

Transformative learning for a sustainable and healthy future through ecosystem approaches to health: insights from 15 years of co-designed ecohealth teaching and learning experiences



Jena Webb, Sergio Raez-Villanueva, Paul D Carrière, Audrey-Anne Beauchamp, Isaac Bell, Angela Day, Sarah Elton, Mathieu Feagan, Jolene Giacinti, Jean Paul Kabemba Lukusa, Celia Kingsbury, Paola A Torres-Slimming, Martin Bunch, Katie Clow, Maya K Gislason, Margot W Parkes, E Jane Parmley, Blake Poland, Cathy Vaillancourt

This paper presents insights from the work of the Canadian Community of Practice in Ecosystem Approaches to Health (CoPEH-Canada) and 15 years (2008–2022) of land-based, transdisciplinary, learner-centred, transformative learning and training. We have oriented our learning approaches to Head, Hands, and Heart, which symbolise cognitive, psychomotor, and affective learning, respectively. Psychomotor and affective learning are necessary to grapple with and enact far-reaching structural changes (eg, decolonisation) needed to rekindle healthier, reciprocal relationships with nature and each other. We acknowledge that these approaches have been long understood by Indigenous colleagues and communities. We have developed a suite of teaching techniques and resources through an iterative and evolving pedagogy based on participatory approaches and operating reciprocal, research-pedagogical cycles; integrated different approaches and ways of knowing into our pedagogy; and built a networked Community of Practice for continued learning. Planetary health has become a dominant framing for health-ecosystem interactions. This Viewpoint underscores the depth of existing scholarship, collaboration, and pedagogical expertise in ecohealth teaching and learning that can inform planetary health education approaches.

Introduction

The nature of current socio-ecological challenges requires transformative educational models activated across multiple fields, disciplines, and domains.^{1–3} Transformative learning generates “a qualitative shift in perception and meaning making on the part of the learner in a particular learning experience such that the learner questions or reframes his/her assumptions or habits of thought.”⁴ For learning to be transformative it requires a conducive environment for dialogue, action, and reflection, where both the students and the teaching team are receptive to learning together.⁴

The urgency to address multiple ecological, societal, and health crises (eg, climate, social justice, and pandemic) simultaneously is intensifying.^{5–7} Until recently, the bulk of planetary health education has focused on ecological decline and human health implications. There has been less focus on broad moral or policy implications, such as systemic racism and fossil fuel dependence, and little acknowledgement of contributions from the wider intellectual landscape (eg, ecohealth, ecosocial approaches, One Health, and Indigenous health). Although differences in these approaches exist,⁸ they allow us to learn and work together, as the task of transformation will require considerable collaboration and exchange.

Here, we describe the work of the Canadian Community of Practice in Ecosystem Approaches to Health (CoPEH-Canada), which is an adaptive community of scholars and practitioners dedicated to the understanding, teaching, and application of ecosystem approaches to address current threats to a healthy and sustainable global future. We identify several ways the teaching team has created

transformative learning experiences, in terms of both what and how we choose to teach. We provide insights and lessons learned from 15 years (2008–22) of collaborative teaching practice, in the hopes that this will be instructive and inspiring for practitioners and educators in planetary health and other integrated approaches to health. Specifically, this Viewpoint offers insights from a transdisciplinary, intergenerational, and collaborative effort between members of the CoPEH-Canada teaching team, alumni, and alumni teachers spanning 15 years of land-based, transdisciplinary, learner-centred, and transformative training. We include reflections from course developers and past participants who re-emphasise the importance of three themes: a networked Community of Practice (CoP), different ways of knowing, and iterative and evolving pedagogy. Our intention is to share lessons learned and offer examples to help enrich the development of planetary health education.

CoPEH-Canada educational approach and course structure

The purpose of our field schools, professional development courses, and university credit courses, which are hybrid and multisite, is to build a community of practice committed to collective learning. We do this by introducing and interrogating six principles (figure 1) that have been useful in guiding research and practice in ecosystem approaches to health.^{8–11} One of the strengths of the ecohealth approach is that it encourages practitioners to think globally, but ground themselves locally. Land-based case studies that illustrate the challenges and the successful application of ecosystem

Lancet Planet Health 2023;
7: e86–96

Canadian Community of Practice in Ecosystem Approaches to Health (J Webb PhD), Département des sciences de l'activité physique (A-A Beauchamp BSc), Université du Québec à Montréal, Montréal, QC, Canada; Département de Médecine sociale et préventive (C Kingsbury MSc), Faculté de médecine vétérinaire, (P D Carrière PhD) Université de Montréal, Saint-Hyacinthe, QB, Canada; Department of Obstetrics and Gynecology, McMaster University, Hamilton, ON, Canada (S Raez-Villanueva MSc); Institute of the Environment, University of Ottawa, Ottawa, ON, Canada (J Bell BSc); Department of Geography, Geomatics and Environment, University of Toronto Mississauga, Mississauga, ON, Canada (A Day MA); Department of Sociology, Ryerson University, Toronto, ON, Canada (S Elton PhD); Department of Knowledge Integration, University of Waterloo, Waterloo, ON, Canada (M Feagan PhD); Madisson Institut, Goma, Democratic Republic of Congo (J P Kabemba Lukusa MPH); School of Medicine, Faculty of Health Sciences, Universidad Peruana de Ciencias Aplicadas, Lima, Peru (P A Torres-Slimming PhD); Red Internacional América Latina, África, Europa, El Caribe, Faculté des Lettres et Sciences Humaines, Université de Limoges, France (P A Torres-Slimming); Faculty of Environmental & Urban Change, York University, Toronto, ON, Canada (M Bunch PhD); Faculty of Health Sciences, Simon Fraser University, Burnaby, BC,

Canada (M K Gislason PhD);
School of Health Sciences,
University of Northern British
Columbia, Prince George, BC,
Canada (M W Parkes PhD);
Ontario Veterinary College,
University of Guelph, Guelph,
ON, Canada (E Jane Parmley PhD,
K Clow PhD, J Giacinti DVM);
Dalla Lana School of Public
Health, University of Toronto,
Toronto, ON, Canada (B Poland
PhD); Institut national de la
recherche scientifique, Centre
Armand Frappier Santé
Biotechnologie, Laval, France
(C Vaillancourt PhD)

Correspondence to:
Dr Jena Webb, Canadian
Community of Practice in
Ecosystem Approaches to
Health, Université du Québec
à Montréal, Montréal, QC,
Canada
webb.jena@uqam.ca

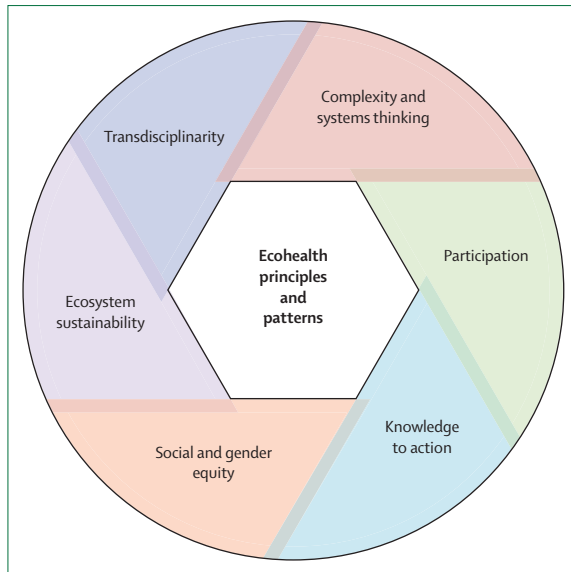


Figure 1: Ecohealth principles and patterns

We begin and end each training session with this wheel. We use it to situate learners and point out the multiple patterns that will be addressed under the theme of the session. Our pattern wheel evolved from an image with discreet boundaries to one with a glow at the edges, demonstrating our growing recognition of the interconnectedness of these approaches.

