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Tracing "Ethical Subjectivities" in Science Education: How Biology Textbooks Can Frame Ethico-Political Choices for Students

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Abstract This article describes how biology textbooks can work to discursively constitute a particular kind of "ethical subjectivity." Not only do textbooks constrain the possibilities for thought and action regarding ethical issues, they also require a certain kind of "subject" to partake in ethical exercises and questions. This study looks at how ethical questions/exercises found in four Ontario textbooks require students and teachers to think and act along specific lines. These include making ethical decisions within a legal–juridical frame; deciding what kinds of research should be publically funded; optimizing personal and population health; and regulation through policy and legislation. While engaging ethical issues in these ways is useful, educators should also question the kinds of (ethical) subjectivities that are partially constituted by discourses of science education. If science education is going to address twenty-first century problems such as climate change and social inequality, educators need to address how the possibilities for ethical engagement afforded to students work to constitute specific kinds of "ethical actors."

Keywords Ethics · Science education · Subjectivity · Foucault · Discourse · Textbooks · Biology

> *Words are never only words*, *they matter because they describe the contours of what we can do* (Žižek 2009, p. 109).

This study draws from poststructuralist notions of subjectivity (Butler 1997; Foucault 1982) to explore how ethical exercises and questions found in four Ontario secondary school biology textbooks work to discursively constitute a specific kind of "ethical subjectivity." While it may appear that students can approach ethical issues, questions, and decision making from a free, strictly rational perspective, I argue here that it is also the case that discourses found in science education materials work to constrain the possibilities for ethical engagement and help constitute the kind of subjectivity necessary to think and act ethically in biology/science education.

Subjectivity can be thought of here in a basic sense: an individual (subject) with particular beliefs, desires, and convictions. With subjectivity in mind, I want to suggest that not *any* ethical thought, action, or subject position can be undertaken within the discursive frame

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of textbook exercises and questions. Choices offered to students for ethical decision making in these texts are mainly restricted to the recurring themes of policy recommendation, juridical/legal action, government regulation, population and personal health, and individual/lifestyle choice. This investigation is intended as a critique of these ethical themes, however; as philosopher Michel Foucault (2000) reminds us, critique consists not in saying that things are bad the way they are, but in questioning the very assumptions by which certain practices are based. Considering forms of ethical engagement can be useful for understanding and changing approaches to issues of ethical importance in science education. In this article, I draw from Michel Foucault's historical work concerning biopower and the emergence of "the population" as a political problem to contextualize recurring ethical themes.

The warrant for rethinking approaches to ethics in science and biology education is roughly threefold. First, it seems ever clearer that the major twenty-first century issues such as climate change and the expanded use of biotechnologies demand ethical engagement from the science education community. This requires re-examination of how science education practices and curricula already portray the "ethical terrain." Second, current modes of ethical engagement in science education may be inadequate for dealing with problems like growing social inequality. The science education community can play an important role in rethinking and organizing solutions to these problems. Third, science educators need to better understand how discourses of science education work to constitute the very subject required to participate in science work, science-civic decision making, or scientific research.

How are science students constrained by the discourses of science curricula when they approach topics of ethical concern? How may these constraints work to constitute particular subjectivities and approaches to ethical issues in science? This article tries to open up discussions around these questions for the purposes of reworking how ethical issues are framed, what constitutes ethical action, and "who" ethical actors in science education can be.

Considering the "wicked problems" (Carter 2011) that face human societies today, the relation between ethics, science, and political thought is perhaps more important than ever. Michel Foucault (1997) underlines a substantial gap in theorizing subjectivity, politics, and ethics, and asserts that "contemporary political thought allows very little room for the question of the ethical subject" (p. 294). Since Foucault, Judith Butler (2004) has examined the moral intricacies related to giving an account of oneself in relation to the law—a useful topic to a comprehensive conversation about any kind of "modern ethical subject." The task of outlining a kind of "ethical subjectivity" comes from an ongoing, broader analysis of how subjectivities are partially constituted by discourses of Ontario biology textbooks (see Bazzul and Sykes 2011; Bazzul 2012). Interwoven with the constitution of an ethical subjectivity are other subjectivities related to sexuality, politics and economy, and colonization (e.g., a "subject" who may or may not disregard indigenous knowledges, but one who devalues them nonetheless). Patti Lather (2012) sums up research that *asks after* how discourses in textbooks constitute subjectivity with the provocative question: *Who does the textbook think you are*?

This article is comprised of three interrelated sections. The first outlines how subjectivity is conceived as well as the methodology for examining Ontario secondary school biology textbooks. The second section discusses some examples of directly ethical questions and exercises from four Ontario biology textbooks. The third section attempts to understand the recurring themes of policy reform, population health, individual responsibility, and government regulation in relation to Foucault's historical work on governance as well as his notions of biopower and biopolitics (Foucault and Senellart 2010; Foucault et al. 2007). In conclusion, I call for a multi-faceted discussion concerning ethics in science education in order to diversify the ways students can engage with issues of ethical importance.

Ethics and Science Education

In his book on scientific literacy, Derek Hodson (2009) dismisses the claim that by simply learning about science as a courageous pursuit of truth outside of personal interests, for example by learning Merton's (1973) norms, students will naturally become more ethical. Instead, he claims that "science would benefit from the transfer of ethical standards in the opposite direction" (p. 12). Michael Reiss (1999) has attempted to provide guidelines for teaching ethics in science education, which include criteria for coming to valid ethical conclusions such as the internal consistency of argumentation, the relation of arguments to already existing ethical frameworks, and whether the ethical conclusion achieves validity and consensus through debate. While this approach to ethics in science education is useful, it is also quite specific in its reliance on logic, validity, and consensus. A number of important aspects of ethical questioning may be occluded from an approach reliant on logic and debate. Critical educators are aware that many ethical actions, conclusions, and practices that arise (and arrive!) in classrooms do so through emotional trauma, suffering, spirituality, personal experiences, political commitments, and wide-ranging ontologies. There are always *assumed* approaches to ethical and social issues related to science, and these approaches can be remolded by engaging other academic disciplines as well as knowledges already held by students, such as indigenous ways of understanding the natural and social world.

