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REVIEW

Composing new understandings of sustainability in the Anthropocene

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Abstract The relationship between sustainability and the Anthropocene takes on new meaning in a time of unprecedented human impact on Earth systems. This relationship is at times contested and not well researched but critical in considering how we will respond to environmental challenges of today and the future. Elaborating on the need for new perspectives and nuanced understandings of sustainability, the contributors to this volume draw on posthumanist and "new" feminist materialist methodologies and theoretical lenses

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to engage readers in ways, which often contrast with prevailing thinking and research. From the cosmopolitics of place in urban Berlin to the watery space of urban wetlands they share research and rich narratives, which illustrate how sustainability is theorized and enacted across a range of diverse educational contexts. Moving beyond the rhetoric of sustainability, the authors invite us to explore innovative ways to engage with new concepts and emerging tensions that are now influencing the fields of education and sustainability.

Keywords Sustainability · Anthropocene · Posthumanism · New materialism · Feminist philosophies

Sustainability in the Anthropocene

Around the world, sustainability has been at the forefront of conversations about how we can best protect fragile and pristine ecosystems in ways that foster ecological and cultural sensitivity and benefit rural and urban communities. Since the release of the Bruntland report in 1987 (Borowy 2014), which characterized sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their needs," (p. 3) scientists, educators, policy makers and the public at large have increasingly called on people to critically examine their role in the world by considering how changing conditions for humans will impact multi-species and the Earth. In recent years there is evidence that increasingly the cultural and ecological commons are vulnerable to climate change, habitat fragmentation, ocean acidity, food and water insecurity and many other escalating anthropogenic impacts (Thomson and Tippins 2013). In light of the recent political environment which celebrates climate change denial, removes vital protection for air, water and Earth resources, and rejects movement towards a sustainable energy future, we were excited to find *Reimagining Sustainability in Precarious Times* (2017), edited by Karen Malone, Son Truong and Tonia Gray. In this book the authors explore new imaginings for sustainability using various theoretical perspectives in order to consider innovative ways of engaging with concepts that are now influencing the fields of sustainability and education. As a group of educators sensitive to the importance of educating today's youth for sustainable ways of living, we have collaborated to write this review in order to highlight the theoretical contributions the book offers to science educators and others interested in understanding sustainability from the perspective of posthumanism, new materialism and feminist philosophies. In the process, we discuss some of the tensions and paradoxes that emerge for us as we entertain new ideas shaping our understanding of sustainability.

The beginning chapters of this book situate the individual examples of research that follow within the larger conversation surrounding the coming of the Anthropocene. The Anthropocene is now widely recognized as a new geological epoch in which there is unprecedented impact on the earth and all its species. Jan Zalasiewicz, Williams, Steffen, and Crutzen (2010) describe this geological epoch as "a new phase in the history of both humankind and the Earth, when natural forces become intertwined, so that the fate of one determines the fate of the other. Geologically, this is a remarkable episode in the history of this planet" (p. 4). In the 1970's Paul Ehhrlic and John Holdren (1971) portrayed the coming of the Anthropocene through the mathematical IPAT equation. This equation suggested that environmental impact multiplies as the world population increases, people become more affluent consumers, and there is a rapid escalation of technology. What

appeared to be missing from this equation was a feedback loop that would predict humans' response to these conditions. Nearly 50 years later, in 2017, climatologists Owen Gaffney and Will Steffen (2017) have formalized the Anthropocene through the development of a new mathematical formula, which states "in the last six decades anthropogenic forcings have driven exceptionally rapid rates of change in the Earth system. This new finding can be represented by the Anthropocene equation, where other forces tend to be zero and the rate of change under human influence can be estimated" (p. 1).

In the first section of the book we are invited to consider what the Anthropocene means for education research and to entertain alternative paradigms for theorizing sustainability in terms of posthumanist perspectives. Paul James (2017), in his discussion of alternative paradigms in Chapter 3: Alternative Paradigms for Sustainability: Decentering the Human without Becoming Posthuman, points to the trouble with the "Triple Bottom Line" (p. 29) concept which has influenced many of the discourses surrounding sustainability in previous decades and even today. The concept of sustainability can be traced back to forestry at the turn of the century and the emphasis on never harvesting more trees than new forest growth could yield (Kuhlman and Farrington 2012). This idea reflected a traditional three-dimensional view of sustainability as consisting of economic development, social development and environmental protection. This view of sustainability stems from the Triple Bottom Line concept, which is used to operationalize corporate social responsibility. James problematizes the Triple Bottom Line Approach to sustainability, noting how it leaves capitalism basically unchallenged and re-centers the economy at the heart of sustainability. In the attempt to balance tensions between the needs of humans and natural systems, sustainability has taken on many meanings. As the term becomes part of everyday discourse, such as sustainable menus, sustainable forests, sustainable wine, sustainable workplace, there is a danger that the very idea of sustainability could be reduced to a mere catchword. At the same time, perhaps the lack of a precise definition may contribute to creative and dynamic theorizing and new directions for research. Ultimately, Iris Duhn (2017) reminds us in Chapter 4: Cosmopolitics of Place Towards Urban Multispecies Living in Precarious Times that the Anthropocene is much more than a new phase in the geological history of the Earth—it is about multi-species (including humans, more-than-humans, and matter of all kinds) learning to make places for living well. In a fascinating chapter Duhn draws on assemblage theory to re-think the cosmopolitics of place in urban Berlin.