approaches to health in diverse, global contexts and with transdisciplinary partnerships are, therefore, central to our teaching.¹⁰

Past course evaluations have highlighted the co-benefits of exploring and addressing complexity while simultaneously building connections between participants and topics.^{12–14} Parkes and colleagues¹² highlight the importance of diversity (background and language), relationships among participants and the teaching team, and variety in the teaching methods. Cole and colleagues¹³ describe how development of collaborations (process) facilitates learning about ecosystem approaches to health (content).¹³ Vansteenkiste and colleagues¹⁴ emphasise the importance of connections and mentorship in the uptake of complex and emotionally charged learning around gender equity and knowledge exchange. In addition to these research and learning phases, which are described elsewhere,^{12,13} the table characterises a key pivot from an in-person to a low-carbon, hybrid learning model in 2016 and gives examples of our teaching, including land-based case studies.

Very briefly, the current structure of CoPEH-Canada's hybrid field course on ecosystem approaches to health (table) involves simultaneously running several (usually three) graduate courses at different universities across Canada and affiliated with departments representing diverse fields. The university sites, as they are referred to, meet for eight joint 2-h webinars and engage in multiple cross-site learning activities, in addition to the sessions and field components run locally. The webinars are also offered as a stand-alone eight-part webinar series

available to people across the globe. More can be found about the CoPEH-Canada yearly course and our teaching modules online.¹⁵ Instructors and participants in the course have come from a large variety of fields including, environmental sciences, public health, epidemiology, medicine, humanities, anthropology, biology, veterinary medicine, development studies, literature, education, nursing, engineering, women's studies, and communication. Further aspects of our course design, namely building a community of practice, practicing different ways of knowing, and iterative and evolving pedagogy, are elaborated on in this Viewpoint.

Approach to collecting viewpoints

A key feature of CoPEH-Canada's 15-year evolution has been an iterative, adaptive, and applied journey informed by phases of formal research and evaluation,^{12–14} alongside a yearly reflective learning cycle fuelled by preparation of annual courses. The core CoPEH-Canada team, composed of faculty representatives from each of the eight member universities of the consortium and the CoPEH-Canada director of programmes, sent an invitation to join this authorial team to alumni. This resulted in compiling reflections from 11 alumni of diverse backgrounds and cultures (anglophone, francophone, and hispanophone from Canada, Congo, and Peru) (SR-V, PDC, A-AB, IB, AD, SE, MF, JG, JPKL, CK, PAT-S) and eight CoPEH-Canada faculty and staff (JW, MB, KC, MKG, MWP, EJP, BP, CV). Alumni and faculty had participated in different versions of the course over the 15 years it has been offered. The group exchanged ideas and testimonials in teleconferences, emails, and shared documents. A subgroup of eight alumni created a writing plan that involved alumni providing their viewpoints on course content and delivery by responding to the following question in a collaborative working document: "What did the ecohealth course enable in terms of your own professional or scholarly development? Feel free to reflect on things like overall impression of the course, mode of learning and any feedback (positive or negative)".

The personal insights from alumni were analysed using NVivo (version 12.7) and open discussions to sort quotes and organise thoughts. The breakdown of themes and subthemes are shown in the appendix p 1. This was not intended to be a formal evaluation and is not necessarily representative of all students' perceptions of the CoPEH-Canada course. Although the number and diversity of backgrounds of the participating students might affect responses, the process generated diverse viewpoints, reflections, and shared themes among students across multiple iterations of the course.

The main themes that emerged from this collective process were: (1) building a community of practice, (2) different ways of knowing, and (3) iterative and evolving pedagogy. Students' responses that best reflected collective discussions were anonymised and are woven together with insights from course developers' ongoing

See Online for appendix

	In-person learning (single-site courses)	Hybrid learning (multisite courses)
Title of course	Workshop and summer field school on ecosystem approaches to health.	Hybrid, multisite, field course and webinar series on ecosystem approaches to health.
Years run	2008–15	Ongoing from 2016
Description	11-day, intensive, graduate-level, summer, field school; from 2011 to 2015, the first three and a half days could be taken as a stand-alone career development workshop.	Composed of full-credit, summer session, graduate field courses* run over 4 weeks to 6 weeks and anchored around eight co-designed and co-taught webinars, which can be taken as a CoPEH-Canada professional development series (without registering for the full course).
Programme content	Programme content varies from year to year depending on factors such as instructors involved, location, and registration. The six ecohealth principles (figure 1) are always presented and teaching always revolves around a case study. The techniques and activities used have been consistently land-based, participatory, transdisciplinary, learner-centred, and transformative in nature and many can be found in our teaching manual. ¹⁵	Programme content varies from year to year depending on factors such as instructors involved, location, and registration. The six ecohealth principles (figure 1) are always presented and teaching always revolves around a case study. The techniques and activities used have been consistently land-based, participatory, transdisciplinary, learner-centred, and transformative in nature and many can be found in our teaching manual. ¹⁵
University hosts	2008: University of British Columbia; 2009: University of Guelph; 2010: Université du Québec à Montréal; 2011: University of Northern British Columbia; 2012: Université de Moncton; 2013: University of Northern British Columbia; 2014: York University; 2015: Université du Québec à Montréal.	2016: University of Guelph, University of Northern British Columbia, University of Toronto; 2017, 2019: University of Guelph, University of Northern British Columbia; 2018, 2020, 2022:* Université du Québec à Montréal, University of Guelph, University of Northern British Columbia; 2021: l'Université du Québec à Montréal, University of Guelph.
How the course and key elements are developed	Pre-course, three-day workshops were held each year. Additionally, an extensive consultation and co-construction of teaching materials took place from 2011 to 2012, to write the first edition of our teaching manual. Also, in this period, a formal evaluation of the entire course, with a research component, was taking place. ^{12, 13}	Regular conference calls between site hosts and CoPEH-Canada staff take place in the 6 months leading up to the course. A course survey is sent each year and results from the previous year are discussed at the early stages of the next iteration. A formal qualitative evaluation of a session on the integration of sex and gender in knowledge-to-action yielded interesting insights on cross-sectional aspects of our teaching. ¹⁴
Case studies	Linked to the host-university location and involved site visits and groups projects.	A common, very broad theme, such as reciprocity, unites the university sites. Place-based case studies developed on-site have included urban greenspaces and watersheds as settings for health. Land-based techniques such as rich picture maps and reflective journaling with prompts ground learners.
Objectives	Although objectives vary slightly from year to year, they are co-designed by a multi-institutional teaching team and can be summarised as enabling participants to be able to apply ecosystem approaches to health principles to environment-health-society issues; reflect critically on ecohealth issues, course discussions, interactive sessions, field trips, and readings; work with and provide feedback to peers; and communicate course themes in a manner that is accessible and of interest to diverse audiences.	Although objectives vary slightly from year to year, they are co-designed by a multi-institutional teaching team and can be summarised as enabling participants to be able to apply ecosystem approaches to health principles to environment-health-society issues; reflect critically on ecohealth issues, course discussions, interactive sessions, field trips, and readings; work with and provide feedback to peers; and communicate course themes in a manner that is accessible and of interest to diverse audiences.
Total number of participants	166 people from 52 institutions representing over 30 fields.	188 people from 54 institutions representing over 50 fields.
Examples of Offshoot courses	Influenced design of One Health courses for veterinarians by the University of Guelph.	Influenced design of advanced topics in environment and health: ecosystem approaches in the field (ENVS4800A) by York University.
Capacity-strengthening collaborations	Ekosante: ¹⁶ a collaboration arising from CoPEH in Canada and Latin America and the Caribbean. Ecological Determinants Group on Education: ¹⁷ aims to bring together public health, allied professionals, researchers, and educators with interest and expertise in the ecological determinants of health to promote the integration of ecological determinants of health with public health education, training, and professional development, attending to issues of content as well as issues of pedagogy.	Environment, Community Health Observatory Network: ¹⁸ aims to work together across sectors to take notice of and respond to the influence of resource development on health and wellbeing, with specific emphasis on rural, remote, and Indigenous communities and environments. l'Équipe GESTE† pour le partage des connaissances: ¹⁹ aims to evaluate the relevance of considering sex and gender in knowledge translation interventions in occupational and environmental health.

