Chapter 23
"Preach or Teach?": An Ongoing Journey to Becoming STEPWISE

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23.1 Introduction

> Our world contains grave evils, which can be remedied if men [sic] wish to remedy them. Those who are aware of these evils fight against them are likely, it is true, to have less everyday happiness than those who acquiesce in the status quo. But in place of everyday happiness they will have something which I, for my part, value more highly, both for myself and for my children. They will have the sense of doing what lies in their power to make the world less painful…They will have the knowledge that they are amongst those who prevent the human race from sinking into stagnation or despair. This is something better than slothful contentment. (Russell, 1932/2009, pp. 67–68)

This chapter outlines my ongoing journey as a science teacher educator towards a more activist approach to science teacher education. Science teacher education curriculum is typically framed within the same neoliberal influences that governments prescribe in school science curriculum documentation. The science teacher educator is thus expected to prepare emerging generations of science teachers to know and be able to teach this prescribed curriculum. Subsequently, the status quo citizenship demanded by a neoliberal, industrial society and supported by school systems is maintained. Perpetuating the status quo like this can be useful and even necessary in order to establish and maintain a well-functioning society where a productive life can be enjoyed. However, the neoliberal climate that is currently evident in societies of the "developed" (or global North/minority) world advantages the privileged few at the expense of the less privileged many, creating an unjust world of increasing inequity. This inequity has led to some (e.g., Ayers, Quinn, & Stovall, 2009; Clover, 2002; Hodson, 2010) to call for an activist approach to education in order to create a 'better' world, one in which the wellbeing of individuals, societies, animals and the broader environment, is promoted.

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Calls for education to inspire a better world are not recent. Some 70 years ago, social theorist and educational philosopher, Bertrand Russell (1932/2009) was calling for education to address social inequity to secure a better future for all. In spite of this, a truly democratic education is yet to emerge as a prevailing global paradigm. In science education there are a few dedicated voices (e.g., Aikenhead, 2006; Bencze & Alsop, 2009; Hodson, 2003, 2010; Roth & Désautels, 2002) calling for science to critically examine relationships between science and society to enhance the wellbeing of all peoples and the world in which we live. Their messages reflect the ideas of Russell, showing how his work is still of relevance today. Accordingly, Russell's work has been heavily drawn on in the shaping of this paper.

One framework that appears to embed principles outlined by Russell (1932/2009) is that of Science and Technology Education Promoting the Wellbeing of Individuals, Societies and Environments [STEPWISE] (Bencze & Alsop, 2009). STEPWISE aspires to contribute to a transformational education for a better world by challenging the nature of science education and working towards wellbeing for all. STEPWISE encourages teachers to move beyond traditional approaches to teaching science that focus on conceptual and procedural knowledge, which ultimately reinforce neoliberal agendas. Instead, STEPWISE links these traditional forms of knowledge in a framework that centers on action and makes explicit associations among scientific ideas and their important social and political implications.

The activist education approach central to STEPWISE aspires to challenge the status quo of science education so that citizenship becomes one of *active* concern for societal wellbeing and, thus, reflect the type of citizen that Russell (1932/2009) describes in the opening quote of this chapter—one who fights to make the world less painful. This contrasts with the construction of citizenship in neoliberal societies, where the privileged excel at the expense of both others and nature. Fostering a more equitable, global citizenship and sustainable future presents a challenge for science teacher educators. First, they must recognise and, second, adopt a curriculum that inspires socio-scientific activism in both citizenship and teaching. In this paper, socio-scientific education for activism refers to the sorts of world issues that Derek Hodson (2010) terms as "civic scientific literacy" which "comprises the knowledge, skills, attitudes and values necessary for making decisions on matters such as energy policy, use of natural resources, environmental protection, and moral-ethical issues raised by technological innovations" (p. 197). Adopting a curriculum that is focused on such societal and ecological wellbeing may, in turn, encourage pre-service teachers to adopt similar practices once they enter the profession as well as in their personal lives.

One tension that can arise from this is that *teaching* for activism could be viewed as *preaching* about activism and, thus, a framework that inspires socio-scientific activism must be carefully constructed and applied. One theory that could inform such a framework is Pierre Bourdieu's (1984) notion of social and cultural capital, and his conception of socialised norms or 'habitus.' His general framework is relevant to education because of ways in which educational institutions create particular social spaces in which social and cultural relations exist individually and institutionally. Such a space, or 'field' (Bourdieu, 1984), involves establishment of class

groups "of which some assume dominant positions and others find themselves subordinate" (Fenge, 2011, p. 378)—reflective indeed of the neoliberal scene.

A particular field has its characteristic features, structures and conventions that guide thinking and behavior—both consciously and sub-consciously. Simon During (2007) provides a useful example to explain the effect of the field on its members: "[I]f you are a writer you can't write anything you like, you find yourself positioned in a field which structures your possibilities" (p. 88). A similar set of invisible boundaries is established through the traditional rules and processes characterising science education. These boundaries act to form the habitus of thinking and behaviour of which we are often unaware so much are they embedded in 'normality' of daily life. Normality formed by the habitus of the field in this way provides legitimacy to its products and outcomes, including the inequities and injustices in the world.