Reclaiming a conversation on sustainability: diverse perspectives

The research discussed in *Reimagining Sustainability in Precarious Times* involves forays into a range of diverse contexts, which foster new imaginings of sustainability. The book presents a number of different ways to engage in the posthumanist and **"new"** feminist materialists theoretical turns that decenter the Enlightenment and positivist model of an evolutionary superior, rational human subject that can be understood in itself and from which the world can be understood by and in relation to it. Like others in the field, we use quotations around the term "new" in reference to the critique of indigenous and on-western forms of knowledge that predate this theoretical turn and mirror many of the same concepts with regards to the communal, interconnected and more-than-human understanding of the knowledge, community, and the human experience. Theorists from across disciplines are taking cues from the work of Karen Barad, among others, to reframe human

beings as part of a flat ontology—no better or worse, and sometimes not even distinct from other animal-beings and other material-beings, all of whom are ethically bound to care for one another, in a world that is both precarious and unpredictable.

The very nature of flat ontology is that it is chaotic and messy and all encompassing. When you recognize that the subject—even a more-than-human subject—is entangled across webs of other becomings and subjectivities, haunted by objects, and stretched across yet-conceived space–time–matterings, writing a focused paper or chapter is not only difficult but can also be theoretically at odds with the theories being used to give shape to a phenomena or map out an assemblage. At the same time, because these theories are new to our largely Western academic audiences, it seems more pressing to be as pedagogical as possible in tracing what concepts are being grappled with, why, how, and what may some implications. In other words, it is important to be as precise as possible when using an ontology that undercuts the very idea of precision.

Before we move on to discuss some of the ideas that have captured our attention across the other sections of the book, we first want to reflect on the significance of the title of the book and particularly the idea of **precarious times**. Undoubtedly, many people will agree that in 2017 we live in precarious times, which invoke a sense of crisis. From an eco-justice perspective, we recognize that language carries forward intergenerational and culturally specific ways of thinking that can reinforce taken for granted thought patterns. In this sense, language and the metaphors we use in schooling can limit our understanding or mask deeply held assumptions. The use of the word *precarious* in the title of the book is a metaphor, which creates this sense of tension for us. Similar to the notion of crisis thinking, the idea of **precarious times** seems to reinforce a pattern of thinking that has the potential to privilege short-term rather than long-term thinking about sustainability.

In today's media-propelled landscape of consumerism educators are called on to take responsibility for educating youth for sustainability. Section two of the book begins with Affrica Taylor's (2017) consideration of what counts as nature and a discussion of mindful behaviors being enacted by kindergarten aged children in Chapter 5: Romancing or Reconfiguring Nature in the Anthropocene? Towards Common Worlding Pedagogies. Taylor maintains that by being within nature, taking walks and being outside, the young child is exposed to the natural world, as natural as it can be in places with development, through encounters which can in some ways forge an appreciation of the relationship between people and nature. Taylor discusses research in terms of pushing beyond both the humanist education paradigm that has prevailed in early childhood education and a romantic notion of nature; given the narrative, these work well together in the context of young children in local places. Taylor points to Richard Louv's (2008) book, *Last Child in the Woods: Saving our Children from Nature-deficit Disorder* as a pedagogy which reflects a romantic and nostalgic longing for a frontier-like experience with nature. Similarly, she notes that Louv's depiction of the disconnect between children and nature is illustrative of the type of crisis thinking mentioned earlier in this review. Taylor notes: "According to Louv, this denaturing and hence disordering of childhood constitutes a crisis, which can only be averted by a 'child-nature' reunion" (p. 64). Louv does not make a distinction between nature as everything outdoors, which is an all encompassing perspective including all matter and energy, and nature-as-experience outdoors. By framing nature as an experience, Louv's premise is that nature-deficit disorder constitutes a lack of relationship, interaction or experience with nature, which places children in peril. Taylor calls on us to "reclaim what counts as nature." (p. 62) We would argue that it may be equally important to examine our assumptions about what counts as *childhood*. Nevertheless, we wonder whether or how Taylor's narrative is an expansion towards education for sustainability. While there may be

inherent value in getting children outside and considering the relationship between human and nature, the challenge arises in how the researcher/educator helps the young child develop a consciousness for the interconnected relationship and unique characteristics of all things, both living and non-living.

