# (Re)framing Socioscientific Issues in Canadian Science Education: A Relational, Indigenous, and Posthumanism Approach

Steffie Dmello, *University of Ottawa*

Michelle Leonard, *University of Ottawa*

Floriane Lévéder, *University of Ottawa*

## Authors' Note

The authors have no conflicts of interest to disclose.

No generative AI services or tools were used in the writing, editing, or preparation of this article.

Correspondence concerning this article should be addressed to Steffie Dmello at sdmel026@uottawa.ca.

## Abstract

This paper explores how socioscientific issues (SSI) can be enacted within science education through relational, posthumanism, and Indigenous epistemologies. We argue that conventional Western science (WS) education often presents knowledge as abstract, objective, and disconnected from social, cultural, and ecological contexts which reinforces human exceptionalism and superiority. Drawing on SSI, posthumanism, and Indigenous knowledges-sciences (IK-S), we foreground relationality, reciprocity, and ethical responsibility and position learners as engaged participants in complex webs of networks rather than isolated beings. We highlight relationality to illustrate how these perspectives inform pedagogical possibilities. Through a Two-Eyed Seeing approach, we outline examples that integrate SSI, posthumanism, and IK-S with relational, land-based, and ethical responsibility. Finally, we argue that teacher education must provide dedicated spaces for pre- and in-service training to support the enactment of innovative, embodied, and relational SSI pedagogy. Ultimately, we advocate for a transformative model of science education that cultivates learners' empathy, humility, and ethical engagement in our common world.

*Keywords*: socioscientific issues (SSI), relationality, posthumanism, Indigenous knowledges-sciences (IK-S), science education

IN EDUCATION



*This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca*

## (Re)framing Socioscientific Issues in Canadian Science Education: A Relational, Indigenous, and Posthumanism Approach

Within conventional Western education, science is often presented as a collection of disconnected facts, abstracted from the students' everyday relationships that give knowledge meaning (Aikenhead, 1996; Snively & Corsiglia, 2001; Tsing & Bazzul, 2022). In presenting scientific knowledge as universal and objective, it often reinforces a reductionist view of the world which decontextualizes knowledge and neglects the more-than-human relations that contribute to our meaning-making (Boileau, 2024; Jukes et al., 2021). Additionally, environmental education narratives within schooling (and elsewhere) position children as future saviours; that is, as agents responsible for saving our planet (Taylor, 2013, 2017), eventually leading to a utopian future. This framing then extends into how education is conceptualized and how dualisms are further reinforced when children (and adults) are positioned as superior to nature rather than learning with and becoming with the more-than-humans (Pacini-Ketchabaw et al., 2016).

The inclusion of socioscientific issues (SSI) in the classroom presents a view of science education as one that is deeply entangled with civic, cultural, social, political, and ecological contexts rather than as objective, isolated knowledge (Viehmann et al., 2024). This paper situates SSI alongside both Indigenous Knowledges-Sciences (IK-S), which emphasize reciprocity and relationality between humans and more-than-humans (Aikenhead & Michell, 2011; Kimmerer, 2002), and posthumanism approaches that reject anthropocentric hierarchies and focus on relational becoming (Braidotti, 2013; Ferrando, 2019, 2024).

What follows is intended as a theoretical position paper that draws on relational and interdisciplinary scholarship to imagine new possibilities for science and environmental education. We present a conceptual synthesis of SSI, posthumanism, and IK-S education through a Two-Eyed Seeing (TES) framework and explore the challenges and possibilities of its practical inclusion within education policy and the classroom. We begin by foregrounding our positionalities and the relational histories that shape us. Though the three of us grew up in different parts of the world, our experiences with and within the realm of the more-than-humans have had profound, yet unique and distinct influences on shaping and enacting who we are and who we are becoming. Our shared commitment to education and educational research is inextricably linked to these experiences. From these stated vantage points, we then discuss how posthumanism and IK-S offer relational onto-epistemological foundations for the teaching of SSI within science and environmental education. Following this, we juxtapose posthumanism, IK-S, and SSI education to illustrate how they may be synthesized to elaborate new perspectives and approaches for ethical science education. Employing a TES approach, examples are outlined to help illustrate what these types of synergies may look like in the classroom. Finally, we discuss the operationalization of SSI within science education, including teacher training, as a relational onto-epistemology.

Ultimately, we argue that by foregrounding relationality, science education can move beyond a content-driven model toward a situated, land-based practice of becoming-with that helps learners navigate SSI with complexity, empathy, humility, and ethical responsibility. Such a (re)imagining represents a transformative shift in how science education understands knowledge, relationships, and our shared futures in the Common World that we co-inhabit (Taylor, 2013).


*This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca*

## Our Stories of Relational Becoming With/in Land

### Floriane

Growing up in Western France, I have fond memories of playing freely in the garden, biking and wandering in the nearby countryside. We would collect the apples; my father would cultivate a huge vegetable garden and my mother would harvest. We would eat our homegrown food throughout the fall and winter and begin the cycle again the next growing season. I had the privilege of vacationing in the Alps every year, skiing for two weeks in the winter and camping for a month in the summer. These early experiences of exploring and playing outdoors have profoundly shaped my understanding of learning and my commitments as an educator. As a teacher in Eastern Canada for the last fifteen years, I have taught every level from kindergarten to teacher education courses, and I feel very passionate about the need for the educational system to change so it can offer meaningful, embodied, outdoor relational learning experiences to all students. I believe every child should have equal opportunity to develop into ecologically literate citizens.

### Steffie

I was born and raised in a post-colonial region on the west coast of India, within a Vadval community where most families relied on farming for their livelihood. Generations of my ancestors cultivated the land, and my own childhood unfolded through relationality with place and more-than-humans. While my formal schooling centered on structured forms of knowledge, discipline, and rote memorization, the learning that occurred beyond the classroom continues to hold deeper meaning. We spent afternoons plucking flowers alongside my parents and grandparents. We weighed and counted the flowers and packed them into banana leaves or small bags to be sold in local markets. These embodied practices nurtured our mathematical thinking, ecological awareness, and understandings of seasonality, plant cycles, labour, and interdependence. Knowledge and learning were lived, sensed, and co-created through entangled relations with land and community. Reciprocity was/is an integral part of our community. I now write as an immigrant scholar residing on the unceded and unsurrendered Algonquin Anishinaabe territory. My social, cultural, and educational experiences influence my commitment to relational pedagogies that honour diverse ways of knowing and call for meaningful attentiveness to the more-than-humans within shared ecological futures.

### Michelle

Growing up in the Canadian Northern Ontario town of Sudbury, I spent much of my childhood playing, learning, and exploring outdoors. Some of my favourite summers were spent on Mnidoo Mnising, known in English as Manitoulin Island. I spent countless hours swimming and fishing in the cool waters of Lake Huron and hiking the Cup and Saucer trail with my cousins. As a child, I knew this land was home to many Anishinaabe communities, but our worlds rarely intersected. It is only as an adult that I have begun to understand the deep relational, spiritual, and reciprocal relationships held by the First Nations of Mnidoo Mnising. As my understanding has grown, so too has my connection with the land. While I cannot claim the depth of relationship that emerges when identity is co-constituted with a sentient land, it has reshaped my sense of responsibility, care, and accountability. As a non-Indigenous settler ally, engaging with Indigenous knowledges (IK) demands more than theoretical understanding; it calls for a continual praxis of epistemic humility and relational accountability. This includes not only


*This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca*

unlearning colonial habits of thought but also confronting the structures that sustain them and working to unsettle and transform colonial dynamics within education and educational research.