Fenge (2011), reporting on Weick (1995), tells us that habitus is "grounded in both individual and social activity" (p. 379). In science, and in science education, the field's structures and conventions involve laws and theories that govern different disciplines of science, which tend to maintain traditional foci on what Bencze and Alsop (2009) refer to as 'products education' within fields of science learning—that is, a focus that supports products associated with ongoing industrialization and consumption in society. Dispositions and behaviours emerging from fields of science education—i.e. the habitus—invoke science processes of inquiry and investigation (skills education) that involve 'fair tests' and evidence-based theorising.

These forms of knowledge and practice drive the nature of science education and influence ways in which science is used in society. Habitus is linked to reproduction and change in society (Rawolle & Lingard, 2013). It also sets particular curriculum and pedagogical dispositions that Rawolle and Lingard (2013) recount, leading to reproduction of "class structure, class codes and class relations through schooling" (p. 121). The western view of science creates a habitus that attempts to be objective and value free. Thus, habitus helps to explain how science education as an institution leads to the reinforcement of the neoliberal state that dominates western culture in the global north minority (developed) world and increasingly, in the global South majority (developing) world.

Fortunately, habitus is not a fixed, permanent state. Navarro (2006) suggests that it can be altered through encountering different contexts and environments that create tensions and, upon reflection, challenge ways in which we think and act. Such reflection can assist in recognising what may have previously been invisible due to the manner in which the field can normalise certain ways of thinking and behaving. Indeed, Bourdieu (1984) reports that habitus is formed from both past experiences as well as current events that can alter our perceptions. Education is one particular institution that can re-shape habitus by challenging the status quo and building in experiences of critical reflection to help ensure there is not an unconscious acceptance of the social/cultural field and, subsequently, a legitimization of social, cultural and ecological inequity.

23.2 Purposes of Education

Education is an institutional concept. It has evolved from its early purposes to induct the rich into educated and privileged society to that of 'training' individuals to work and operate in the type of citizenship seen as desirable by the State (Russell, 1932/2009). Bourdieu referred to education as "a sorting institution that functioned to divide groups primarily through the valuing of cultural capital" (Rawolle & Lingard, 2013, p. 120). Today, still, education is viewed as a major vehicle through which one achieves social mobility: success, affluence, and (supposedly) wellbeing (Kalantzis & Cope, 2008). Education is also seen as key to growing a 'knowledge economy' and, perhaps in conflict with this notion, also a precursor to resolving significant inequities in the world.

Different stakeholders can view purposes of schooling differently. In current neoliberal contexts, governments tend to view education as a process for developing emerging knowledge economies of the world and, thus, become/remain competitive in a global economy. To this end, despite rhetoric claiming its power to resolve inequities in the world, education for neoliberalism is one in which the prevailing habitus values individual power and wealth above equity and access to resources for everyone and maintenance of functioning ecosystems. This neoliberal view of education creates an individualistic sense of purpose—that of preparing individuals for productive, working lives, through which they contribute to building of the economy (and by unexamined implication, the society) of their respective countries. However, as Kalantzis and Cope (2008) attest, education is central in this shaping of "certain types of citizens" (p. 71). With such centrality, careful consideration is needed to determine what content, skills, values and attitudes should be included in education programmes, and whether present foci on individualistic approaches are, in fact, suitable for emergent global citizenship required for wellbeing in the twenty-first century and beyond.

It has been argued that education focused on producing 'good individuals' should naturally foster a society of 'good citizens' (Russell, 1932/2009). The notion of a 'good citizen' can, however, mean very different things to different people. For example, some view 'good citizens' as those who do achieve individual success (usually measured in terms of monetary wealth), and subsequently contribute to larger society through their services, taxes, and/or philanthropic ventures. In this model, it is quite likely that 'success' comes at the expense of others; for, in the competitive neoliberal archetype, success is based on competition and personal gain deriving from a capitalist political model. Alternatively, good citizenship can be viewed in a more egalitarian manner; as equity and working toward the betterment of all. The variability in how the notion of good citizenship can be perceived demands that the ways in which it is characterised receives careful attention if it is to be a focus of educational outcomes.

In contrast to the dominant neoliberal discourse, Kalantzis and Cope (2008) report that "many political and community leaders present education as a mechanism for ensuring social equity" (p. 6). It is difficult, however, to see equality as the

product of an education that is so focused on individuals' aspirations and achievements (Kalantzis & Cope, 2008). In fact, Mirra and Morrell (2011) report that, in the United States (US), the neoliberal agenda has led to entrenchment of educational inequality. They also allege that this leads to a "mechanistic purpose for teaching" and promotes the "capitalist purpose for education" (p. 409). Such a view attributes both success as well as any lack of success to the individual (Kalantzis & Cope, 2008). This further promotes an education system that is geared towards individual performance and outcomes, and individual accountability and blame when outcomes are not achieved. This attribution to individual effort often comes with little consideration of one's position, or the impact of one's actions and outcomes on nature, or on others in the local or global community. Bourdieu recognised that education geared this way leads to *reproduction* of cultural and social inequities (Rawolle & Lingard, 2013), rather than resolving them.

This often-unconscious disregard contributes to a number of socio-scientific transgressions, including over-consumption of resources; excessive waste; unsustainable population growth; food security risks; loss of biodiversity and detrimental climate change. It is also linked to exploitation of peoples from disadvantaged communities who may be recruited into slavery types of roles, such as child slavery for cocoa and coffee production; primitive and often dangerous working conditions for production of clothing in sweat shops; and generally, threats to the livelihood and wellbeing of current and future generations.