Chapters six and seven continue to focus on the relationship between humans and place, through research involving movement, artistry, and the natural environment. While these approaches are interesting because they encourage awareness for the surrounding place, they reflect a tension in that humans and nature are positioned as binary opposites. In order to encourage a developing view of interconnected relationships, it is critical for this duality to be addressed in ways that increase mindfulness rather than expect an obliteration of the differences. We continue to celebrate diversity, but anticipate that all things be viewed in the light of equity and responsibility required for sustainability to be a truly viable prospect.

In Chapter 6: A Precarious Body, Carol Birrell (2017) discusses artistry and movement through objects in the ocean and her personal interaction with these **entities**. Humans, poles, and fabric are placed in the ocean; the concept of flow and movement of items is fantastic in explaining the ever-changing process of nature. Nevertheless, we can't help but wonder if, by imposing other objects that do not naturally exist in the ocean and presuming a relationship that is forced, a message of duality of human and other is conveyed. Of particular interest in Sarah Crinall's (2017) Chapter 7: Bodyplacetime: Painting and Blogging 'Dirty, Messy' Humannatured Becomings is her discussion of interacting with space through body-place-blogging. Essentially, Crinall describes this as a type of journaling that takes place after one has interacted with space, together with eventual analysis after time spent away from the initial writing. This could be a very interesting way to encourage interaction with space, but leads us to wonder whether simply recognizing changes in the space, within the environment, is something that makes you one with the location. Crinall mentions the idea of recognizing changing of the seasons and the influence that has on her action, but we wonder, does that really encourage or exhibit a connection to place? The notion of a more holistic approach to interacting with and studying one's relationship with nature may encourage a deeper scrutiny of self from **within**, but the question remains—how does this approach encourage sustainability or provide a conversation as to how the practice could be enacted?

Upon reading the last two chapters in this section of the book we pause to ask ourselves: is it possible for an in-animate, non-living, entity to take on human characteristics and agency such is the case with play? Or are we superimposing this very humanistic idea of play onto the **other** because it is easily identifiable? The idea of knowing is a very human-centered construct. Can we assume that a human can know something in the same way that a rock knows the river or a sea can know the shoreline? The process of becoming something plays a key role in both of these chapters, but is further illuminated as a process that occurs in its own time and under circumstances unique to that entity which is in the act of changing. In the context of becoming we wonder if the focus is on what we can become or on the here and now and how we interact within our place. In order for sustainability to be learned and enacted, it is critical that we exist in this moment and remain cognizant and appreciative of what we are and experience at this very place in time. This is not to say that the act of becoming is not significant; in order to better our space, we must learn to progress, we must become rather than simply exist. While we are not sure if it is the authors' intent, the notion of becoming stood out as a very significant event in education for sustainability. If you are doing more than being and actually attempting to **become**

something, you may be working towards the goal of common interactions, with the awareness that we do not exist in isolation.

Using the framework of new materialism, Marek Tesar (2017), in Chapter 8: Tracing Notions of Sustainability in Urban Childhoods makes an excellent connection through the discussion of how children interact with the nonliving around them and how those same objects lay witness to inaction. However, there is still a suggestion to reconfigure matter into something that is meaningful for us. What if we simply create less waste of our own and reimagine the value of all things, without giving those things a purpose we created. If we are truly to "become," then should we not allow others to "remain"? What role does the inanimate have in the livelihood of young children and how can we encourage them to become more mindful of these interactions (or non-interaction)?

Within Kumara Ward's (2017) Chapter 9: Beyond Sustainability: New Visions for Human Econnection in Early Childhood Education, varied theories used in environmental education research and practice are deconstructed. Specifically, Ward notes how the experience of educating young children for sustainability involves multiple dimensions of theories currently understood in ways that challenge current approaches. While the ideas of biophilia and ecopsychology discussed in this chapter are useful, they do not fully meet the divide that exists between the child experiencing and being of and within the environment. As with other chapters in this section of the book, Ward talks about how teachers can help children make connections to the natural world by **becoming** the natural world. While this is valuable in helping children understand that diversity exists, it still creates an obvious dichotomy of us and them through the act of creatively depicting nature.

In the final chapter of this section: Transnational Knowledge Exchange: Connecting Knowledge Traditions for Sustainability of the Planet, Neera Handa (2017) emphasizes the differences between western and non-western knowledge systems, with the conversation being directed onto where and how alternatives to the current system of education can occur. The primary focus of the chapter is on globalized education and the current approach of preparing teachers through the most accepted approaches and language, western and English. Yet, the bigger question being addressed is, how can we change the system if we only approach instruction in ways that have devalued the other? The argument is made that if a new vision of education is to **become** enacted, there must be the inclusion of "non-western conceptions of nature, sustainability, and development" (p. 147). We would argue that this needs to happen regardless, as we have often overlooked the value in ideas that do not align with the traditional accepted Western philosophy.

The chapters in this section are describing a way of teaching that is interactive and allows students to make sense of the natural world by enacting relationships in the classroom and within nature. All chapters in this section emphasize the need for engagement in and with nature, and the subsequent discourse related to the interactions or non-interaction. However, a disconnect does exist because while children may go out to see things which will help them **become**, the relationship takes place in a human-made space.

