



Conclusion: Another Complicated Conversation

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Maria: This edited collection is not just a conventional “body of work,” but a living-breathing community of more-than-human potential. Writing, researching, questioning, and yes, even, feeling; perhaps another science education is actually possible?

Jesse: I really think so Maria! When we conceived this collection sometime in late 2018, we had no idea how the COVID-19 pandemic would make the realities of the Anthropocene more visible and more urgent. I think there’s a few things to note as we sit here at the end of this collection.

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First, the variety of different concepts and new ethical–political considerations for science education that have been introduced or elaborated in this collection such as pedagogies of fire, black holes, magical realism, and Anthropocentric detonators. All of these have the potential to recast how educators engage the Anthropocene with students. The introduction of such concepts is not through any special virtue of the authors, but rather these realities and new ways of thinking are unavoidable. Second, we are writing at a time when COVID-19 has made the interconnected nature of science even more visible. It's clear that science and technology (in all their manifestations) must somehow play a positive and nurturing role in collective life going forward. Justice absolutely belongs in our pedagogies. And third, that things are even more strange than when we began. This is one of the lessons of *Feral Atlas*, a resource discussed by Anna Tsing in the interview section of this book. Science educators can engage the uncanny nature of the Anthropocene with different stories of kinship and just futures. How is science a welcomed element among many in these exciting, strange, and sometimes sacred stories? Maybe we're on the right track with this volume. Maybe our work as science educators will become even more unrecognizable from the field we've inherited (a word Marc has used to describe our predicament of being caught between worlds and fields).

Marc: Sharing your enthusiasm Jesse, I absolutely agree that another science education is possible (and necessary!) (see Stengers, 2018; Higgins, et al., 2019). At the same time, I also believe that Jane Gilbert's (2016) question of whether science can be transformed to respond to the Anthropocene, articulated half a decade ago, continues to lurk and linger. Despite the pluralizing forms of science education towards what would be unintelligible *as* science education a decade or two ago, there continues to be forms of science education whose commitments continue to be (re)produced by modernity, the age of extractivism; "the 'subjects' of the modern school curriculum, including science, were developed to support the growth of modern economies/societies" (Gilbert, 2016, p. 192). Above and beyond the problematic ethical, social, and political commitments that this double(d) subject engenders, as both learner and curricular content, Gilbert brings significant attention to the pedagogical modes presented in science-education-as-usual: critical, social, and ecological issues pertaining to science often remain inert as they are *added* to the curriculum and learned *about*. As she states:

Why is it that, while science educators *say* they are committed to meeting the needs of learners in their socio-cultural context/s, they default to "aboutism"? Is there something in the way science educators are socialised that predisposes them to think like this? Or does science education attract people who think like this? Or does this have something to do with how science education is structured, with how it has developed as a discrete field of enquiry? I do not think we know the answers to these questions, and I think this is part of the problem. (Gilbert, 2016, p. 190, emphasis in original)

However, rather than present a dichotomy between progressive and regressive science education, I think that these latter forms continue to haunt our attempts to move beyond them. There is no being without inheritance, and no inheritance without responsibility (Derrida, 1994/2006). As we move toward a science education which pedagogically produces modes of being *implicated* and *called upon* (den Heyer, 2009) that bring into question the double(d) “subjects” of science education, I believe Gilbert’s (2016) advice continues to bear relevance and should be heeded: “We need to look at ourselves to dig up some of our assumptions about science education—what it *is* and what it is *for*—and our assumptions about science, education, society and the future” (p. 190, emphasis in original).

Sara: Comrades, these are such critical and visionary points. In regard to Gilbert’s call above—taking a serious look at our assumptions about science and education—I think the authors in this edited collection have taken up that challenge in beautiful and imaginative ways. I feel one way we/they do this in the book is by engaging unique local and global perspectives that inevitably lure us as readers, thinkers, educators, activists to look (dream) outside of the way(s) our own systems and structures of “science education” (particularly in formal schooling) are organized. These visions prompt us to see that science/education doesn’t really have to be the way our arborescent “structures” demand it to be (or make us think it should be)... Imagine if the engaging and radical ideas of authors in this book were taken up and dispersed with the same gusto and enthusiasm as “NGSS three-dimensional learning © ®” ! I believe fervently in this possibility. Recently a group of educators reimagining mathematics education in Aotearoa New Zealand shared this video with me (<https://www.youtube.com/watch?v=fW8amMCVAJQ>), which I’ve adopted as a bit of a mantra: “A leader needs the guts to stand alone and look ridiculous...”. We may feel, at times, like “lone nuts” but collectively we are all igniting a movement of nuts that can revolutionize science and education in ways that the Anthropocene so desperately desires and demands.

Maria: Yes, I love this idea of “lone nuts” igniting a movement. It reminds me of the hidden ways that trees communicate sending energy and nutrients to each other just below the surface (Wholleben, 2016). In many ways the chapters in this book represent some of the hidden work and ideas that have lingered in the margins of science education—quietly sending nutrients to the field. The fact that this book was even thinkable a few years ago depicts the impact of this *slow* work. In research on science education, there is an abundance of work that has sustained the factory of science education (e.g., acquisition of proper science identities, efficacy of NOS implementation, production of “good” argumentation techniques) for *quickly* and *efficiently* meeting the needs of federal mandates (e.g., NGSS, workforce development). Rather than continue to reproduce this capitalistic model of research on science education, I see this book as an invitation for science educators to *stay with the trouble* (Haraway, 2016). Across each section, we see authors

providing non-formulaic examples of *slow science*, *minor inquiry*, and *disruption*—three features of what it might look like to stay with the trouble in science education (Higgins et al., 2019).