These and other injustices in the world have resulted in a number of activist groups mobilising against disparity and inequity in an effort to achieve greater parity in the world and to promote a more sustainable way of living. Campaigning for a better and more just world, however, should not just be the concern of activists, but rather, of all citizens of the world, and education plays a central role in addressing needs of humankind (Hopkins, 2013). Through education, there are greater chances of reframing the field, fostering dispositions that engender knowledge, values, attitudes and desires to take actions required to secure a more sustainable, equitable and ethical citizenship. "It is only through the will and through the exercise of power that the individual … becomes an effective member of the community" (Russell, 1932/2009, p. 3). Science education, in particular, offers a natural conduit for such a citizenship-focused education, due to its link with many of the most significant issues threatening the world (e.g. climate change; food security, land and water usage, biodiversity, unethical development/use of technology).

23.3 Scientific Literacy and School Science

The relationship between science and social, ecological and cultural world issues has led to many within science education communities rethinking purposes of science education (e.g., Aikenhead, 2006; Bencze & Carter, 2011; Hodson, 2003; Roberts, 2007; Roth & Lee, 2004). Traditionally, science education has been conceived as serving to foster scientific literacy (De Boer, 2000). Generally, this has

meant a science education focused on developing knowledge and skills for evidence-based thinking and argumentation associated within the long-established science disciplines (e.g., physics, chemistry, biology). In recent times, the usefulness of this dichotomisation has been questioned and there have been claims that science education is in a state of crisis in most post-industrialised countries (Tytler, 2007).

While scientific literacy is commonly considered to be the overarching purpose of science education, historically there has been little consensus on its definition (De Boer, 2000; Fensham, 2004). In the past decade, however, there has been an increasing shift away from the traditional products-based approach to one more sympathetic to the socio-scientific issues that plague the contemporary world. Many (e.g., Bencze & Carter, 2011; Roth & Lee, 2004) argue that science education needs to respond to these societal issues by embedding them in a more active and overt manner in the curriculum. Such deliberate focus on the social implications of modern day science should help the wider public to participate in effective, informed decision-making about "personal and public science-based issues" (Tytler, 2007, p. 4).

Recent discourse around "re-imagining" (Tytler, 2007) science education has reinforced existence of two main themes about the purpose of science education, which Roberts (2007) tells us are competing for precedence. The first theme aligns with his 'Vision I' view of processes and products of science, in which students are essentially prepared for an expert science career path—a "propaedeutic" approach (Roth & Lee, 2004, p. 275) and something seen as important for "carry[ing] the nation into a technologically driven future" (Tytler, 2007, p. 1). The second theme recognises needs for accessibility and engagement in science by all citizens to ensure "lifelong participation in and learning of science-related issues" (Roth & Lee, 2004, p. 263). Roberts (2007) views this 'Vision II' form of science as being concerned with ways in which students are likely to encounter science in every day life.

The first of these themes tends to encourage content-based approaches to teaching that deal with products and processes of science and often manifests in the delivery of abstract concepts (Aikenhead, 2006). This approach is representative of what Roth and Lee (2004) describe as the "competitive and individualistic nature [of science] and its claims to objectivity, value-free inquiry, and being an isolated enterprise" (p. 265)—that is, a neoliberal approach geared towards business-as-usual capitalist outcomes. Alas, it is this approach that often discourages ongoing participation in science education (Roth & Lee, 2004) due to its lack of relevance to contemporary life and the perpetuation of the image of science as being for the elite.

The second theme of science education encourages a contextualized approach, providing a means for education about ideas and ethics related to "fundamental societal conditions" (Tytler, 2007, p. 2). This second approach also relates to issues encountered in everyday life, making school science more relevant to most students, rather than just the relatively small proportion who follow it into further study and careers (Aikenhead, 2006). Approaching science in this way involves a shift from the traditional objective, value-free, view of science that produces 'answers' to the

questions of the world. There is no doubt that the sense of certainty provided by traditional science is no longer enjoyed. The current milieu in which scientific progress has enabled science to be used in highly controversial ways: the atomic bomb; unraveling the human genome and subsequent designer babies; genetic engineering in foods, among others, has seen science become less certain in providing answers to important, value-laden, and subjective concerns of the world. This places natural and timely socio-cultural emphases on science that should be reflected in education if the world is to move to a more equitable and sustainable future.

Given the problematic nature of science-related issues in the modern world, and the uncertainty of science in providing definite solutions/resolutions to these problems, it seems appropriate to view scientific literacy in the same way that do Wolff-Michael Roth and Stuart Lee (2004)—as a social practice; and a more authentic and relevant school science as "citizen science". This change in focus generates what I see as a third theme for science education, that of *socio-eco-activism* in which ideas of science related to society and nature are not just explored in cognitive ways, but their ethical implications are debated and authentic action is incorporated through an activist science education. Education framed around citizen science in this way would better address significant ethical problems and questions of the world. Indeed, During (2007) recognises that "Science has…become of more interest to cultural studies in response to the increasing technologicalization of nature and the human body as well as in response to global warming" (p. 23), which further strengthens its association with a more social, cultural, ecological and citizen-based definition. Such a view is consistent with other discourses, not only within science education, but also about education more generally (Mirra & Morrell, 2011). It aligns with what Kalantzis and Cope (2008) portray as a "new learning", which they describe as being "about action as well as cognition…about the capacity to be productive in the world as well as knowing about the world" (p. 9).

