

Specifying a curriculum for biopolitical critical literacy in science teacher education: exploring roles for science fiction

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Abstract In this essay I suggest some ways in which science teacher educators in Western neoliberal economies might facilitate learners' development of a critical literacy concerning the social and cultural changes signified by the concept of *biopolitics*. I consider how such a biopolitically inflected critical literacy might find expression in a science teacher education curriculum and suggest a number of ways of materializing such a curriculum in specific literatures, media, procedures, and assessment tasks, with particular reference to the contribution of science fiction in popular media.

Keywords Biopolitics • Curriculum • Popular media • Science fiction

From educational ideas to curricula

More than three decades ago, the late Lawrence Stenhouse (1980, p. 41) issued the following challenge to advocates of particular interventions in educational programs:

All educational ideas must find expression in curricula before we can tell whether they are day dreams [sic] or contributions to practice. *Many educational ideas are not found wanting, because they cannot be found at all.*

If someone comes along asking you to adopt an idea or strive after an objective: political maturity or basic literacy, ask him [sic] to go away and come back with a curriculum. Or give you a sabbatical to do so for him. What does 'Back to Basics' mean? What books? What procedures? What time allocations? What investments? (my italics).

This essay is a response to this issue's editors' call for 'examinations of how biopolitics is shaping science education' (Lyn Carter, pers. comm. 25 February 2014), which necessarily implies normative questions as to whether neoliberal biopolitics *should* shape science education and, if so, *how*? Several science educators, including Jesse Bazzul (2014), Lyn Carter (2014), and Clayton Pierce (2012) have answered the first part of this question, very persuasively, in the affirmative and, like a number of other education scholars, notably Henry Giroux (2006, 2008, 2009) and Tyson Lewis (2007, 2008, 2009a, 2009c), provide cogent reasons for resisting neoliberal biopolitical priorities in education. However, with the possible exception of Pierce, I do not see these authors as satisfying Stenhouse's desideratum to 'come back with a curriculum'. Bazzul and Carter certainly provide ample theoretical and ethical justification for a critical and activist stance in science education, as does Pierce (2015a, 2015b) in two subsequent articles describing work he conducted with seventh and eighth grade science students, teachers, and community members to develop a biopolitically critical scientific literacy informed by actor-network theory (ANT) focused on community activities (such as learning gardens) and controversies around

genetically engineered food products. I strongly support the approach Pierce models in these papers, which could readily be adapted to science teacher education, but he does not specify a curriculum – either for schools or teacher education – in the way Stenhouse recommends. For example, all of the authors named above locate their understandings of biopolitics in Michel Foucault’s analyses of neoliberal governmentality, beginning with his argument in *The Order of Things* (1970), that developments in political economy and the life sciences should be understood as entangled and mutually constitutive events, which he elaborates in his lectures at the Collège de France between 1975 and 1979 (Foucault, 2003, 2008, 2009). Other theorists to whom some or all of them refer include Giorgio Agamben (1998, 2005), Michael Hardt and Antonio Negri (2000, 2004, 2009), and Thomas Lemke (2011). I assume that these and other philosophical works would inform the curriculum decisions that these science educators make in teaching their students, but such an assumption does not constitute a curriculum specification.

A scenario

For the purposes of this essay I imagine that I am participating in teaching a graduate science teacher education program in a Western neoliberal economy such as Australia or Canada (I choose these two nations because they are the locations in which I have had the most substantial experience of teaching graduate programs with Anglophone teachers. However, my thinking about biopolitics in relation to science education is also inflected by my experiences of undertaking research and professional development activities in China (mainland, Hong Kong and Taiwan), Iran, and Southern Africa). If the opportunity arose, I would be prepared to offer an elective course or module with a demand time of between 60 and 70 hours (in Australia, a course or module with this demand time might be of one semester’s length with the class meeting for two hours per week, with the assumption of at least two hours per week of out-of-class reading and writing). I realize that the politics of participating in the design of a graduate science teacher education program would require me to ‘sell’ the idea of such a course or module to colleagues (and eventually to students). What follows is my attempt to specify a curriculum for developing biopolitical critical literacy in science teacher education in terms that are specific enough to convince colleagues that this is not a ‘daydream’ but, rather, constitutes a contribution to good practice in science teacher education.

Curriculum design

I argue in detail elsewhere (Gough, 2013) that the widespread adoption of ‘constructive alignment’ (Biggs, 1996) as a curriculum design principle in higher education is inherently oppressive. The doctrine of closely aligning learning activities and assessment tasks with intended learning outcomes recycles and reinscribes the early 20th Century orthodoxies of Anglophone (and chiefly US-centric) curriculum development literature inspired by Frederick Winslow Taylor’s (1911) principles of ‘scientific management’ and exemplified by Franklin Bobbitt (1928) and Ralph Tyler (1949), which persisted until Joseph Schwab’s (1969) challenge to this dominant discourse was taken up by the diverse group of curriculum scholars for whom William Pinar (1975) coined the term ‘reconceptualists’. Constructive alignment, like the curriculum development models that precede it, presumes that curriculum components, such as intended learning outcomes, learning/teaching activities, and

assessment tasks interact as elements of a simple system. With reference to Ted Aoki's (2005 [1985/1991], pp. 159-160) characterization of teaching as 'indwelling between two curriculum worlds', namely curriculum-as-plan and curriculum-as-lived, I prefer to assume that a lived curriculum is a complex system that is open, recursive, organic, nonlinear and emergent. Reconceptualizing curriculum, teaching and learning in complexivist terms foregrounds the unpredictable and generative qualities of educational processes, and invites us to value that which is unexpected and/or beyond our control. Pre-specifying learning outcomes, and attempting to align them tightly with learning/teaching activities and assessment tasks, enforces a form of complexity reduction directed towards predictability and control. Complexity offers ways to think about educational inputs and outcomes that do not assume that causal relationships between them are, or should only be, instrumental. Complexity invites us to consider that many educational processes *should* be characterized by gaps between 'inputs' and 'outputs'. In Gert Biesta's (2004) terms, these are not gaps to be 'filled' but *sites of emergence*. As Jeffrey Goldstein (1999, p. 49) writes, emergence 'refers to the arising of novel and coherent structures, patterns, and properties during the process of self-organization in complex systems'. In other words, many 'outcomes', 'products' and effects of teaching and learning – knowledges, understandings, individual subjectivities, etc. – emerge (and *should* emerge) in and through educational processes in unique and unpredictable ways. Therefore, I think of curriculum design as a tentative plan for creating conditions that, in my judgment and experience, provide possibilities and opportunities for the emergence of unique and unpredictable outcomes. I am aware that any course that I teach is likely to be embedded in a context within which a majority of other courses that students experience will have been developed by reference to the tenets of constructive alignment, in response to which I will deliberately (and openly) deploy tactics of *deconstructive nonalignment* (for an elaboration of these tactics see Gough, 2013).

Encouraging emergent outcomes

I think of the activity of teaching in similar ways to Pinar (2011, p. 1):

I present what has been written on the subject I am trying to teach, invite [students'] comments and questions, and in the process try to contribute to the conversation. As a teacher, I am not trying to implement 'objectives' or be 'effective', to make an 'impact', something better left to tanks or think tanks. As a teacher, my commitment is to informing students about the subject they are studying...while helping them to understand it...Rather than devising an 'airtight' argument, I deliberately cut 'holes' in the curriculum-as-plan to enable students to breathe, thereby creating space and encouraging voices.

The only 'objective' that I could authentically share with students of this hypothetical course is that I expect them to explore, in some productive way, the conceptual territory shared by neoliberal biopolitics and science education and to provide me with some material evidence (in a medium of their choice) of their explorations. To this end, I would specify an indicative (but not restrictive) range of resources that could assist them in exploring this conceptual territory and suggest (not prescribe) a variety of ways in which they might be able to demonstrate the products of their explorations. My approach is consistent with the late Garth Boomer's (1982) principle of negotiating the curriculum with learners, which includes being honest with students

about what is non-negotiable (such as institutional requirements for assessing and reporting student achievement by reference to prescribed protocols and codes).

