



Climate change professionals' perspectives on the competencies for One Health graduates

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Results

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Abstract

There is a pressing need for novel approaches to help address climate change and for a workforce that is equipped with a combination of new and different types of knowledges. The One Health (OH) core competencies perhaps offer the new knowledges, skills and attitudes that will be needed in a future generation of practitioners that does not shy away from complexity. The objective of this research was to identify overlapping and transferable OH-climate change competencies that are needed of professionals working to address climate change. Using focus groups and qualitative content analysis, 23 professionals from across Canada whose employment positions had a key focus on climate change were brought together across five sessions. Participants agreed that the OH competencies were applicable to their employment roles and responsibilities, but they identified four key missing areas that are important for graduates: evaluative and reflective practice, personal resilience, turning knowledge into action and having an openness to other knowledges (particularly Indigenous and non-Western viewpoints). This work also provided a first iteration of a process that should be continually used to bridge the gap between theory and practice, as employer needs are a key consideration during the development of educational programs.

Introduction

Population growth, climate change, urbanization and increased migration of people, animals and their products have changed the way people and animals interact with each other and their shared environments (CDC 2022). One Health (OH) recognizes these interdependencies and is an approach that fosters collaboration and transdisciplinarity to attain better and more sustainable health for humans, animals and ecosystems (CDC 2022; Zinsstag et al 2021). Key principles of the OH approach include striving for equity between actors and disciplines, including marginalized voices, recognizing the intrinsic value of and seeking balance between humans, animals and ecosystems taking responsibility as humans to change behaviour and fostering transdisciplinarity (OHHLEP 2022).

Climate change has caused irreversible changes to water availability, agricultural production, human and animal health and well-being, built and natural environments and biodiversity in all types of ecosystems (IPCC 2023). Climate change has resulted in challenges that involve all pillars of OH, such as increased concern about zoonotic and vector-borne diseases, food insecurity, mental health issues and inequality at local and global scales (WHO 2021). Addressing these challenges requires involvement of researchers and practitioners, academics and societal actors, policy makers and policy users (Gosselin et al 2011; Stephen 2022). The breadth of actors responsible for and invested in adapting to and mitigating the effects of climate change highlights the benefit of using an approach, such as OH, that supports shared knowledge and resources to create unique solutions in both practice and policy (Stephen 2022).

There is a pressing need for novel solutions in a society where human, animal and ecosystem health threats continue to emerge and worsen. This requires new and different types of knowledge and skills to be developed and combined (Laing et al 2023). Existing OH core competencies describe the knowledge, skills and attitudes that someone trained in using a OH approach should fundamentally possess (Frankson et al 2016; Laing et al 2023). Between 2008 and 2023, several initiatives were undertaken to identify core OH competency domains, such as through the Bellagio Working Group (Frankson et al 2016), the Stone Mountain Meeting Training Workgroup (Frankson et al 2016), the RESPOND Initiative (Hamilton et al 2015), the Rome Synthesis (Hueston et al 2014) and the Network for Evaluation of One Health (NEOH) (Laing et al 2023). Across four of these initiatives, major competency domains were summarized as management, communications and informatics, values and ethics, leadership, team and collaboration, roles and

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responsibility and systems thinking (Frankson et al 2016). The most recent publication by NEOH provided an update to these domains based on existing literature and work conducted by the network; effective communication, collaborative and resilient working, systems understanding, transdisciplinarity, social, cultural, and gender equity and inclusiveness, collective learning and reflective practice and knowledge of OH concepts and practice were added (Laing et al 2023).