New learning requires a significant shift in thinking about organisation and delivery of curriculum (Kalantzis & Cope, 2008). Typically, school curriculum programmes and, indeed, teacher education programmes, are fragmented into subjects and disciplinary areas, such as English, mathematics, and science. Citizen-based education programmes require more holistic approaches, and these require reform of both school and teacher education programmes to ensure that teachers have adequate skills and knowledge to challenge, change and implement more relevant, citizen-based education. With gross inequity and significant science-based issues prevailing in the world, today's version of citizen-based education is going to require a further critical element of educating for activism. This chapter goes on to consider this transformation from the perspective of science teacher education, where the discourse and relevance of citizenship that is tied to science-related ideas and issues is paramount.

23.4 Teacher Education

Roles of teacher education are ill-defined beyond their general purposes in preparing teachers for the profession. There are a number of differing views about what such preparation should involve, as is reflected by what Louden (2008) denotes as the "101 damnations of initial teacher education", referring to the large number of reviews into teacher education in Australia and how it should be conducted. For example, it has been argued that educators should be "agenda-setters and change-makers" (Kalantzis & Cope, 2008, p. 33), whereby current practices and approaches to teaching, learning and school organisation are challenged and reformed. This would require teacher education to inspire pre-service teachers to challenge the status quo, and focus their education and subsequent teaching practices on new ideas, approaches and structures. Others view roles for teacher education in preparation of pre-service teachers to learn about characteristics of curricula that they will be charged with delivering upon entering the profession. Such preparation supports schools in satisfying requirements of teacher accreditation bodies, government agencies, and other governing bodies. However, the sometimes complementary and sometimes competing demands of stakeholders driving education leaves little room for reform in most schools—especially when government school funding is often tied to student outcomes and/or adherence to government initiatives such as accountability measures and national testing. Moreover, Mirra and Morrell (2011) suggest that quality of teachers and teaching are often based on measures of these "unexamined assumptions about what constitutes desirable student learning outcomes" (p. 408). These ties to important resources and measures of accountability represent yet more mechanisms for advancing the neoliberal agenda.

The same unexamined outcomes for school student learning create pressure on faculties of education to deliver teacher education in ways that support the system in place. However, if teacher education acts merely as a prop for the status quo, how does change occur—in the school or classroom, let alone in the world? Transformational education (Mezirow, 1991) towards a focus on active citizenship means a more authentic curriculum is needed in which students and teachers can connect knowledge and skills with key issues in the local and global community and actively participate in measures to improve conditions for the greater good. Situations need to be utilised to engage students in "participatory modes" (Roth & Lee, 2004, p. 267) where they can make their own decisions and pursue their own interests in authentic situations that not merely *reflect* daily life, but rather, are *embedded* in daily life. Tytler, Symington, Kirkwood and Malcolm (2008) refer to such an approach as "knowledge 'in action' and 'in context'" (p. 17). Aikenhead (2007) introduces this knowledge in action as a Vision III expansion of Roberts' (2007) visions I/II of scientific literacy.

Kalanzis and Cope (2008) do warn, however, that transformational education requires more than just authenticity. They say:

> [w]e have the power to transform our classrooms and our schools. As we embark on these transformations, we also make our own contribution to the transformation of broader

society. Better learners will better contribute to the making of a better society … This means more than being "authentic". Being authentic may produce a better fit between education and society, but leaves society fundamentally the way it is. It sets out to reflect the realities of the world more than to change them. (p. 33)

This is particularly evident in science education and, subsequently, science teacher education. Much curriculum tends to be written quite conservatively and, thus, supports propaedeutic approaches described by Roth and Lee (2004). In this curriculum, it is 'safe' to stick to abstract ideas and science inquiry skills. Authenticity may be attempted by contextualising content and skills within thematic topics. Even within contextualised themes, however, science education is primarily about acquisition of a body of knowledge—knowledge of science and knowledge to follow general scientific processes—the habitus of the field. The risk with this is that science is represented as an objective, value-free discipline; yet, as mentioned earlier, in the twenty-first century science is inherently entwined with ethical and value-based issues that plague the world. In an activist approach, science education would frame curricula to reflect knowledge and obligations to use knowledge in socially and ecologically responsible ways that strive for equity and justice for all. However, rarely does learning in science demand, or sometimes even discuss, notions about students as agents of change within communities to benefit the world as a whole.

23.5   Activist Science Teacher Education

Gallavan and Webster-Smith (2012) claim that "[t]eacher education is a powerful mechanism for helping teachers to understand the importance of agency" (p. 55) and that this occurs through rich opportunities and reflection. Thus, even though knowledge and action "are ultimately entwined" (Alsop & Bencze, 2010, p. 178), it is not likely to be sufficient to merely impart knowledge of concepts and ideas about socio-scientific issues with hopes that, with such knowledge, action will result. One need only reflect on the still-widespread inaction on climate change in some quarters, despite overwhelming scientific evidence to recognise this. Instead, education that is research and community-based is required, which has potential to lead to lifelong learning and action where "the collective praxis of the community takes precedence over the individual" (Roth & Lee, 2004, p. 284). This is the sort of science education that has potential to create more global forms of citizenship. Increasing participation in community issues is more likely to result in an education that moves beyond the acquisition of knowledge to one that encourages "discovery and action" (Mirra & Morrell, 2011, p. 412).