CoPEH=Community of Practice in Ecosystem Approaches to Health. *In 2022, the course is being offered at Université du Québec à Montréal as ISS9420-santé, société et environnement; at the University of Guelph as POPM*6950 directed studies in population medicine; and at the University of Northern British Columbia as field course in human ecology: ecosystem approaches to health (cross-listed as HHSC 860, HHSC760 and NRES 760). †French acronym for gender, environment, health, work and equity.

Table: 15 years of CoPEH-Canada courses, from in-person to hybrid learning modes

For university case studies see <https://copeh-canada.org/en/teaching-manual/cross-cutting-teaching-tools.html>

reflective learning in the subsequent sections. Responses provided by the 11 alumni were anonymised by replacing initials with letters A to K.

Building a community of practice

Addressing the complex uncertainties of multiple crises requires building capacity as a diverse community of learners, thus shifting the context of training from an individualised transmission of content expertise (ie, the experts tell the students what and how to think about a specialised topic) to creating conditions conducive to collective action, dialogue, and reflection that promote learning across different experiences and forms of expertise. In this sense, CoPEH-Canada's training is not just a single-event course designed to deliver an already finished framework ready for student consumption. Rather, it is a living example of multi-institutional collaboration and an invitation into a global network in which diverse communities of practitioners around the world are in the process of learning how to apply the framework in nuanced ways across vastly different local contexts. The term ecohealth practitioner is used broadly and includes anyone who is working toward the betterment of ecosystem and human health while being attentive to interconnections, systems, and equity.

Student A, a PhD student at the time of taking the 2010 full course (table), underscored this by noting that the CoPEH-Canada field school was much more than a one-off course. It was a whole network of relationships with people from around the world working across different fields such as the natural sciences, social sciences, humanities, medicine, Indigenous ways of knowing, and public health to explore and intervene in the health and environment intersection.

The CoPEH-Canada course is a doorway into communities of practice among scholars, practitioners of ecohealth, and students. These communities of practice are organised in a network that provides opportunities (eg, webinars, research projects, email lists, blogs, teaching resources, and tools) for members to become involved in new and ongoing ecohealth projects. For example, since 2014, long before the pandemic spurred a trend toward the proliferation of webinars, CoPEH-Canada have run a monthly series of so-called webalogues aimed at highlighting the variety of ways in which a range of practitioners, professionals, policy makers, and community members are grappling with topical, current, and complex issues emerging at the nexus of population health, ecosystems, and society. The 90-min sessions are participatory and focused on learning and sharing across generations of alumni and external actors. The networked community of practice provides a dynamic structure connecting people involved in different iterations of the course, encouraging diverse forms of collaboration.^{12–14}

This point was elaborated on by student B, a master's student in the 2021 full course, who noted that the course offered an enriching experience and an occasion to meet

different students from different backgrounds and disciplines, which enabled learning about other countries' realities, worldviews, and ways of conducting research.

The aspect of the course that had the biggest impact and was most inspiring for student C, a PhD student during the 2018 webinar series, was (and continues to be through planetary health education publication discussions) listening to, learning from, and engaging in the productive, often tangential, dialogue that develops among course participants and instructors.

Likewise, a unique strength of the summer school for student D (professional development participant), who was enrolled in the 2015 full course, were the field trips, which provided for peer-to-peer interactions. As a professor, student D was able to appreciate that we underestimate the necessity of giving students time to digest content and develop friendships. As these participant observations show, an important part of the CoPEH-Canada course is the connections formed between and among students and instructors.

Beyond the benefits to the course, the evolving CoPEH-Canada collaboration has been beneficial to the teaching team, alumni teachers, and alumni, whose interactions—as a community of learners—reflect a culture of curiosity and learning that in turn feeds back to the CoP. Although the scope of what can be done is often limited by time, monetary, and recently pandemic constraints, we have aimed to enable a diverse, transdisciplinary team to participate in the co-design of our activities. When faced with limitations in expertise, we complement our perspective with invited guest lecturers and engagement with community members in case-study contexts, continually building our community of practice.

Practicing different ways of knowing

The course embraces different ways of knowing across a global ecology of knowledge—this is not a course focused on one very narrow method or disciplinary literature. As such, the CoPEH-Canada course is an invitation to hear and learn from mixed method approaches (figure 2), bringing together different kinds of disciplinary, community-based, and professional forms of expertise, locally and globally, to address complex, real-world challenges. Former students underlined the significance of this participatory approach to knowledge and knowledge production.

To sustain and nourish the diverse community of practice approach, we use an adaptive pedagogy based on exploring different ways of knowing and oriented to Head, Hands and Heart pedagogy,²⁰ which symbolise cognitive, psychomotor, and affective learning, respectively. We overtly mapped onto three learning domains²¹ (ie, cognitive, psychomotor [behavioural, action, and skills oriented], and affective [emotional]). Over the 15 iterations of our course, we have strived for a balance between these dimensions, although the emphasis has varied according to factors such as the type of training

