idea that has captured the imaginations of many scholars has been the concept of place based education, and one of its leading exponents appears to be David Gruenewald (2008). Arising out of a concern, on the one hand, that critical pedagogy was missing an ecological sensitivity and had an undue bias on urban education contexts; and that traditional environmental education appeared as a concern for natural surroundings without consideration for the unjust conditions of human relationships on the other, place based education was developed to help bring about a merging of the two concepts. To illustrate the bifurcation, around Earth Day 1970, white middle class activists protested against resource depletion, waste and were promoting

environmentalism as a 'non-class issue', while African-American families bemoaned "the lack of jobs, poor housing, racial discrimination [...] and claimed that their major environmental problem was Richard Nixon" (ibid., p. 314). Place based education (PBE) attempts to steer away from the oppositional, 'messianic', over-politicised approach of critical pedagogy, while at the same time avoids the 'premature abstraction' of the version of environmental education whose pedagogical strategies involve out-of-reach global crises such as species extinction and climate change which run the risk of creating anxiety, hopelessness, and fear. In contrast to the environmental movement which "has attempted to educate citizens mainly by focusing on tragedy, malfeasance, and ignorance" (ibid., p. 316), a major thrust of PBE is the inculcation of love and the development of mutually enhancing relationships with nature. PBE is centred around the twin aims of reinhabitation and decolonisation, the former being the concern with "identifying, affirming, conserving and creating those forms of cultural knowledge that nurture and protect people"; while the latter involves "unlearning much of what dominant culture and schooling teaches, and learning more socially just and ecologically sustainable ways of being in the world" (ibid., p. 318).

In practice, Gruenewald suggests five areas where PBE could be effectively deployed include: (a) local cultural studies; (b) local nature studies; (c) community issue-investigation and problem-solving; (d) local internships and entrepreneurial opportunities; and (e) induction into community decision making. Surveying the work of a few outstanding teachers, Smith (2007) found that PBE demonstrated potential for disrupting the regularities of schooling, but required teachers who were exceptionally committed and who were willing to take risks and confront great pressures from the *status quo*. For science and technological education, a PBE approach provides a teleological purpose: learn to love and care for the place that one is in, not necessarily limited to the 'green spaces', but also the 'grey' urban environment, then learning the science that facilitates the understanding of how their place works, and how science can contribute to an enhanced appreciation of place, rather than the current goals of a ritualised acquisition of abstract, commodified knowledges in support of globalised economic 'expansion' and 'wealth creation'.

Conclusions

The demands of the teaching profession are such that it is all too easy to ignore the 'big picture' considerations in the hustle and bustle of schooling. If we are to be serious that schooling should be educational, we must periodically ask ourselves these critical questions, and problematise our most basic assumptions. Here, the use of the term is derived from Dewey (1902), who distinguished between educational and non-educational experiences based on the criteria of an expanded possibility for future action. In the same way that science and technology are but tools that can serve the aims of whoever wields it, science and technological education cannot be considered a neutral and technical enterprise with no possibility of negative consequences for our students. Schooling has remained relatively static in form for the better part of almost one and a half centuries since public schooling was popularised, and it would probably be the height of hubris at this point to propose that a single idea can change what has been so deeply ingrained that it forms a veritable pillar of our social structure. Ultimately however, we have to persist, and we only have the words of the old man who continued to throw starfish into the receding sea for our words of comfort: "It matters for this one".

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