This socially responsible activist outcome of science education is reflected in STEPWISE (Science and Technology Education Promoting Wellbeing for Individuals, Societies and Environments). The four vertices of the STEPWISE tetrahedral framework: Science Technology Society and Environment (STSE) Education; Skills Education; Students' Research, and Products Education, are already, to some extent, reasonably-well embedded in both school and science

teacher education. For example, socio-scientific issues are prevalent through topic areas such as genetic engineering, climate change, biodiversity, sustainability, and are explicit in most formal curriculum documents (e.g., ACARA, 2013; Ministry of Education (Ontario), 2011; NCCA, 1999; UNESCO, 2009). Science inquiry skills and processes have also had an increasing profile in curriculum documents over past decades and students are regularly involved in research projects, some about socio-scientific issues, and others on more traditional science-related topics (e.g., famous scientists, inventions, diseases etc.).

In spite of the prevalence of individual aspects of STEPWISE already present in schools, it appears that there has been limited uptake of the framework across education sectors, and pre- and in-service teachers find the framework difficult to implement (Bencze & Carter, 2011). There may be a number of reasons for this. For one, there appears to be a gap between how different aspects of STSE, Science Inquiry skills and Students' Research are approached in schools—often in a disconnect from one another. This is exemplified through traditional modes of science teaching where content is often delivered through transmission approaches; recipe-style practical work is conducted, in which some inquiry skills are privileged over others (such as collecting and analysing data to form a conclusion, but rarely posing a question and designing the processes to collect evidence); and student research is completed in isolation from these two arms as well. This creates particular social fields (Bourdieu, 1984), in which the habitus underpinning practice in fields perpetuate objective, value-free, views of western science.

What STEPWISE does that is perhaps unique is to encourage traditionally-separate aspects of science education to be brought together such that they work in harmony: student-led research about a science inquiry where students contemplate, pose, process and attempt to answer a question and relate to existing ideas within the science field. This does not so much *change* the social field, but rather *expands* it. This expansion helps to ensure that critical inquiry and societal concerns underpin development of habitus within the field. Such an approach reflects Hodson's (2010) urging for alignment of issues-based learning with traditional subject-based curriculum; not as an 'add-on' but, rather, as an inter-related activity. Students' research then embeds science inquiry skills and contexts of inquiry are selected from STSE content areas. This marriage between aspects of science learning provides a more holistic learning framework (Bencze & Carter, 2011). It allows science research, content and theory to become relevant and useful rather than abstract and disconnected.

Critically, STEPWISE requires yet a further aspect of education to emerge—the vital step of *action* towards enhancing societal and ecological wellbeing. Supporting Hodson (2003), Bencze (2014) points out that this aspect of scientific literacy is relatively rare in science learning experiences but is central to STEPWISE and central for a citizenship education. Teaching for activism is emerging as an increasingly urgent requirement if the survival of earth's ecosystems is to prevail into the future. In spite of the increasing urgency of the global situation and the recognition of similar arguments dating back to the 1930s (e.g., Russell, 1932/2009), there remains limited uptake of activist approaches to education. Such resistance to activism, or

even learning about socio-scientific issues, is exemplified in the current United Kingdom (UK) curriculum (see UK Department of Education, 2013), in which the terms 'sustainability' and 'climate change', perhaps two of the most significant issues in the modern world, are conspicuously missing—purportedly due to "reservations about the inappropriate use and, indeed, over-use of the term 'sustainability'" (UK Environmental Audit Committee, 2005, p. 3). The ongoing omission of these significant areas of global concern from the UK curriculum is reflective of general neoliberal positions of the wider global North minority world.

Bourdieu argues that the dominating field of power can be responsible for both the social production and the social consumption that occurs within the field (Rawolle & Lingard, 2013). This reinforcing structure makes the nature of the science education field one of importance, given its power to influence how society is produced, or reproduced, and how those within it behave. With the current neoliberal approach, reinforcing powers encourage social consumerism that is individualistic and inequitable. This perpetuates construction of this model of society at the expense of others. If a new field of influence is to emerge, where a more socially aware and equitable habitus is to ascend, the present dispositions shaping production and consumerism of the social condition must be transformed. Activist education offers the possibility of such a transformation. 'Real' action on issues like climate change, sustainability, and general resource inequity in the world, exposes students to underpinning issues and *involves* them in affirmative action. Bearing witness to the results of such action can be empowering (Stevenson & Robottom, 2013) and, thus, small shifts may begin in the disposition and ultimately the social field in which science education manifests. This would, however, require a significant shift away from the capitalist drivers that underpin neoliberal philosophy and current education systems that support it.

A further factor that may be exacerbating limited uptake of activist science teaching may stem from confusion, or sense of ethical responsibility, that teachers may have about what and how they present this type of learning—which, by its nature, can be quite controversial in wider society. Teachers are accountable to a range of stakeholders—students, parents, their colleagues, school managers, system agencies, as well as to their own sense of ethics—as to content and pedagogies they adopt in teaching for activism. Hodson (2010) alludes to this, stating importance of care to be "taken to ensure both the appropriateness of a set of actions for the particular students involved and the communities in which the actions will be situated" (p. 203).