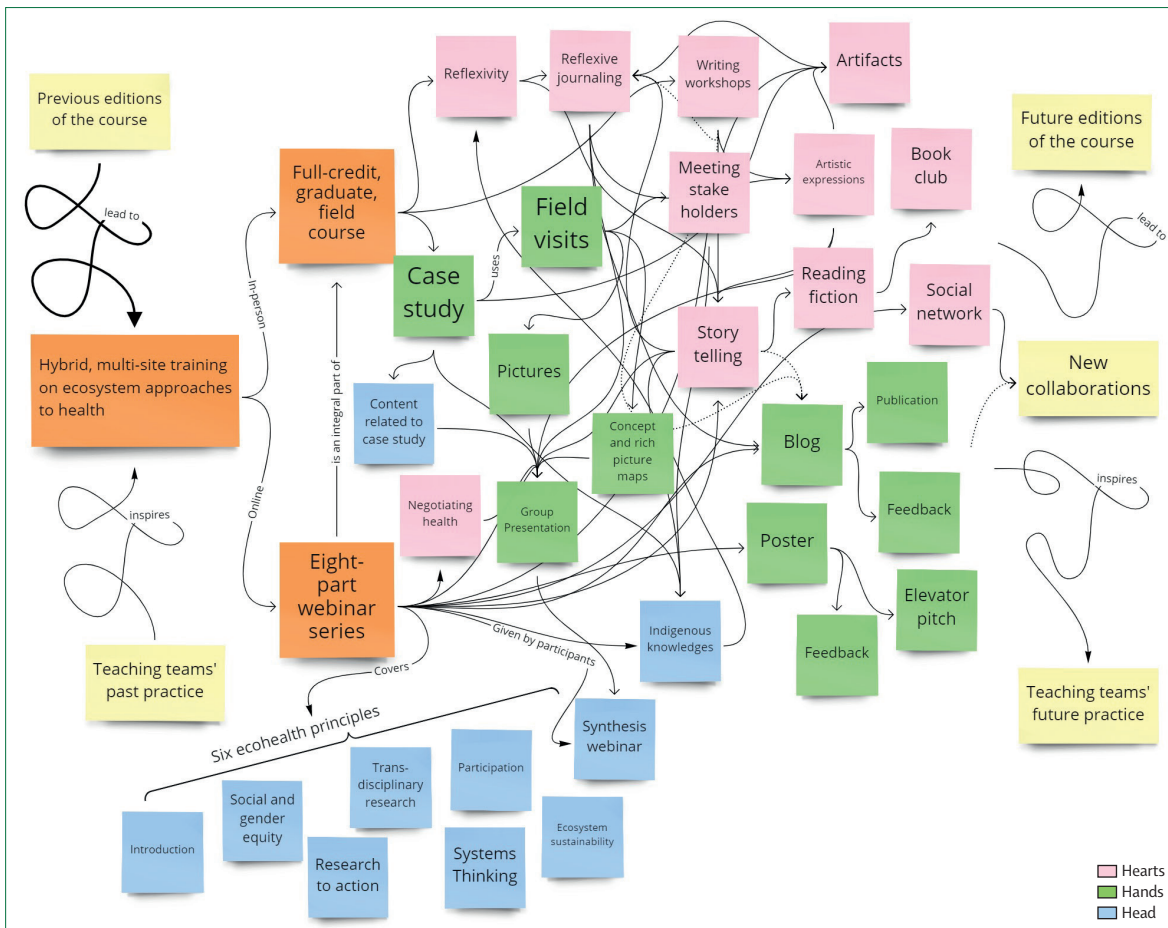


Figure 2: Snapshot of the Head, Hands, Heart pedagogy balance of CoPEH-Canada's 2021 hybrid, multi-site, field course on ecosystem approaches to health Content and activities are displayed in the colour of their predominant learning dimension. Overlap in these categories is significant; for example, storytelling is both a behavioural (Hands through writing) and emotional (Heart through developing empathy for different viewpoints) learning dimension. Likewise, the webinar topics are displayed in blue (Head), but each 2-h webinar includes multiple breakout discussions and activities designed to give participants experience with the concepts (Hands), work together in transdisciplinary groups (Hands) and question existing structures and approaches (Heart), among other things.

(eg, self-motivated professional development *vs* linked to a university programme); composition of participants; composition of teaching team; and most recently the pandemic. We have noted a progression away from content (eg, information and concepts) delivered in lectures towards activities that anchor the experience of ecohealth in practice (eg, approaches and methods) and invite critical inquiry into normative ideas and practices (eg, empathy and questioning of structural factors; figure 2). While content is provided, training is not content driven. Rather, we emphasise appreciative inquiry, critical thinking, and collaboration. This evolution has been fuelled by inviting and integrating feedback from participants in each successive cohort.

Research is increasingly showing that the assumption that environmental action requires overcoming an assumed information deficit is both misleading and potentially counterproductive.^{22,23} Risks of the traditional information deficit approach are information overload, teaching about the problems without also addressing the

potential solutions, engendering a freeze-fight-flight stress response, and not recognising that change is hindered by a range of other social, political, and economic forces.^{24,25} Psychomotor and, especially, affective learning are necessary to grapple with and enact the sweeping structural changes, such as decolonisation, dismantling of systemic racism, and questioning tenets of neoliberal capitalism, that are needed as we forge a more reciprocal relationship with nature and each other.²⁶⁻³⁰

A clustered set of approaches, skills, and insights, including developing a reflexive practice through reflective journaling (eg, cross-cutting teaching tools;¹⁵ figure 2), are needed to consolidate necessary knowledge that can lead to transformative action. Our courses also manifest important engagement through commitments to learning about decolonisation, engaging actively with Indigenous colleagues and students, foregrounding Indigenous knowledge and pedagogies, and acknowledging how these approaches have been long understood by Indigenous colleagues and communities. One example of this

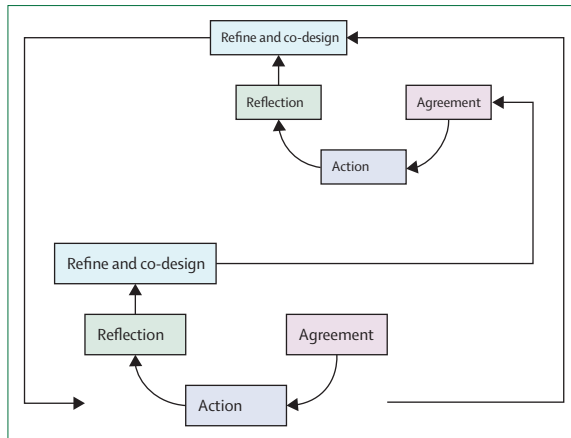


Figure 3: Reciprocity between co-designed ecohealth endeavours exemplified by cycles of arts-based and narrative approaches via teaching and research

Watershed partners in an Ecohealth and Watersheds research project requested digital stories.³⁶ Increased team capacity for digital stories enabled trialling and embedding of these approaches in the 2013 course (connecting an individual poster activity, a group rich picture map, and a collective digital story). This collective approach to digital storytelling informed future research initiatives (eg, Environment, Community, Health Observatory Network).³⁷ Refinement and co-design of new iterations of the course are informed by past courses, ongoing research by the teaching team and alumni teachers, and reflection, action, and agreement among all participants.

so-called heart-based approach is Indigenous talking circle methods,³¹ an approach first used in our 2011 course, and shared by Anishinaapekwé educator Kaaren Dannenmann in the participation and research module of our CoPEH-Canada teaching resources.¹⁵ This holistic approach to teaching across learning domains is consistent with models for transformative learning.⁴ It plants seeds during the intensive, albeit brief, courses that both students and instructors can nurture and grow upon returning to other academic and professional contexts.