In teaching any course of study, my usual practice is to begin negotiations with students by clarifying my position on how they can provide evidence of satisfying the institutional requirements for their attendance and participation and the expectation that, at the conclusion of the course, I will be able to submit results in whatever form the institution requires. My default position typically takes the form exemplified in Figure 1 below, which is a facsimile of the assessment details that I specified when teaching course ED-B591 Narrative and Educational Inquiry in the Masters Program in Curriculum Studies at the University of Victoria, Canada, in 2000. I would of course adapt the wording of the second bullet point to reflect the subject matter of this hypothetical course and then invite (and respond to) any questions that students might have about my approach to assessment.

Assessment outline

I require *evidence* that you have engaged (in productive/constructive/generative ways) with the subject matters of this course, as indicated by the recommended (and your choice of wider) readings. *My suggestions* for what you might do to provide such evidence are outlined below. If you have other suggestions, I will be pleased to negotiate them with you. Unless we agree otherwise, I will expect you to:

- actively participate in class discussions/activities; this should include an individual seminar-style presentation
- write an essay of approximately 2000 words (or a negotiated equivalent in another medium) in which you demonstrate your developing skills and understandings in a form of narrative-based inquiry

FIGURE 1: ASSESSMENT OUTLINE FOR ED-B591 NARRATIVE AND EDUCATIONAL INQUIRY, UNIVERSITY OF VICTORIA, CANADA, SUMMER 2001

My experience has been that this open-ended way of framing assessment facilitates emergent, unpredictable outcomes by encouraging students to explore a topic through processes that I have described and exemplified elsewhere in terms of ‘making a rhizome’ (Gough, 2006) and ‘becoming nomadic’ (Gough, 2007). Thus, I would neither model nor suggest that students should undertake any kind of systematic review or appraisal of ‘what has been written on the subject’ of neoliberal biopolitics but, rather, would present them with an array of readings and other resources and encourage them to wander among them and ‘play’ with connecting them in productive ways. For reasons that will become clear in what follows, I would encourage students to commence their explorations of biopolitics by focusing initially on a relevant example of science fiction – or what I prefer to call SF – in popular media. As Donna Haraway (1989, p. 5) explains, SF designates ‘a complex emerging narrative field in which the boundaries between science fiction (conventionally, sf) and fantasy became highly permeable in confusing ways, commercially and linguistically’; SF designates ‘an increasingly heterodox array of writing, reading, and marketing practices indicated by a proliferation of “sf” phrases: speculative fiction, science fiction, science fantasy, speculative futures, speculative fabulation’.

It is difficult to represent a curriculum conceived rhizomatically or nomadically in a linearly organized text. Therefore, I suggest that readers who are already familiar with

the academic literature of biopolitics (as represented by Foucault, Agamben, Cooper, Hardt and Negri and Lemke) and who are also comfortable with what Katherine Hayles (2012, p. 68) calls fast or hyper reading that relies on sporadic sampling (as distinct from close reading, which requires deep attention and characterizes much academic research), initially skip the sections of this essay that deal directly with these authors, and go straight to the subsection focused on *The LEGO Movie*, which demonstrates how the work of academic authors like these can be interpreted by reference to a popular SF text. Although I realize that many academic authors hope that the texts they produce will be read closely by their peers, I do not share that expectation. Indeed, I subscribe to the spirit (but not the letter) of Umberto Eco's (1984, p. 7) dictum: 'the author should die once he [sic] has finished writing. So as not to trouble the path of the text'.

Presenting 'what has been written on the subject': a schematic overview

I agree with Pinar (2011), as quoted above, that a defensible way to begin teaching a given course of study is to 'present what has been written on the subject', which in practice means making deliberate selections (in terms of sample, scope and sequence) from a vast quantity and variety of materials, given that 'what has been written' on the subject of biopolitics in the broadest sense encompasses not only academic texts but also works of visual and literary art and popular media. As already noted, I do not consider that it would be desirable to provide students with a systematic or comprehensive review of these materials, but neither would it be possible for me to do so within the constraints that are likely to apply to the delivery of the course I envisage (such as the time and library/media resources available to me and the students). To provide an overview of the materials that I believe should merit students attention, I suggest that 'what has been written' on the subject of biopolitics as it is presently understood can be represented by three types of material:

1. Materials relating to the gestation of concepts of neoliberal biopolitics in Michel Foucault's work;
2. Academic materials produced in the wake of Foucault's work that interpret and critique neoliberal biopolitics in relation to early twenty-first-century scientific, economic, political, social and educational practices;
3. Selected examples of SF that invoke, interpret and interrogate contemporary manifestations of neoliberal biopolitics in popular media, together with the academic (and fan) commentaries that they generate.

In the sections that follow, I suggest some specific ways of acquainting students with these materials and indicate which of these materials I would present as recommended readings. Any materials mentioned in the following sections that are not specified as recommended can be regarded as wider reading. Although I will discuss the materials in the sequence indicated above, I do not necessarily regard this as the sequence in which I would eventually present the materials to students. The sequence I enact will be a matter for negotiation with the particular cohort of students that I encounter. I suspect that some science educators will be tempted to see the above sequence as representing a logical, historical progression of ideas, which might indeed appeal to students who prefer the security of logical sequences. However, as I will explain in more detail below, I would follow a brief introduction to Foucault's work by providing an overview of what readers can expect to find in the recommended

academic materials produced in the wake of his work, and then suggest that their further reading be selected in response to their choices of particular works of SF for further exploration.

Materials relating to the gestation of concepts of neoliberal biopolitics in Michel Foucault's work

I thought I could do a course on biopolitics this year... But it seems to me that the analysis of biopolitics can only get under way when we have understood the general regime of this governmental reason I have talked about, this general regime that we can call the question of truth, of economic truth in the first place, within governmental reason... only when we know what this governmental regime called liberalism was, will we be able to grasp what biopolitics is (Foucault 10 January 1979; quoted in Foucault, 2008, p.21).

Much of what has been written about biopolitics in relation to science invokes Foucault's work, and I would therefore begin by recommending that students read François Ewald and Alessandro Fontana's Foreword to *The Birth of Biopolitics* (Foucault, 2008, pp. xiii-xvii), which describes the historical and institutional context for Foucault's lectures at the Collège de France, including quotes from a journalist's description of the atmosphere at Foucault's lectures, which provides readers with a palpable sense of history in the making and of Foucault as a living teacher and researcher rather than a lifeless name on a page. I would also recommend that students read at least the first lecture, to get a sense of Foucault's voice, method and style of historical scholarship, but would not spend much more time with the contents of this volume, because I suspect that students will be more interested in moving fairly quickly to considerations of what biopolitics has become in the context of contemporary scientific, economic, political, social and educational practices, rather than poring over Foucault's detailed historical analysis of its gestation in the increasing extent to which the bodies of citizens became objects of governance from the late seventeenth century to his then present time. As the following passages make clear, Foucault (2008, p. 78) only partially achieves the intentions of his 'course on biopolitics' as he stated them in lecture four (31 January 1979):

subject to the qualification that I might change the plan... I hope we can study successively the problem of *law and order*, the opposition between the state and civil society... and then, finally, if I am lucky, we will come to the problem of biopolitics and the problem of life. Law and order, the state and civil society, and politics of life: these are the three themes that I would like to pick out in this broad and lengthy history of two centuries of liberalism (a translator's note describes the italicised words as being 'in English in original' [Foucault, 2008, p. 78]).

As Foucault (2008, p. 185) admits in lecture eight (7 March 1979), in the remainder of the course he actually deals with only the first two of the three themes he specifies above:

I would like to assure you that, in spite of everything, I really did intend to talk about biopolitics, and then, things being what they are, I have ended up talking at length, and maybe for too long, about neo-liberalism.