23.6   A Journey Towards Activist Teaching

Certainly, my own journey towards a more activist approach to science teacher education has been hesitant. I have struggled with a sense of competing pressures; between a profound sense of responsibility and capacity to 'do some good' and a deep concern for the potential misuse of my position and power. Continually, I have

(and still do) question whether my teaching could be construed as preaching, or perhaps what Gramsci (2007) describes as "moralistic sermons" (p. 47). Russell (1932/2009) expresses such a tension as a type of burden, stating that "[i]n this world of flux men [sic] *bear* their part as causes of change, and in the consciousness of themselves as causes they exercise will and become aware of power" (p. 3, emphasis added). Commitment to educating for social justice and equity in the world has been compromised by my uncertainty about content and approaches I have used to teach about it and consequently, has at times felt like a burden of conscience.

When I examine the STEPWISE framework now, I can see clearly that my early engagement in teaching about socio-scientific issues reflected the typical, disconnected approach—that is, concerned with content, products, skills and, to a limited extent, research about particular ideas and issues. To this end, I believe I delivered a reasonably good Products Education—the government mandated curriculum frameworks helped ensure this; I was reasonably good at incorporating Skills Education, mainly because I enjoyed teaching when learning was focused on science skills and processes rather than just conceptual knowledge. I was also reasonably effective in addressing Science Technology, Society and Environment (STSE) education, as I already had a passion for learning and teaching about socio-scientific issues in the world and their associated ethics. I did not, however, have an explicit awareness or understanding of links between these aspects of science education.

I can also see that I did not have a very good understanding of the impact my teaching had on my students; believing, without ever really questioning, that by equipping them with knowledge and informing them about issues, they would feel inspired to take action in their own lives. With time, it has become obvious that these conventional forms of STSE education are, as Hodson (2010) describes, "inadequate to meet the needs and interests of students faced with the demands, issues and problems of contemporary life" (p. 197). Using Hodson's (1994) levels of sophistication, I was operating at the lowest level (Level 1): "appreciating the societal impact of scientific and technological change and recognising that science and technology are, in substantial measure, culturally determined" (p. 85).

In preparing for lectures and tutorials in the core science education courses I taught in a Bachelor of Education (Primary) program, I began to learn more about particular injustices in the world. I also gained some experience working in the Pacific country of Solomon Islands, both in a capacity-building role, co-planning and presenting teacher professional development alongside local teacher leaders; and supervising a small group of pre-service teachers on a four-week teaching practicum. Solomon Islands is one of the poorest and least developed countries in the world (United Nations Conference on Trade and Development [UNCTAD], 2011), and education is difficult for most people to access. My work, over a seven-year period (and which is ongoing), provided direct observation of impacts of social inequity. I was able to witness first-hand impacts of global issues like climate change, and see how those with the least power to effect any change were the ones already suffering consequences imposed on them by the global North minority's way of life.

These encounters and experiences expanded my own social field and, with reflection, altered dispositions informing my personal habitus. My sense of responsibility to others and my sense of being able to contribute in some way influenced the amount and the manner in which I taught about and increasingly, *for*, socio-scientific issues. In an effort to minimise what I feared was 'preaching' about these issues, I introduced a range of student-led research and presentations. One particular strategy involved running debates about particular genetically modified foods/crops (e.g., Flavr Savr tomato (no longer available); Bovine Growth Hormone, Roundup Ready, etc.). Here, I believed (perhaps somewhat naïvely) that students would uncover information for themselves and, in trying to form an argument using their research-evidence, would come to see risks, injustices and unethical behaviours of self-interested corporate and capitalist organisations. To some extent, this did occur. Disappointingly, however, often the 'winners' of debates (as selected by the remaining peer group) were those who exhibited good debating skills, rather than the information alone acting as bases for decisions. The power and danger of charisma, and ability to present an argument with confidence, was far more convincing than even some of the most frightening of statistics and information presented.

I was quite confronted, and somewhat disappointed by these experiences, although they did enable me to better see how people can be swayed into particular actions and ways of thinking by the power of the person or media used to inform them. The self-interest of certain groups (government and for-profit organisations) became increasingly obvious to me and I began to advance through Hodson's levels of sophistication. I became better able to recognise links between the presentation and uptake of certain commodities and interests of associated funding bodies/capitalist organisations. I began to realize how this power and influence had potential for conglomerate control (Level 2); and consequently, my own values, attitudes and actions; i.e., habitus, began to transform (Level 3). I also recognised that lack of direct involvement with an issue led to a disconnect between the issue and the real-life impact it had on people. My students may have learnt about the topic, but the task lacked authenticity to really engage students' values about the examples and their use in the world.

The transformation occurring in my own thinking and actions, in turn, further impacted my teaching, which also began to better reflect Hodson's (2010) levels of sophistication. I designed tasks, questions and information to reflect, far more explicitly, levels of power that those with privilege, money and position can influence on those without (Level 2). I engaged students in critical reflection on their own actions that might be supporting or challenging the outcomes of the organisations wielding such power (Level 3). Yet, I still hesitated to challenge students to participate in their own socio-scientific action (Level 4). I was still in a false state of belief that with knowledge and reflection, my students would, as I had, change their values, attitudes and subsequently, their own actions.

In transitioning between educating about socio-scientific issues to teaching to challenge students' attitudes and beliefs for action, I again became self-conscious that my teaching might be construed as preaching. Placing explicit expectations on them for action created a conflict in my mind that I was misusing my position.