The development of core competencies for OH professionals coincide with the development of OH training programs at universities; most of the OH programs in the USA were founded since 2002 (Togami et al 2018). Several universities in Canada have also created various OH training, degree, or certificate programs: specifically, the Universities of Guelph, Montreal, Saskatchewan, Calgary, and Western Ontario. Across Canada, Europe and the USA, most OH programs are housed in departments or colleges that focus on veterinary epidemiology, zoonoses, public health and infectious diseases (Sikkema et al 2016; Togami et al 2018). This is not surprising as the OH concept emerged from and has mainly been propagated through veterinary medicine channels (Gibbs 2014), but the need for these programs to address concerns beyond zoonoses is becoming more urgent. Among the most urgent needs is a workforce that can meaningfully contribute to climate change mitigation and adaptation. Therefore, the objectives of this research were to identify the needs perceived by individuals employed in climate change work and to determine overlapping and transferable climate change and OH competencies for university graduates.

Methods

This study was approved by the University of Guelph Research Ethics Board (#21-04-014), the Northwest Territories' Aurora Research Institute (#17131) and the Nunavut Research Institute (#01 033 22N-M). This manuscript was written following the consolidated criteria for reporting qualitative studies (COREQ) checklist (Tong et al 2007).

Research team and reflexivity

Two researchers (CKMM, English sessions; CA and CKMM, French session) facilitated the focus groups, with two additional researchers present for notetaking (RKG, EJP). CKMM is a cisgendered white female and was a PhD candidate in Population Medicine and OH at the time of the study. The OH approach used by CKMM involved thinking about the health of humans, animals and ecosystems equitably in her work, and not only in considering animal/ecosystem health for the benefit of humans; it is the tenets within OH (i.e., transdisciplinarity, communication and systems thinking, reflexivity) that were central to her application of this approach. CKMM had no prior focus group facilitation experience; however, she was trained in focus group methodology through graduate-level coursework. CA had extensive focus group training through prior qualitative research studies. There were no prior relationships between the participants and CKMM or CA. Participants were informed of the credentials and research purpose of CKMM at the time they were approached to participate.

Study design

Theoretical framework

Focus group and qualitative content analysis methodology (Bengtsson 2016; Braun and Clarke 2020) were used following a

pragmatist paradigm wherein the research question drove the selection of the research methodology (Brierley 2017).

Participant selection

Participants were purposively selected based on province/territory of their employment and their role/responsibility within their organization. To be eligible, participants had to be located in Canada and have publicly available contact information. Participants also had to hold a position related to (i.e., their job title or employment description used the following words) or be employed at an organization with a strong mission towards climate change impacts, mitigation, adaptation, or resilience; environmental sustainability; or biodiversity conservation. All fields (i.e., not only science or health-related fields) were eligible. Relevant organizations and individuals were identified by the authors and through an internet search. Other potential participants were identified through snowball sampling from contacted individuals.

Due to Canada's diverse landscapes, geographies and ecosystems and, therefore, diverse climate change needs and responsibilities, representation of all provinces and territories was the goal of participant recruitment. Five catchment areas, with one focus group session *per* area, were used to group participants: Ontario, West (British Columbia, Alberta, Saskatchewan and Manitoba), Québec (conducted entirely in the French-language), Atlantic (New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland & Labrador) and North (Nunavut, Northwest Territories (NWT) and Yukon Territory). Eligible participants were contacted via email with the study details, a consent form, and tentative focus group dates/times. Recruitment documents for the Québec and North sessions were translated into French and Inuktitut, respectively, for recruitment of participants in those locations. The aim was to enroll four to 10 participants *per* focus group region; therefore, recruitment efforts continued until this aim was roughly met. Overall, 102 eligible participants were contacted: 20 for the Ontario session, 12 for the Atlantic session, 11 for the West session, 24 for the Québec session and 35 for the North session. No incentives to participate were provided.

Data collection

The focus groups were conducted via Microsoft® Teams (version 1.6 2023), audio- and video-recorded and lasted 120 min. The guide included eight main questions about competencies needed to be successful working in climate change and specific questions regarding the appropriateness of the proposed OH competencies for climate change work, with additional probing questions where needed (Appendix 1). A portion of the focus group guide involved discussion of previously developed competencies for OH graduates in Canada (Parmley and Clow, unpublished manuscript), further referred to as the One Health Competencies Framework (OHCF) (Figure 1), to identify competency domains that were important for participants' workplaces, particularly in the context of climate change. In this study, a "One Health graduate" referred to those who completed a university- or college-level training program in OH. A unique focus group summary was provided to participants for comment to validate the major findings from each session.