Academic materials produced in the wake of Foucault's work that interpret and critique neoliberal biopolitics in relation to early twenty-first-century scientific, economic, political, social and educational practices

At the time of writing this essay, presenting what has been written on the subject of biopolitics necessarily requires making a selection from a burgeoning field of literature and other media. In their briefing notes to prospective authors, the editors of this issue drew particular attention to two relatively recent academic works, namely, Melinda Cooper's (2008) *Life as Surplus: Biotechnology and Capitalism in the Neoliberal Era*, and Thomas Lemke's (2011) *Biopolitics: An Advanced Introduction*, to which I would add Roberto Esposito's (2008) *Bios: Biopolitics and Philosophy*, as being equally worthy of attention (Lemke's book was first published in German under the title, *Biopolitik zur Einführung*, in 2007, which means that these three books are more or less contemporaneous). Without going into excessive detail here, I would present to students, in summary form, what I see as each book's claims to represent the state of the art in relation to current scholarship on biopolitics, and the various theoretical perspectives that each author brings to bear on the object of their inquiries (in broad terms, Lemke's is Foucaultian, Cooper's is post-Marxist, and Esposito's is deconstructive). To provide students with some guidance for their further reading, I would produce my own annotated bibliography of the texts discussed in this section and recommend that they consult Miguel Vatter's (2009) perceptive essay review of Cooper, Lemke and Esposito. I would also draw attention to some other authors that Vatter cites, such as Giorgio Agamben (1998, 2005), whose concepts of *bare life* and *the camp*, as elements of his theorization of biopower, invite scrutiny of neo-liberal and humanitarian perspectives on issues of belonging, subjectivity, and social inclusion/exclusion. For example, if I was teaching the course in Australia at the present time, I would certainly recommend that students read Michalinos Zembylas's (2010) very effective use of Agamben's work, and urge them to consider the implications for curriculum and pedagogy that, as Zembylas explains, arise from violations of human rights and the politics of fear produced by nations, such as Australia, that impose harsh laws against immigrants, refugees, and asylum seekers.

As Vatter (2009, n.p.) points out, although Cooper, Esposito and Lemke adopt different theoretical perspectives on biopolitics, these authors 'share the premise that a condition of possibility for the emergence of biopolitics is the connection of biological life to the idea of surplus'. Foucault (1981, p. 143) alludes to the idea of surplus life when he warns, following his characterization of biopolitics as a power-knowledge, that 'it is not that life has been totally integrated into techniques that govern and administer it; it constantly escapes them', which suggests that the idea of surplus life has a negative sense (analogous to 'surplus value' in the Marxist critique of political economy) and an affirmative one (where life's excess can be a source of resistance to power-knowledge).

From my standpoint, the chief merit of Lemke's work lies in his elucidation of the complex genealogy of 'biopolitics', which predates (by at least 50 years) Foucault's adoption of the notion (see Michael Lait, 2012, p. 201). Although Lemke's tracing of how the concept of biopolitics was deployed before and outside of Foucault in a number of intellectual and political contexts (primarily focused on Germany) is of historical interest, I suspect that science education students will find more relevance in Esposito's and Cooper's more overt deployment of scientific concepts and examples.

My working life as an educator is bookended by biology (the main focus of my undergraduate studies and early years as a teacher and teacher educator) and poststructuralism (the philosophy that has most influenced my work in curriculum theory and research methodology) and these two influences on my thinking dispose me to find Esposito's work the most useful of the three books Vatter reviews. Esposito deploys the concept of 'immunization' to simultaneously politicize the biological and biologize the political in his development of an affirmative biophilosophy of the relations between individuals and their communities. Esposito's starting point is his uncertainty about Foucault's understanding of biopolitics as part of the evolution of governmentality in the West: In Vatter's words, is it 'the last mask of sovereign power', or does it 'effect a radical break with the logics of sovereignty'? Esposito (2008, p. 39) writes:

How do we account for the outcome obtained in modernity of the mass production of death? How do we explain that the culmination of a politics of life generated a lethal power that contradicts the productive impulse?... How is it possible that a power of life is exercised against life itself?... There have never been so many bloody and genocidal wars as have occurred in the last two centuries, which is to say in a completely biopolitical period... Why does a power that functions by instilling, protecting, and augmenting life express such a potential for death? It is true that wars and mass destruction are no longer perpetrated in the name of a politics of power – at least according to the declared intentions of those who conduct these wars – but in the name of the survival itself of populations that are involved. But it is precisely what reinforces the tragic aporia of a death that is necessary to preserve life, of a life nourished by the deaths of others, and finally, as in the case of Nazism, by its own death.

Esposito (2008, p. 45) attempts to explain how and why biopolitics turns out to be a politics of death, and how it could be reformulated otherwise. For Esposito, a 'paradigm of immunization' connects life to politics: 'Rather than being superimposed or juxtaposed in an external form that subjects one to the domination of the other, in the immunitary paradigm... life and politics, emerge as two constituent elements of a single, indivisible whole that assumes meaning from their interrelation'. On this point, Frédéric Neyrat (2010, p. 32) argues that 'Esposito pulls off a conceptual masterstroke: *in bio-politics, the hyphen is immunological*'. That is, Esposito sees contemporary biopolitics emerging as an autoimmune response to the immunizing strategies established by neoliberal political thought, in which the protection of life is seen as a central imperative. Neyrat (2010, p. 34) uses a recent example of US political controversy to demonstrate how Esposito's conceptual system enables us to understand how our societies function:

Think, for example, of the difficulties that Obama faced when he was trying to pass his proposed health-care reform – they are typically immunological. Because people experience the State as an intrusive element, it is unconditionally rejected in the name of so-called individual liberty – a rejection that leads, however, to a situation in which millions of people, and in the end anyone who lives in the margins of existence (margins that are programmed, one should note, by our fatal, neoliberal 'risk societies'), are without medical protection.

Esposito argues that liberal lines of thinking set the bases of political order (under the names of sovereignty, property, and liberty) as functions of the preservation of life, but that attempting to mediate life and politics through categories of juridical order necessarily leads to a negative outcome – namely, the alienation of individuals from their commonality with others – that threatens the individual's life more than previously. He thus understands biopolitics in modernity as an attempt to immunize the individual from its liberal immunities, setting off massive auto-immunitary reactions. With respect to education, Lewis (2009b, p. 486) provides a very useful supplement to Esposito's work by analyzing the relation between the medical discourse of immunity and the practice of pedagogy 'to imagine the present state of education differently' and to suggest 'a new philosophical foundation for a positive and affirmative notion of biopolitical education that is no longer predicated on the dialectics of immunization'.

Esposito (2008, p. 12) introduces *Bios* with five vignettes that exemplify his thesis that 'it is no longer possible to disarticulate politics and life in a form in which the former can provide orientation to the latter'. Each vignette could function as a very generative and provocative focus for classroom discussion of the problematic articulation of politics and life, as the following passage, which introduces the first of these vignettes, demonstrates:

France, November 2000 A decision of the French Appeals Court opens a lacerating conflict in French jurisprudence... The court recognized that a baby by the name of Nicolas Perruche, who was born with serious genetic lesions, had the right to sue the doctor who had misdiagnosed a case of German measles in the pregnant mother. Against her expressed wishes, she was prevented from aborting. What appears to be the legally irresolvable object of controversy in the entire incident is attributing to small Nicolas the right not to be born. At issue is not the proven error of the medical laboratory, but rather the status of the subject who contests it. How can an individual have legal recourse against the only circumstance that furnishes him with juridical subjectivity, namely, that of his own birth?... If it is already problematic that a being can invoke his or her right not to be, it is even more difficult to think of a nonbeing (which is precisely who has not yet been born) that claims the right to remain as such, and therefore not to enter into the sphere of being (Esposito, 2008, p. 3).

