



Conclusion: Amplifying Science Education Research with(in) a Minor Key

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How many people today live in a language that is not their own? Or no longer, or not yet, even know their own and know poorly the major language that they are forced to serve? (Deleuze & Guattari, 1975/1986, p. 17)

The chapters in this second volume collectively announce a refrain: another science education is not only necessary, but also possible. They demonstrate examples of what it might mean to enact science education research in a minor key: working within, against, and beyond a “major language” of science and science education that they are forced to serve but that no longer serves them. In the midst of this ecological reckoning without a roadmap, *majoritarian thinking* in science education that values (only) dominant discourses, epistemologies, and views of reality (i.e., what

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students “ought” to think) cannot wholly account for and be accountable to the Anthropocene, this new geological epoch we live in. Within the Anthropocene, the planet is predominantly shaped by extractivism, the ever-accelerating project of extracting resources for energy production and in service of economic growth. As a result, it disproportionately threatens large swaths of the Global South, endangered animal and plant species, Indigenous peoples, and marginalized communities of color (both urban and rural). As science education makes possible and palatable such realities which render so many worlds within this world minor(itized), with both material and semiotic consequences, moving from a reliance on majority thinking as well as its prevailing onto-ethico-epistemological frameworks and methodological orientations toward thinking in a *minor key* is significant: “there is nothing that is major or revolutionary except the minor” (Deleuze & Guattari, 1975/1986, p. 26).

Drawing inspiration from Deleuze and Guattari’s (1975/1986) notion of minor literature, we offer *science education research in a minor key* as a figuration to articulate the ways in which the chapters in this book, as well as the previous volume, depict images of what is possible for science education research within a new tenor. Of minor literature, Deleuze and Guattari (1975/1986) state that, “a minor literature doesn’t come from a minor language; it is rather that which a minority constructs within a major language” (p. 16). Stated otherwise, this minor(itized) language, that which is rendered other by majoritarian language, becomes a minor literature when it is put in relation with majoritarian language in a way that makes it stutter, stumble, or stop in its tracks. In turn, science education research in a minor key is situated firmly in relation to both science education as well as ideas, literatures, disciplinary and beyond-disciplinary knowledges, voices, and beings made-to-be at the periphery of science education. Importantly, working the minor key is not necessarily an escape from major articulations of science education; rather, it is a means of creating new possibilities for a structure otherwise marked by impossibility, of reconfiguring what possibilities are possible, through a “minor utilization” (Deleuze & Guattari, 1975/1986) of major language.¹ In other words, it is to make science education “a sort of stranger *within* his own language” (p. 26, emphasis in original).²

¹Importantly, we heed Spivak’s (1988) critique that not all possibilities are possible, or desirable: whilst resistance to majority thinking can happen in innumerable locations and manners, it does not mean that all are equally significant in critical import and potentiality.

²Here, retaining the gendered pronoun *his* from Deleuze and Guattari’s (1975/1986) *Kafka: Towards a Minor Literature* is an intentional nod to the ways in which Western Modern Science is often referred to as White Male Science.

In making meaning across these novel and necessary ways of being and knowing in science education research which register discourses and practices of anti-racism and -colonialism; ecopedagogy; speculative fiction; spatial, social, and ecological justice; and (post-)critical pedagogies, amidst other orientations, we turn to Deleuze and Guattari's (1975/1986) characterization of minor literature. As they articulate, the three most significant qualities of minor literature are deterritorialization, political immediacy, and collective enunciation.

Deterritorialization: Where territorialization is the metaphorical constraining and containing of a territory, deterritorialization asks us how we might (re)open spaces that are stuck or sedimented. In science education, this invites us to engage in questions beyond *How do we best teach science?* to engage with related and relevant questions of *What and who is science for?* and *What counts as science?* as a means of identifying and enacting potentialities beyond the major image of science education proposed.