Data analysis

Focus groups were manually transcribed *verbatim*, and the Québec session was translated from French to English prior to analysis. The focus groups were transcribed directly following each session and preliminary content analyses occurred at that

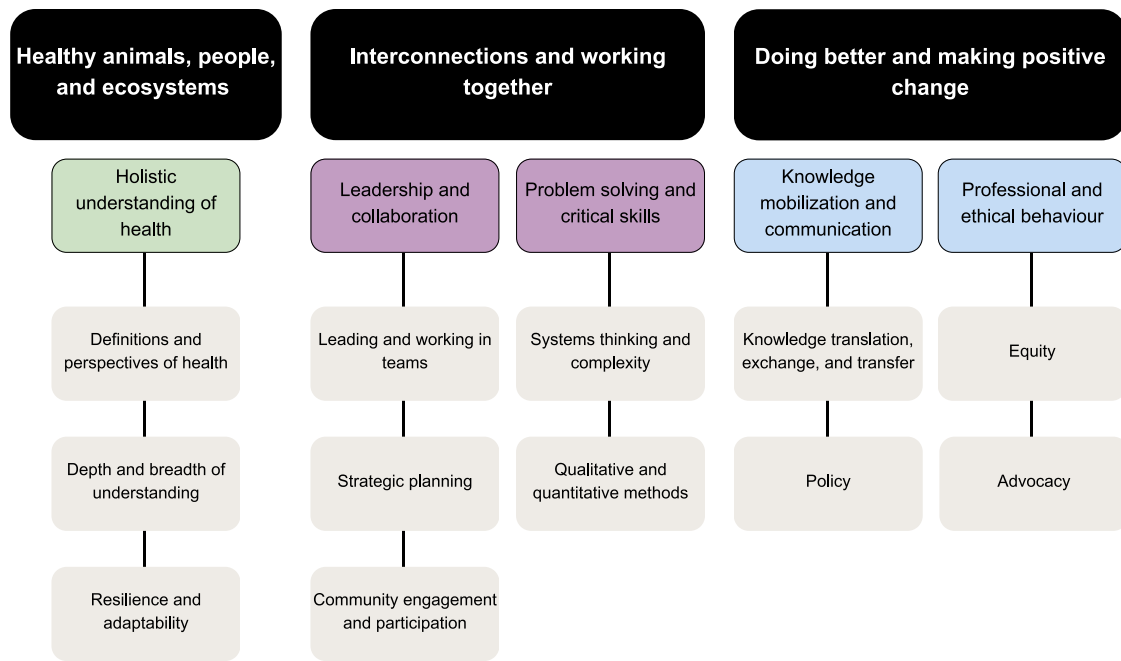


Figure 1. The One Health Competencies Framework (OHCF) created by academics working or conducting research within a OH area from across Canada, adapted from Parmley and Clow (unpublished manuscript). This competency framework describes the foundational competency domains (boxes at top of figure), the core competency domains (second tier boxes), and enabling competency domains within each core domain (third tier boxes). The OHCF was shared with focus groups participants for their commentary (see Section 3.3).

time. Initial open coding of the transcripts was conducted by CKMM using NVivo (Release 1.7) to identify key concepts and categories of codes and develop a codebook. Coding validation was conducted independently by other authors (EJP, KMC and RKG) on a subset of the transcripts by applying the codebook developed by CKMM. A coding meeting followed to discuss discrepancies or changes that needed to be made to the codebook. The validated codebook was then used to inductively code the remainder of the transcripts, with deductive *a priori* themes (i.e., OH competencies identified in the literature and within the OHCF) revisited throughout the coding process.