The second vignette concerns the 'acute oxymoron' of the 'humanitarian' air bombardment of Afghanistan in November 2001 (two months after the September 11 attacks on the USA) during which 'both highly destructive bombs were released along with provisions and medicine on the same territory at the same time' (Esposito, 2008, p. 4). Another vignette refers to news from China, in February 2003, that 1.5 million Chinese in the Henan province had tested seropositive [for HIV and/or HCV], affecting more than 80% of the population in some villages. 'Unlike other Third World countries, the contagion does not have a natural or a sociocultural cause, but an immediate economic and political one. At its origin is not unprotected sexual relations nor dirty drug needles, but rather the sale en masse of blood, which the central government encouraged and organized' (pp. 5-6). There are eight such vignettes in total and, given their brevity (each could be reproduced on a single page) and generativity, I would go beyond merely 'recommending' them to students. I would provide copies of each vignette as a classroom handout and ask students (perhaps

working in a small group focusing on one of the vignettes) to discuss how each of them problematizes the articulation of politics and life.

Despite Vatter's (2009) assertion that Cooper, Esposito and Lemke share the view that a precondition for emergence of biopolitics lies in the connection of biological life to the idea of surplus, I did not find this particularly obvious in Esposito's text, which seems to exemplify Lemke's (2011, p. 116) assertion: 'On the whole, only very few studies that employ the term "biopolitics" have pursued the question of how the politicization of life is intertwined with its economization'. Cooper's (2008) book, which examines the relation between biological (re)production and capital accumulation in the US during the last thirty years, is a clear exception to Lemke's generalization. Cooper's (2008, p. 1) thesis is that 'neoliberalism and the biotech industry share a common ambition to overcome the ecological and economical limits to growth associated with the end of industrial production, through a speculative reinvention of the future'. I suspect that science education students might find Cooper's text the most approachable of the three I discuss here, not least because she supports her arguments with numerous specific examples drawn from the subject-matter sciences with which they are likely to be familiar.

According to Cooper (2008), the neoliberal economy became a 'bioeconomy' during the 1970s, when the influential Club of Rome Report on world futures (Meadows et. al., 1972) raised awareness of the limits to the growth of Fordist, industrial production and the risks it created for the continued reproduction of life on earth. Cooper (2008, p. 19) argues that the biotech revolution resulted from 'a whole series of legislative and regulatory measures designed to relocate economic production at the genetic, microbial and cellular level so that life becomes, literally, annexed within capitalist processes of accumulation'. Cooper (2008, p. 20) describes her starting point as 'classically Marxian: I take it for granted that the periodic re-creation of the capitalist world is always and necessarily accompanied by the reimposition of capitalist limits; that capitalist promise is counterbalanced by willful deprivation, its plenitude of possible futures counteractualized as an impoverished, devastated present, always poised on the verge of depletion'. For Cooper, the extraction of surplus value from biological life requires that life be manipulated, controlled, and then pushed beyond its 'natural' limits to generate a surplus of biological life. Examples include microbial life that thrives in extreme conditions, new immunitary devices, self-assembling artificial life forms, technologies of in-vitro fertilization and embryonic stem cell lines. Cooper argues that all this creation of biological life in excess of its limits is paid at the price of a deepening devaluation of human lives.

Other readings to which I would refer students include Henry Giroux's (2009) *Youth in a Suspect Society* and selected essays by Tyson Lewis (2008, 2009a, 2009c), all of which can be introduced to students via Gregory Bourassa's (2011) excellent essay review of them. I would add the science education articles/chapters by Bazzul (2014), Carter (2014) and Pierce (2012, 2015ab) together with two articles focused on curriculum studies writ large, namely, Ross Collin and Michael Apple's (2007, p. 435) 'Schooling, literacies and biopolitics in the global age' – which examines the 'production, commodification and leveraging of knowledge in educational and economic systems' in relation to Michael Hardt and Antonio Negri's (2000) conception of 'biopolitical production' – and William Reynolds' (2006) 'The devils in curriculum studies: multitudes and multiplicities', which also works with Hardt and Negri's (2000, 2004) conceptions of 'biopolitical' and 'multitude'.

Selected examples of SF that invoke, interpret and interrogate contemporary manifestations of neoliberal biopolitics in popular media, together with the critical (and fan) commentaries that they generate

I describe, defend and exemplify my long-standing rationale for privileging SF as a key resource for science education in a research monograph, *Laboratories in Fiction: Science Education and Popular Media* (Gough, 1993), which sets out my vision for what I called at the time of writing a postmodern science education, and which John Weaver (1999; 2010, p. 38) more recently characterizes as a ‘posthuman curriculum’. In *Laboratories in Fiction* I argue that the science textbooks and classrooms of late-20th century schooling are manifestations of a Newtonian worldview and a 19th century image of science as the study of material structures of simple systems. I provide evidence and examples to demonstrate that SF – in comics, books, movies, and popular music, offers more plausible representations of 20th century science as the study of informational structures of complex systems and more realistic representations of the ways in which contemporary scientists work. Scientists in SF are not the objective, value-neutral and apolitical creatures of textbooks who work in disciplinary silos but, rather, are more lifelike people who struggle with moral and political issues and improvise their interactions with other organisms, materials, machines, and colleagues in their own and other disciplines. SF should not be understood simply as what Catherine Hasse (2014, n.p.) calls ‘a motivating fantasy’, that is, as ‘bait’ on a ‘hook’ that lures and then lands learners in the flawed representational construct of late-20th century textbook science. Rather, I argue that SF gives imaginative form to the limits of our own constructed knowledge (and especially to what might lie beyond those limits) and is thereby a conceptual territory in which learners can explore ideas and issues that might be more significant to them than those presented in conventional science textbooks.

For present day science educators, I believe that the most relevant texts addressing biopolitical issues can be found in works of SF and the critical academic and fan literatures that they attract. Sherryl Vint (2011, p. 161) cogently outlines the relationship between SF and biopolitics in her editorial introduction to a special issue of *Science Fiction Film and Television*:

For Foucault, biopower has two interrelated objects of governance: the disciplined body of the individual subject and the managed citizenry, conceived on the aggregate level of the population. In twenty-first-century technoculture, both of these biopolitical objects are thoroughly colonised by subjects which once belonged entirely to the fictional realm. For example, bioethical debates over the status of emergent citizen/subjects, such as embryonic stem cells or ‘brain dead’ patients, challenge the ideas of what counts as life or death... At the same time, epidemics and their attendant panics – such as 2005’s spread of ‘avian flu’ and 2008’s H1N1, with their images of burning pyres of animals and airports filled with people wearing surgical masks – conflate the management of borders, disease vectors and agriculture trade with speculative fantasies about invader species and zombie plagues. Under biopolitics, life itself becomes the object of political governance, and political governance becomes the practice of steering the biological life of individuals and species. Technoscience, sf speculation and biopolitical practice converge in this context.

SF and material worlds are now so entwined that they cannot be understood in isolation, as Sarah Franklin (2007) demonstrates in her account of the ways in which Dolly – the now (in)famous cloned sheep produced at Scotland’s Roslin Institute in 1996 – is situated within a broader genealogy that stretches from the past (where did she come from?) to the future (what does she point toward?). Franklin (2007, p.3) emphasizes ‘the inseparability of the new biologies from the meaning systems they both reproduce and depend upon, such as beliefs about nature, reproduction, scientific progress, or categories such as gender, sex and species’.

In my imagined curriculum I would present to students some of my idiosyncratic selections of SF works that draw attention to and question contemporary manifestations of neoliberal biopolitics, and that have also attracted critical appreciations and commentaries that might help students to understand their relevance to, and implications for, science education. I make no apology for drawing students’ attention to particular works of SF that appeal to me and motivate me to seek critical appreciations of them. I believe that it is important for a teacher to model and exemplify whatever s/he exhorts students to do. In this instance, as I state above, ‘I want [students] to explore, in some productive way, the conceptual territory shared by neoliberal biopolitics and science education and provide me with some material evidence (in a medium of their choice) of their explorations’, and I believe that the most authentic way for me to model such an exploration is by demonstrating my enthusiasm for both the works of SF and the critiques of them that I privilege.