Another common thread we noticed across all of the chapters in this section is the need for a clearer dialogue, with specific emphasis on the language, which is used and the implications for education and sustainability. The thread of non-Western philosophy woven throughout this section encourages the consideration of alternative ways of teaching. When the approach to education is not promoting a sustainable mindset, the need to change how education takes place has to be altered. It could almost be argued that a more mindful direction for teaching and learning would allow for the inclusion of multiple perspectives, and would include the "subjectivities" of living and non-living objects and in

turn encourage a clearer picture of how to **become** something respectful and inclusive in the search for sustainability (p. 124). From our perspective, it's not about the difference between indigenous knowledge and western science; it's about the intersection of those two and how functioning from that space we can foster education for sustainability.

The very assumption that we can tell the real story, a story which is impacted by our presence, still affords ownership and agency to humans and not the space. Writing stories of place and being aware of how the space forms and reforms is considered mindful, but does not in itself allow us knowledge of what that place is enacting or feeling. We cannot pretend to know that which we are not; we are observers who change the very space we are embodying simply by existing there.

Considering sustainability from posthumanist and new materialist theoretical perspectives

Section three of this book represents re-reading and grappling with posthumanist and new materialist theories; the application of new theories to the old modes of organizing and understanding the world to see what appears. Each chapter in this section provides an example of how these new theories are or could be taken up in applied settings; the role of children's voice in research; considering outdoor educator practices; re-conceptualizing teacher discomfort with LGBT-topics in schools; the impact of plants in a workplace; and indigenous knowledges in political and social discourses on sustainability. By applying new materialist and posthuman theories to specific questions, the authors advance an understanding of how this ontology works and open up new venues and modalities of inquiry. At the same time, these chapters reveal ways in which further grappling with a new ontology may be needed to elaborate how discursive and material practices of sustainability and education can be theorized as entangled with one another, other things, and becomings within posthumanist and new feminist materialism onto-ethico-epistemology. Elaboration may be needed on conceptualizing and conducting research. In addition, further theorizing of agency and relationality with regards to the specific concerns to the field of sustainability could prove fruitful.

Almost every chapter in this section raises the question of how we should consider research practices and approaches within this new ontology. In essence, if we no longer conceive of the human subject as unified and singular, what are the implications for using traditional qualitative research? Moreover, Karen Barad's (2007) work on intra-action and quantum entanglements specifically troubles the concept between a perceivable cause and effect; in such a construct it becomes difficult if not impossible to produce an intervention, or even examine qualitative data and make claims about causality. Although a number of the chapters in this section take up the ideas of these ontologies, their methodologies, analysis and discussion still appear situated in positivist understandings of research, interventions, and outcomes.

To start with a counter example, Tonia Gray (2017) in Chapter 14: Re-Thinking Human-Plant Relations by Theorising Using Concepts of Biophilia, clearly articulates a case for the agency of non-human actors and the possible transformative power of supporting human-plant entanglements by describing the use of "desk-buddy plants" in non-natural workplace environments (p. 204). This is one of the more traditional research projects, with a series of hypotheses, an intervention, data collection points, and findings. Notably, Gray draws on Jane Bennett (2004) to theorize thing-power, but appears to be

working more out of Doreen Massey's (2005) understanding of the "thrown-togetherness" of urban spaces, rather than Barad's (2007) theorization of quantum entanglements, although, it was not clear exactly how Massey's concept fits into these theoretical frames and turns (p. 140).

Neither Chapter 14, or any other chapter in this section, went into great detail about how the author(s) saw the project of research itself. In Chapter 11: Ecological Posthumanist Theorizing: Grappling with Child-Dog Bodies, Karen Malone (2017) provides an intriguing re-reading of photographs and stories gathered for a previous research project, which could be used by future academics to return to old 'data' and see what comes out within a new framework. Angela Foley's (2017) Chapter 15: Deep Mapping Towards an Intercultural Sustainability Discourse, comes closest to engaging in a different type of inquiry and theorizing of research altogether. In this project Foley engaged in arts-based inquiry as a method of generating artifacts that were used to interpret and think through experiences, in place of a more traditional data collection method. A major take-away from this section of the book is the need to elaborate what does and does not fit into posthumanist and new materialist research projects; and to differentiate between the two concepts that are frequently used interchangeably. Of course, such articulations may not be possible until people take up research in these theories. At the same time, there should not be a rush to employ and apply them without serious discussions about how some of the possible conflicts between the ontology and research methodology are being thought-through.