## Posthumanism and Relational Onto-Epistemologies

In this section, we draw on posthumanism and Indigenous relational perspectives to (re)imagine science education and SSI. We explore how these perspectives can unsettle human-centered assumptions and foster more relational and ethical engagements with the more-than-human world.

### Posthumanism as Relational Approach to Knowing and Learning

Posthumanism offers a lens to re-examine, unsettle and (re)configure our assumptions of children as learners who must be taught rather than beings who are already engaged with the world through embodied, sensory, and relational ways of knowing (Murris, 2022; Nxumalo & Pacini-Ketchabaw, 2017). As such, we ask: How might posthumanism guide our pedagogical approaches within science education, particularly when engaging with SSI? What shifts are needed for science education in Canada (and elsewhere) to respond meaningfully to posthuman thinking and SSI?

Posthumanism challenges human exceptionalism by decentering the human and foregrounding relationality within complex networks of beings, forces, and histories (Riley et al., 2024). The post in posthumanism does not imply a world 'after humans' or the disappearance of the human. Instead, it signals a shift away from the humanist ideal of the autonomous, rational, bounded individual (Ferrando, 2019; Nayar, 2014). As scholars (e.g., Braidotti, 2013; Haraway, 1985, 2016) argue, we are already posthuman; we are continually constituted through dense, dynamic networks of relations with technologies, microbes, materials, environments, and more-than-humans who co-shape who we are and how we come to know the world. Barad's (2006) work provides a powerful provocation here; they argue that entities do not pre-exist their relations but rather come into being through their ongoing intra-actions (i.e., beings are not separate, isolated entities that then relate; instead, they emerge through their entanglements with one another) (Barad, 2006). This challenges the assumptions that center humans as the principal meaning-makers of the world and instead situate humans as one among many co-constitutive participants in vast relational ecologies. Our understanding of the world is never neutral because it is embodied through our actions, which in turn shape the world around us. Consequently, what is called for is an ethics of teaching and learning grounded in accountability and care. Hence, posthumanism opens up perspectives for affirmative (re)configurations of both subjectivity and the very conditions through which theory and knowledge are produced, by moving toward more relational, ethical, and multispecies modes of existence (Braidotti, 2013).

Through our readings on Indigenous epistemologies (Donald, 2021; Kimmerer, 2024; Kovach, 2021; McGregor, 2013) and through reflection on our own lived experiences as individuals from diverse communities, we have come to understand that the ideas associated with posthumanism are not new in any literal sense (Nail, 2023). Indigenous peoples within Canada (and elsewhere), as well as people from diverse communities, (e.g., Steffie's Vadval community in India) have long maintained relationality with more-than-humans (Patterson et al., 2023). Hence, posthumanism is not a novelty but rather signals a critique of longstanding traditions that privilege human-centered rationality and agency over material, ecological, and relational forces (Nayar, 2014).


This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca

## Indigenous Knowledges-Sciences (IK-S) as Relational Ways of Knowing

Before moving on to a discussion of IK-S, it is important to emphasize that IK are place-based and specific to their local context. They cannot be reduced to a monolithic body of knowledge. Whenever possible, classroom engagements with IK-S should be grounded in the knowledge, languages, histories, and teachings of the local Indigenous Nations on whose lands students are learning. At the same time, there are enough similarities between Indigenous philosophies generally, and North American Indigenous worldviews more specifically, that general concepts may be discussed while still holding space for individual differences and emphases (Little Bear, 2000).

Articulated by an animate language, Indigenous epistemologies describe a world "as one of flux, motion, and interrelationship" (Kovach, 2021, p. 70). In this worldview, knowledge is more than a body of information. It is a way of life grounded in relationships with others, the land, and the more-than-human beings that inhabit it (Mazzocchi, 2008). It is also rooted in a spiritual dimension expressed through connection to a larger external force (Kovach, 2021) and in ongoing entanglements with the world we inhabit. Such inter-connections preclude the clear divisions of ontology, epistemology, and axiology, that reflect a Western preference for categorization.

Building on this rejection of fixed categories, defining Indigenous sciences (IS) as a distinct subset of IK reflects a Western convention that packages Indigenous practices and knowledges to "fit within existing academia's cultures and values" (Kim et al., 2017, p. 260). In fact, it is impossible to differentiate between them because they are interconnected in ways that shape and respond to one another, reflecting a holistic understanding of the world that rejects the isolation of phenomena from their wider contexts. As such, Kim (2018) uses the term Indigenous knowledges-sciences (IK-S) to capture the interdependent relationship between IK and IS. IK-S is a living process that integrates empirical, ethical, cultural, and spiritual knowledges whereby "nothing is simply a cause or an effect, but all factors are influences impacting other elements of the systems as-a-whole" (Freeman, 1992, p. 10). It is from this understanding that we adopt this terminology to reflect the relational and interconnected character of IK and IS.

IK-S is a robust body of empirical knowledge embedded within an interconnected set of relationships (Kimmerer, 2013), which have been developed over thousands of years of living in sustained kinship with a sentient land and the myriad lives that inhabit it. Knowledge, therefore, is not an individual pursuit but a collective one enacted through relationships among people, communities, and the more-than-human world (Cajete, 2000; Kimmerer, 2013). Tewa author and educator Gregory Cajete explains that "reality is wholly interrelated – knowledge emanating from an Indigenous worldview has to be understood relationally. Nothing exists in isolation or can be understood apart from all its relationships" (as cited in Goodchild, 2022, p. 55). Western Science (WS) often considers environmental and social factors to be "confounding" (Snively & Corsiglia, 2001, p. 11). As such, WS is often conducted in isolated laboratories or under strict control in the field, but this is not the world we inhabit. The interconnectedness of our lives with each other, with the material and with the more-than-human is not apart from our reality, together they constitute our reality. In contrast, IK-S represents integrated ways of knowing, being, and doing that are inseparable from the land, community, and lived experience. Together, WS and IK-S provide us with both micro- and macro-level perspectives and help us to understand how these parts function as a whole.


*This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca*

Ultimately, scientific knowledge alone is insufficient for addressing the complex ecological and social challenges we face; it must be tempered by wisdom and guided by an ethics of reciprocity (Davis & McMurtry, 2025; Snively & Corsiglia, 2001). It is in this space that posthumanism, IK-S, and SSI come together to nurture learners who think critically, act responsibly, and engage with the world through relations of care and accountability.

## Toward Relational and Situated Science Education Through the Entanglement of SSI, Posthumanism, and IK-S

The overarching goal of SSI is to foster the development of students' scientific literacy, thereby enabling them to become active and engaged citizens equipped with the decision-making skills needed to consider the relational interplay between scientific and social issues (Högström et al., 2025). Although SSI represents an important move toward situating science within broader societal contexts, it remains largely grounded in WS and Western socio-economic perspectives. In their recent scoping review, Viehmann et al. (2024) found that the vast majority of SSI publications (in English or Spanish) originated from the United States, Spain, and Germany, with comparatively few contributions from non-Western countries. All this to say that the underlying assumption is that the literacy, knowledge, and communication skills being cultivated through SSI approaches reflect Western scientific and societal goals.