Running Wild (a novella by J.G. Ballard)

At the time of writing this essay, I would be likely to begin by recommending that students read (or listen to the audiobook of) J.G. Ballard’s (1988) novella, *Running Wild*, a text that is likely to be attractive to students because it is relatively brief (104 pages in print, 2.5 hours as an audiobook). Although Ballard’s work is often associated with SF, *Running Wild* exemplifies the literary distinctiveness of his work that led to the inclusion of the adjective ‘Ballardian’ in the *Collins English Dictionary* (2014), which defines it as ‘resembling or suggestive of the conditions described in J. G. Ballard’s novels and stories, especially dystopian modernity, bleak man-made [sic] landscapes and the psychological effects of technological, social or environmental developments’. Colin Greenland (1983, p. 93) characterizes Ballard’s early novels, such as *The Drowned World* (1963) and *The Drought* (1965), as ‘a sub-genre especially favoured by English sf writers: the catastrophe story’, but later works are more eclectic. For example, SF author and anthologist Bruce Sterling (1986, p. viii) cites Ballard as an important forebear of cyberpunk SF, literary theorist Brian McHale (1987, p. 69) describes Ballard’s novel, *The Atrocity Exhibition* (1970) as ‘a postmodernist text based on science-fiction topoi’ and Jean Baudrillard (1981, p. 119) hails Ballard’s *Crash* (1973) as ‘the first great novel of the universe of simulation’ (see also Gough, 2001).

Running Wild focuses on Pangbourne Village, a luxurious 32 acre residential estate for the upper middleclass, surrounded by a metal fence with an electronic alarm system, patrolled day and night by security staff and guard dogs, while the roads and the entrances to the homes are constantly monitored by television cameras. No one can enter the estate without an appointment. Its ten families are wealthy, respectable, 40-something couples with adolescent children on whom they lavish everything money can buy. The children attend the same private schools and spend their free time in the sports and recreational facilities provided on the estate. The residents of

the Village have little contact with the local community other than as a source for chauffeurs, housekeepers and other maintenance staff. The story unfolds as a series of excerpts from the forensic diaries of Dr Richard Greville, Deputy Psychiatric Adviser, Metropolitan Police, who notes: ‘there is an antiseptic quality about Pangbourne Village, as if these company directors, financiers and television tycoons have succeeded in ridding their private Parnassus of every strain of dirt and untidiness. Here, even the drifting leaves look as if they have too much freedom’ (Ballard, 1988, p. 7).

Despite the security measures, on 25 June 1988 all of the adults living and working in the Village, about thirty altogether, comprising owners and employees, are found massacred, but there is no trace of the residents’ children and at first it is surmised that they might have been kidnapped by the killers. In the course of investigating the case, Greville finds a home video, filmed by two of the children,

which at first sight appeared to be a matter-of-fact documentary of daily life at Pangbourne Village. Some seventeen minutes long, it was made with the happy cooperation of the parents, and adopts the style of a real-estate developer's promotional video. With its glossy color and tableau-like settings, it depicts the parents sitting in their drawing rooms, having dinner, parking their cars... There is a certain gentle leg-pulling at the parents’ expense...

Extracts of the film were shown to the parents and often screened for the benefit of visitors. However, the final version that secretly circulated among the children was very different. This carried the identical jovial sound track, but [the children who made the video] had added some twenty-five seconds of footage, culled from TV news documentaries, of car crashes, electric chairs and concentration-camp mass graves. Scattered at random among the scenes of their parents, this atrocity footage transformed the film into a work of eerie and threatening prophecy...

Seeing the film, I had the strong sense, not for the first time, of young minds willing themselves into madness as a way of finding freedom ((Ballard, 1988, pp. 71-2).

Greville concludes that the children themselves had carried out the massacre and interprets their mad gesture as an extreme attempt to escape from the prison of a perfect life:

By a grim paradox, the instrument of the parents’ deaths was the devoted and caring regime which they had instituted at Pangbourne Village. The children *had* been brainwashed, by the unlimited tolerance and understanding that had erased all freedom and all trace of emotion – for emotion was never needed at Pangbourne, by either parents or children.

Denied any self-expression, and with even the most wayward impulse defused by the parents’ infinite patience, the children were trapped within an endless round of praiseworthy activities – for nowhere were praise and encouragement lavished more generously than at Pangbourne Village, whether earned or not... Unable to express their own emotions or respond to those of the people around them, suffocated under a mantle of praise and encouragement, they were trapped forever within a perfect universe. In a totally sane society, madness is the only freedom (Ballard, 1988, pp.82-4; italics in original).

Providing students with the above synopsis of *Running Wild* might be sufficient information on which to base a discussion focused on why Pierangelo Di Vittorio (2006, p. 1) subtitled his brief but illuminating critical appraisal of the novella, 'Biopolitics told by J.G. Ballard' (the brevity of Di Vittorio's incisive commentary – four pages plus references – is another reason I would advance for recommending it for student reading). Di Vittorio begins by quoting the final sentence from the passage above – 'In a totally sane society, madness is the only freedom' – to which Di Vittorio adds: 'This is a dark and at first sight enigmatic statement, but it could be interpreted as a stunning synthesis of the relationship between health policies and the practices of freedom in modern history'. Di Vittorio (2006, pp. 1-2) continues:

Ballard's visionary novel sketches quite a precise outline of the polarity that runs through the history of public health. On the one hand there is a totalising tendency, the idea of a perfect control of society aimed at the maximum development of its vital potentials... Born as a technology aimed at developing the strength of the State to combat epidemics and, more generally, the dangers connected with urbanisation and poverty, social medicine has developed as a 'biosecurity' device loaded with authoritarian intervention: quarantines, sanitary cordons to protect privileged populations, [and] public aid policies aimed at the control and normalisation of the underprivileged classes.

Di Vittorio does not explicitly state what he sees as being on the *other* hand from the 'totalising tendency' he refers to above, but much of what follows in his brief commentary draws attention to the totalizing *effects* of neo-liberal governance of public health. He notes that the institutionalization of public health runs parallel to the emergence of new forms of popular resistance and suggests that the historic struggles of dissident groups protesting against the interference of the State in religious matters during the Middle Ages later took the form of antimicrobial uprisings that focused on questions concerning life and death, the right to fall ill, and to follow the medical treatment one prefers. Di Vittorio (2006, p.2) argues that the political project of a medicalization of health – from hygienism to contemporary epidemiology – manifests itself as a 'secular religion' of the modern world and that the secularist struggles of earlier times have given way to forms of political struggle against the excesses of medical governmentality. He draws particular attention to Matthew Ramsey's argument (2001) that the history of public health in Europe cannot be separated from that of various anti-hygienist movements, which have interwoven complex and different relationships with liberalism (and other political ideologies), depending upon the national and regional contexts in which these relationships were materialized (here I have paraphrased Di Vittorio's [2006, p. 2] summary of Ramsey's work, because Ramsey writes in French, and although my 'schoolboy French' is sufficient for me to be reasonably confident that Di Vittorio's summary is defensible, I provide full bibliographic details for Ramsey's [2001] text to enable Francophone readers to draw their own conclusions). The paradoxes that characterize different versions of liberalism have been manifested in both the promotion and rejection of public health policies and medical governmentalization in various locations and criticisms of public health embrace heterogeneous positions.