One way to reconceptualize research is of course to reconceive of the research subject. In Chapter 13: Exploring 'Thing-Power' and the 'Spectre of Fear' on Schooling Subjectivities: A Critical Posthuman Analysis of LGBT Silencing, authors Tania Ferfolja and JacquelineUllman (2017) present an interesting argument for considering how curriculum create a "teacher-becoming-spectre-becoming-teacher" which is entangled with the "thing-power" of a "spectre" of fear-of-LGBT-subjectivites-in-schools" (p. 192); this does not necessarily cause teachers to act in a certain way, because they incorporate Barad's (2008) interrogation of the connection between cause and effect, but is rather embodied in material silencing or apprehension. The authors' choose a rich area for discussion and their arguments have purchase with the posthumanist and new materialist theories with which they are grappling. At the same time, this chapter seems to ask a question that occurs when the **thing** being analyzed through a lens of "thing-power" is in fact a text (p. 196); how is this analysis different than if you were to employ a Foucauldian knowledge/power discursive analysis? The **things** that Jane Bennett (2010) refers to in her seminal work on thing-power are "edibles, commodities, storms, and metals" (p. viii). Nevertheless, once we assume that all things are entangled with countless other discourses, materialities, and agencies, it may be tempting to apply thing- power to any assemblage that is recognized as such.

Agency is grappled with across these chapters in a variety of ways that run alongside or around the question of locating agency in this new ontology. In Chapter 11 Karen Malone (2017) argues for the "development of a new subjectivities as the means for decentering the human" (p. 162), by re-imagining a previous research project that aimed at simply inserting the voices of children into a project through a conceptualization of the child-dog-bodies as a subjectivity. Malone's articulation of this subjectivity in the words and photos of children as well as her own experiences provide a compelling example of a type of agential body that is open to a more complex worlding to "support a new imagining for sustainably and environmental education" (p. 170). However, it may be helpful to more fully articulate the connection between what is discovered through a posthumanist and new materialist theoretical lens and potential future educational projects.

In Chapter 12: Connections, Compassion, and Co-healing: The Ecology of Relationships author Denise Mitten (2017) extrapolates research on human relationships and therapeutic models of treatment and techniques to the relationship between "human interactions with the more-than human world" to diagnose problematic perspectives of nature and suggest how outdoor educators may change these perspectives (p. 180). Mitten transposes findings from inter-personal psychological practices and theories and suggests that outdoor educators apply them to guide other humans to have a better relationship with the natural world. This chapter provides an interesting prescription for this population, but may have missed an opportunity to provide a fuller picture of how the concepts of ecopsychology and terrapsychology may be folded into the idea of relationships between humans and more-than-humans and more fully grapple with limitations. Mitten notes that the chapter "reflects how our relationships are intertwined with all beings and natural systems as an ecology of relationships" (p. 174). However, the question may also be raised about how our concepts of relationships, based in a humanist outlook, may need to be reconceived of altogether.

The chapters in this section all apply conceptions of posthumanism and/or new materialism across different environments, relating broadly to education and sustainability. In doing so, they all provide examples of how posthumanist and new materialist theories can help us see classrooms and sustainability in a different way. At the same time, these applications bring to the surface theoretical questions about research, agency, and relationality.

Disrupting subject/object binaries in thinking about sustainability

In the fourth section of this book, chapter authors draw on posthumanist theory, feminist theory, and social ecology, as well as emergent methodologies to re-read and re-present their research and teaching. Some authors trace posthumanist contours of process-relational relationships captured in research artifacts such as photographs or excerpts from interview transcripts. Others delve into the entanglements and discontinuities arising from new ways of analyzing perspectives and voices emanating from an array of formal and informal educational settings. These chapters are particularly effective at tethering theoretical themes and constructs to concrete contexts in which sustainability education and research practices commonly unfold, ranging from formal school settings to wetlands and mountaintops. In this portion of our review, we begin by exploring two important themes from section four: the non-binary character of posthumanist thought and the notion of intra-action.

Non-binary character of posthumanism

One of the most salient aspects of the various posthumanist perspectives that resonate throughout the fourth section, and indeed this volume, is the notion that posthumanist theory seeks to disrupt the divide between binary modernist dichotomies such as "mind/body, animal/human, organism/machine, public/private, nature/culture, and primitive/civilized" (Truong 2017, p. 241). Authors in the first two chapters of this section, for example, deploy posthumanist optics to reconceptualize child and nature relationships, focusing on "affectively potent pedagogical encounters between young people and animals" (Gannon 2017, p. 253) and "those in-between moments" (Truong 2017, p.249)

when child/nature dualisms dissolve. Even though disruption of dualist subject-object perspectives is germane to posthumanist theory, some chapters leave these binaries firmly intact. For example, in Chapter 20: Caretakers or Undertakers: How Can Education Support Humanity to Build a Sustainable Future?, Les Vozzo and Phil Smith (2017) call for school systems to cultivate a sense of stewardship toward the Earth, an orientation that not only leaves human/nature binaries intact but is inherently anthropocentric because it positions humans as benevolent overseers who assume responsibility to manage all forms of more-than-human life on Earth.