Student D noted that the format of the course allowed for unexpected and feel-good experiences. For instance, this student appreciated the talking circle exchange based on Indigenous knowledge in which different narratives from students from other countries inspired a spiritual connection with the land. This contrasted to the context of academia in science dominated programmes, in which discussing spirituality or religion is taboo. Similarly, student E, a 2015 full-course master's student, observed that the course enabled them to understand that spirituality has an important role in society and in different domains and should be developed on a global scale.

Student F, a master's student at the time of taking the 2020 webinar series, recognised that the course effectively passed on the importance of collaboration across sectors and of Indigenous knowledge and traditional ecological knowledge. Student F was inspired by the course to collaborate in a transdisciplinary project that has encouraged a model of partnership between Indigenous, academic, and governmental sectors, educating these sectors as well as the public through a website.³² Student F

elaborated further that the course webinars were well-delivered, including Indigenous speakers and the integration of both fictional and academic selected readings. They allowed for rich perspectives of health and connection to the land and mutual discussions on these subjects (figure 2).

Land-based and experiential learning have been recognised as helpful for changing health behaviours,³³ unsustainable practices,^{29,34} and colonial mindsets.³⁵ Hence, we prioritise land-based learning in the field, illustrated through pre-planned, place-based case studies that include meeting with local community members for social learning (table; figure 3; appendix p 2). The emphasis on field work grounds participants in a real place with real people, and correlates primarily with the Hands part of our pedagogy. By bringing participants to urban greenspaces in our more urban sites (our focus being on ecosystems, equity, and health) and situating cities within watersheds, we attempt to disturb what Tuck and Habtom³⁸ describe as a concerning trend to conceive of the urban as placeless. Whether in urban or more rural or remote contexts, our case studies are designed to show the integration of different ecohealth principles and to exemplify connections between the patterns. Through our practice we have observed a progression from looking at the six principles separately to looking at them simultaneously as recurring patterns (figure 1). Increased engagement with Indigenous knowledges has exemplified this, such as webinar contributions from Sandra Martin Harris, a Wet'suwet'en scholar, on how an integrative and Indigenous, land-based framework for health and wellbeing relate to and can fuel conversations about resilience, sustainability, and transdisciplinarity. Mashford-Pringle and Stewart³⁴ have similarly recommended introducing health-care professionals to Indigenous knowledge through land-based education during their training.

Student G, a master's student in 2021 during their full course, underscored the participation component of ecohealth, which allowed them to learn about and even participate in the process of mobilisation by supporting a citizen group in the preservation of a green space near a school exchange. Student G added that systems and complexity thinking were also emphasised throughout the process, through the consideration of various issues, factors, and networks in the development of the assignment. Consideration of the complexity of the issues surrounding a problem was at the centre of reflections leading to transdisciplinary thinking.

Student H, a PhD student while participating in the 2018 webinar series, noted that, as a physician, ecohealth gave them a broader understanding of primary-care models by incorporating and integrating social, cultural, and ecological dimensions at the individual and community health levels. These comments point to alumni's recognition that transdisciplinary affective, psychomotor, and cognitive learning are needed to resolve value conflicts associated with ecohealth issues.

For course participation see <https://copeh-canada.org/en/teaching-manual/participation.html>

For ecohealth learning see <https://copeh-canada.org/en/teaching-manual/ecosystem-land-based-learning.html>

Through our specific case study activities and beyond, we have developed generative spaces,³⁹ designed to give people a chance to connect, time to discuss, and reason to explore macrolevel and sometimes highly charged aspects of our problematic relationship with ecosystems and their health. These activities provide opportunities for critical reflection, peer-to-peer feedback, and dissonance and conflict, the latter of which has been shown to be beneficial for learning to live sustainably.⁴⁰

Iterative and evolving pedagogy

Factors that have contributed to the continuity and tenacity of our long-standing collaboration have been a commitment to flexibility and adaptiveness through operating learning cycles, actively maintaining a collaborative model, and integrating approaches. There is an undercurrent of progressing this work that encompasses tenacity, care, connectedness, compassion, curiosity, and commitment.

Our courses have intentionally adapted to new contexts (table) through several iterations and learning cycles (eg, fields schools or multisite hybrid course), the spawning of offshoots carried out by our members, such as a course run in Costa Rica out of York University, Toronto, ON, Canada, and the integration of ecohealth principles and practices into other courses on complexity and health. This approach has also been adapted to courses outside of the health field, such as sociology of food and qualitative research methods.

The development of each CoPEH-Canada course is informed by a period of reflection, refinement, and co-design that involves colleagues from across multiple institutions who carry forward lessons into related education and research practice.^{12,13,36–37,41} Each cycle also involves multiple forms of boundary crossing in the ways that we prioritise content: crossing jurisdictions, languages, disciplines, and backgrounds. Figuring out how to value context-specific aspects involves a rich process of meta-learning, informing ongoing reflections on strengths and limitations of education, research, and practice across domains.

The contribution of participants—the diverse knowledges and backgrounds that they bring to the course—is, likewise, a learning experience for the team.^{12,13, 42} In this sense, we are all co-learners. Unexpected contributions by participants to the content and process of the course have enriched the experience for everyone. For example, following a participatory activity with local stakeholders in Hamilton, ON, Canada, during the 2009 course hosted by the University of Guelph, Guelph, ON, Canada, students decided to produce a summary of the discussions for local actors. This was not part of the assignment, but students felt that after having dedicated their time to the exercise, community organisers deserved a concrete output. In courses since 2009, we have integrated real-life learning scenarios that involve providing deliverables to community

organisations. This spirit is especially exemplified by the increasing use of creative and arts-based means for students to share their insights. This development is a reflection of the reciprocity between the team's research and teaching where, for example, integration of arts-based and narrative approaches through rich picture maps (a collection of images composed in a way that tells a multi-layered, complex, visual narrative of an issue, through the lens of a theme within a specific context) and digital stories (a completion of images, voices, and video presented in digital format) our courses,^{12,13} reflects lessons arising across the teaching team in research.^{37,41} This point is depicted as a vignette of learning cycles in figure 3 (appendix p 2), elaborating on what was articulated by Cole and colleagues¹³ and noted at the edges of figure 2. Our educational orientation is, therefore, a microcosm of wider, integrative, ethical challenges that planetary health and ecohealth research approaches are grappling with; it requires both courage and co-learning as we collectively seek to disturb entrenched defaults through teaching and research and commit to going beyond reification of either teaching or research praxis.

During 15 years of working together to iteratively refine and co-design our training, it has been important to apply ecohealth principles (figure 1) to the process of designing, carrying out, and evaluating our courses.⁴³ This has involved strengthening collaborative capacity to work together¹³ and deepening attention to the driving forces of the issues being explored (eg, root causes of environmental harm, racism, and power imbalances).^{31,33,34,36,37} Our commitment to the refinement and evolution of our courses has included the design of pedagogical workshops to co-create, debate, and trial teaching techniques; 15 annual iterations of teaching together; social activities in which we build trust-based relationships; and engagement with activism.

Student input has played a key role in bringing forth innovation in how course delivery is reviewed, revised, and reshaped each year. Consistent with transformative learning models,⁴ the CoPEH-Canada course is iterative and does not deliver one message that is expected to be adopted by students without critique. The flexible approach to content, and emphasis on student input, allows the ecohealth course to remain locally and temporally relevant. The following reflections illustrate key challenges around timing, debate, and the practical constraints that students face putting ecohealth approaches into action.