Results and interpretations

Twenty-three (22.6% response rate) climate change professionals participated in the five focus group sessions: seven in each of the West and Atlantic sessions, four in the Ontario session, three in the Québec session and two in the North session. The two participants in the North session were both from Nunavut, despite recruitment efforts also occurring in NWT and Yukon. The Québec and North sessions did not meet the aim of enrolling four to 10 participants *per* region due to last minute participant drop-outs and recruitment challenges. Participants were highly educated and were from the following types of organizations: federal government ($n=1$), provincial government ($n=11$), municipal government ($n=2$), academic institutes ($n=1$), non-profit organizations ($n=6$) and other ($n=2$). The sessions were conducted between October 2021 and January 2022 (West, Atlantic, Ontario and Québec), and in December 2022 (North). The perspectives shared were the participants' own, and not those of the institutions at which they were employed.

Common reasons for non-participation were non-response, participants said they did not see the relevance of their

employment to the study objectives, participants said they could not attend during the proposed time and participants said they were interested in the study but did not have time available due to increased responsibilities associated with the COVID-19 pandemic. The representation of all provinces and territories was the goal of participant recruitment; however, code saturation (Hennink et al 2017) was assumed to be met after no general deviations to the codebook or from the importance of the major themes were identified following completion of the fifth session.

Competency domains identified for success in climate change positions and addressing climate change

Ten major competency domains were identified through the discussions as important for success in fulfilling employment roles, meeting responsibilities and/or to contributing to addressing climate change (Figure 2). These domains resulted from the discussions that occurred prior to participants viewing the OHCF such that they could identify, without persuasion, the important knowledge, skills and attitudes. These competency areas elaborate on the importance of combining *the knowledge* (i.e., appropriate scientific and policy knowledge), *the team* (i.e., effective, equitable and inclusive collaboration), *the doing* (i.e., affecting change using equitable actions) and *the bettering* (i.e., improving adaptation efforts and bolstering resiliency through evaluation, communication and reflexivity). Subdomains are presented to further clarify the meaning of each major domain.

The major domains are listed here by order of volume (those with the most codes to those with the least codes): collaboration, knowledge and literacy, action, communication, reflexivity, fairness and justice, professionalism, policy and governance, evaluation and resiliency. Subdomains and minor domains were also identified (Appendix 2).