Di Vittorio also draws attention to an extreme position in biopolitics analyzed by science historian Robert Proctor (1999) in *The Nazi War on Cancer*, which documents the anti-smoking crusade conducted by the Third Reich after German scientists established the link between smoking and lung cancer prior to World War II. Proctor notes that the Nazi's conception of the German *Volkskörper* (people's body) and their

obsession with its long-term health, made them particularly keen to manage public health even if it meant making unprecedented public excursions into private spheres. The Nazis regarded Jews and the cancer to which they were perniciously compared as perils that could be managed and even eradicated if there was sufficient political will. The Nazis waged campaigns against alcohol and smoking and urged Germans to eat more whole-grain bread and foods high in vitamins and fiber, but as Proctor (1999, p 49) points out, what at first seems like a familiar campaign to educate the public was in fact the mobilization of private bodies to public ends: ‘Enlightenment in the Nazi era was not something you yourself strived to attain, but rather something you did to other people or other people did to you’. Proctor emphasizes that the Nazi administration of German health was but one element in a murderous racialized view of the world. The Nazis fought the war on cancer not least because their politics was premised on the possibility of segregating and eradicating what was racially and genetically alien. Moreover, the stress was always on the collective so that the *Volkskörper*’s health often obscured an indifference to individuals. For example, declining disability pensions in the face of an expanding workforce revealed that ‘Nazi leaders wanted a healthy workforce, but they were not always willing to help an injured worker’ (p. 84). Being sick or injured became more dangerous: ‘Inability to work could itself become a death sentence if there were any doubts about your “racial fitness”.’ (p. 83).

Di Vittorio (2006, p. 2) notes that despite Proctor’s precautions, ‘his work brings grist to the mill of those who radically dispute public health measures’ (p. 2) by portraying public health programs as assaults on individual freedoms. For example, in *For Your Own Good: The Anti-Smoking Crusade and the Tyranny of Public Health*, Jacob Sullum (1998, p. 274), a senior editor of *Reason* magazine, makes the unqualified assertion: ‘A government empowered to maximize health is a totalitarian government’ (*Reason* magazine [see <http://reason.com/>]) is a publication of the Reason Foundation, a US think tank that ‘advances a free society by developing, applying, and promoting libertarian principles, including individual liberty, free markets, and the rule of law’ [<http://reason.org/about/faq/>])

The account I have given above does not exhaust the features of Ballard’s (1998) novella, or of Di Vittorio’s (2006) response to it, that are relevant to science educators’ critical literacy concerning biopolitics, but it should be sufficient to indicate their potential generativity.

Orphan Black (television series)

After providing students with an example of exploring biopolitical questions and issues via a work of SF, I would invite students to reflect on their own encounters with popular media that engage this subject matter. For example, as I write this essay in 2015, I am confident that many students I am likely to be teaching will be familiar with the Canadian television series *Orphan Black* (Graeme Manson & John Fawcett, 2013-?). The series follows Sarah Manning, a street-wise con-artist who assumes another woman’s identity after witnessing her suicide. The stranger looks exactly like Sarah, who hopes to solve her problems by cleaning out the dead woman’s savings. This is the beginning of a convoluted mystery as Sarah realizes that she and the dead woman are clones and that there are more genetically identical individuals who were planted in unsuspecting birth parents and nurtured in completely different circumstances. Not knowing who created the clones, she needs to ascertain the reason quickly because an assassin is killing them one by one. *Orphan Black* interrogates the

speculative discourses of biopolitics by dramatizing familiar anxieties about cloning and human identity. It also addresses, in non-superficial ways, complex questions about patent law and corporate control of one's biology, personalized stem cell lines, the privatization of medicine and the relationships between science and the military.

Critical works of SF scholarship that address *Orphan Black* are beginning to be published and can readily be found via Google Scholar. I recommend Jimena Escudero Pérez's (2014) 'Sympathy for the clone' as a particularly useful supplementary resource for science teachers and teacher educators exploring biopolitical issues, because it draws attention to the tendency for 'clone fiction' to generate dystopian scenarios in which a community is oppressed and abused by scientific means and thus portrays science and its agents as evil. Pérez notes that, in the case of clone fiction, the inhumanity of the oppressive powers enhances the questioned humanity of the clones, a particularly complex and evolving type of character that is often commodified. Pérez analyses the 'evil science' construction and the semiotics of the human/clone identity it produces in *Orphan Black* and other selected SF works so as to expose typical patterns through which clone fictions produce both clone identities and intimations of scientific 'evilness'.

The LEGO Movie

In choosing further works on which to focus, I would be guided by students' reading/viewing histories. In my experience, especially in graduate programs, these can be quite diverse, varying with the mix of ages and cultural backgrounds. With mature age students, I also ask them to consider their children's media consumption experiences, because these may be particularly useful in thinking about media that will engage their own students. For example, many primary school-aged children (and their parents) will recently have seen the very popular computer-animated adventure comedy, *The LEGO Movie* (Phil Lord & Christopher Miller, 2014), which C.L. Sloan (2014, n.p.), a blogger who posts regularly on the website of the Digital Writing and Research Lab of the University of Texas at Austin, persuasively describes as a 'highly sophisticated commentary on politics, capitalism, gender and the body'. Sloan's interpretation of *The Lego Movie's* engagement with the specific ways in which politics intersects with everyday life draws not only on Foucault (2008) and Lemke (2011) but also refers to Gilles Deleuze's (1992) expansion of Foucault's understanding of disciplinary societies to accommodate 'societies of control' and to Hardt and Negri's (2000) further elaboration of Deleuze's concept in *Empire*. Sloan quotes Hardt and Negri's (2000, p. xv) argument that 'the passage to Empire and its processes of globalization offer new possibilities to the forces of liberation...The creative forces of the multitude that sustain Empire are also capable of autonomously constructing a counter-Empire, an alternative political organization of global flows and exchanges'. Sloan (2014, n.p.) thus interprets *The Lego Movie* as an illustration of how 'the positive biopower of the multitude stands in promising opposition to the restrictive biopolitics of Empire':

The movie follows Emmett, a regular old Lego figurine living out his normal life in an urban Lego landscape that looks suspiciously like a vision of corporate America. Up-beat, top-of-the-charts pop music assures the citizens of this Lego world that 'Everything is Awesome!' even as their leader, President Business, casually drops references about the end of the world and putting disobedient individuals 'to sleep'... Through a series of accidents, Emmett falls in with a

group of revolutionaries bent on taking President Business down, reuniting all of the various Lego worlds and liberating Lego citizens around the Lego globe. The revolutionaries are all ‘Master Builders’, individuals with the uncanny ability to take apart the tidily assembled Lego landscape in order to craft their own unique creations. Gradually, Emmett learns to delight in deviating from his rule book and the revolutionaries learn not to underestimate the ‘normal’, apparently brainwashed citizens of President Business's society. Ultimately, Emmett and the Master Builders rely on the creative powers of the masses in order to dismantle President Business's overly strict, rule-bound world. *The Lego Movie* can be read as a rather sophisticated allegory about using the master's tools (or Lego pieces) to effectively deconstruct the master's house. In just such fashion, the multitude might reconfigure Empire, turning their mutual citizenship into teamwork, their individualism into self-pride and their indoctrination into a weapon.

Sloan's conclusion that ‘*The Lego Movie*... seems practically created to serve as a fictional, highly stylized thought experiment for Hardt and Negri's liberation of the multitude’ invites a closer scrutiny of what Hardt and Negri's theorizing of the multitude overlooks. *The Lego Movie*'s target audience is children and their parents, but as Lewis (2008, p. 250) argues:

Hardt and Negri (2004) exclude from their list of political, economic, and social demands of the multitude any notion of education... Furthermore, Hardt and Negri lack any sociological, philosophical, or historical analysis of adult–child relationships within Empire. If the multitude is inclusive of difference, then why have children been left out of the equation? Certainly children make up the vast majority of the poor which Hardt and Negri describe as the disavowed center of global Empire. And if education is a major sphere for defining adult–child relations, why has this seminal activity been marginalized? How does this marginalization lose sight of children and young adults as resources for and active agents within the multitude?