We also recognize that posthumanism theories are similarly rooted in Western intellectual traditions. Even as posthumanism scholarship appears in universities and journals outside of Europe and North America, the conversations remain shaped by Western thought, including its critiques of the Western humanist tradition and its particular constructions of the 'human' (Rubins, 2019). In this sense, posthumanism may universalize this concept and overlook other existing conceptions of humanity. However, while acknowledging their eminence from dominant Western frameworks, we believe that SSI and posthumanism relational approaches can create opportunities for more relational, inclusive, and ethically attuned ways of teaching and learning within science education.

While these relational approaches find affinity with IK-S, the latter emerges from an Indigenous episteme and therefore brings a fundamentally different orientation to science education, whereby learning is facilitated through participation and reflection (Aikenhead & Michell, 2011). Where SSI emphasizes preparing learners to imagine and evaluate possible solutions to complex socioscientific challenges, IK-S foregrounds the work of restoring right relationships as the basis for any such solutions. IK-S also challenges presumptions about who gets to define which relationships matter and opens space for decolonizing approaches that unsettle assumptions about whose knowledge counts and whose interests science is meant to serve (Harding, 1991).

Similarly, a posthumanist relational approach allows students to see complex SSI not only as an interplay between human science and socio-political factors, but also as a dynamic entanglement of humans, nonhumans, and material forces. Children do not merely observe their environment; they intra-act with it (Barad, 2006). That is, their actions, perceptions, and understandings are entangled with what they encounter, whether it is a plant, an insect, water, stones, or soil (Rautio, 2013). These encounters constitute phenomena in which neither the child nor more-than-humans pre-exist as independent agents; rather, they emerge through their intra-actions (Harwood & Collier, 2017). In these moments, children and the environment co-constitute one another, each shaping the possibilities, actions, and learning of the other (Cutter-


*This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca*

Mackenzie-Knowles et al., 2020). Complementing SSI's critical and ethical examination of contemporary issues, posthumanism invites us to attend to the entangled relationalities of challenges such as climate change, water management, and/or biodiversity loss. This approach foregrounds how human decisions are inseparable from more-than-human agencies and local material realities (Atkinson, 2015; Nxumalo & Pacini-Ketchabaw, 2017). In doing so, students are encouraged to explore how humans, non-humans, and environments co-inhabit our shared world, rather than viewing nature as a backdrop to human activity or a resource to be managed (Taylor, 2017).

Examining these same SSI issues from an IK-S lens encourages students to explore how these concerns are rooted in relationships and how proposed responses might mend, or further strain, those connections. Translating these concepts into SSI teaching means (re)imagining classroom inquiry as relational work rather than strictly problem-solving. For teachers, this invites pedagogical moves such as grounding SSI units in local land-based contexts, incorporating Indigenous narratives and community voices, and prompting students to consider reciprocity alongside scientific evidence (McGregor, 2013). A communal understanding of knowledge frames learning, not as an individual pursuit, but as a collective process grounded in community and place. In this way, cultivating relational responsibility grounds the critical reasoning needed for informed decision-making within a broader web of relationships (Aikenhead & Michell, 2011). Such a relational view of teaching and learning reminds us that knowing is situated: it matters who speaks, from where and in relation to what. This emphasis is also central to posthuman ethics and avoids reproducing the universalizing tendencies of traditional humanism (Braidotti, 2013, 2019). For example, in India, Steffie, observed that the same farm holds very different meanings for children. For some children who visit the farm during summer vacation, it is merely a site of play, while for children from some communities (e.g., Adivasi) the same farm is part of everyday life and labour. Such differences challenge the assumption within traditional science education that all children might encounter 'nature' in similar ways and can therefore learn about it through standardized activities. What this example serves to illustrate is that these relationships are neither romantic nor universal; they are shaped by social, economic, cultural, political and complex material conditions that create very different possibilities for how children come to know and co-inhabit the land (Malone, 2020).

As we consider these orientations together, it is important to resist the temptation to collapse them into direct comparisons. The focus on constant comparison can obscure the dynamic, relational and emergent qualities that animate SSI, posthumanism, and IK-S, and reduce them to static categories rather than living practices (Barad, 2003). Instead, we treat these theoretical approaches as active, material-discursive forces that shape how learners notice, interpret, and respond within their environments (Atkinson, 2015; Barad, 2014). In this view, IK-S, posthumanism, and SSI are not frameworks to be measured against one another but are to be considered as mutually generative onto-epistemologies that expand what science education can become when grounded in relationality, responsibility, and situated engagement. Their entanglement opens space for pedagogical approaches that braid multiple ways of knowing, which we explore next through the guiding principle of TES.

To support teachers in weaving relational responsibilities with scientific inquiry, TES offers a meaningful starting point. It is a guiding principle first introduced by Mi'kma'ki Elders Albert and Murdena Marshall in 2004 (Rankin et al., 2023). Inspired by the Mi'kma'ki word,


This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca

Etuaptmumk, which means "the gift of multiple perspective [*sic*]" (Bartlett et al., 2015, p. 295), TES calls for:

> learning to see from one eye with the strengths of Indigenous knowledges and ways of knowing, and from the other eye with the strengths of Western knowledges and ways of knowing, and to use both these eyes together, for the benefit of all. (p. 295)

Rather than merging knowledge systems, TES invites teachers and learners to 'weave' back and forth between knowledges, calling upon the strengths within IK-S or WS as required (Bartlett et al., 2015). Both offer different ways of understanding a problem and working together can offer unique and innovative solutions (Cirkony et al., 2023).

The application of TES in this approach could be considered from the perspective that one of the eyes sees through the Western-centered approaches of SSI and posthumanism, while the other eye provides a view through Indigenous epistemologies and IK-S. However, here it is important to remember that the English translation of *Etuaptmumk*, *Two-Eyed Seeing*, is not meant to convey a binary. All knowledges are partial and situated (Haraway, 1988), and as Elder Albert Marshall explains, they all have insights and understandings to contribute. In this sense, one might just as easily speak of Three-Eyed Seeing, Four-Eyed Seeing, or more. In this context, TES is not merely a matter of pairing WS and IK-S content, it offers a generative way to bring IK-S, posthumanism, and SSI into productive relationships in classroom practice. SSI pedagogies support inquiry-based engagement with complex scientific and societal issues through approaches commonly associated with WS. IK-S, in turn, foregrounds relational, ethical, and land-based responsibilities that broaden how these issues are understood and addressed. Posthumanism further invites students to see organisms, environments, technologies, and humans as co-constitutive and co-shaping one another. Cirkony et al. (2023) have shown that these kinds of pedagogical 'weavings' are possible when educators intentionally combine the inquiry-based models of pedagogy often employed with SSI (Högström et al., 2025; Viehmann, 2024) with relational, story-rich, and place-centred approaches of IK-S and Indigenous ways of learning and knowing.

Let us now consider how TES can guide teachers in bringing posthumanism, IK-S, and SSI together by briefly outlining two examples.