Student F pointed out that CoPEH-Canada's teaching methods are not unconventional, but deliver a message highlighting the interconnectedness of environment and population health. It is by no means possible for a webinar series to create an expert in the field, but the course ideals are comprehensive and can inspire and ignite projects for the betterment of planetary health. Development is more up to the individual and their own

For case studies on ecosystem health see <https://copeh-canada.org/en/teaching-manual/health.html>

capacities, because the webinar-only version of the course cannot offer sufficient room to discuss these ideals or opportunities to develop them fully in the short delivery time.

Student G, who took the course during the pandemic, noticed an inconsistency between the knowledge gained and the skills and opportunities offered to apply them to effect change. As a group of students, collaborative input and participation helped to facilitate concrete application of knowledge, but only in the short term. The sustainability of student action through further assignments is therefore scarce. Similarly, in terms of implications of learning, student D would have appreciated more emphasis and expertise on conducting ethical debates to help resolve conflicts of values that emerge from ecosystem approach to health determinants.

Student I, a PhD student, noted that as a 2021 webinar participant during the height of the pandemic the relational piece with other participants was quite minimal. Doing the course online meant joining during their workday, or while also looking after children and navigating life during the pandemic. Student I did not have the energy to engage virtually the way that being in person necessitates. In their opinion, this is not a fault of the course, but a reality of education in a virtual environment, and might be especially so with a subject like ecohealth. Student I appreciated the idea of bringing in works of fiction (figure 2) alongside the webinars as a valuable pedagogical choice to build more relationality into the course.

Facilitating access to ecohealth content for students early on could encourage a nuanced understanding of the relationships between human and environment and planetary health dimensions among future physicians and health advocates and could also be valuable to students across disciplines and stages of training.

Student J recalled clearly sitting in a park in a newly developed community by a ravine, learning about political ecology for the first time during the 2016 full course. They recalled a grasshopper and the view of the new housing tower that was under construction. The two scales of political analysis colliding. This was a potent moment for student J as a PhD student and one-day educator. Now as a professor, student J recognises that the ecohealth experience has encouraged them to help students in their sociology of food class to see those various scales of political analysis: how the hamburger is connected to livestock agriculture and how livestock agriculture is connected to not only climate change, but also to settler colonialism and histories of colonial trading systems. Student J brings elements of an ecohealth approach into all of their classes.

Student K observed that completing the full course in 2018 as an undergraduate student studying biomedical sciences was a valuable exercise in zooming out on health-related issues to examine how health intersects with the environment and locally relevant social factors.

These students' comments highlight some perennial challenges that continue to inform our evolving practice, including when to introduce ecohealth concepts, providing enough time for interaction with the land and peers in time-limited initiatives, and sustaining action over the long term. Students' requests for more time to explore topics underscores the importance of introducing elements of ecohealth into a variety of health-related programmes, including medical school, master of public health training, dietetics, and beyond. Making ecohealth concepts mainstream would expose a wider student body to the theories and approaches of the course. These areas represent promising prospects for future practice.

Synthesis and conclusion

We share our experiences developing educational initiatives based in ecosystem approaches to health because we believe that through a community of practice, learning across different ways of knowing and with a critical, reflective, iterative, and evolving pedagogy, we can collectively strengthen the capacity necessary to engage with the complex dynamics of this changing world in transformative ways. Multiple approaches to understanding and teaching about the complex physical and normative links between humans and ecosystems have emerged, including ecohealth, One Health, and planetary health. Although there are differences,⁸ there are enough similarities between these approaches that insights from one can be beneficial for others. For example, through collaborating across disciplines and contexts we have been able to integrate aspects from ecohealth and One Health into our course. Although One Health has traditionally been grounded in zoonotic disease response and food safety issues, this focus is expanding^{44–48} as programmes are developing at universities across Canada and internationally. The composition of the CoPEH-Canada team, course hosts, and students (table) has enabled One Health research and training programmes to incorporate elements of ecohealth, and for One Health researchers, teachers, and learners to contribute to the evolution of ecohealth. Recognising the shared goal of health for all—and the corresponding need to work together, share knowledge, and build trust—underscores the potential benefits of intentional cross-fertilisation with planetary health education, beyond initial efforts.^{49–52}

The reflections presented here provide insights into the unique ways that CoPEH-Canada has developed a versatile suite of teaching techniques and resources based on a mix of cognitive, psychomotor, and affective approaches that can be adapted to teaching the links between ecosystems, health, and society in a variety of contexts. Leaders in planetary health will find these approaches informative when seeking to teach diverse health professionals to understand and respond to combined health, equity, and environmental issues.^{8,31,46,49,50} Proponents of One Health can harness our lesson plans to teach future health-care professionals to identify the links between animals,

ecosystems, health, and society.^{44–46} Our modules can also be drawn on to encourage future ecologists, planners, and natural resource managers to look for upstream root causes of ecosystem decline and downstream to human health impacts, especially invisible, cumulative, and neglected impacts.^{36,37,53} Even in courses not explicitly focused on health or wellbeing (ranging from generalist courses in sociology, political science, or international development to specialised fields of study such as food studies) our experiences with teaching ecosystem approaches to health are pertinent to engage students in thinking about climate futures and their place in the biosphere^{6–8,54–56}

The CoPEH-Canada course has been a 15-year journey that has been nourishing enough for key people to stay engaged. This Viewpoint has highlighted elements enabling this ongoing engagement, alongside needs to deepen critical attention to ongoing challenges and contextual forces that constrain integrative research, practice, and education.^{31,36,43,53,57} Our reflections are offered here as insights from a maturing training initiative, including careful intention to building a land-based, transformational experience that incorporates a balance of Head (cognitive learning), Hands (psychomotor), and Heart (affective); operating reciprocal and evolving pedagogical-research learning cycles; integrating different approaches and ways of knowing; and embedding this practice within a networked, collaborative CoP. Increasingly, this learning journey also demands critical perspectives; the inclusion of civil society stakeholders; and emotional, spiritual, and ethical guidance in finding ways to resolve value conflicts that emerge when trying to implement ecohealth principles to planetary health decisions (unpublished). As a cross-generational CoP committed to being lifelong learners, we are striving to improve our teaching and research praxis with each new iteration. The western academic industrial complex, across fields, is in need of a reckoning with problematic issues surrounding our relationship with ecosystems, fossil fuel culture, gender equity, political economy, power, neoliberalism, colonialism, and increasingly health.^{22,36,44,57,58,59} We, as scholars, and fields such as ecohealth or planetary health, are not beyond this reckoning.

Contributors

Contributors to this manuscript were eight faculty members and staff at CoPEH-Canada and a group of 11 volunteer alumni that responded to an open invitation to participate. The identification of each teaching team and alumni author appears in the approach to collecting viewpoints section. The final product is an operational example of an ecohealth education course delivered over consecutive years reflecting both teaching and learning perspectives from a diverse group of contributors. All authors contributed to the conceptualisation of the study. MB, KC, MKG, MWP, EJP, BP, CV, JW, SR-V, PAT-S, A-AB, PDC, CK, and MF contributed to the analysis of the study. MWP acquired funding for the study. All authors contributed to the validation of the study. All authors contributed to the visualisation of the study. JW, SRV, MF, CK, and PDC contributed to original draft writing of the manuscript. All authors contributed to the review and editing of the manuscript.