WHAT REMAINS TO BE DONE?

Jesse: One of the authors of our book (Aswathy Raveendran) recently used the adjective “derived” to describe a science education that works solely for interests already outlined by institutions and apparatuses of power. Perhaps, there’s slightly more room after this year to explore this foreboding, yet oddly pleasurable, trouble that comes with this Anthropocene moment. What has struck me about this past year is how much easier it’s been to discuss ecological–social entanglements, transdisciplinarity and matters of concerns with undergraduate and graduate students due to the pandemic. Some of the work that needs to be done involves embracing the pleasure of ecologically connected existence in general, something that well exceeds what capitalism, colonialism, and rigid hierarchies have to offer. As Sara and Maria point out, there must be overt elements of collectivity and solidarity with both nonhumans and humans in this work. One problem I see going forward is how science education might simultaneously make room for a vibrant and multiplicitous ethics, while not shying away from matters of urgent political concern. For me, the tensions between ethics and politics run through this book. Questions of how beings might live brought into relation with diverse principles of equality. There’s no reason why science education can’t engage the most pressing questions of collective existence—however, students, communities, and teachers might formulate them!

Marc: Thank you Maria and Jesse for the reminder about the temporality of the work that remains to be done: there is at once great urgency (as the wicked problems of the Anthropocene are pressing) and a necessary engagement with slowing down (as to not too quickly reproduce the same problematics elsewhere, if but only slightly differently). Part of this work, as mentioned above, involves *slow science*, “facing up to the challenge of developing a collective awareness of the particularly selective character of [science education’s] own thought-style” (Stengers, 2018, p. 100). I also think that there are chapters within this collection that aptly bring to life the notion of *slow activism* as well. After Métis scholar Max Liboiron and her colleagues Manuel Tironi and Nerea Calvillo (2018),

If a permanently polluted world is characterized by chronic slow disasters – incremental and attritional violence that stars no one, and fails to manifest in an event or clear-edged representation... – then a complementary form of politics is slow activism, which is also incremental and attritional, stars no one, and is not premised on nor produces events or clear-edged representation. Slow activism describes some of the political and representational tropes that eschew immediate visible and measurable outputs... that the effects of action are slow to

appear or to trace... Slow activism does not have to be immediately affective or effective, premised on an anticipated result. It can just be good. (pp. 340–341)

Such a call for slow activism is of particular relevance to teaching and learning practices which, as Maria pointed out, are busy by design and caught up in logics of measurability and effectiveness. While we need clear, cracking, and concise political action at various levels of representation (including the individual), the tension proposed is productive: “ethics, rather than an anticipated result, is at the core of slow activism” (Liboiron et al., 2018, p. 342). How might we act, in relation of ethical obligation to one another (humans, other-than-humans, and more-than-humans), if we did not and could not (wholly) know what our actions would produce (recognizing that the need to act is more pressing than ever)? Certainly, we might come to be perceived as “lone nuts” as Sara pointed out (even if our activism “stars no one”)! Echoing Jesse, the need for (and emergence of) critical ecological collectivism without sameness in science education feels greater than a decade ago.

But there are also larger questions here that bears attending to: while science (and science education) cannot easily be disentangled from production of the Anthropocene, what does it mean to address the myth that science can and will ultimately “solve” the problem that is toxicity and pollution? What if we treat a teleology of progress as its own form of seeping and spreading toxicity? What if the world is to be permanently polluted? What then of science education? Surely, “a permanently polluted world is one that, because of its deep alteration, reclaims the need to incite new forms of response-ability” (Liboiron et al., 2018, p. 332).

Sara: Important questions, Marc! I think this idea of slowness—as not only research and activism but also more generally as being/becoming—is the “arts of living on a [rapidly changing] damaged planet” (Tsing et al., 2017) or a “permanently polluted world” (Liboiron et al., 2018)—and clearly one that the authors in this edited collection, and others elsewhere, have taken up. Certainly “Science” needs to slow down. (We can look to recent and ongoing attempts at solar engineering as one poignant example of the importance of such slow ethics.) And as Maria has argued, “Education” needs to be derailed from impossible factory-like timelines and mandates. Also, in the context of growing concerns about eco-anxiety (especially among children), I am empathetic to fierce rejections of overly simplified and perhaps unproductive narratives of Despair (Mann, 2021). At the same time, this moment does necessitate both mourning *and* resurgence (Haraway, 2016). Dahr Jamail’s (2020) work, *The End of Ice: Bearing Witness and Finding Meaning in the Path of Climate Disruption*, encourages us to ponder deeply: What does it mean to (slow down and) bear witness as the Earth is in hospice? “Not shying away from urgent political concerns” as Jesse states resonates as another form of bearing witness. It seems to me some activisms, which may often be the subject of critique (like Extinction Rebellion or SchoolStrike4Climate), are not necessarily “narratives of Despair” but forms of simultaneous mourning

and resurgence. Meanwhile, people who are coming together to reimagine (or resuscitate) forms of life and education on a damaged planet, such as those described in this book, are similarly bearing witness for all that is lost, but also possible, in the Anthropocene. Paulo Freire's (1992) *Pedagogy of Hope* comes to mind as I reflect on what this means for science education: "What can we do now in order to be able to do tomorrow what we are unable to do today"? (p. 215).

Authors in *Reimagining Science Education in the Anthropocene* take on these nuances and complexities of science and education, looking to (and disrupting) the past(s), present(s), and future(s)—asking what science education has been, what/how should it be and do? And, what are the disruptions in/to science education that can hold space for mourning and resurgence in the Anthropocene?

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