**Example of Pimìzì (American eel) in the Kitchissippi (Ottawa River)**

The story of pimìzì in the Kitchissippi, which runs through the traditional territory of the Anishinaabe Algonquin people in present-day Ontario and Québec, demonstrates how IK-S, posthumanism, and SSI can be meaningfully woven into science education. Kitchissippi pimìzì populations have drastically declined by about 99% as a result of dams and habitat fragmentation (Ottawa Riverkeeper, n.d.). As a culturally and ecologically significant species, it risks disappearing from the waters of the Kitchissippi. The Kitchissippi pimìzì is an important traditional source of food and medicine and holds deep spiritual significance for the local Anishinaabe Algonquin. Archaeological evidence dating back more than 5,000 years reveals that one of the largest pimìzì harvesting sites in North America was situated on a Kitchissippi island west of Ottawa (Algonquins of Ontario, 2014). For the Algonquins, the eel holds sacred significance and is understood as a carrier of prayers, moving through rivers, wetlands, and subterranean passages in ways that connect the waters and lands of Mother Earth (Algonquins of Ontario, 2014).


This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca

This example serves to highlight a suite of interconnected ecological, political, policy, and conservation challenges. Employing a TES framework, educators can combine SSI activities with story-rich, land-centered learning that encourages students to explore these entanglements, reflect on ethical responsibilities, and recognize agency as not situated within any individual but rather distributed within this intra-action. Such pedagogical 'weaving' can potentially foster critical, relational, and ethical understanding and cultivate ecological literacy that is attuned to the co-constitutive dynamics of living systems within shared ecological worlds. Posthumanism and IK-S encourage us to move beyond what solutions humans can implement toward mapping the complex relationalities among infrastructure, river flows, eel biology, human policies, and broader ecological systems. This perspective emphasizes co-constitution: humans, eels, rivers, design, and technologies co-shape one another and what patterns emerge from these entanglements rather than from isolated actions (Rosén, et al., 2024).

**Example of Classroom Inquiry into Local Water Quality**

Another example is a classroom inquiry into local water quality, where students are invited to draw on both relational responsibilities and scientific reasoning. From a TES perspective, WS facts regarding the physical and chemical properties of water would be accompanied by an invitation for students to enter into a relationship with water as a living relative that moves, responds, sustains kin, and gives of itself. This orientation prompts students to ask not only "What is happening to this water?" but also "What responsibilities arise from this relationship, and what do we owe in return?" As McGregor (2013) highlights, "while people are caretakers of water, we do not 'manage' or 'control' it; it has its own life force that must be respected" (p. 83). In this context, TES means valuing community testimony, land-based observations, and local stories as legitimate forms of knowledge alongside pH readings and contaminant assays.

From an integrative and relational SSI perspective, this same classroom inquiry not only requires learners to analyze Western scientific data but also consider how contaminants affect human and more-than-human ecosystems, how harms are unevenly distributed across communities and what intersecting political, economic, and social justice interests must be weighed when examining possible responses. For example, many Indigenous communities on reserves continue to face long-term issues with safe drinking water. Although some progress has been made in recent years, as of May 2026, there were 39 active long-term drinking water advisories affecting 37 Indigenous communities across Canada (Government of Canada, n.d.).

As such, rather than focusing on 'fixing' the problem or finding a solution solely from a human perspective, a posthumanism perspective would extend this line of inquiry by asking: How do humans and nonhumans intra-act in this ecosystem? What patterns and assemblages emerge out of these intra-actions? Whose needs and interests are prioritized in decision-making: Are they those of fishers, politicians, fish, seabirds, or shoreline vegetation? How do water cycles, industry, climate change, and human interventions co-produce the current ecological situation? Through a posthumanism lens, SSI approaches can be expanded to work with these interconnected forms of inquiry, allowing students to form assemblages and recognize that agency is distributed across humans, nonhumans, and broader environmental forces (Boileau, 2024). Here, IK-S also intersects with the social and ethical dimensions of SSI and posthumanism by prompting students to ask which relationships have broken down or become strained—among people, water, communities, governance structures, human settlements, more-than-human worlds, and more. Such an inquiry attends to how these complex, myriad,


This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca

interconnected, and/or fractured relationships shape both the causes and the consequences of contamination.

Working with diverse epistemologies, including IK-S, in ways that are meaningful to students' own local contexts can empower learners to see themselves, their families and their broader communities as legitimate sources of knowledge and as agents capable of addressing the issues they face (Kayumova & Dou, 2022). However, we recognize that working across these epistemological divides is not without its challenges. Reflecting on the concept of *settler moves to innocence* (Tuck & Yang, 2012), it may often feel easier and safer for non-Indigenous educators to excuse themselves from the tension, ambiguity, and discomfort of engaging with Indigenous epistemologies and knowledges because they may be afraid of making a mistake, and it is simply "not my stories to tell" (Sargent, 2021, p. 46). However, as Cree scholar Dwayne Donald (2021) explains, if we are to (re)new and (re)imagine our relationships, including Indigenous-Canadian relations as well as those with the other-than-human, then educators must "engage in such topics in qualitatively different ways" (p. 61). It is not meant to be easy or straightforward; it requires both the deconstruction of oppressive epistemic systems and the reconstruction of more relational and pluralistic ones (Battiste, 2013). As Tuck and Yang (2012) argue, "Settler colonialism and its decolonization implicates and unsettles everyone" (p. 7).

In this context, TES offers an approachable and collaborative framework through which educators may bring SSI, IK-S, and posthumanism into dialogue. Together, they can co-cultivate ethical, affective, and civic engagement by opening space for epistemic as well as disciplinary pluralism. However, as previously discussed, current practical applications of SSI frameworks frequently remain centered on Western scientific ways of knowing, which can limit how relational, land-based, and more-than-human perspectives are taken up. Hence, it is crucial to understand how we can move forward toward more meaningful forms of relational and systemic transformation. We therefore now turn to the operationalization of SSI as a relational pedagogy and discuss the barriers and opportunities relating to the enactment of these approaches within educational practice.

## Enacting SSI Relationally: Toward System Transformation

There is often a disconnect between pedagogical intentions and their actual implementation in classrooms (McLaughlin & Ruby, 2024). The reasons for the difficulty in turning relationally focused pedagogy into reality are multiple and multi-layered (Field et al., 2024). This tension becomes particularly visible in the enactment of SSI with topics such as climate change, biodiversity loss, and/or water contamination. Returning to the previous example of the decline of pimìzì populations in the Kitchissippi, we can see how ecological degradation is entangled with colonial histories, hydroelectric infrastructures, conservation policies, and Indigenous relationships to land and water. Engaging with this topic therefore requires learners to attend to these complexities, adopt a holistic stance, and explore relationships between physical, biological, and social sciences. However, classroom inquiries often become reduced to technical or scientific analyses, while relational, historical, ethical, and political dimensions remain peripheral. Teachers may also face uncertainty regarding how to engage with IK, facilitate discussions around colonialism and environmental injustice, and/or work with emotionally and politically complex issues within institutional constraints (Roberts, 2024). Consequently, while SSI frameworks conceptually support relational and transdisciplinary engagement, their enactment frequently remains limited by existing educational structures, epistemic norms, and lack of teacher training in this area.


This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca

First, we need to be upfront about the fact that IK-S and posthumanism inspired SSI teaching is countercurrent in the Canadian and global context where educational systems are themselves embedded in neoliberal logics of competition and performativity (Ball, 2021; Pinto, 2015). Reflecting logics of modernity, these systems often reinforce linear ways of knowing, fixed notions of progress and development, hierarchical relations of power, and the separation of humans from the more-than-human world (Machado de Oliveira, 2025; Stein, 2018). This ideological context affects the possibility to invest time and money away from standardized testing's main criteria of success (i.e., literacy and numeracy). For example, provincial school boards are funded based on a complex formula that relies largely on the number of students registered. Therefore, school boards need to attract students by highlighting features such as their academic scores or the high employability of their students (DiMartino & Jessen, 2018). An education system that is entangled in competitive structures (i.e., university rankings; public scores of national and international standardized testing), often runs counter to relational pedagogical values of interconnectedness, sharing, and reciprocity.