As Bourassa (2011, p. 10) points out, Hardt and Negri's failure to acknowledge youth as agents of the multitude offers Lewis an opening to imagine a theory of education that retains the spirit of the multitude and its oppositional dimensions. Bourassa's synthesis of Giroux's and Lewis's efforts to rethink curriculum and schooling in relation to neoliberal biopolitics provides a useful springboard for science educators to think critically about the opportunities their particular curriculum specializations offer for assisting young people to ‘become central agents within the multitude’ (Lewis, 2008, p. 259).

Sloan's (2014) blog post is a readymade resource that, with the aid of a data projector, could readily be shared with science teacher education students in a classroom setting, working through her/his argument and questions, discussing these with students, and drawing attention to the readings discussed above that could help to illuminate the concepts Sloan deploys in her/his reading of *The Lego Movie*. I would point out that Sloan's blog post exemplifies the kind of exploration of biopolitics that I would hope they could produce in response to an SF work of their choice.

Many other popular SF works are ripe for the kind of treatment I provide for Ballard's *Running Wild* and that Sloan provides for *The Lego Movie*. The following examples are indicative, not exhaustive.

Alfonso Cuarón's film, *Children of Men*

Alfonso Cuarón's (2006) acclaimed film, *Children of Men*, is a dystopian SF set in 2027. After nearly two decades of global human infertility, humanity is on the brink of extinction. The UK is the only stable nation with a functioning government, but is deluged by asylum seekers fleeing the chaos and war endemic in the rest of the world. In response, the UK has become a militarized police state in which British forces round up and incarcerate immigrants in refugee camps. The 2007 DVD release includes a number of critical commentaries by scholars including Slovenian sociologist and philosopher Slavoj Žižek, who says, in part:

I think that this film gives the best diagnosis of the ideological despair of late capitalism. Of a society without history, or to use another political term, biopolitics. And my god, this film literally is about biopolitics. The basic problem in this society as depicted in the film is literally biopolitics: how to generate, regulate life. (a video clip of Žižek's comments can be viewed at www.youtube.com/watch?v=pbgrwNP_gYE).

Sarah Trimble (2011, p. 251) draws on what she calls Hannah Arendt's (1951) 'enigmatic principle of natality' and Agamben's (1998) concept of 'bare life' to provide a reading of *Children of Men* that foregrounds the figures of the reproductive female and the child as foci for biopolitical analysis. Trimble shows how differences between the plotlines of Cuarón's *Children of Men* and the novel by P.D. James (1992) from which it was adapted, expose fears about the relationship between race and reproduction (such as perceived threats to the reproduction of whiteness) that fuel what Zembylas (2010, p. 32) calls a 'hidden curriculum of fear' of immigrants, refugees and asylum seekers. I would invite students to consider the roles that science educators might play in exposing and destabilizing such a hidden curriculum.

The 'zombie apocalypse' in post-millennial popular media

Carter's (2014) essay on science education, neoliberalism and resistance links Foucault's lectures on biopolitics in the late 1970s with the Occupy Wall Street protests that began during September 2011 in New York City. Carter (2014, p. 30) invokes Deleuze and Guattari's now well known figuration of the rhizome in asserting that 'it is 'difficult to come to grips with...Occupy':

There is so much one could interrogate – from the protester demographics of the mainly highly-educated young White males and the concomitant elision and erasure of the racialised nature of inequality, to the information-age protest style with its own generator, YouTube™ videos, tweets, blog posts and help from hacktivist group *Anonymous*.

One characteristic of the Occupy Wall Street movement that Carter does not address is that many of the protesters coupled their political discontent with a specific aesthetic figuration by dressing as zombies (Daily Mail Reporter, 2011). A number of cultural and political commentaries describe neoliberal economics by reference to the zombie imaginary, including John Quiggin's (2010) *Zombie Economics: How Dead Ideas Still Walk Among Us*, David McNally's (2011) *Monsters of the Market: Zombies, Vampires and Global Capitalism*, and Chris Harman's (2012) *Zombie Capitalism: Global Crisis and the Relevance of Marx*.

For contemporary science educators, the biopolitics of zombie SF is perhaps best illuminated by comparing the early modern conception of the zombie exemplified in George A. Romero's (1968) film *Night of the Living Dead*, or its sequels, *Dawn of the Dead* (1979) and *Day of the Dead* (1985), with almost any of the post-millennial narratives that represent zombies as agents of an apocalypse. These include Zack Snyder's (2004) remake of *Dawn of the Dead*, Danny Boyle's (2002) *28 Days Later* and its sequel, Juan Carlos Fresnadillo's (2007) *28 Weeks Later*, and many others in various media (the sections of Wikipedia's entry on zombies that deal with the 2000s and 2010s and with 'zombie apocalypse' are very useful guides to this range of media).

Yari Lanci (2014, p. 25) argues that the figure of the zombie can be employed as 'a way of understanding our subjective position under a politico-economic framework dominated by neoliberal economics'. He notes that 'one of the most common tropes in zombie narratives is to take the end of the world for granted or as inevitable...[and] that the current economic and political subjectivation is something to be acknowledged as unavoidable' (Lanci, 2014, p. 26) and asks:

Is this really the case? In our perception of the End through zombie narratives, who interprets the role of 'us'? Are we the zombie subjectivized by neoliberalism? And what kind of zombies are we? Or are we the humans who try futilely to escape the living dead? And if so, how do we relate to the inescapable apocalyptic walking hoard of undead and the actual subjects zombies allegorically represent?

In response to these questions (all of which could be foci for discussion in a science teacher education course), Lanci focuses on the increased speed of zombies' movements apparent in post-millennial zombie narratives. Earlier representations of zombies depicted them as slow and lumbering, but the zombies that precipitate apocalyptic scenarios are more agile, vicious and intelligent. As Anna Froula (2010, p. 197) observes, since Boyle's (2002) *28 Days Later*, the living dead have shifted from being 'lurching ghouls to adrenaline-filled berserkers'. Through the lens of Foucault's analysis of neoliberal economics and its strong emphasis on the responsibility of the individual worker, Lanci reads the increased speed of zombies' movements in recent years as a metaphor of a particular economic and cultural conjuncture.

Daniel Drezner (2011, pp. 7-8) reads Romero's zombies as products of the social and economic climate of 1960s USA – as allegorical critiques of capitalism, racism, and American involvement in conflicts abroad. Lanci (2014, p. 30) elaborates:

in *Dawn of the Dead*, zombies gather and endlessly wander around different shops as a result of memory patterns of their previous state as living humans remaining attracted to one of the most powerful symbols of the American consumerist culture – the shopping mall. In this way, one could argue that Romero was trying to warn his spectators about the state of hypnosis caused by the intense regime of mass-production and consumption of commodities, encouraged by corporations. The typical sluggishness of Romero's undead reproduced the uniformity and massification of the majority of the Western population, half-hypnotized by TV and by consumer culture.

Steve Beard (2002, p. 78) points out that if the zombie film is ‘treated as a “dreamtext” with a political unconscious buried beneath a layer of critical defense mechanisms, then it is possible to see that the zombie is a figure of an expanding post-Fordist under-class filtered through a bourgeois imaginary of disgust’.

In many post-millennial zombie apocalypse movies, including Snyder’s (2004) remake of *Dawn of the Dead*, the slow shuffling of Romero’s zombies is replaced by frenetic running towards the living. Lanci (2014, p. 32) couches his interpretation of this shift in the language of Foucault’s biopolitics:

After *28 Days Later*, it is speed, not class or ethnicity, which is the trait that might provide an alternative understanding of the political relevance of the zombie. If Romero’s zombie hoard is the counterpart to the general image the director himself had of American culture – in political and economic terms – how are we to understand the increased speed of the living dead? Can we consider this increased speed as anything other than a symptom of a generalized anxiety about the kind of speed the *homo oeconomicus* must adopt in order to survive the neoliberal market?