In light of looming social and ecological problems, our current global situation demands that science education become a site for social justice. This entails developing curriculum and pedagogies that cultivate different lines of thinking concerning pressing environmental, biotechnological, and sociopolitical issues. It may also mean questioning what would seem like good pragmatic advice for science curricula, policy, and pedagogy, such as Michael Matthews' (1998) call for modest goals in the history and philosophy of science (HPS) for science education, a field which informs ethics. Concerning HPS, Matthews insists that "there is no need to overwhelm students with cutting-edge questions" (p. 169); however, this is what educators who want to work toward an ethically just and sustainable future may *need* to do. While Matthews is speaking of HPS education and not necessarily ethical engagement, it is worth questioning the political ramifications of limiting cutting-edge questions, as this may lead to a more conservative approach to ethical issues in science education—ironically, at a time when environmental conservation requires open, cutting-edge thinking. Strong support for positivism (Matthews 2004) in science education may be linked with a refusal to ask cutting-edge questions if we consider how Henry Giroux (2011) describes the link between positivism and ethics:

> The culture of positivism rejects the future by celebrating the present. By substituting what is for what should be, it represses "ethics" as a category of life and reproduces the notion that society has a life of its own, independent from the will of human beings. The neutralization of ethics effectively underscores the value of historical consciousness as well as public discourse on important political issues. But instead, we are left with a mode of reasoning that makes it exceptionally difficult for human beings to struggle against the limitations of an oppressive society. (p. 29)

Tracing ethical subjectivities in science education will require thinking about what we take for granted as ethical engagement and, consequently, how we as educators want to go about reworking these ethical engagements in a way that is socially, politically, culturally, and economically desirable.

David Blades' (2006) essay, "Levinas and an ethics for science education", makes the very critical point that little to no attention has been given to theorizing ethical frameworks for

Science, Technology and Society (STS) or Science Technology Society and Environment (STSE) curriculum and pedagogy. Regarding the mission of STS(E) education, Blades maintains that,

> … the nature of ethics and responsibility essential to this mission are not considered in the theorizing of an STS(E) approach; there is no discussion on how responsibility informs action, such as how to understand whether students should engage in dissection, or how to approach the natural world, such as [the dissection of] frogs, from an ethical perspective. (p. 648)

Blades proposes an extension of Emmanuel Levinas' (1979) concept of "other" as a potential basis for ethics in science education by extending it to include non-human and abiotic entities. Whether or not one agrees with Levinas' ethics, Blades opens up the question of ethics in science education on a philosophical level, which is, as philosopher Slavoj Žižek (2009) maintains, "to change the very concepts of the debate" (p. 51). In reformulating ethics as a radical, erotic, and terrifying relationship to other, Blades gives science educators an alternative for ethical engagement. The goal of this discursive analysis of ethical exercises/questions in four Ontario textbooks is to better capture what kind of ethical themes are *already* in place in biology education, and how these themes play a part in constituting a kind of ethical subjectivity.

Notes on Methodology: Textbooks, Discourse, and Subjectivity

The methodology for the following analysis relies on an approach to critical discourse analysis (CDA) that draws extensively on the work of Michel Foucault (1972, 1982) in order to highlight specific sociocultural and epistemological underpinnings, as well as relations of power, in Ontario biology textbooks. Discourse in the Foucauldian sense can be thought of as a group of statements that carry institutional force and have profound effects on how people think and act (Foucault 1972; Mills 1997). Discourses found in science textbooks are important as they arguably help constitute particular social practices in school science and "professional" science through relational and conditional language, not simply language that represents the "natural" world. As Foucault (1982) argues, the constitution of subjectivities consists "in guiding the possibility of conduct and putting into order the possible outcomes" (p. 221). Peter Ninnes' (2002) analysis of space science and national politics in science textbooks demonstrates how textbooks discursively limit the range of views students can legitimately hold. This study applies Foucault's notions of discourse and subjectivity to directly ethical exercises and questions, where choices for ethical engagement are delimited, in order to examine what kinds of ethical subjectivities Ontario biology textbooks may work to constitute.

To be sure, the many different ways students and teachers have already been constituted as subjects will inform any approach to ethics in classrooms. In this analysis, the term "ethical subjectivity" should be thought of as an *abstraction* used to outline the way students and teachers can legitimately approach issues of ethical importance. Questions and exercises that have students decide on a "right" course of action make up the discursive data for this analysis, as they position students as direct ethical actors. The reasoning for focusing on instances in the texts where students are meant to decide on a right course of action is related to Max Weber's (Weber and Andreski 1983) differentiation between the tenets and practices of religions—where the two can often operate with different rationales, motives, and goals. A focus on directly ethical exercises and questions separates the tacit messages students receive about ethical engagement (e.g., through the description of a social issue) from the instances where students

are actually led to decide on a course of action. While textbook discourses in their entirety will orient students toward particular forms of ethical engagement (and analyses of ethical assumptions in all parts of textbooks should be undertaken), looking at specific instances where students are meant to directly think and act ethically may give us a much more detailed picture of how students can legitimately be ethical actors in science education.

Some Elements of a Foucauldian Archeological Approach to Text(books)

Looking at the "surface" of texts, what is being said literally in statements, and the possible effects of these statements, can provide insight into the normative, and often oppressive ways science education discourses can work to constitute the subjectivities of students. While textbooks are co-written by many authors, such as publishing companies, curriculum advisors, and teachers, this analysis downplays the notion that texts are the unique creations of authors by trying not to intuit the intentions of the textbook writers (Foucault 1979). Instead, this analysis privileges the idea that subjects always speak within larger circulating discourses that set limits on what can be said, done, or thought. Focusing on what one *thinks* an author was *trying* to say, or trying to delve into some "deeper" meaning can distract the analyst from focusing *more* on what the text *actually* says literally.

Although acts of reading are always, to some extent, specific interpretations, in an archeological analysis the analyst tries to concentrate on the surface of statements without inferring a meaning "under the surface." As Kendall and Wickham (1999) explained, in a Foucauldian analysis "we cannot go beyond this discursive surface to a 'deeper inside' of 'thought': the surface is all there is" (p. 37). While textbook authors have intentions, what is most salient in an archeological analysis are the actual statements found within discourses and texts, the limits they set, and the specific ways they may work to constitute particular kinds of subjectivities.

Considerations of Method

The four biology textbooks used in this study were: *Nelson Biology 11*: *College Preparation* (DiGiuseppe 2004), *Nelson Biology 12* (DiGiuseppe 2003), *McGraw Hill Ryerson Biology 11* (Dunlop 2010), and *McGraw Hill Ryerson Biology 12* (Blake 2011). These texts were chosen because they represented in-use textbooks that a secondary school student would use when studying biology in Ontario, Canada. They are government-sanctioned texts in that they largely comprise the biology section of the "Trillium List," the approved list of textbooks for Ontario public schools (Ontario Ministry of Education 2008). These textbooks also represent "sanctioned knowledge" and can therefore distribute the effects of power more than "non-sanctioned" texts. This government-sanctioned aspect is relevant when we begin to consider how students come to engage ethically in some ways and not others; that is, in ways that align with, and not against, the interests of governments.