Nevertheless, some jurisdictions have tried to draft policies supporting relational pedagogies. For example, in Ontario, Environmental Education (EE) was 'infused' across all subject areas rather than taught as a distinct stand-alone program. Yet this approach has been shown to further marginalize EE. As Karrow and Fazio (2015) explain, this infusion "falls short of preserving the holistic nature of EE. It takes the holistic nature of EE, carves it up into pieces and inserts these pieces into other curricular areas" (p. 98). While the intention of this policy was to support EE, its practical implementation failed to manifest its intended goals. Nevertheless, the Ontario experience with EE integration is instructive because the EE policy framework (Ontario Ministry of Education [OMoE], 2009) aligns closely with the goals of SSI. It promotes experiential and inquiry-based approaches and encourages transdisciplinary investigations of complex natural and social phenomena, all to cultivate "future scientifically conscious and active citizens" (Viehmann et al., 2024, p. 2). While some educators and administrators have used these policy documents (OMoE, 2009, 2013) to develop innovative programs, EE has not yet fully flourished at the systemic level in Ontario (Bardecki & McCarthy, 2020). Reasons are numerous, including (but not limited to): lack of pre- and in-service teacher training, absence of an accountability mechanism on the part of school boards, lack of ministry budget, lack of time due to pressure to cover the curriculum, dominant grammar of teaching that remains traditional and not conducive to pedagogical risk-taking, deep-seated culture of neutrality, and rationality attached to science teaching (Bardecki & McCarthy, 2020; Barrett, 2007; Gough & Gough, 2020).

What we learn from the Ontario context is that well-intentioned policy making and curriculum integration are necessary, yet not sufficient. If these policies are not accompanied by adequate and meaningful supports for successful policy enactment, progressive reform efforts are at risk of stalling and not delivering on their promise. In the current neoliberal context, marked by an unprecedented volume of prescriptive policies, educational leaders' central role as the "meaning-makers" (Pinto, 2015, p. 140) who interpret and enact these policies is being challenged and constrained. Pinto (2015) argues that educational leaders feel "compelled to produce an illusion of policy compliance by way of performativity" (p. 152), which may translate into minor or cosmetic changes rather than meaningful, well-executed initiatives.

In the Canadian context with ten provinces and three territories who all have their own educational jurisdictions, these challenges are all the more problematic. Field et al. (2024)


*This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca*

describe how climate change education is unevenly applied across Canadian provinces and calls for stronger leadership and collaboration across provincial educational ministries to ensure that all students, regardless of geographic location or course choices, receive meaningful education on this issue. This uneven education across the country raises important questions about how younger generations will grapple with such complex phenomena, particularly in an increasingly polarized context, where political adversaries openly distrust one another (Schedler, 2023).

Therefore, in such a current landscape it is important to acknowledge the challenges of implementing widespread SSI teaching practices, including relational theories. For posthumanism and IK-S inspired SSI pedagogy to be taken up by teachers, and for embodied, relational, transdisciplinary learning experiences to take root, significant systemic changes are required. Such changes must go beyond minor modifications to existing frameworks and/or the introduction of additional policies, particularly within a context in which school and district administrators are already operating under significant constraints. Fortunately, these challenges are not insurmountable, and there is hope to operate deep, meaningful changes within the educational system. In line with IK-S and posthumanism pedagogies as communal endeavours, Shah (2026) posits hope as something that does not belong to the individual but rather emerges through relationship, conversation, and the shared work of imagining other worlds. Many dedicated and passionate administrators and educators are striving to disrupt the status quo and put in place innovative programs, prioritizing relationality for individual and collective flourishing while illustrating the principle that "there is almost always a place for the exercise of positive choices and agency" (Walker et al., 2021, p. 316).

Analyzing how leaders function in schools that are driven by positive psychology, rather than identifying deficits and ways to solve these gaps, Walker et al. (2021) crafted a conceptual framework for flourishing based on four principles: purpose, presence, passion, and play. The authors emphasize interconnectedness as key in fostering a "sense of enjoyment, meaning, purpose, and connectedness" (p. 5) in schools, which seems very congruent with a wider relational enactment of SSI in schools. This also suggests that relational enactments of learning require organizational structures that support sustained engagement with complexity, uncertainty, and collaborative inquiry (Machado de Oliveira, 2025; Stein, 2018). For example, adjusting timetables for longer periods of time for student inquiries, creating opportunities for land-based and community-engaged learning, supporting teacher networks, and ongoing training can foster relational and affective conditions required for this non-traditional pedagogy to take place. Such practices move beyond transactional models of schooling toward educational environments that recognize learning and knowing as an emergent, relational, and co-constitutive process (Machado de Oliveira, 2025). In this sense, flourishing is not an isolated achievement but a relational process emerging through reciprocity, care, and mutual responsibility. We also draw inspiration from Kimmerer's (2024) assertion that "all flourishing is mutual" (p. 28) which emphasizes that the wellbeing of humans, communities, lands, waters, and more-than-human worlds is fundamentally interconnected. Relational leadership therefore becomes significant not only for fostering institutional flourishing, but also for cultivating the ethical and relational conditions through which collective flourishing and transformative educational possibilities may emerge.

These stories of positive leadership are based on leaders' personal traits and their capacity to rise above an ever-increasing workload to bring the organization further. While this cannot be expected of all educators in the system, it does speak to the role of inner development


This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca

within overall system transformation. Katie Hodgetts (2026) has coined the term inner-tersectional changemaking to express that lasting change demands a union of inner development and political reform. She argues that sustainable changemaking demands more than external action; it also requires profound internal transformation. This rightly puts into focus a significant limitation of much educational leadership preparation. Under the influence of standards-based accountability and performance pressures, leadership programs have often privileged managerial, administrative, and technical competencies, while giving comparatively limited attention to the moral, relational, reflective, and personally developmental dimensions of leadership (Spooner, 2024).

Relational leadership is premised on the idea that it is the relationship between the leader and their followers that makes leadership not a determined set of skills exercised by a highly qualified leader (Clarke, 2018). "All too often we reduce relational experiences to an objectified, causal transaction between two people" (Giles, 2019, p. 5). Relational leadership should instead be considered a holistic, embodied, dynamic, and context-dependent process that recognizes the complex interplays between several factors such as the individuals themselves, both leader and followers, their own previous experiences of being in relationship, the organizational culture, and broader cultures (Clarke, 2018; Giles, 2019). In a complex and rapidly changing world, relational leadership is seen as a social influence process within which change can emerge through intentional practices of co-construction between a leader and their followers (Nicholson & Kurucz, 2019). Away from managerialist, top-down conceptions, we are convinced that the practice of relational leadership, which is intrinsically reflective and collaborative, is essential in fostering innovation in educational contexts. It invites leaders to continuously and holistically reflect on their own inner development, ethics, and way of being, as well as organizational goals, thereby nurturing positive relationships and achieving meaningful and lasting change.