In the section's last chapter: Educating Beyond the Cultural and the Natural: (Re)framing the Limits of the Possible in Environmental education, David Clarke (2017) draws on Perez de Vega (2014) and Morton (2010) to demonstrate that posthumanism can sometimes unveil dualism in unexpected places. The deep ecology philosophy of Arne Naess (1973) explicates an ecocentric orientation that situates humans within nature rather than in dominion over it. Unlike anthropocentric orientations that value humans above all else, or biocentric standpoints that place inherent value on all living things, ecocentric perspectives extend inherent value to both living and non-living components of the natural world. Clarke explains that deep ecology's ecocentric notion of nature as home of human culture cannot escape the lingering dualism of the nature/culture metaphysical divide because it leaves intact distinct concepts of nature and culture. This and other metaphysical schisms can be challenged though the notion of intra-action, the second posthumanist theme examined in this portion of the book.

Intra-action

While posthumanist lenses can be directed toward a wide variety of modernist binaries, disrupting the subject/object divide can result in especially potent possibilities for re-imagining sustainability in precarious times. Clarke begins his chapter by recounting a scene of rock climbing with his undergraduate students in France during an outdoor adventure education course. He challenges the conventional interpretation of regarding the climber as the subject acting upon the rocks, and the rocks as the passive and inert object receiving the subject's actions. Clarke points out,

> But the rock acts on the climber in very physical ways also, asking her to contort, balance, rush, be still, endure, sprag, bridge, create, push, pull and above all, feel—through searching fingers and weighted toes, and the gentle pendulum of a balance nearly caught. There is none of this without the rock. If the rock is climbed, then the climber is rocked. (p.306)

This collapse of the subject/object dichotomy is an important aspect of Karen Barad's concept of "intra-action," a central element of her agential realist theory (2008).

Clarke, along with several other chapter authors in this volume, draw to varying extents on Barad's notion of intra-action, a concept that "signifies the mutual constitution of entangled agencies…[that] don't exist as individual elements" (2007, p.33). In the familiar view of interaction, distinct agencies exist before and after the interaction, but in intra-action, the ability to act arises from within the relationship and does not exist outside of it. Mcphie and Clarke (2015) explain that,

> …phenomena such as plants, trees, stones, clouds, rainbows, plastic bags, and smart phones are not objects or subjects that interact, relate or even connect with each

> other. Rather they are transient, enactive physical processes continuously taking place and always becoming as intra-agencies. (p. 231)

Barad's concept of intra-action extends beyond "matter-in-the-process-of-becoming" (2003, p. 823), however, and also envelops discourse, thus opening new possibilities for questioning and understanding material-discursive relationships. Indeed, intra-actions are germane to a process-relational world where ontology, epistemology, and ethics are inextricably entangled (Barad 2007). The chapters in this volume authored by Margaret Somerville (2017) and by Son Truong (2017) experiment with research methods emerging from Hultman and Lenz-Taguchi's relational materialist research methodology (2010), which is based on Barad's (2007) notion of intra-action.

The culture/nature dichotomy that persists in ecocentric perspectives such as Naess' deep ecology (1973) can be disrupted by re-conceptualizing relations between humans and the more-than-human world as intra-actions rather than interactions. Informed by Perez de Vega (2014) and Deleuze and Guattari (2004), Clarke contrasts shallow/deep ecology with a Deleuze-Guattarian *flat* ecology, an orientation that "places the emphasis on the continuous and immanent materiality of the world, before the formation of signifying language (i.e. 'nature' and 'culture')" (as cited in Clarke 2017, p. 311). In a flat ecology, subject/object dichotomies are replaced with a "smooth space of univocity or plane of immanance" (p.312), and material-discursive intra-actions permit us to supplant the familiar state of *being* with the continual process of *becoming*. Rather than regarding nature as the home of human culture, the non-binary character of posthumanist lenses together with constructs like intra-action permit human/nature and culture/nature boundaries to dissolve entirely.

The chapters in this volume authored by Margaret Somerville and by Son Truong experiment with research methods emerging from Hultman and Lenz-Taguchi's relational materialist research methodology (2010), which is based on Barad's (2007) notion of intra-action. While disruption of binaries can be conceptualized philosophically, we wonder about the extent to which relational materialist research methodology truly succeeds at disrupting binaries. When focusing intently on the intra-actions between subjects and objects, are subject/object binary dissolved or simply ignored? Might such a research approach inadvertently result in an emergent dichotomy that contrasts the subject/object with the corresponding intra-active entanglements?

Looking ahead with a diffractive lens

While the chapters in section four vary widely in the types of educational settings explored and the methodologies deployed, all offer potent insights and pose thorny questions informed by theoretical orientations ranging across posthumanism, feminism, and social ecology. Rather than positioning these creative re-imaginings in binary opposition to more traditional views of the modern environmental movement, it may be helpful to draw on Donna Haraway's metaphor of diffraction (1992) that underpins relational materialist methodology:

> Diffraction does not produce 'the same' displaced, as reflection and refraction do. Diffraction is a mapping of interference, not of replication, reflection, or reproduction. A diffraction pattern does not map where differences appear, but rather maps where the *effects* of differences appear. (Haraway, 1992, p. 300)

"Re-imagining Sustainability in Precarious Times" calls for expanded approaches to educational research that challenge the doctrine of anthropocentric exceptionalism. Diffractive ways of seeing the creative re-imaginings offered in this volume together with diffractive re-readings of our own work in research and teaching may contribute to our readiness to respond to that call.