Initially, these textbooks were perused in order to examine how discourses worked to constitute various kinds of sex/gendered, colonized/colonizer, and political–economic subjectivities (Bazzul 2012; Bazzul and Sykes 2011). During this examination, two basic patterns related to ethical engagement began to emerge. First, potential readers of these textbooks (students and teachers) were seldom invited to think or act on a *directly* ethical level. The term "directly ethical" should be understood in a very broad sense. That is, any time we deliberate/think about a *right* behavior, *right* course of action, or what individuals and groups *should* do based on an implied sense of responsibility or obligation. Though the boundary between directly ethical and "indirectly ethical" is admittedly a very fine one, this distinction allows for the consideration of the discursive limits set on ethical decision making, thought, and action. The

second pattern was that, quite often, the choices available for students to engage ethical issues were constrained. These patterns prompted two general questions. First, what constitutes a "legitimate" ethical issue? Second, what is the range of choices offered to students when taking an ethical position or action (e.g., recommending policy)? These questions led to the idea that a kind of ethical subjectivity—how one is meant to act, feel, think, and deliberate on what should be done in relation to ethical issues involving science—could be outlined alongside the ways the texts worked to constitute other subjectivities (e.g., related to sex/gender and sexuality).

The four biology textbooks were then re-examined for exercises or questions where students were *directly* asked to think and act along ethical lines. It was impossible to unify all of the ethical questions/exercises in each text under singular categories; however, some recurring themes emerged. The discursive data from all four texts were analyzed according to the types of actions students were given as choices (whether or not they were meant to actually carry out these actions). Modes of ethical engagement revolved around the regulation of a wide variety of practices and materials, from research funding to banned substances, personal lifestyle choices, policy and legislative reform, and optimizing the health of individuals and the population.

What Qualifies as an "Ethical Question or Exercise" in these Texts?

What comprises a *directly* ethical question or exercise in these textbooks is, to be certain, complex and necessarily *contestable*. A basic definition of ethics from the *Encyclopedia of Postmodernism* (Taylor and Winquist 2002) defines ethics as "the historical inquiry into how one is to be" (p. 114). And for Merriam-Webster, "ethic" is defined firstly as "the discipline dealing with what is good and bad and with moral duty and obligation" (Merriam-Webster's online dictionary, n.d.). For the purposes of this analysis, I have chosen to identify directly ethical exercises/questions as ones where students are asked *explicitly* to recommend or defend a "right behavior" or "correct course of action" in terms of explicit or implicit obligations and responsibilities related to what individuals or organizations ought to do. This broad definition is meant to target those instances where students are put in the position of ethical actor. While everyday pragmatic decisions and unusual ethical dilemmas can be imagined under this rubric, the point is that these decisions and dilemmas would have also been included as part of the discourse surrounding ethical questions. The application of this definition of ethics acts like a catch-net for gathering themes surrounding directly ethical exercises and questions, and should not be confused with a comprehensive approach to ethics. Table 1 lists the criteria by which directly ethical questions and exercises were selected, including examples that did and did not qualify.

While some questions/exercises in these textbooks have students indirectly consider ethical implications, this is not the same as having students directly deliberate on what ought to be done. For example, in *McGraw Hill Biology 12* (p. 267), there is a discussion about the social implications of artificial amino acids synthesis. While this discussion certainly has ethical implications it does not meet the criteria of a directly ethical question in this analysis because it does not have students directly think about what should be done regarding this research in relation to responsibilities or obligations. Similarly, while questions concerning endangered species and summits against environmental degradation have obvious ethical dimensions, this analysis only includes such exercises *if* they require students to directly think and act concerning a "correct," "right", "responsible" course of action. In these discursive instances, a student is placed in a situation of being an *ethical actor*, and can be said to be a kind of "ethical subject."

It could be said that isolating specific instances where students explicitly think/act in ethical ways limits the analysis. However, it is this notion of limitation that is precisely the point, in that these texts limit the range of ethical choices set before the students. In a sense, only looking at directly ethical questions and exercises in the textbooks *is a limitation by which to*

Table 1 Examples of exercises and questions that fit and did not fit criteria of a directly ethical exercise

Criteria for directly ethical questions	Examples that qualify	Examples that do not qualify (with explanation)
Students are directly asked to take a position on an issue	"[Debate statement] The government should allow xenotransplants in Canada" (DiGiuseppe 2003, p. 360).	"Are organisms more than just their genes?" (Blake 2011, p. 372) (*No direct backdrop of obligation or responsibility*; "*correct*" *course of action not a concern*.)
This position comprises something that "should" be done; a "correct" course of action	"Write a brief position paper containing your recommendations to a legislature on [the decriminalization or legalization of marijuana]" (DiGiuseppe 2004 p. 183).	"Taking a global view (societal, economic, etc.), list the advantages and disadvantages of UHT technology" (DiGiuseppe 2004, p. 115). (*Exercise does not directly engage a* "*correct*" *course of action*; *dimension of responsi bility is not explicit*.)
The position, decision, or action taken is related to an implicit or explicit responsibility or obligation of individuals and/ or organizations	"[In terms of treatment or prevention of a disease] What do you think the priorities for research should be" (Dunlop 2010, p. 460)?	"What steps could people who are allergic to fungal spores take to ensure that their living environment is relatively spore free?" (DiGiuseppe 2004, p. 140)? (*Question lacks both a dimension of responsibility and a chance to deliberate on a correct course of action*.)

expose limitations; even though textbooks may speak about ethical issues, how students are *directly situated* as ethical actors may tell us more about current possibilities for ethical engagement in science education.