While discussing whether SSI should be promoted as a subject in its own right or not, we as authors encountered tensions and complexities in arriving at a shared conclusion. Some of us believe that SSI should exist as a standalone subject, while others argue that it should remain integrated across curricula. Considering the challenges educators face when engaging with SSI within already crowded disciplinary curricula (Avraamidou, 2016; Gough & Gough, 2020), one argument is that SSI should be a stand-alone subject with its own curriculum, so that educators can be adequately trained and engage with it more meaningfully. According to this position, SSI would require the creation of a transdisciplinary space, with its own pre- and in-service training, methodologies, and pedagogical tools capable of supporting ethical, affective, epistemic, and ecological forms of inquiry. Alternatively, there was value in weaving SSI approaches and pedagogies across disciplines. The significance of SSI lies not only in where it is positioned within the curriculum, but also in how it invites educators and learners to engage ethically, relationally, and responsively (beyond their curricula) with complex socio-ecological issues.

While we all agreed that SSI and other relational pedagogies should be prominent within curricula, there was critical discussion regarding whether making it a stand-alone subject would risk siloing cross-curricular connections or whether it would provide the recognition and support needed for it to thrive. In navigating these dialogues, we considered how multiple epistemologies coexist without one agenda or policy expectation being positioned as more legitimate than another (Machado de Oliveira, 2025, p. 44). In this sense, our dialogue itself disrupts Cartesian assumptions that privilege linear and universal ways of knowing (Roberts, 2024). Instead, it foregrounds plurality, uncertainty, ambivalence, and relational negotiation (Machado de


This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca

Oliveira, 2025) which resists the oversimplification of SSI and acknowledges the ongoing tension and complexity involved in imagining its place within education. Regardless of these differing lenses, we collectively agree that SSI risks being diluted if it is not intentionally supported. This is important because educators that seek to foster relational accountability, ethical responsiveness, and emotional and epistemic growth in their students are often faced with dominant systemic trends shaped by standardization, performativity, and disciplinary compartmentalization. Thus, pre-service and in-service teacher education must include training that enables teachers to embrace uncertainty, complexity, ambiguity, hold space for emotion and ethics and draw on diverse epistemologies in their practice (Machado de Oliveira, 2025). This is an ambitious goal and as such needs to have its own spaces/referents in faculties and school boards, to allow for (re)imagining and enacting innovative, embodied, and relational pedagogies.

Finally, we encourage the creation of new alliances and synergies to ensure the sustainability of SSI as a relational pedagogy. Teacher educators also need to work closely with local school boards' pedagogical consultants to develop a coherent pre- and in-service training program that offers lifelong learning opportunities to dedicated teachers, in partnership with Indigenous and environmental community organizations. These partnerships are already in place in a few faculties and school boards that have prioritized system transformation to support land-based learning and Indigenization of pedagogy (Karsgaard et al., 2025; Schnellert et al., 2024). However, these efforts are not yet widespread. SSI approaches are best enacted by educators who are familiar with critical scholarships and can navigate educational, scientific, and socio-political dominant discourses with discernment. Effective SSI teaching, including adequate preparation for IK-S and Etuaptmumk/TES, cannot be sustained without an adequate budget to finance the creation of training/support hubs linking school boards to faculties of education and community organizations.

## Conclusion

This paper offers an entry point into how diverse ways of knowing can be meaningfully woven into science education. By bringing IK-S, posthumanism, and Western scientific practices into dialogue, educators can cultivate the epistemic and intellectual diversity needed for students to approach SSI with greater critical insight. Engaging with multiple epistemologies strengthens ecological literacy (Black & Tylianakis, 2024) while also fostering the ethical sensibilities and civic responsibility that support an engaged citizenry. Attending to the relational and more-than-human dimensions of inquiry encourages learners to consider the responsibilities that arise within the complex webs of relations that shape our shared world. Taken together, these approaches nurture a relational and ethically attuned science education that prepares students to navigate and respond thoughtfully to the challenges of the complex world we co-inhabit (Taylor & Giugni, 2012).


This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca

## References

Aikenhead, G. S. (1996). Science education: Border crossing into the subculture of science. *Studies in Science Education, 27*(1), 1–52. https://doi.org/10.1080/03057269608560077

Aikenhead, G. S., & Michell, H. (2011). *Bridging cultures: Scientific and Indigenous ways of knowing nature*. Pearson Canada.

Algonquins of Ontario. (2014). *Bridging the gap between scientific and Aboriginal traditional knowledge: Exploring Algonquin and Aboriginal relationships with the American eel* (Volume 2: Traditional knowledge report). http://www.tanakiwin.com/wp-system/uploads/2013/10/AOO_Traditional-Knowledge-Report_Volume-2_E-Version_Pimisi_Final_20140814.pdf

Atkinson, K. (2015). Wasps-bees-mushrooms-children: Reimagining multispecies relations in early childhood pedagogies. *Journal of Childhood Studies, 40*(2), 67–79. https://doi.org/10.18357/jcs.v40i2.15180

Avraamidou, L. (2016). Stories of self and science: Preservice elementary teachers' identity work through time and across contexts. *Pedagogies: An International Journal, 11*(1), 43–62, https://doi.org/10.1080/1554480X.2015.1047837

Ball, S. J. (2021). *The education debate*. Policy Press.

Barad, K. (2003). Posthumanist performativity: Toward an understanding of how matter comes to matter. *Signs, 28*(3), 801–831. https://doi.org/10.1086/345321

Barad, K. (2006). *Meeting the universe halfway*. Duke University Press. https://doi.org/10.1215/9780822388128

Barad, K. (2014). Diffracting diffraction: Cutting together-apart. *Parallax, 20*(3), 168–187. https://doi.org/10.1080/13534645.2014.927623

Bardecki, M., & McCarthy, L. (2020). Implementation of the Bondar Report: A reflection on the state of environmental education in Ontario. *Canadian Journal of Environmental Education, 23*, 113–131. https://cjee.lakeheadu.ca/article/view/1585

Barrett, M. J. (2007). Homework and fieldwork: Investigations into the rhetoric–reality gap in environmental education research and pedagogy. *Environmental Education Research, 13*(2), 209–223. https://doi.org/10.1080/13504620701284928

Bartlett, C., Marshall, M., Marshall, A., & Iwama, M. (2015). Integrative science and Two-Eyed Seeing: Enriching the discussion framework for healthy communities. In M. W. Parkes, N. P. Guehlstorf, & L. K. Hallström (Eds.), *Ecosystems, society, and health* (pp. 280–326). McGill-Queen's University Press. https://doi.org/10.1515/9780773583122-012

Battiste, M. (2013). *Decolonizing education: Nourishing the learning spirit*. Purich Publishing. https://doi.org/10.59962/9781895830972

Black, A., & Tylianakis, J. M. (2024). Teach Indigenous knowledge alongside science. *Science, 383*(6683), 592–594. https://doi.org/10.1126/science.adi9606

Boileau, E. (2024). Navigating approaches to "thinking with": A discussion of the practicalities of posthuman research involving young children. *Australian Journal of Environmental Education, 40*(2), 216–230. https://doi.org/10.1017/aee.2024.30


*This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca*

Braidotti, R. (2013). *The posthuman*. Polity Press.

Braidotti, R. (2019). A theoretical framework for the critical posthumanities. *Theory, Culture & Society, 36*(6), 31–61. https://doi.org/10.1177/0263276418771486

Cajete, G. (2000). *Native science: Natural laws of interdependence*. Clear Light Publishers.