The specter of system thinking

From photographic representation of relationships between children and nature through rock climbing and flat ecology, section four of this text explores the different ways representation matters, the ways in which presence can be explored as the space between human and non-human, and the ways in which relationships are built and the environment changed (including all within the environment). The enchantment of Son Truong's (2017) chapter 16 that seeks out wellbeing and a "…sense of openness and responsiveness (p. 246)" is another theme found throughout this section of the book. The beautiful and expressive language provides visuals that rival the images found throughout—all while drawing connections to the natural environment in ways that provide suggestions for moving toward a more sustainable future.

In the field of cultural studies of science education, many of us come from critical perspectives that we consider cutting edge and boundary pushing—the authors here are not an exception to this. We reimagine new possibilities, we explore the precarious nature of the world that we live in, and look for ways to engage with sustainability by opening up who and what counts as legitimate within our world. But what if the foundation of everything we think we know—the places we think we are challenging, the knowledges we think we are legitimating—is instead reifying the structural inequities that we think we are fighting against? "These attitudes are a consequence of ecological understanding." (Wright 2017, p. 277).

Much of our **commonsense** scientific understanding around sustainability and ecology is based on **commonsense** systems thinking—natural processes that occur within a closed loop, that if out of equilibrium, cause significant issues for some of the living organisms within that system. This idea of balance is an important one in our understanding of the scientific side of sustainability. We use the phrase **commonsense** because we believe that those espousing an approach to studying complex adaptive systems grounded in panarchy theory (Gunderson and Holling 2011) would argue for a more nuanced understanding of the dynamic and emergent properties of systems; yet our common, everyday understanding does not always take those nuances into consideration, and so our everyday understanding falls back on the idea of systems. On the cultural side, we flirt with more open systems—ones that may not have a **normalized** stasis, but instead systems that evolve into **dark** ecologies, or new entanglements that stretch the systems that we wear into a comfortable old pair of slippers. But systems thinking might be a dangerous comfort—one that keeps us locked into not only hierarchical positions of power over the environments we are trying to sustain, but move us into techno-rational solutions that allow us to ignore the moral imperatives outside of the system and instead focus us on means-end reasoning (Richard Quantz 2011). Richard Quantz's work (2008) focuses on democratic processes in schools, but also on the ways in which systems thinking affects our thinking about those processes. He attempts to move us outside the rational, away from the irrational, and into an examination of the nonrational through ritualized action. While those are theories worth

exploring at length on their own, particularly around the ways in which his ideas might apply to eco-justice education, here we want to focus on his ideas around systems and system thinking. Quantz (2008) states, "…the assumption of systemic wholeness results in practices which claim to work in the common interest but which too often resemble the imposition of a hegemonic social order that represents the special interests of the dominant social groups" (p. 55). In other words, the **commonsense** systems that we use to understand the world around us—natural or otherwise– may be providing more space, not for legitimizing minoritized human or non-human experiences, but rather for reifying position of power and centers of dominant thinking.

Any theory based in a critical perspective begins analysis by uncovering the places where power might be hidden. For us, this begins by exploring where systems thinking might be found in this section of the text, all the while reminding ourselves that we, too, are often bound up in systems thinking, even as we try to untangle the consequences of such thought. Where is systems thinking at play in this section of the text? How is systems thinking a dangerous attitude that often remains hidden in plain sight, particularly within these chapters? How might challenging systems thinking help us move our thinking forward?

In Chapter 16: Expanding Curriculum Pathways Between Education for Sustainability (EfS) and Health and Physical Education, Son Truong (2017) recognizes the challenge of using the idea of enchantment within the current curricular and accountability systems at play in school systems in the following: "However, becoming responsive to enchantment in formal educational settings, where there is increasing emphasis on accountability, documentation, and assessment of outcomes, may be a challenging task for teachers, teacher educators, and educational researchers (p. 246)." Instead of challenging the idea of the system, however, Truong instead explores ways to bring new ideas into older systems, creating new feedback loops that prevent real change from occurring.

As Quantz (2008) reminds readers,

> Creating new feedback loops will not solve a problem that is fundamentally about the distribution of power. It will only provide better information to those elites to help them manage challenges to the present power distribution even more efficiently and, therefore, make the organization even less democratic. (p. 58)