Blades (2006) argues that it is not enough to simply assume "the good" or "the right" in science education. He uses the example of implicit and circular reasoning concerning STSE issues:

> While a strong sense of education for the good and right pervades the concept of an STS(E) approach, there is little discussion on exactly what is meant by the 'good' or 'right' action … In the absence of such reasoning STS(E) defaults to the most superficial, circular ethical reasoning: action on an STS(E) issue is ethical because it is ethical to act on STS(E) issues. (p. 650)

What should also inform a discussion about the "good" in science education are analyses of ethical forms and themes that are already actually present. What "should be done" has always to do with complex behaviors/motivations/codes that people accept for many reasons. An ethical question/exercise and a possible response can be seen as separate, yet also inclusive of each other, in that the context of an ethical question often sets the limits for its solution. Isolating directly ethical questions/exercises in these textbooks yielded about 15–25 per textbook; Table 2 presents some examples according to the themes that emerged around ethical exercises/questions.

Results, Analysis, and Summary

After a thorough examination of four Ontario biology textbooks, six recurring themes emerged in all four textbooks, and two recurring themes in two to three of the four textbooks. Table 3

Table 2 Recurring ethical themes and examples

Recurring theme	Examples from four Ontario biology textbooks
Policy recommendation at government level	"Debate with classmates whether Canada should adopt an 'opting out' policy to increase the number of cadaveric donors. What problems might this create" (Blake 2011, p. 119)?
Research funding decisions, government or otherwise	[In terms of treatment or prevention of a disease] "What do you think the priorities for research should be" (Dunlop 2010, p. 460)?
Regulating the use of particular substances	"Do you think people's urine should ever be tested for drugs? Use a PMI chart to examine the advantages and disadvantages of urine testing and make recommendations on its use" (DiGiuseppe 2004, p. 214).
Considerations of specifically regulating genetic research/biotechnology	"What effects might the creation of such 'designer babies' have on society? Explain what laws, if any, you think the government should enact to regulate this area of genetic research" (Blake 2011, p. 329).
Optimizing health of population	[Debate statement]: "Women should not drink even small amounts of alcoholic beverages while pregnant" (DiGiuseppe 2003, p. 120).
Personal habits/lifestyle choices	"One of your friends talks constantly about losing weight, while another has decided she is going to become a vegan. What advice would you give each of them, and why" (Dunlop 2010, p. 366)?
Regulating food safety at government level	"Nutriceuticals should be regulated as drugs under the Canada Food and Drug Act" (DiGiuseppe 2003, p. 51).
Using cost/benefit analysis (pros/cons)	"Your town council is debating whether or not to pass a resolution banning pesticide use in local parks. Compile a list of pros and cons that could be used in reaching a decision" (DiGiuseppe 2004, p. 144).

summarizes recurring themes and lists textbooks in which they occur. This is not to say that these themes are the only ones surrounding directly ethical questions and exercises; on the contrary, different themes could be formulated to describe different ethical, sociopolitical, and cultural considerations. The recurring themes below represent just one possible set for characterizing the choices offered to students in directly ethical exercises and questions.

Table 3 Recurring themes of directly ethical questions/exercises in Ontario biology textbooks

Recurring theme	Texts where themes are found
1. Policy recommendation at government level	✓ McGraw Hill Biology 11
2. Research funding decisions, government or otherwise	✓ McGraw Hill Biology 12
3. Regulating the use of particular substances	✓ Nelson Biology 11: College Preparation
4. Considerations of specifically regulating genetic research/biotechnology	✓ Nelson Biology 12
5. Optimizing health of population	(All four textbooks)
6. Personal habits/lifestyle choices	
7. Regulating food safety at government level	✓ Nelson Biology 12 ✓ McGraw Hill Biology 11 ✓ McGraw Hill biology 12
8. Using cost/benefit analysis (pros/cons)	✓ Nelson Biology 12 ✓ McGraw Hill biology 12

Generally, when students are meant to think and act ethically in response to textbook questions and exercises, they very often engage in terms of juridical/legal concerns, regulating practices through government, making policy recommendations, deciding what research should be funded, ensuring personal and population health, and personal habits/lifestyle choices. All of these aspects interconnect, discussed in the section.

Government and Policy, Health and Population, the Individual and Lifestyle

An in-depth conversation about ethics in science education should be a collaborative endeavor involving science teachers, students, scientists, and education researchers. This discussion draws from Michel Foucault's historical analyses concerning sovereignty, governance, and population to situate some of the recurring themes above and should be understood as just one way of contextualizing ethical themes in biology/science education. In this section, I will address the recurring themes of: *government and policy*, *health and population*, and *the individual and lifestyle*, and engage the topic of biotechnology in the final section with a view to where ethics in science education may be heading (e.g., a redefinition of the body). I will not discuss the recurring theme of using cost/benefit analysis (pros/cons), as this discussion requires a different analytical context.

What may be the most salient point about these interrelated recurring themes is that by representing ethical issues as revolving around health, population, regulatory and policy concerns, ethical questions inevitably fall under the umbrella of state governance and help constitute an ethical actor as someone who attempts to change, evaluate or amend the law, legislation, and/or policy. The fact that government-funded education *requires* students to engage ethical scenarios that are *also* the concern of government (those that involve regulation, policy change, safety, health) may be a major reason why these concerns and these modes of engagement, and not others, are outlined for students. Considering ethical themes in these textbooks from a biopolitical perspective, whereby populations become the object of politics, may be a productive way to view ethical concerns in science education. In addition, thinking about how directly ethical questions/exercises can work to constitute subjectivities can also benefit from a focus on Foucault's later work on how subjectification involves relations between objects, others, and self (Peters 2004). The overall point of the following sections is to show that it is not *any* ethical course or action that can be undertaken by students, as the texts discursively limit the range of possibilities for ethical thought and action.

Since many of the ethical questions or exercises in these textbooks touch several recurring themes simultaneously, it is worth considering the relationships between policy, regulation, population, health, and science education. This is not because these themes are a dangerous configuration for students, but rather to better understand the limitations and underlying motivations—ones that exceed the will of any individual or group of textbook writers—for ethical engagement in science curriculum materials. Thinking about how the subjectivities of students and teachers are partially being constituted by discourses surrounding ethical questions is a vital step to reworking these subjectivities.

Government, Regulation, and Policy

Each of the four textbooks contain several ethical exercises whereby students are meant to deliberate on what governments should do in terms of policy reform, regulation, and amendment of the law. *The primary effect on the subjectivity of students would be that whatever the*

ethical problem or question, *the decision or action taken would have to be framed within a kind of legal–juridical context*. A student must consider what laws and policies are *already* in place, making a legal/juridical context a large part of the framing of the ethical issue. This is a literal example of what Judith Butler (1997) describes as a subject's freedom being tied to subjection to the law (in the abstract). In this case, the (ethical) subject must make their ethical decision in total accordance to the law; that is what laws are *already* in place and to come. While Butler (1997) does not mean only "law" in the juridical sense, but any social order that constitutes individuals as subjects, in this analysis we can coincidentally see the two overlap in that the law gives legitimacy to choices involved in an ethical question or exercise *prior* to a student's engagement. An important, general question to ask here is: What other approaches are foreclosed when ethical questions and exercises are framed in this way?