However, my teaching did tend towards providing explicit and, by the nature of my delivery, implicit learning in a one-sided manner. Many students' unit (course) evaluations began to demonstrate the value of such teaching, with comments like, "Learning about the state of the world/sustainability issues enlightened us and gave us information we can use" and "I valued the range of sustainability topics… It made me see how science is related to everyday life and gave me an understanding of human impact". However, there would also be an occasional criticism with comments urging me to "keep [my] personal political views out of the classroom." Although these criticisms were by no means in the majority, these latter types of comments made me question whether I was misusing my position and authority as a means of propaganda.

23.7 Propaganda in Education

Russell (1932/2009) tells us that propaganda in education occurs when educators present information that, whilst may possibly be completely accurate, tends to be selective in its content and given at the exclusion of other existing, contrary, information. Russell also asserts, however, that it is impossible for educators to avoid propaganda, as attempting to do so would be an unnatural suppression of their personality. Foley (2004) also recognises the personal effect of the teacher, stating that: "anything educators do should be grounded in their values based on the deepest possible understanding of their work" (Foley, 2004, p. 10). Teaching and learning cannot be value-free; particularly in a world where all actions can have direct and indirect effects on others, and especially when these effects are often detrimental. As Foley states:

> Every technique you use, every theory you employ, has moral and political effects … Critical educational theory alerts us to the moral and political implications of educational interventions. It does so with an emancipatory intent. It is interested in learning and education that frees people from exploitation and oppression, and helps them develop their capacities and take control of their lives. It focuses on collective educational efforts in community and worker organisations, social action and social movements. (p. 16)

Foley's view helps us to see that propaganda, *per se,* is not the issue; but rather, as Russell (1932/2009) also recognises, that educators need to ensure they present more than just one side of any topic of controversy. This allows for transparency leading to critical reflection and personal decision-making. This decision-making and reflection should be couched not so much in science/technology content, which is useful for informing the decision, but rather, in ethical uses of science/technology so as to preserve interests of the wider public (Bencze & Carter, 2011). A further challenge for the educator is to move this sort of learning beyond what is known as the *interpretivist* approach to education. Interpretivism recognises social and cultural contexts associated with individual ideas and values; it does not critically examine the manner in which particular ideas and values are presented, how they

are shaped, or to whose benefit or detriment they affect. As Hodson (2010) recognises, these affects can be quite profound. Foley (2004) reports that:

> [a]ccording to Habermas and other critical theorists, the limitation of the interpretive framework is that it over emphasises the subjective dimension of knowing and learning, and pays insufficient attention to the ways in which our understandings are shaped by the structure and culture of the institutions in which we live and work. (p. 14)

Critical theory recognises ways in which understandings are shaped. It acknowledges inter-relationship between theory, ideology and power (Foley, 2004) and, thus, allows for emancipatory intent of more democratic education. This is similar to how Bourdieu (1984) describes formation and re-shaping of habitus. It is inter-relationships between social and cultural dimensions that influence dispositions of habitus within a given social-cultural field and critical reflection on these influences and dispositions that can re-shape it. Such emancipatory approaches to education also align with conceptions of *new learning*. New learning also aspires for emancipation, which Kalantzis and Cope (2008) say is about making the world a better place, rather than settling for encouraging students to do their best, as if somehow they are bound by prevailing social conditions in which they live. An education aspiring to such an outcome requires promotion of voice, choice and ownership (Gallavan & Webster-Smith, 2012). This means giving each person opportunities to express themselves and be heard; the right to select from a range of possible outcomes, so long as rights of others are safeguarded in any selection; ownership and responsibility for what is expressed, choices that are made, and subsequent actions that follow (Gallavan & Webster-Smith, 2012).

23.8   An Application of Activist Teaching

In an attempt to develop my teaching to better reflect an activist framework, I used my growing knowledge and awareness in the design of a unit (course) for futures learning. In this unit, I worked with two colleagues to implement Mezirow's (1991) transformative learning. This was my first experience of planning for intentional teaching of activism. It was also the basis of a small research grant through which we collected data about types of triggers and actions to which students reported committing, or intending to commit, as a result of their learning. Results of this study were limited (see Carter, Castano & Jones, 2014) in that there were some personal actions taken up as a result of the unit (e.g., greater awareness and commitment to buying free-range chicken/eggs); but, overall, impacts appeared minimal. A second iteration of the study in 2013, demonstrated more substantial commitments to personal action, including two students who reported becoming vegetarian as a result of information about (1) the impact of meat-eating on the environment and/or (2) because of animal cruelty. In fact, I also became vegetarian as a result of this work and, two years after that, vegan. Three years later, the lasting affects of this work have led to my ongoing commitment to a vegan lifestyle.

Interestingly, my personal action to become vegetarian and later, vegan, and tak-ing other personal actions based on my developing ethics and values, has once again made me self-conscious as to how my teaching might be interpreted. I am fearful that my students will see my choice of content and strategies as a judgment on them and/or a form of recruitment into a lifestyle similar to my own. As a result, I com-municate to my students less than I normally would about my own personal stance on particular issues or, if I feel that I am expressing an opinion that tends one way over another, I try to be explicit that this is what I am doing. Otherwise, I now teach passionately and overtly ideas for and against a range of issues, particularly those concerned with sustainability and animal cruelty. Outside of the two-cycle experi-ence of teaching explicitly for action using Mezirow's (1991) transformative learn-ing, however, I have still not developed a strong emphasis of Hodson's (1994) Level 4 of sophistication: Preparing for and taking action on socio-scientific and environ-mental issues in my individual teaching.