Truong adjusts the systems to incorporate new ideas—new feedback loops are created to add additional systems, to grow current systems, to adjust the flow of thinking, material, and power. While the goal is to use enchantment as a way of thinking about and building relationships with nature, by adding to the current system, dominant discourses around assessment and curriculum, enchantment becomes entangled in the system of accountability. This is not because Truong is wrong! It is instead that the specter of systems is wound into all of our thinking, particularly around issues of ecology and sustainability. It is a silent assumption that is not explored or challenged, but rather left to make its mark on the rest of our thinking—even when, particularly when, we attempt to frame ideas in critical theories. Systems thinking winds its way through every chapter of this section. From curriculum systems to ecosystems, from water cycles to assessment cycles, systems are a part of the fabric of our understanding, particularly within science education, and even more so in ecological studies, where systems are foundational to our current, commonsense, understanding of the ways in which nature works. It is because systems thinking is so commonsensical that it is invisible, in the same ways that power is often invisible. Even

the metaphors used in Suzanne Hannon's Chapter 17: Watery Configurations of Animals, Children, Pedagogies and Politics in a Suburban Wetland suggest systems thinking. As Gannon (2017) says:

> My use of "watery" in the title—as well as referencing the lagoon and its creatures—suggests the instability and fluidity that I want to draw attention to in pedagogy. I'm interested in flows, movement, blurring and mergings, rather than in the solidity and separation of subjects, objects and knowledge projects. With "configurations" I mean to suggest the ways that things come together to form patterns and arrangements. (p.253)

The flow of water through the water cycle and the patterns that arise from that system are key in Gannon's discussion of entanglements. But those entanglements are bound up in systems of power. Gannon moves toward pointing out those systems of power when she discusses the creation of the artificial wetlands and the students' simplification of the life cycles and ecosystems that are present in their understandings of the wetlands' living organisms. She even claims "…encounters with the "outside" are quite literal, and where there are even more things than usual "outside" the control of the teachers." As we move through the chapter, however, we shift into the technical aspects of student work. This shift into the technical is an effect of systems thinking. "A systems approach might help us see where the communication loops had failed and how we might restructure our system to help facilitate such information flow. But such language is technical language and reduces the issues to technical problems" (Quantz 2008, p. 57). It is this shift in thinking that can become dangerous—it is here where we can lose sight of our morals and engage in a means-justify-the-end game. Our problems become puzzles to solve—our rock climbing, no matter how much the rock climbs us and we climb the rock, becomes a technical problem about where to place our fingers and feet; our learning falls back into a system of assessments and accountability AND a seeking of stasis. Our solutions become technical, and while our critical theories help us to seek out our moral obligations, we cannot quite let go of the system or our technical thinking around **solutions** that will **fix** the problem. Terri-Anne Philpott (2017) begins to explore our moral obligations through her critical lenses by pointing out the "…important role outdoor leaders and outdoor educators play especially in teaching the moral responsibility of nurturing sustainable practices that care for the health of the planet" (p. 283). However, she then switches to a technically oriented response including sustainable practices that hints at returning to an equilibrium based world and caring for the health of the planet.

There are several ideas from Quantz (2008, 2011) that we want to pull in here by looking at two of his quotes:

> …systems thinking is not really inaccurate as much as it is narrow and naïve. It is narrow for it defines the issue as technical and internal … and, therefore, the solution lies in accommodating or deflecting the disrupting force. (p. 58, 2008)

and

> Above all else, the world of puzzles is a technical world—A world of givens with limited and known conditions and rules and with specific and particular answers. (p. 137, 2011)

Les Vozzo and Phil Smith (2017) write themselves into this very conundrum: "Humans can halt or reverse all of these trends; this is mostly not in dispute. The real disagreement is around how to take a different path (p. 295)." Here we see the authors trying to use

technical action to deflect the disruptive force. Briefly here, we could have a lovely conversation about what counts as the disruptive force—Capitalism? Climate change? Human actions? Or in another vein altogether, activism? Sustainable practices? Ecological literacy education? When we attempt to overlay our critical theories on systems foundations, we are pulled into the **world of puzzles** (Quantz 2011), where we use any and all of the rules of the system, as well as some outside the system, to achieve a given end, which can be a healthy planet. And while the idea of a healthy planet seems like **THE** end, particularly if we are bound into systems thinking, have we really engaged in a deep analysis of what a healthy planet might be, what it might look like? What if a healthy planet is actually one void of human interaction? Void of humans all together? Have we actually spent time thinking through various ends in between a healthy and a dead planet—the only two choices that systems thinking gives us?

Sustainability *MATTERS* in the Anthropocene as concluding remarks

We began this review by situating a discussion of sustainability in the context of recent advances in thinking about the Anthropocene. The chapter authors provide us with many opportunities to reflect on how sustainability is interpreted and enacted within the Anthropocene discourse. The robust insights throughout the book afford us with the chance to reflect on "posthumanist performative accounts of the entanglement of things, bodies, spaces, objects, discourses and meanings" (Taylor in press, p. 3). As the chapter authors point out, the way we choose to frame our understanding of sustainability matters in terms of possibilities for today and the future. The authors challenge us to think about sustainability in light of new contexts, new questions and new modes of research. At the same time, we are reminded that novel ethical dilemmas and questions of fairness will undoubtedly emerge as we envision a role for sustainability in the Athropocene. We continue to draw inspiration from the ideas presented in this book which propel us forward to consider the educational changes that need to be undertaken in a time of unprecedented human impact on the Earth system.

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