Consider the following two examples, the first from *McGraw Hill Biology 11*, and the second from *Nelson Biology 12*:

1. "Should labeling be required by federal and provincial governments?" (Dunlop 2010, p. 574)
2. [Debate statement]: "The government should allow xenotransplants in Canada" (DiGiuseppe 2003, p. 360).

In these examples, students are asked to consider the "right" thing to do from a standpoint of government policy. The reason put forward for labeling in the first example (Dunlop 2010, p. 574) is so consumers can make good decisions about genetically modified organisms (GMOs) in food—which also links this particular ethical exercise with consumerism. Since the government *already* enforces labeling laws related to nutritional information and ingredients, the question restricts debate to whether government should extend the policy to GMO foods. It is not a debate about whether *all* consumers should have a choice between organic foods or GMO foods, nor is it a debate about whether GMO foods are ethical. Though the labeling debate *could* touch on these questions, ultimately, the student is really only left to decide on slightly more stringent labeling laws—occluding pertinent questions, such as whether GMO foods should be grown in the developed or developing world. By framing a debate about GMO foods around labeling laws, students and teachers must tacitly accept that the political locus of action centers on legalities and policies for consumers. Through a focus on individual consumers, market forces become an indispensible (invisible) backdrop to the problem, yet are not open to ethical debate. Agri-business and multinational food corporations are not expected to change their packaging procedures on their own. In the case of xenotransplants, the student is led not to examine anthropocentrism or cultural beliefs about the meaning of non-human animal life, but to reason from the standpoint of government and policy about a health-related issue. In this case, the decision becomes tied to livestock health, which in turn is tied to population health through concerns about disease. The decision to allow xenotransplants involves making a decision for the good of the (human) population.

What is interesting is that these ethical exercises, and many others in the four textbooks, both give legitimacy to the "state," but also make it disappear in that there is no ethical frame outside the legal–juridical political order. This may seem banal, but what if one wanted to speak about ethical problems in which governments were *actually already implicated*? These problems could include state racisms such as the destruction of indigenous environments and knowledges, collusion with private interests over the public good, or the pursuit of economic dominance at any cost. A recent example of the latter is Canadian Prime Minister Stephen Harper's unifying declaration of "Science and Sovereignty" in the Arctic, that is, conducting scientific research in the Arctic for Canada's political–economic benefit—something for which the government needs Inuit peoples' cooperation for a variety of reasons. If one were to ask

whether or not the government *should* conduct its research projects in the Arctic, it could leave to the periphery more important questions concerning the relations of government with Inuit and First Nations people and the natural environment. A different ethical question would be what kinds of scientific research should be conducted in the Arctic? How will scientific research contribute to social and material well-being or harm of communities? And perhaps only secondarily, what is the role of government? A strong interconnectedness between government policy and scientific research makes sense because governments make decisions about scientific research on the basis of what *science offers government* in terms of legitimacy, infrastructure, technology, and labour. Approved textbooks in Ontario must cover at least 85 % of the Ontario curriculum (Ontario Ministry of Education 2008), which in a practical sense also makes them government documents. It is easy to imagine a situation where "truths" being spoken under the authority of either government *or* science could sometimes become interchangeable in educational settings (especially when textbook authors are anonymous).

Health and Population

The following three examples of ethical questions or exercises fall under the recurring theme of optimizing the health of populations.

1. [Debate statement]: "Women should not drink even small amounts of alcoholic beverages while pregnant" (DiGiuseppe 2003, p. 120).
2. "Given the potential benefits and risks, prepare a brief report arguing whether or not the use of artificial blood should eventually replace natural blood in all cases" (Dunlop 2010, p. 298).
3. [Debate statement]: "Non-therapeutic use of antibiotics in farm animals should be banned" (DiGiuseppe 2004, p. 127).

Direct ethical questions regarding health cannot be separated from regulation and law/policy reform as well as population health (e.g., the concern with what women do during pregnancy in the discourses of government-sanctioned textbooks). Michel Foucault's lectures (Foucault and Senellart 2010; Foucault et al. 2007) concerning *The Birth of Biopolitics and Security*, *Territory*, *and Population* can help contextualize the recurring themes surrounding ethical questions and exercises. Since these ethical themes are intertwined, I think it is useful to consider how Foucault developed the idea of the population as a political problem. From a modern-historical perspective, Fouceault positions questions of health, regulation, and policy, from food safety, to farming practices, to medical procedures, as having specific linkages to the governance of individuals and populations. This biopolitical context, where the growth, maintenance, and control of populations as well as individuals becomes a key political problem for governing, can be especially useful when trying to understand a textbooks' focus on matters of health.

Health and Population: A Historical Look

Foucault's historical work deals with changes from disciplinary forms of governance, which focused on corporeal forms of discipline, to the rise of governance that employs law and "policy" (police), statistics, and the management of goods (Foucault et al. 2007). According to Foucault the latter forms of governance emerged in conjunction with an entirely new political problem: *the population*. The emergence of the population as a "natural" phenomenon in the seventeenth and eighteenth century meant that it became an object that had to be *managed*. This involved aspects of health, as Foucault explains:

> … the management of this population required, among other things, a health policy capable of diminishing infant mortality, preventing epidemics, and bringing down the rates of endemic diseases, of intervening in living conditions in order to alter them and impose standards on them (whether this involved nutrition, housing, or urban planning) and of ensuring medical facilities and services (p. 367).

The management of populations is a key facet of Foucault's notions of biopower and biopolitics,[1] in that populations, their daily life, productivity, and even pathologies, become the focus of various techniques of control, including scientific knowledges that help govern, divide, subjectify, as well as inform. The population comes to be seen as something that can be "intervened upon" through campaigns aimed at influencing different "modes of life", from the economic activities of subjects to their very "attitudes". The individual becomes somewhat subsumed under concern for the population:

> The final objective is the population. The population is pertinent as the objective and individuals, the series of individuals, are no longer pertinent as the objective, but simply as the instrument, relay or condition for obtaining something at the level of the population. (p. 42)

This population now becomes "the reality the state will have to be responsible for, rather than individuals who must be subjugated and subject to imposed rules and regulations" (p. 352). This responsibility involves managing and monitoring things like hygiene, problems of scarcity, and developing demographic measurements. More importantly, the population comes to be seen as a natural phenomenon. Foucault's not-so-subtle point, however, is that the notion of the population is a historical contingency, co-extensive with techniques and institutions of control, such as educational institutions and "scientific" discourses that work to shape the conduct of subjects. Science textbooks written under the supervision of modern governments therefore can be understood, to some extent, as interventions for the management of populations. The recurring ethical themes found in these biology textbooks can also be seen as historically contingent and visible rather than "taken for granted." We can now view ethical orientations in science education materials as malleable and therefore always open to change.