Declaration of interests

We declare no competing interests.

Acknowledgments

First and foremost, we would like to thank Johanne Saint-Charles who has collaborated on every course since the beginning. Without her insight and direction, the course would be only a shadow of what it is. We would especially like to thank the late Bruce Hunter, Donna Mergler, David Waltner-Toews, and Dominique Charron whose work and collaborations laid the foundation for Canadian Community of Practice in Ecosystem Approaches to Health (CoPEH-Canada). Our authorial team also thanks others who have contributed substantially to the development and teaching of the course along the way, in alphabetical order: Ben Brisbois, Chris Buse, Donald Cole, Myriam Fillion, Marc Fraser, Sherilee Harper, Karen Houle, Mélanie Lemire, Sandra Martin Harris, Karen Morrison, Suzanne McCullagh, Audrey Simon, Jerry Spiegel, Céline Surette, Jennifer Vansteenkiste, Robert Woollard, and Annalee Yassi. We would like to thank Sherilee Harper for sharing her original version of figure 1. We would like to recognize Chloé Barrette-Bennington, at the Centre interdisciplinaire de recherche en opérationnalisation du développement durable, for her contribution to the design of figure B in appendix p 2. A thanks to all the people, including alumni teachers, who contributed to different degrees, of whom there are too many to name here. A huge thanks to all the participants of the course. Finally, we would like to thank two anonymous reviewers for their valuable comments. Funding support for CoPEH-Canada and the writing of this the manuscript has been received from The Canadian Environment, Community, and Health Observatory, funded by the Canadian Institute of Health Research Environment and Health Signature Initiative Team Grant (funding reference number IP4150712) and the Consortium for the Canadian community of practice in ecosystem approaches to health. The funding source had no involvement in the writing of this paper. The formal phases of research associated with the establishment of CoPEH-Canada received ethics committee approval from the University of British Columbia Behavioural Research Ethics Board (UBC BREB H07–02815, 2008–2015), University of Northern British Columbia Research Ethics Board E2013-0123-014-00 (2011–2016), and the Université du Québec à Montréal ethics review board (certificate #2613_e_2018).

References

- Hathaway M. Fostering reorienting connections via ecological practices. In: Nicolaidis A, Eschenbacher S, Buergett PT, Gilpin-Jackson Y, Welch M, Misawa M, eds. *The palgrave handbook of learning for transformation*. London, Springer International Publishing, 2022: 279–300.
- Hathaway MD. Overcoming fear, denial, myopia, and paralysis: scientific and spiritual insights into the emotional factors affecting our response to the ecological crisis. *Worldviews Glob Relig Cult Ecol* 2017; **21**: 175–93.
- Tuck E, Habtom S. Unforgetting place in urban education through creative participatory visual methods. *Educ Theory* 2019; **69**: 241–56.
- Sterling S. Transformative learning and sustainability: sketching the conceptual ground. *Learning and teaching in higher education* 2011; **5**: 17–33.
- Destoumieux-Garzón D, Matthies-Wiesler F, Bierne N, et al. Getting out of crises: environmental, social-ecological and evolutionary research is needed to avoid future risks of pandemics. *Environ Int* 2022; **158**: 106915.
- Halonen JI, Erhola M, Furman E, et al. A call for urgent action to safeguard our planet and our health in line with the Helsinki declaration. *Environ Res* 2021; **193**: 110600.
- Martin J-L, Maris V, Simberloff DS. The need to respect nature and its limits challenges society and conservation science. *Proc Natl Acad Sci USA* 2016; **113**: 6105–12.
- Buse CG, Oestreicher JS, Ellis NR, et al. Public health guide to field developments linking ecosystems, environments and health in the Anthropocene. *J Epidemiol Community Health* 2018; **72**: 420–25.
- Saint-Charles J, Webb J, Sanchez A, Mallee H, van Wendel de Joode B, Nguyen-Viet H. Ecohealth as a field: looking forward. *EcoHealth* 2014; **11**: 300–07.
- Charron D. Ecohealth research in practice: innovative applications of an ecosystem approach to health. 2012. <https://doi.org/10.1007/978-1-4614-0517-7> (accessed March 1, 2022).