Cirkony, C., Kenny, J., & Zandvliet, D. (2023). A Two-Eyed Seeing teaching and learning framework for science education. *Canadian Journal of Science, Mathematics and Technology Education, 23*(2), 340–364. https://doi.org/10.1007/s42330-023-00276-z

Clarke, N. (2018). *Relational leadership: Theory, practice and development*. Routledge. https://doi.org/10.4324/9781315620435-1

Cutter-Mackenzie-Knowles, A., Malone, K., & Hacking, E. (2020). *Research handbook on childhoodnature: Assemblages of childhood and nature research*. Springer.

Davis, B., & McMurtry, A. (2025). *Inventions of teaching: A genealogy* (2nd ed.). Routledge. https://doi.org/10.4324/9781003493440

DiMartino, C., & Jessen, S. B. (2018). *Selling school: The marketing of public education*. Teachers College Press.

Donald, D. (2021). We need a new story: Walking and the wâhkôhtowin imagination. *Journal of the Canadian Association for Curriculum Studies, 18*(2), 53–63. https://doi.org/10.25071/1916-4467.40492

Ferrando, F. (2019). *Philosophical posthumanism*. Bloomsbury Academic.

Ferrando, F. (2024). *The art of being posthuman: Who are we in the 21st century?* Polity Press.

Field, E., Berger, P., Lee, D., Strutt, C., & Nguyen, A. T. (2024). Knowledge, urgency and agency: Reflections on climate change education course outcomes. *Environmental Education Research, 30*(11), 2108–2130. https://doi.org/10.1080/13504622.2023.2296359

Freeman, M. M. (1992). The nature and utility of traditional ecological knowledge. *Northern Perspectives, 20*(1), 9–12.

Giles, D. L. (2019). *Relational leadership in education: A phenomenon of inquiry and practice* (1st ed.). Routledge.

Goodchild, M. (2022). Relational systems thinking: The Dibaajimowin (story) of re-theorizing "systems thinking" and "complexity science". *Journal of Awareness-Based Systems Change, 2*(1), 53–76. https://doi.org/10.47061/jabsc.v2i1.2027

Gough, A., & Gough, N. (2020). Series editors' foreword. In D. D. Karrow & M. DiGiuseppe (Eds.), *Environmental and sustainability education in teacher education* (pp. v–ix). Springer.

Government of Canada. (n.d.). *Active long-term drinking water advisories*. https://www.sac-isc.gc.ca/eng/1614387410146/1614387435325

Haraway, D. (1985). *A cyborg manifesto*. University of Minnesota Press. https://theanarchistlibrary.org/mirror/d/dh/donna-haraway-a-cyborg-manifesto.pdf


*This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca*

Haraway, D. (1988). Situated knowledges: The science question in feminism and the privilege of partial perspective. *Feminist Studies, 14*(3), 575–599. https://doi.org/10.2307/3178066

Haraway, D. J. (2016). *Staying with the trouble*. Duke University Press. https://doi.org/10.1215/9780822373780

Harding, S. G. (1991). *Whose science? Whose knowledge? Thinking from women's lives*. Cornell University Press.

Harwood, D., & Collier, D. R. (2017). The matter of the stick: Storying/(re)storying children's literacies in the forest. *Journal of Early Childhood Literacy, 17*(3), 336–352. https://doi.org/10.1177/1468798417712340

Hodgetts, K. (2026). *Act, rest, reset, repeat*. Watkins Publishing.

Högström, P., Gericke, N., Wallin, J., & Bergman, E. (2025). Teaching socioscientific issues: A systematic review. *Science & Education, 34*(5), 3079–3122. https://doi.org/10.1007/s11191-024-00542-y

Jukes, S., Stewart, A., & Morse, M. (2021). Following lines in the landscape: Playing with a posthuman pedagogy in outdoor environmental education. *Australian Journal of Environmental Education, 38*(3–4), 345–360. https://doi.org/10.1017/aee.2021.18

Karrow, D., & Fazio, X. (2015). Curricular critique of an environmental education policy: Implications for practice. *Brock Education: A Journal of Educational Research and Practice, 24*(2), 88–108. https://doi.org/10.26522/brocked.V24I2.404

Karsgaard, C., Jin, Q., Howard, P., & Kreber, C. (2025). An ethical imperative for higher education: cultivating community partnerships in climate change teacher education. *Environmental Education Research, 32*(10), 3114–3138. https://doi.org/10.1080/13504622.2025.2588691

Kayumova, S., & Dou, R. (2022). Equity and justice in science education: Toward a pluriverse of multiple identities and onto-epistemologies. *Science Education, 106*(5), 1097–1117. https://doi.org/10.1002/sce.21750

Kim, E.-J. A. (2018). *The Relationships at play in integrating Indigenous knowledges-sciences (IK-S) in science curriculum: A case study of Saskatchewan K-12 science curriculum* (Order No. 28248733) [Doctoral dissertation, McGill University]. ProQuest Dissertations and Theses Global. https://www.proquest.com/docview/2501270857/abstract/8346278454214973PQ/1

Kim, E.-J. A., Asghar, A., & Jordan, S. (2017). A critical review of traditional ecological knowledge (TEK) in science education. *Canadian Journal of Science, Mathematics and Technology Education, 17*(4), 258–270. https://doi.org/10.1080/14926156.2017.1380866

Kimmerer, R. W. (2002). Weaving traditional ecological knowledge into biological education: A call to action. *BioScience, 52*(5), 432–438. https://doi.org/10.1641/0006-3568(2002)052[0432:WTEKIB]2.0.CO;2

Kimmerer, R. W. (2013). The fortress, the river and the garden: A new metaphor for cultivating mutualistic relationship between scientific and traditional ecological knowledge. In D. R. Longboat, K. Young, & A. Kulnieks (Eds.), *Contemporary studies in environmental and*


*This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca*

*Indigenous pedagogies* (pp. 49–76). Sense Publishers. https://doi.org/10.1007/978-94-6209-293-8_4

Kimmerer, R. W. (2024). *The serviceberry: Abundance and reciprocity in the natural world*. Simon and Schuster.

Kovach, M. (2021). *Indigenous methodologies: Characteristics, conversations, and contexts* (2nd ed.). University of Toronto Press.

Little Bear, L. (2000). Jagged worldviews colliding. In M. Battiste (Ed.), *Reclaiming Indigenous voice and vision* (pp. 77–85). UBC Press.

Machado de Oliveira, V. (2025). *Outgrowing modernity: Navigating complexity, complicity, and collapse with accountability and compassion*. North Atlantic Books.

Malone, K. (2020). Children in the Anthropocene: How are they implicated? In A. Cutter-Mackenzie-Knowles, K. Malone, & E. Barratt Hacking (Eds.), *Research handbook on childhoodnature: Assemblages of childhood and nature research* (pp. 507–573). Springer. https://doi.org/10.1007/978-3-319-67286-1_36

Mazzocchi, F. (2008). Analyzing knowledge as part of a cultural framework: The case of traditional ecological knowledge. *Environments, 36*(2), 39–58.