Having students engage directly ethical questions and exercises related to optimizing health concerns through regulation and policy reform may align students' ethical concerns toward the same goals of the state in terms of the management of populations. Part of this subjectification process, producing a subject who engages ethical issues in particular ways, involves repetition. As Butler (1997) puts it, "If conditions of power are to persist, they must be reiterated; the subject is precisely the site of such reiteration, a repetition that is never merely mechanical" (p. 16). Consequently, educators can examine potential effects related to the repetition of directly ethical exercises and questions in curriculum materials where students are led to consider individual and population health, regulation and policy, etc.

For Foucault, understanding biopower, the control of populations and the extraction of value and productive power from various modes of life relies heavily on knowledges that see human beings as a species,[2] as can be seen in his description of biopower:

[1] Biopower and biopolitics are different in that the former involves controlling modes of life, populations and harnessing their power, while the latter involves interventions into these forms of control for various ends. I encourage readers who wish to have a fuller understanding of these concepts to engage with Foucault's work.

[2] This is not to say that human beings are not a species, but simply to say that knowledge about human beings is tied up with techniques and practices of governance.

> By this, I mean a number of phenomena that seem to me to be quite significant, namely the set of mechanisms through which the basic biological features of the human species become the object of a political strategy or a general strategy of power or, in other words, how, starting from the eighteenth century, modern Western societies took on board the biological fact that human beings are a species. (Foucault et al. 2007, p. 1)

Foucault links the notion of the population to its root in *biological fact*; and it is in this way that political conceptions of the population become intertwined with science: "The population is therefore everything that extends from biological rootedness through the species up to the surface that gives one a hold provided by the public" (p. 75). Foucault sees a strong relationship between objective knowledge (the sciences and political economy) and governance:

> You have a science which is, as it were tête-à-tête with the art of government, a science that is external to the art of government and that one may perfectly well found, establish, develop, and prove throughout, even though one is not governing or taking part in this art of government. But the government cannot do without the consequences, the results, of this science. *So*, as you can see, a quite particular relationship of power and knowledge, of government and science appears. (Foucault et al. 2007, p. 351)

The discipline of biology, what we know about humans as a species, is tied to a "series of specific government apparatuses" that are intricately linked to "the development of a series of knowledges" (p. 108), all of which have the population as their target.

A relationship between scientific knowledge and governing can be seen in the kinds of directly ethical questions being asked of students. What kind of person (subject) can make ethical decisions in this context? How can we rework, expand, or change the foci of ethical engagement?

The Individual and Lifestyle Choices

Although ethics may not be often associated with lifestyle and personal choices, Foucault's (Foucault et al. 2005) work shows that ethical concerns that have to do with personal care should not be overlooked when considering ethics. The following three examples highlight how directly ethical questions in the Biology texts are framed within a context of individual action and lifestyle.

1. [What students can do to defend the biosphere] "Take action. Decide what issue is most important to you and pursue it. Write to politicians and corporations expressing your opinion" (Dunlop 2010, p. 608).
2. [Preamble to question about the willingness to change personal behavior] "Individuals can do little about the decisions of governments and corporations; they do, however, have control of their personal lifestyle decisions" (DiGiuseppe 2004, p. 423).
3. "List three changes that can be made to your personal lifestyle that would reduce the odds of a mutation taking place" (DiGiuseppe 2003, p. 263).

The second example maintains that individuals cannot do much against governments and corporations; however, the next clause has students take action individually. Here, an ethical subject is one who takes action against corporations and governments through lifestyle

choices. Organized political dissent, which includes organizing groups, petitions, and protests, does not seem to be within the discursive range of choices for students (subjects). The complete absence of collective action—how what is not said interplays with what *is* said—underlines how students are discursively oriented towards a focus on individual action and behavior in the framing of direct ethical questions or exercises.

Foucault's notion of governmentality does not only refer to structures and institutions that overtly govern but anything that concerns the conduct of others and self (Lemke 2011). With the emergence of the modern state's concern for populations comes the co-development of a self-governing individual. Foucault's (Foucault and Senellart 2010) lecture series, *The Birth of Biopolitics*, demonstrates that the legitimacy of the modern nation state after 1945 rests with its ability to allow a competitive market to function while certain "freedoms" become less of a concern. In this new economic milieu, the individual becomes not just a rational unit of liberal economic theory whose self-interest is essential for proper market functioning, but one who *must become* entrepreneurial and competitive herself. A key feature of neoliberalism is the penetration of "free-market" logic to many spheres of life; from love relationships to values. This kind of governmentality produces a "free" subject who makes choices between alternatives, and bears responsibility for those choices (rather than responsibility falling to the state). As far as political interests and the neoliberal subject is concerned, Wendy Brown (2006) explains, "Neoliberal de-democratization produces a subject who may have no such interests, who may be more desirous of its own subjection and complicit in its subordination than any democratic subject could be said to be" (p. 702). Neoliberal governmentality involves the state as a partner in producing certain kinds of economic conditions and an individualistic, self-investing subject. The role of neoliberal education policy in producing entrepreneurial subjects through education has been convincingly outlined by Marten Simons (2006). Neoliberal practices and ideologies also shape science education practices and discourses, as has been outlined in the literature (Bazzul 2012; Bencze and Carter 2011; Tobin 2011; Weinstein 2012).

In this vein, we should ask: Are students constituted as ethical actors who must see "themselves" as the sole locus of responsibility and action? If these ethical questions are co-extensive with state governmentality, it makes sense that they would surface in state-sanctioned biology textbooks, especially in the absence of collective action being any kind of possibility. As Thomas Lemke (2011) points out concerning governmentality, the individual's "capacity for self control" (p. 204) and its role in maintaining a political order must become the target of political (and I would add social and cultural) analysis.