One of the issues raised by Lanci’s analysis that should commend it to science educators is his re-examination of the work of French philosopher, Paul Virillio (1986), whose *Speed and Politics: An Essay on Dromology*, first published in 1977, introduced ‘dromology’ as the science, discipline and logic of speed. Virilio argues that human history is best understood through a focus on the technological progress enabled by militarization of society and the speed of the weapons employed. Virilio contrasts the speed of the projectiles used to defend the fortified cities of feudal societies with that of the ballistic missiles of capitalist systems and concludes that speed, rather than class or wealth, drives civilization’s progress.

Spin-offs from the popularity of zombie apocalypse themes in film, television and videogames include responses from government agencies and academics. For example, the US Centers for Disease Control and Prevention (2011) published a graphic novel, *Preparedness 101: Zombie Pandemic* that provides advice on surviving a zombie invasion as a ‘way of teaching the importance of emergency preparedness’. Mathematics researchers (e.g., Munz, et. al., 2011) have used theoretical zombie infections (modeled on biological assumptions derived from popular zombie movies) to test epidemiology-modeling methods that may be applicable to the spread of diseases with dormant infection. Zombies also inspired neuroscientists Timothy Verstynen and Bradley Voytek (2014) to write one of the best works of popular science I have read since Jack Cohen and Ian Stewart’s (1994) *The Collapse of Chaos*. Verstynen and Voytek combine tongue-in-cheek analysis with current knowledge of neuroanatomy, neurophysiology, and brain-behavior relationships to show how the zombies of popular culture can be understood in terms of contemporary neuroscience.

In contemporary SF zombies, like vampires, are no longer understood in the supernatural terms of earlier narratives but, rather, through scientific images of genetic mutation and viral contamination. Contemporary genomic science goes beyond the commodification of biological life into what Cooper (2008, p. 148) calls its ‘transmutation into speculative surplus value’. That is, the value of biotech commodities is now linked to the speculative fantasies of biocapital, such as anticipated therapeutic regimes or promises of targeted genetic modification, rather than to a material commodity or process. Thus, as Vint (2011, p. 165) argues:

biocapital goes further than previous modes of genetically modifying bodies to enact biopolitical governance (and capitalist accumulation): we have now entered an era in which biology has become a discourse of information, and the value established through the biotech industry is largely a value based on market projections. A strange reversal thus takes place: the tools and techniques of sf, a discourse able to make concrete and interrogate the future worlds anticipated in contemporary technoscientific production, have become the tools of technoscience itself.

Vint suggests that recent cinematic reimaginings of zombies might be understood as a kind of monstrous surplus of biocapital, a crisis of overproduction (of life) that becomes monstrous in the image of living-dead bodies. Cooper (2008, p. 125) argues that the postindustrial body, unlike the machinist body of the Fordist era, which was plagued by problems of fatigue, depletion, or entropy, is ‘more likely to be overcome by a surplus productivity that is indistinguishable from a surplus of life – that is, crises of overproduction or the dangerous, excessive vitality of cancer’. Thus, as Deleuze and Guattari (1977, p. 425) assert, ‘the myth of the zombie, of the living dead, is a work myth and not a war myth’.

Conclusion/confession and commencing in the middle of things

I usually resist writing a ‘conclusion’ because I agree with Susanne Kappeler’s (1986, p. 212) remarks:

I do not really wish to conclude and sum up, rounding of the argument so as to dump it in a nutshell on the reader. A lot more could be said about any of the topics I have touched upon... I have meant to ask the questions, to break the frame... The point is not a set of answers, but making possible a different practice.

So rather than dumping a conclusion on the reader, I will end with a confession, that some of my colleagues might regard as heretical: I am not a big fan of Foucault. My preferred French philosophers come earlier in the alphabet (Baudrillard, Deleuze, Derrida) or later (Guattari, Nancy). But by accepting the invitation to write this essay, I committed myself to engaging with Foucault’s unassailable role in constructing contemporary conceptualizations of biopolitics. For reasons that can probably be discerned from what I have written above about his lectures, I did not find Foucault’s work (or, rather, his way with words) to be particularly illuminating. But I am always disposed to accept assistance from like-minded colleagues, and I found my key to understanding Foucault’s delineation of biopolitics in Rob Cover’s (2011, p. 206) essay on *Star Trek: The Next Generation*:

Both dovetailing with and distinguishing itself from the power formations of (1) sovereignty, with its injunctions, prohibitions, kingly rights over life and death, juridico-legal system and mechanisms of domination (Foucault, 2003, p. 37; 2009, p. 3); and (2) disciplinarity, expressed through surveillance, supervision, inspections and the production of docile bodies (Foucault, 2009, p. 4), biopolitics governs through investigation, assessment and examination at the level of the demographic and statistical; it intervenes and regulates where necessary for

equilibrium and social modification, thereby producing a subject which is both in flux and flexible, different from the earlier historical deployments of power and knowledge (Foucault, 2009, p. 4). Biopolitics is thus a milieu of technologies which make multiplicities of individuals and arranges its field of intervention in order to produce subjects somewhat differently from institutional disciplinary power's docile bodies and, even more so, from the earlier sovereign power formation that produce identities through subjugation.

In the passage above, Cover clearly and succinctly specifies the characteristics of neoliberal biopolitics that science educators should address, such as interrogating cultural meanings of 'investigation, assessment and examination' as techniques of biopolitical governance and the ways in which these have been shaped by expressions of scientific disciplinarity. Foucault's Eurocentric historical analysis of the ways in which the bodies of citizens became objects of governance between the late seventeenth century and the 1980s is invaluable, but it does not speak to my experiences of life since by birth year (1944) with the immediacy provided by recollections of the *Star Trek* franchise films and television series. Cover's essay demonstrates how SF texts theorise, and provide allegories for, the construction and performance of identity, personality, change and development within the context of broader disciplinary social structures. His biopolitical reading of *Star Trek: The Next Generation* investigates the production of identity by exploring the ways in which governance systems produce subjects within the framework of the multiplicity of bodies, the competition of states and the neoliberal formation of the self as economic citizen.

The task I undertook in this essay was to respond to the underlying questions posed by the editors concerning the relationships between biopolitics and science education. To recall Stenhouse's (1980, p. 41) words, I have done this by attempting to 'come back with a curriculum' for science teacher education specified by questions such as: 'What books? What procedures? What time allocations? What investments?' I believe that I have been very specific about the books and other media that I would recommend as key resources for such a curriculum. I have indicated my preference for a time allocation, but recognize that time allocations (like investments) will necessarily be negotiated with teaching colleagues and administrators. I trust that I have also made it clear that I see the procedures that I would adopt are ones that are likely to produce emergent (rather than predictable) outcomes. The procedures that I describe and exemplify as 'making a rhizome' (Gough, 2006) accept that rhizomes have no beginnings or ends but are always in the middle; beginnings and ends imply a linear movement, whereas working in the middle is about 'coming and going rather than starting and finishing' (Deleuze & Guattari, 1987, p. 25). As Elizabeth St. Pierre (1997, p. 176) writes:

we must learn to live in the middle of things, in the tension of conflict and confusion and possibility; and we must become adept at making do with the messiness of that condition and at finding agency within rather than assuming it in advance of the ambiguity of language and cultural practice.

Elsewhere (Gough, 2006), I demonstrate how rhizomatic textual assemblages that commence in the 'messiness' of cultural materials that are readily at hand in our everyday lives can be used to generate questions, provocations, and challenges to dominant discourses and practices of contemporary science education. In this essay I

have tried to indicate that I would not present biopolitics to learners in a way that assumes beginnings (as the association of Foucault with ‘the birth of biopolitics’ suggests) or ends (as represented by contemporary SF allegories and critiques of neoliberal biopolitics). Rather, I would commence building a lived curriculum around biopolitics and science teacher education from the middle of the messiness constituted by the plethora of SF texts with which we (teacher and learners) are familiar.

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