McGregor, D. (2013). Anishinaabe environmental knowledge. In A. Kulnieks, D. Longboat, & K. Young (Eds.), *Contemporary studies in environmental and Indigenous pedagogies* (pp. 77–88). Sense Publishers. https://doi.org/10.1007/978-94-6209-293-8_5

McLaughlin, C., & Ruby, A. (2024). Global and national shifts in implementing educational reform: Learning across the cases. In C. McLaughlin & A. Ruby (Eds.), *Politics and knowledge shaping educational reform: Case studies from around the globe* (pp. 186–200). Cambridge University Press. https://doi.org/10.1017/9781009414753.013

Murris, K. (2022). *Karen Barad as educator*. Springer Nature Singapore. https://doi.org/10.1007/978-981-19-0144-7

Nail, T. (2023). What is new materialist aesthetics? In A. Bayley & J. Chan (Eds.), *Diffracting new materialisms* (pp. 106–166). Palgrave Macmillan.

Nayar, P. (2014). *Posthumanism.* Polity Press. https://www.wiley.com/en-us/Posthumanism-p-9780745662404

Nicholson, J., & Kurucz, E. (2019). Relational leadership for sustainability: Building an ethical framework from the moral theory of "ethics of care". *Journal of Business Ethics, 156*(1), 25–43. https://doi.org/10.1007/s10551-017-3593-4

Nxumalo, F., & Pacini-Ketchabaw, V. (2017). "Staying with the trouble" in child-insect-educator common worlds. *Environmental Education Research, 23*(10), 1414–1426. https://doi.org/10.1057/9781137453082_10

Ontario Ministry of Education. (2009). *Acting today, shaping tomorrow*. http://www.edu.gov.on.ca/curriculumcouncil/ShapeTomorrow.pdf

Ontario Ministry of Education. (2013). *The Ontario curriculum. Social studies Grades 1 to 6 history and geography Grades 7 and 8*. http://www.edu.gov.on.ca/eng/curriculum/elementary/sshg18curr2013.pdf


This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca

Ottawa Riverkeeper. (n.d.). *The American eel*. https://ottawariverkeeper.ca/what-we-do-2/issues/endangered-species/the-american-eel/

Pacini-Ketchabaw, V., Taylor, A., & Blaise, M. (2016). Decentring the human in multispecies ethnographies. In C. Taylor & C. Hughes (Eds.), *Posthuman research practices in education* (pp. 149–167). Palgrave Macmillan.

Patterson, K., Labreche, K., Morcom, L., & St. Amant, D. (2023). Stitching together my Anishinaabe research paradigm: An approach to storytelling with Algonquin Ikwewag (women) and gender-diverse people in Mattawa and North Bay, Ontario. *International Journal of Qualitative Methods, 22*, Article 16094069231185454. https://doi.org/10.1177/16094069231185454

Pinto, L. E. (2015). Fear and loathing in neoliberalism: School leader responses to policy layers. *Journal of Educational Administration and History, 47*(2), 140–154. https://doi.org/10.1080/00220620.2015.996869

Rankin, A., Baumann, A., Downey, B., Valaitis, R., Montour, A., Mandy, P., & Bourque Bearskin, D. (2023). Two-Eyed Seeing application in research analysis: An integrative review. *International Journal of Qualitative Methods, 22*, Article 16094069231197342. https://doi.org/10.1177/16094069231197342

Rautio, P. (2013). Children who carry stones in their pockets: On autotelic material practices in everyday life. *Children's Geographies, 11*(4), 394–408. https://doi.org/10.1080/14733285.2013.812278

Riley, K., Jukes, S., & Rautio, P. (2024). Relational ontologies and multispecies worlds: Transdisciplinary possibilities for environmental education. *Australian Journal of Environmental Education, 40*(2), 95–107. https://doi.org/10.1017/aee.2024.23

Roberts, C. (2024). *Re-storying education: Decolonizing your practice using a critical lens*. Page Two.

Rosén, A. P., Salovaara, A., Botero, A., & Søndergaard, M. L. J. (2024). Introduction. In A. P. Rosén, A. Salovaara, A. Botero, & M. L. J. Søndergaard (Eds.), *More-than-human design in practice* (pp. xix–xxxi). Routledge. https://doi.org/10.4324/9781003467731-1

Rubins, M. (2019). Posthumanism reimagined: De-Westernizing perspectives on post/humanity. *Slavonic and East European Review, 97*(4), 761–772. https://doi.org/10.5699/slaveasteurorev2.97.4.0761

Sargent, L. (2021). *Shifting environmental education towards reconciliation rooted in land and relationship* [Master's portfolio, Lakehead University]. https://knowledgecommons.lakeheadu.ca/bitstreams/10d596fa-ca76-4ed4-9c42-ab8f98d5caf3/download

Shah, S. (2026). Atoms of the not-yet. *Resurgence & Ecologist, 355*. https://www.resurgence.org/magazine/article6602-atoms-of-the-not-yet.html

Schedler, A. (2023). Rethinking political polarization. *Political Science Quarterly, 138*(3), 335–359. https://doi.org/10.1093/psquar/qqad038



*This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca*

Schnellert, L., Davidson, S. F., & Donovan, B. L. (2024). Educational transformation through ethical relationality in education change networks. *Curriculum Inquiry, 54*(3), 231–252. https://doi.org/10.1080/03626784.2025.2458071

Snively, G., & Corsiglia, J. (2001). Discovering Indigenous science: Implications for science education. *Science Education, 85*(1), 6–34. https://doi.org/10.1002/1098-237X(200101)85:1<6::AID-SCE3>3.0.CO;2-R

Spooner, N. (2024). An examination of educational leadership preparation in Ontario: Are principals prepared to lead equitably? *Canadian Journal of Educational Administration and Policy*, (204), 41–54. https://doi.org/10.7202/1111524ar

Stein, S. (2018). Beyond higher education as we know it: Gesturing towards decolonial horizons of possibility. *Studies in Philosophy and Education, 38*(2), 143–161. https://doi.org/10.1007/s11217-018-9622-7

Taylor, A. (2013). *Reconfiguring the natures of childhood*. Routledge. https://doi.org/10.4324/9780203582046

Taylor, A. (2017). Beyond stewardship: Common world pedagogies for the Anthropocene. *Environmental Education Research, 23*(10), 1448–1461. https://doi.org/10.1080/13504622.2017.1325452

Taylor, A., & Giugni, M. (2012). Common worlds: Reconceptualising inclusion in early childhood communities. *Contemporary Issues in Early Childhood, 13*(2), 108–119. https://doi.org/10.2304/ciec.2012.13.2.108

Tsing, A., & Bazzul, J. (2022). A feral atlas for the Anthropocene: An interview with Anna L. Tsing. In M. Wallace, J. Bazzul, M. Higgins, & S. Tolbert (Eds.), *Reimagining science education in the Anthropocene* (pp. 309–319). Palgrave Macmillan.

Tuck, E., & Yang, K. W. (2012). Decolonization is not a metaphor. *Decolonization: Indigeneity, Education & Society, 1*(1), 1–40. https://jps.library.utoronto.ca/index.php/des/article/view/18630

Viehmann, C., Fernández Cárdenas, J. M., & Reynaga Peña, C. G. (2024). The use of socioscientific issues in science lessons: A scoping review. *Sustainability, 16*(14), 5827. https://doi.org/10.3390/su16145827

Walker, K. D., Cherkowski, S., & Kutsyuruba, B. (2021). Concluding thoughts. Momentum for future striving. In B. Kutsyuruba, S. Cherkowski, & K. D. Walker (Eds.), *Leadership for flourishing in educational contexts* (pp. 315–327). Canadian Scholars.


*This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported License. www.ineducation.ca*