Thinking About Relations to Self

A student's relationship to themselves may also play a role in their constitution as ethical subjects in science education. Foucault (1986) outlines how this relationship, exercised through practices of self, is important to consider alongside other ethical precepts or codes:

> … It is easy to conceive of moralities in which the strong and dynamic element is to be sought in the forms of subjectivization and the practices of self. In this case, the system of codes may be rather rudimentary. Their relative observance may be relatively unimportant, at least compared with what is required of the individual in the relationship he has with himself, in his different actions, thoughts and feelings as he endeavors to *form himself as an ethical subject*. (p. 30, italics added by author)

In the formation of an ethical subject through relations to self, rules and codes are still important. However, what becomes more important is to consider "how the individual

establishes his relation to the rule and recognizes himself as obliged to put it into practice" (p. 27). For Foucault (1985), studying relationships to self can help separate what may appear to be identical ethical behaviors, whereas each actually involves completely different modes of "being an ethical subject."

The practice of recycling industrial waste can serve as an example of how the same behavior involves different relations to self and the world. Reasons to recycle range from (i) Satisfying the criticism of environmentalists for the good of one's business (dealing with critics) (ii) Finding resource/income potential in a dynamic economy (being an excellent entrepreneur) (iii) Doing one's own share to protect the environment, and (iv) recycling becoming a philosophy of life (only by giving back exactly what we took can we live a moral life). Self formation as an ethical subject involves

> … a process by which the subject delimits that part of himself that will form the object of his moral practice, defines his position relative to the precept he will follow, and decides on a certain mode of being that will serve as his moral goal…Moral action is indissociable from these forms of self-activity. (Foucault 1985, p. 28)

For Foucault, determining dimensions of ethical behavior would include an examination of moral subjectification as well as "the practices of self that are meant to insure it" (p. 29). Practices of self represent another way individuals are constituted as subjects and can be considered when looking at the constitution of various kinds of ethical subjectivities in science education.

What Should Compromise Ethics in Biology and Science Education?

While the choices offered in these Canadian textbooks for ethical engagement, such as regulating various practices, legal and policy reform, and lifestyle choices, are not negative options for students, it is questionable whether they are able to contend with what Slavoj Žižek (2009) sees as the four great antagonisms for the twenty-first century. Žižek identifies these antagonisms as: (1) The inappropriateness of private property in relation to intellectual property; (2) The socio-ethical implications of new techno-scientific developments (biogenetics); (3) The looming threat of ecological catastrophe; and (4) New forms of apartheid, new walls, and slums. What role should science and science education play in facing these challenges? How will science curriculum and policy writers begin to construct programs that allow communities to engage these challenges? To do so, questions of ethics in biology and science education must deal with changing notions of what it means to be a human being, which include the way biotechnology has recast discourses regarding human life at the molecular level (Gerlach 2011). They should also allow the freedom to ask after the subjective positions that lead to this knowledge. A biopolitical focus should inform a multi-dimensional discussion about ethics in science education because it brings into play how sanctioned, legitimized modes of thought and action (ethical or otherwise), at both the level of the population and individuals, are also the concern of various forms of governance. At stake is how students and teachers come to see human life through institutions and practices of education.

Biotechnology, Medical Research, and New Considerations for Life

Nicolas Rose's (2007) work outlines new relationships between biomedical and biotechnological research and the political, social, and economic contexts that shape them. The questions

he asks are important for engaging ethically in the twenty-first century. The list of questions below draws from Rose's work to outline five contexts that should inform a conversation around ethics and science/biology education:

1. Private interests: How have private interests, for example, health insurance companies and pharmaceutical industries, shaped research? How has the push for profits shaped the way we come to see ourselves in terms of living "productive" lives?
2. Genomic research: How has genomic research changed the way we understand ourselves in terms of susceptibility to disease and genetic enhancement? How is "self-responsible" behavior structured around "risk" assessment and self-enhancement? How are ethical questions framed through opportunity and promissory hope?
3. Governance: How does biological knowledge order priorities and set ethical relationships? How is this knowledge a part of sociopolitical and economic regimes? How have social movements influenced scientific knowledge production? What are the overall strategies of this governance and its consequences? How are teachers and students to challenge these forms of governance?
4. Nonhumans: Who and what qualifies as having a "right to life"? What is the relationship between biotic/abiotic, human/animal, and included/excluded binaries?
5. Gatekeepers and principles: In what ways do genomics and biotechnology require new gatekeepers to ethical knowledge (counselors, researchers, and policy makers)? What are the new ethical principles by which we make decisions about our bodies (informed consent, choice, voluntary action)? How do we make our bodies amenable to choices, judgments, and ethical stances?

Politicizing Questions of Environmental Destruction

Although topics such as climate change and deforestation find their way into biology textbooks, the choices offered to students and teachers for ethical engagement need to be wider in order to effect change. The following suggestions may help provide more options for engaging issues of great importance.

1. Organized action: Provide options for students to actively build and organize communities. Time and web-based resources are integral to successful organizing.
2. Multi-faceted solutions: Issues of social justice need to be presented in such a way as to require an array of comprehensive responses. For example, proposed pipeline projects that conflict with existing indigenous treaties and the fact that most victims of climate change reside in the Global South are immanent problems whose full solution has not yet come.
3. Freedom to challenge: Provide students and teachers the freedom to challenge the sociocultural and political assumptions that undergird ethical decision making. How and who do social issues exclude? Who gets to make decisions about key issues and who does not? What assumptions must teachers and students *already make before* they can participate in coming to a decision (e.g., a distinction between "humans" and "nature")? Are there alternative ways of framing or engaging the ethical issues?

A comprehensive approach to ethics needs to be the focus of a community of science education scholars. While the above points certainly do not suffice as a guideline, they may work to challenge assumptions around ethical engagement and afford more choices for students.

Conclusion

This study has attempted to identify themes surrounding directly ethical questions and exercises in biology textbooks that may work to discursively constitute students as ethical subjects. The recurring themes related to health, individual action, and policy and legal reform were discussed with reference to Foucault's historical analyses in order to contextualize these themes.

Closer examination of the complex historical, political, and social processes that have molded discourses of ethics in science education materials needs to take place with a wide range of policy documents and curriculum resources. Researchers can begin by examining what is presented as a salient ethical issue, action, or position. Students and teachers will likely need different approaches to ethics to face twenty-first century problems such as climate change, for example, those provided by indigenous practices and knowledges. Teachers, students, and researchers need to continually open up different ethical approaches in teaching and learning toward new ways of being in the world.