Recently I collected some feedback from students participating in my third year core science unit in a Bachelor of Early Childhood and Primary Education; and my second year Bachelor of Education (Primary) course. The 12-week unit focused on energy for a sustainable future and other sustainability issues, such as food security, access to fresh water, waste production and climate change. When asked whether learning in the unit had inspired them to take, or consider taking, any action in regard to any of the socio-scientific issues covered in the unit, a range of small to medium personal actions were reported. These included types of actions that are easily implemented, like conserving energy through reduced electricity use; not over-filling the kettle when boiling water; buying Australian-made products where possible to reduce embodied energy; and buying locally grown/farmed foods where possible to reduce food miles. The embodied energy of products appeared to have been one of the most significant topics, with many students indicating never having thought about/realised this issue before. They felt, generally, that their everyday consumer choices were something on which they could easily improve. Some of the statistics around food wastage were also quite powerful and many indicated that they had taken measures to reduce their food waste and, for the food waste they did generate, they had started composting, with a few reporting that they had estab-lished worm farms.

The more substantial actions mentioned included two students who decided to become vegetarian and one, who was already vegetarian, deciding to become vegan. A further five claimed to have reduced the amount of meat in their diet from daily consumption to between two and four times per week. These sorts of actions were not necessarily sought-after, and I am not advocating that these are in any way cov-eted forms of action. They are, however, substantial in that they can be more chal-lenging to adopt and are generally less likely to emerge as an outcome, especially when unsolicited. They demonstrate that raising awareness and encouraging per-sonal reflection in general teaching can influence changes in the dispositions of some people in quite substantial ways. However, it is worth noting that each of the people involved (including myself) were already part way through the thinking pro-cess about making such a change. Collectively, the personal actions reported

reflected that there was a range of more informed, effective measures and behaviours towards a more sustainable lifestyle. Some also mentioned that they had begun taking part in signing activist petitions and trying to influence their family and friends to take similar actions to themselves.

23.9   Conclusion and Future Implications

Overall, there was a strong sense from the feedback provided that there had been considerable increases in knowledge and awareness reflecting Hodson's (1994) Levels 1 and 3 stages of sophistication, and some evidence of Level 4 action; and, even though this had not been an explicit requirement of the unit, it did appear to come about as a consequence of the learning. This is perhaps an outcome of what Russell (1932/2009) terms "herd education" where: "every collection of human beings in close proximity develops a herd feeling, which is shown in a certain instinctive uniformity of behavior" (p. 60). There was a general consensus of attitudes and opinions voiced throughout the semester in a variety of forms (lectures, discussions, student presentations, online blogs) that could be representative of this "herding".

These results have further inspired my thinking about my teaching. They demonstrate the beginnings of a shift in the disposition of many of the students involved. Thus, explicit teaching and raising awareness, not just of STSE issues, but also of power and influence of those with vested interests in particular issues/actions, appears to have some effect on habitus. It suggests also, that science teacher education framed in certain ways can create particular social fields that, in turn, affect dispositions and habitus of students involved towards a socio-eco-activist field. It is not just what was presented that was highly valued, but also how it was presented and approached that was important.

Results here have engendered in me both a sense of relief from my fear that my teaching would be viewed as preaching and a sense of inspiration to further this style of teaching. At the end of the semester, I mentioned to my students that I was concerned about 'preaching' rather than teaching, and I would be interested in any comments that they wanted to add to their unit evaluations about the matter. A number did comment and indicated that my teaching was inspiring and not at all commensurate with preaching. This has certainly assisted my confidence and intensified my commitment to pursue a teaching agenda that does require more explicit forms of socio-eco-activist education. STEPWISE appears to serve as a useful framework to pursue such an agenda.

Implications of the journey to date are that I am more committed and more courageous about delivering an activist science teacher education. Critical analyses of my practice, undertaken through self-reflection, student feedback and reviewing literature in the field, has also been influential in my thinking about how I might undertake activist science teacher education in future. It seems likely from the journey to date, that I have potential to affect dispositions/habitus of my students by

creating a social field that focuses on equity, justice and wellbeing for all people and for nature. The tetrahedral framework of STEPWISE will also be useful in helping me place action at the centre of my teaching, although I will be interested to compare impacts of more indirect approaches to activism I have recently taken with more direct and explicit activist approaches I am planning and that is promoted through STEPWISE. I wonder if explicit identification of my hesitation and concern about 'preaching' is perhaps beneficial in creating a sense of concern that it not be construed this way that subsequently engenders the opposite effect. It is also important to avoid propagandist approaches described by Russell (1932/2009) by ensuring both sides of arguments are exposed and explored. The student research aspect of STEPWISE can certainly allow for this, as does the opportunity to critically reflect on results of this research. As Gallavan and Webster-Smith (2012) recognise:

> By giving teacher candidates rich opportunities to reflect within themselves and to design the tapestries that tell their stories, each teacher can find her or his personal power by discovering voice to choose the option that yields choice, ownership and action for societal change. The change may be global or local, public or private, loud or quiet, grandiose or humble. All the same, their actions can overcome situational boundaries and not allow conditions to thwart their positions. (p. 55)

Investigating these wonderings will form bases of my ongoing journey towards a new vision for science teacher education or, perhaps, a Vision IV for scientific literacy, one that is concerned with education as socio-eco-activism.

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