Political immediacy: Political immediacy calls us to consider the ways in which the personal is political: it asks us to consider the ways in which individual learning and concern reverberate and resonate with questions of politics. For example, we might ask *Whose or which perspectives are included or excluded from science education?* Or, *If they are included, are they included in ways which refuse and resist the logics which excluded them in the first place?* in order to investigate what is at stake within the classroom and beyond.

Collective enunciation: When speaking with or from the margins, we may be in communication with different communities of practice beyond the classroom, the school, or the field of science education; when we speak in a minor key, we always speak with others. Collective enunciation elicits us to ask *With whom am I relationally in conversation?* and *What are the possibilities of and for a community of practice otherwise?* as well as the significance of these new or different constellations of relationships.

To conduct research in science education in a minor key is simultaneously an act that denaturalizes thought and illuminates political immediacy and the necessity for collective enunciation. We understand these three qualities as being sometimes implicitly infused and sometimes explicitly articulated throughout each section of this book, but always present. For

example, the authors in this volume intentionally trouble the linguistic assumptions that produce normative and normalizing grids of intelligibility within science education. Considerably, we see these three qualities as provoking critical questions with respect to the means of research in science education in addition to its ends—that is, how might science education consider the ways in which methodologies of majority thinking further complicate what possibilities are possible for science education (Higgins et al., 2018)? For example, we might ask *How do we think about how we think without using the thing with which we think (when the thing with which we think is part of the problem)?* (see Higgins et al., 2019).

Enacting science education research in a minor key is to confront the co-constitutive trends in majority thinking which render thought circular, a circularity which produces and (fore)closes itself against its rendered “non-scientific” Otherness by rendering these supplementary ways of thinking inadmissible, unintelligible, and at times unimaginable. More specifically, minor thinking is *a refusal* to move directly to the center of such circular thought (i.e., majority thinking) through too-simple forms of inclusion while simultaneously not renouncing a potentially productive relation to this problematic center. This is done by moving along the circular contours of majoritarian thought while on the lookout for ethico-political lines of thought which move us away from what rigid majorities would have us think and embody which move us toward a yet-to-come that is with, from, or made-to-be-periphery (e.g., following the *mights* of science education rather than its *oughts*).

To animate this conversation, we revisit some of our own earlier work on *Thinking with Nature* (Wallace et al., 2018)³ as *an* additional and explicit example of science education research in a minor key. Therein, we invited science educators to consider the always-already capacity of Nature to address some of the persistent dilemmas confronting our work as science educators in this contemporary moment. There is increasing awareness that the (re)production of “nature” is only in part a human meaning-making practice, and one that is often deeply territorialized within majority thinking. However, in deterritorializing “nature,” we might take seriously the notion that it may not only be co-constructed with other humans, but also with other-than-humans (e.g., thinking with

³Thinking with Nature is a differential articulation of Jackson and Mazzei’s (2012) work on *thinking with theory* developed by and for science education to stay with the trouble of science education.

lightning, with holobionts; Wallace et al., 2018; thinking with horseshoe crabs; Byers & Wallace, 2021), and more-than-humans as well (e.g., thinking with ghosts; Higgins, 2022)—those who would come to co-constitute the collective enunciation. The political immediacy of such a task takes many shapes in the Anthropocene as well having multiple bearings on how nature and those who are positioned as “closer to nature” are consequentially conceptualized (e.g., Higgins & Tolbert, 2018). One such example of lines of questioning that might be made possible through thinking with Nature, in the context of North America, which makes explicit the qualities of science education research in a minor key is as follows:

How does sustainability science seriously contend with the genocides of large Indigenous populations (as a marker of the Anthropocene) and our more-than-kin (such as the disappearance of Buffalo herds and grass species)? How are practices of forgetting these disruptions, intentional or not, part of genocides-in-the-making? (Higgins et al., 2019, pp. 162–163)

We distinguish these tensions in science education with “N” versus “n”: little-n nature and capital-N nature. Where nature depicts majoritarian thinking, a (re)articulation of the language of science based in logics of control, representation, and dominion/domination, the expansive concept of Nature (beyond, but not oppositionally defined against nature) is synonymous with thinking in a minor key. Some further examples of departures of Nature from nature are depicted in Table 22.1.