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References

Bazzul, J. (2012). Neoliberal ideology, global capitalism, and science education: engaging the question of subjectivity. *Cultural Studies of Science Education*. doi:10.1007/s11422-012-9413-3.

Bazzul, J., & Sykes, H. (2011). The secret identity of a biology textbook: straight and naturally sexed. *Cultural Studies of Science Education*, 6(2). doi:10.1007/s11422-gk010-9297-z.

Bencze, J. L., & Carter, L. (2011). Globalizing students acting for the common good. *Journal of Research in Science Teaching, 48*(6), 648–669.

Blades, D. W. (2006). Levinas and an ethics for science education. *Educational Philosophy and Theory, 38*(5), 647–664.

Blake, L. (2011). *McGraw-Hill Ryerson biology 12*. Toronto: McGraw-Hill Ryerson.

Brown, W. (2006). American nightmare: neoliberalism, neoconservatism, and dedemocratization. *Political Theory, 34*, 690–714.

Butler, J. (1997). *The psychic life of power: theories in subjection*. Stanford, California: Stanford University Press.

Butler, J. (2004). What is critique? An essay on Foucault's virtue (2001). In S. Salih & J. Butler (Eds.), *The Judith Butler reader* (pp. 302–322). Malden: Blackwell.

Carter, L. (2011). Gathering in threads in the insensible global world: the wicked problem of globalization and science education. *Cultural Studies of Science Education, 6*(1), 1–12.

DiGiuseppe, M. (2003). *Nelson biology 12*. Canada: Nelson Thomson Learning.

DiGiuseppe, M. (2004). *Nelson biology 11: college preparation*. Toronto: Nelson.

Dunlop, J. (2010). *McGraw-Hill Ryerson Biology 11*. Toronto, Ont.: McGraw-Hill Ryerson.

Ethics. (n.d.). In Merriam-Webster's online dictionary. Retrieved from http://www.merriam-webster.com/dictionary/ethic

Foucault, M. (1972). *The archaeology of knowledge (1st American ed.)*. New York: Pantheon Books.

Foucault, M. (1979). What is an author? *Screen, 20*, 13–35.

Foucault, M. (1982). The subject and power. In H. L. Dreyfus & P. Rabinow (Eds.), *Michel Foucault: beyond structuralism and hermeneutics* (pp. 208–226). Chicago: University of Chicago Press.

Foucault, M. (1985). *The use of pleasure*. New York: Pantheon Books.

Foucault, M. (1986). *The care of the self: volume 3 of the history of sexuality*. New York: Vintage Books.

Foucault, M. (1997). Ethics of the concern for self as a practice of freedom. In M. Foucault & P. Rabinow (Eds.), *Ethics: subjectivity and truth* (pp. 281–302). New York: New Press.

Foucault, M. (2000) [1981]. *"So is it important to think?"* In J. Faubion (ed.). Tr. Robert Hurley and others. Power: the essential works of Michel Foucault 1954–1984. Volume Three. New York: New Press.

Foucault, M., & Senellart, M. (2010). *The birth of biopolitics: lectures at the Collège de France, 1978–1979*. New York: Picador.
Foucault, M., Gros, F., Ewald, F., & Fontana, A. (2005). *The hermeneutics of the subject: lectures at the Collège de France, 1981–1982*. New York: Palgrave-Macmillan.
Foucault, M., Senellart, M., Ewald, F., & Fontana, A. (2007). *Security, territory, population: lectures at the Collège de France, 1977–78*. Basingstoke: Palgrave Macmillan.
Gerlach, N. (2011). *Becoming biosubjects: bodies, systems, technologies*. Toronto: University of Toronto Press.
Giroux, H. A. (2011). *On critical pedagogy*. New York: Continuum International Publishing Group.
Hodson, D. (2009). *Towards scientific literacy: a teachers' guide to the history, philosophy, and sociology of science*. Rotterdam: Sense Publishers.
Kendall, G., & Wickham, G. (1999). *Using Foucault's methods*. London: Sage Publications.
Lather, P. (2012). The ruins of neoliberalism and the construction of a new (scientific) subjectivity. *Cultural Studies of Science Education, 7*, 1021–1025.
Lemke, T. (2011). *Biopolitics: an advanced introduction*. New York: New York University Press.
Levinas, E. (1979). *Totality and infinity: an essay on exteriority*. The Hague: M. Nijhoff Publishers.
Matthews, M. R. (1998). In defense of modest goals when teaching about the nature of science. *Journal of Research in Science Teaching, 35*(2), 161–174.
Matthews, M. R. (2004). Reappraising positivism and education: the arguments of Philipp Frank and Herbert Feigl. *Science & Education, 13*(1), 7–39.
Merton, R. K. (1973). *The sociology of science: theoretical and empirical investigations*. Chicago: University of Chicago Press.
Mills, S. (1997). *Discourse*. London: Routledge.
Ninnes, P. (2002). Discursive space(s) in science curriculum materials in Canada, Australia and Aotearoa/New Zealand. *Journal of Curriculum Studies, 34*, 557–570.
Ontario Ministry of Education. (2008). *Guidelines for approval of textbooks*. Retrieved from http://www.edu.gov.on.ca/trilliumlist/guide.pdf. Accessed 1 Mar 2011.
Peters, M. (2004). Educational research: 'games of truth' and the ethics of subjectivity. *Journal of Educational Enquiry, 5*(2), 50–63.
Reiss, M. J. (1999). Teaching ethics in science. *Studies in Science Education, 34*(1), 115–140.
Rose, N. S. (2007). *Politics of life itself: biomedicine, power, and subjectivity in the twenty-first century*. Princeton: Princeton University Press.
Simons, M. (2006). Learning as investment: notes on governmentality and biopolitics. *Educational Philosophy and Theory, 38*(4), 523–540.
Taylor, V. E., & Winquist, C. E. (2002). *Encyclopedia of postmodernism (Taylor & Francis e-Library ed.)*. London: Routledge.
Tobin, K. (2011). Global reproduction and transformation of science education. *Cultural Studies of Science Education, 6*, 127–142.
Weber, M., & Andreski, S. (1983). *Max Weber on capitalism, bureaucracy, and religion: a selection of texts*. London: Allen & Unwin.
Weinstein, M. (2012). Schools/citizen science. A Response to "the future of citizen science". *Democracy and Education*, *20*(1), 6.
Žižek, S. (2009). *First as tragedy, then as farce*. London: Verso.