- 11 Webb JC, Mergler D, Parkes MW, et al. Tools for thoughtful action: the role of ecosystem approaches to health in enhancing public health. *Can J Public Health* 2010; **101**: 439–41.
- 12 Parkes MW, Saint-Charles J, Cole DC, et al. Strengthening collaborative capacity: experiences from a short, intensive field course on ecosystems, health and society. *High Educ Res Dev* 2017; **36**: 1031–46.
- 13 Cole D, Parkes M, Saint-Charles J, Gislason M, McKellar K, Webb J. Evolution of capacity strengthening evolution of capacity strengthening: insights from the Canadian community of practice in ecosystem approaches to health. *Transformative Dialogues: Teaching & Learning Journal* 2018; **11**: 1–21.
- 14 Vansteenkiste J, Saint-Charles J, Fillion M. Évaluation de la prise en compte du sexe et du genre dans l'application des connaissances dans des projets de recherche en santé environnementale à la suite d'une formation. Le 89e Congrès de l'Acfas conference. Engager le dialogue savoirs-sociétés; May 27–31, 2019.
- 15 Canadian Community of Practice in Ecosystem Approaches to Health. Ecosystem approaches to health teaching resources. 2022. <https://copeh-canada.org/en/teaching-manual.html> (accessed March 1, 2022).
- 16 Ekosante. A Latin American, Caribbean and Canadian Collaboration in ecohealth. 2022. <https://ekosante.org/> (accessed March 1, 2022).
- 17 CPHA. Ecological determinants group on education. <https://www.cpha.ca/EDGE> (accessed March 1, 2022).
- 18 Environment, Community Health Observatory Network. Environment, Community Health Observatory Network Research. <https://www.echonetwork-reseaeuco.ca/> (accessed March 1, 2022).
- 19 ACFAS. Construire des savoirs pour favoriser l'équité en santé. 2022. <https://www.acfas.ca/evenements/congres/programme-preliminaire/enjeux-recherche/12> (accessed March 1, 2022).
- 20 Sipos Y, Battisti B, Grimm K. Achieving transformative sustainability learning: engaging head, hands and heart. *Int J Sustain High Educ* 2008; **9**: 68–86.
- 21 Bloom BS, Masia BB, Krathwohl DR. Taxonomy of educational objectives (two volumes: the affective domain & the cognitive domain). New York, NY: David McKay & Co, 1964.
- 22 Hicks D, Bord A. Learning about global issues: why most educators only make things worse. *Environ Educ Res* 2001; **7**: 413–25.
- 23 Nagel M. Constructing apathy: how environmentalism and environmental education may be fostering “learned hopelessness” in children. *Aust J Environ Educ* 2005; **21**: 71–80.
- 24 Lehner L, Gribi J, Hoffmann K, Paul KT, Kutalek R. Beyond the “information deficit model”. Understanding vaccine-hesitant attitudes of midwives in Austria: a qualitative study. *BMC Public Health* 2021; **21**: 1671–1671.
- 25 Sturgis P, Allum N. Science in society: re-evaluating the deficit model of public attitudes. *Public Underst Sci* 2004; **13**: 55–74.
- 26 Hathaway MD. Overcoming fear, denial, myopia, and paralysis: scientific and spiritual insights into the emotional factors affecting our response to the ecological crisis. *Worldviews Glob Relig Cult Eco* 2017; **21**: 175–93.
- 27 Hathaway MD. Activating hope in the midst of crisis: emotions, transformative learning, and “the work that reconnects”. *J Transform Educ* 2017; **15**: 296–314.
- 28 Hathaway M. Fostering reorienting connections via ecological practices. In: Nicolaidis A, Eschenbacher S, Buergelt PT, Gilpin-Jackson Y, Welch M, Misawa M, eds. *The Palgrave handbook of learning for transformation*. London: Springer International Publishing, 2021: 279–300.
- 29 Hathaway M, Cole D, Poland B. Nurturing ecological consciousness. In: Zywert K, Quilley S, eds. *Health in the anthropocene: living well on a finite planet*. Toronto, ON: University of Toronto Press, 2020: 323–38.
- 30 Lotz-Sisitka H, Wals AE, Kronlid D, McGarry D. Transformative, transgressive social learning: rethinking higher education pedagogy in times of systemic global dysfunction. *Curr Opin Environ Sustain* 2015; **16**: 73–80.
- 31 Poland B, Mashford-Pringle A, Bowra A. Many lenses for planetary health: seeding citizen engagement for sustainable futures visioning with new ways of seeing. *Can J Public Health* 2020; **111**: 901–11.
- 32 Kotawān. A portal to access wildlife and environmental monitoring data. 2022. www.kotawanportal.ca. (accessed March 1, 2022).
- 33 Schultz K, Walters KL, Beltran R, Stroud S, Johnson-Jennings M. “I’m stronger than I thought”: Native women reconnecting to body, health, and place. *Health Place* 2016; **40**: 21–28.
- 34 Mashford-Pringle A, Stewart SL, Akiikaa (it is the land): exploring land-based experiences with university students in Ontario. *Glob Health Promot* 2019; **26**: 64–72.
- 35 Bowra A, Mashford-Pringle A, Poland B. Indigenous learning on Turtle Island: a review of the literature on land-based learning. *Can Geogr* 2021; **65**: 132–40.
- 36 Brisbois BW, Delgado AB, Barraza D, et al. Ecosystem approaches to health and knowledge-to-action: towards a political ecology of applied health-environment knowledge. *J Polit Ecol* 2017; **24**: 692–715.
- 37 Gislason MK, Morgan VS, Mitchell-Foster K, Parkes MW. Voices from the landscape: storytelling as emergent counter-narratives and collective action from northern BC watersheds. *Health Place* 2018; **54**: 191–99.
- 38 Tuck E, Habtom S. Unforgetting place in urban education through creative participatory visual methods. *Educ Theory* 2019; **69**: 241–56.
- 39 Gunnlaugson O. Shedding light on the underlying forms of transformative learning theory: introducing three distinct categories of consciousness. *J Transform Educ* 2007; **5**: 134–51.
- 40 Wals AEJ, Heymann F. Learning on the edge: exploring the change potential of conflict in social learning for sustainable living. In: Wenden AL, ed. *Educating for a culture of social and ecological peace*. New York, NY: State University of New York Press, 2004: 123–44.
- 41 Environment, Community, Health Observatory Network. Arts-based and narrative approaches. 2022. <https://www.echonetwork-reseaeuco.ca/tools-and-processes> (accessed March 1, 2022).
- 42 Feagan ML. Fostering the next generation of sustainability leadership: graduate student experiences with ecohealth communities of practice. *Int J Sustain High Educ* 2018; **19**: 681–98.
- 43 Nevens F, Frantzeskaki N, Gorissen L, Loorbach D. Urban transition labs: co-creating transformative action for sustainable cities. *J Clean Prod* 2013; **50**: 111–22.
- 44 Parkes MW. Working together for WHOLE systems: approaching well-being and health, while oriented to living-systems and equity. In: Stephens C, ed. *Animals, health, and society health promotion, harm reduction, and health equity in a One Health world*. London: CRC Press, 2020: 71–94.
- 45 Wallace RG, Bergmann L, Kock R, et al. The dawn of structural One Health: a new science tracking disease emergence along circuits of capital. *Soc Sci Med* 2015; **129**: 68–77.
- 46 Gislason M, Stephen C. Chapter 3. Health equity in One Health. In: Stephen C, eds. *Animals, health and society: health promotion, harm reduction, and health equity in a One Health World*. London: CRC Press, 2020: 35–52.
- 47 Rabinowitz PM, Pappaioanou M, Bardosh KL, Conti L. A planetary vision for one health. *BMJ Glob Health* 2018; **3**: e001137.
- 48 Horwitz P, Parkes MW. Intertwined strands for ecology in planetary health. *Challenges* 2019; **10**: 20.
- 49 Parkes MW, Poland B, Allison S, et al. Preparing for the future of public health: ecological determinants of health and the call for an eco-social approach to public health education. *Can J Public Health* 2020; **111**: 60–64.
- 50 McKimm J, Redvers N, El Omrani O, Parkes MW, Elf M, Woollard R. Education for sustainable healthcare: leadership to get from here to there. *Med Teach* 2020; **42**: 1123–27.
- 51 Shaw E, Walpole S, McLean M, et al. AMEE consensus statement: planetary health and education for sustainable healthcare. *Med Teach* 2021; **43**: 272–86.
- 52 Guzmán CAF, Aguirre AA, Astle B, et al. A framework to guide planetary health education. *Lancet Planet Health* 2021; **5**: e253–55.
- 53 Gillingham MP, Halseth GR, Johnson CJ, Parkes MW. The integration imperative: cumulative environmental, community and health impacts of multiple natural resource developments. London: Springer International Publishing AG, 2020.

-
- 54 Galway LP, Parkes MW, Allen D, Takaro TK. Building interdisciplinary research capacity: a key challenge for ecological approaches in public health. *AIMS Public Health* 2016; **3**: 389–406.
- 55 Buse CG, Patrick R. Climate change glossary for public health practice: from vulnerability to climate justice. *J Epidemiol Community Health* 2020; **74**: 867–71.
- 56 Gislason MK, Galway L, Buse C, Parkes M, Rees E. Place-based climate change communication and engagement in Canada's provincial north: lessons learned from climate champions. *Environ Commun* 2021; **15**: 530–45.
- 57 Dakubo C. Towards a critical approach to ecohealth research, theory and practice. In: Gislason MK, eds. *Ecological health: society, ecology and health*. Bingley: Emerald Group Publishing, 2013: 23–43.
- 58 Laberge M, Chadoin M, Inigo M, et al. Integration of sex and gender in interventions by students in ergonomics. *Ergonomics* 2022; **65**: 1578–91.
- 59 Simpson LB. Land as pedagogy: Nishnaabeg intelligence and rebellious transformation. *Decolonization* 2014; **3**: 1–25.

Copyright © 2023 The Author(s). Published by Elsevier Ltd. This is an Open Access article under the CC BY-NC-ND 4.0 license.