With the advent of the ontological “turn” in education more broadly, and in science education specifically—a movement which, while not wholly unproblematic in and of itself, offers new possibilities for engaging science education research in a minor key—the role of Nature in the construction of “nature” is increasingly being considered (as well as the role of Nature in constructing Culture). From this view, Nature itself (as immanent totality) exceeds and continues to trouble our constructions of nature (e.g., as a simple opposite to culture). Furthermore, the ontological turn challenges researchers to deeply grapple with the ways nature and culture become entangled—rather than in binary opposition. The age-old discussion of nature versus nurture is no longer relevant, as the questions have now become *What does it mean for nature and nurture to be co-constitutive entities?* For example, there is much research coming out of the ecological and biological sciences depicting ways in which communication and knowledge making exceeds the human subject. One fairly mainstream

Table 22.1 Departures of Nature from nature

<i>[With]</i> N ature	<i>[About]</i> n ature
<ul style="list-style-type: none"> • A flow, intensity, and force in the making of knowledge • Knowledge generation that occurs within, against, and beyond traditions of inquiry • Includes other-than-humans, more-than-humans, and the not-yet as possible agents in phenomena 	<ul style="list-style-type: none"> • Content or standards to be absorbed or mastered • Reality is strictly empirical (i.e., measurable observation through the senses—touch, feel, see, hear, or taste—in which some senses are valued over others) and within specific traditions of inquiry

example of this can be found in Peter Wohlleben’s (2016) *Hidden Life of Trees*. It is becoming increasingly important in science education research to account for and be accountable to the other-than- and more-than-human actors whose meanings and practices are rendered unintelligible by majoritarian thinking. In its most succinct articulation, it is to think *with* rather than *about*.

As one might already sense, thinking with Nature is a non-normative and non-normalizing perspective in science education. Research, as it’s typically produced and disseminated within the field, tends to methodologically function as a mirror. That is, it is an attempt to reproduce sameness, elsewhere, circuitously, in the interests of power. Alternatively, thinking with Nature invites a non-linear view which does not aim to reproduce thought or life as it is already conceptualized within the logics of representation, but instead tries to keep thought on the move. As an irritative and iterative movement, we understand thinking with Nature as an additional entry point into minor thinking like the chapters provided in this collection which reveals new questions rather than solving old ones by attending to Nature’s molecular connectivities inherent to the work of science education.

In conclusion, we invite researchers of science education to explore and enact modes of minor thinking as methodological practice rather than the “common sense” logics⁴ that permeate our field which reproduce majoritarian thinking (e.g., framing knowledge of nature as its own desirable and

⁴This is particularly important as appeals to “common sense” in science education rarely account for and are accountable to the power dynamics and structures inherent to how a particular sense is made-to-be common (see Higgins, 2021).

atomizable object of acquisition). Again, this is a task of particular significance in the Anthropocene when science education is caught up in the distributed responsibility toward making possible and palatable the extractivist practices leading up to this point as well as the systematic ongoing devaluation and erasure of peoples and their practices who are most negatively impacted by this era. Such questions and quandaries remind us that science education is at a critical juncture. Whereas the pendulum of science education cyclically swings between progressivism and conservatism as a function of majoritarian thinking, the work found in this (and the former) volume explores critical and creative ways of knowing and being in science education: science education in a minor key. In this contemporary moment in which science education is easily susceptible to further territorialization within majoritarian lines of thought (i.e., dominant, hegemonic, dogmatic), we see hope in the inseparable enactments of deterritorialization, political immediacy, and collective enunciation that are brought to life by the diverse scholars who have contributed here. They demonstrate the limits of anthropocentric ways-of-knowing and -being, creatively generate a proliferation of onto-epistemological and ethico-political possibilities to attune otherwise, and explore the potential and possibilities of a minor science education that, by design and with purpose, goes against the grain.

Once more, and louder for the folks in the back, another science education is not only necessary, but also possible.

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