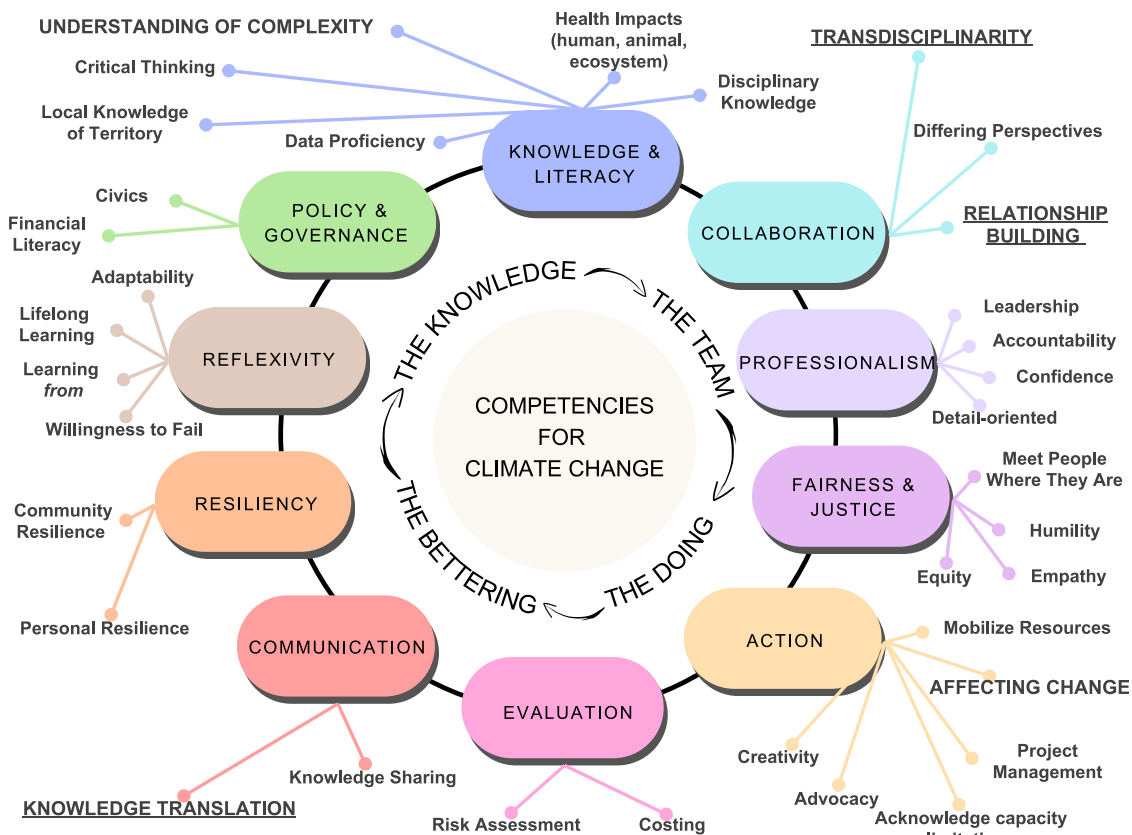


Figure 2. Competency domains identified through focus groups with climate change professionals from Ontario, Québec, Atlantic Canada, Western Canada, and Northern Canada as necessary to be successful in their employment roles and responsibilities, and for addressing climate change. Ten major domains (collaboration, professionalism, fairness & justice, action, evaluation, communication, resiliency, reflexivity, policy & governance, and knowledge & literacy) were identified, with subdomains reported for each major domain. Capital lettering represents subdomains with >10 coded references, and underlined capital lettering represents subdomains with >20 coded references.

Skills that graduates lack the most when entering the workforce

A theme across all focus groups was that most new graduates are naïve, have difficulty grasping the complexity involved in climate change work and lack practical experience. For example, one participant said, "...junior staff who are fresh out of school... [have] a certain naivety... [and] there's a lack of real-world experience..." (North participant 2). This naivety referred both to the complexity of climate change as a science, but also to the complexity of institutional governance and internal politics. There is also a need for students to be able to think beyond the theory and knowledge gained through coursework. Although not specific to OH or climate change, one participant remarked that new graduates often bring a clean theoretical approach to their work in a problem area that is messy and complex:

"...there's a bit of naiveness, which I think is in some ways good because... they're not battle worn, but it's a bit too much of an academic approach. It's like "Well, I read this in a textbook, and this is how it works, and this is how we're going to move forward [and solve] this..'. Whereas when you're trying to solve something in reality... usually those academic approaches don't necessarily work." (Ontario participant 3).

Possible interventions for this naivety were suggested by participants. This included more co-operative program opportunities, more practical experience, or the addition of mentorship programs. One participant from the North identified a

mutually beneficial mentorship program between students and advising organizations could be helpful: "...maybe that's something that programs could focus more on... more of a long-term mentorship program maybe throughout a master's where they come and they spend time in person, but then there's also kind of that longer term relationship building process" (North participant 2).

While the solutions to this naivety discussed during the sessions involved practical work experience or mentorship that is gained beyond the walls of an educational institution, there may be opportunity to provide some of the identified missing skills during a training program. For example, oral and written communication skills are often identified as an institutional learning outcome but were a major thematic area of missing skills of graduates. The following gaps were identified by participants: the ability to communicate succinctly, "I think people spend so long in school, and you spend so much time writing academically, which is... very long winded" (Atlantic participant 4); communicating the most essential results, "I would say the first weakness is that there is a lot of fluff... Try to guide [readers] on the things that are the most important." (Québec participant 2); and the ability to convey meaning to target audiences, "[see] the forest for the trees... but also know how to shape the message" (Ontario participant 4). These gap areas could be used to inform improvement in pedagogy that focuses on communication skills.

Similarly, participants remarked that recent graduates are often not confident in collaborative settings. This theme appeared in

Table 1. Competency domains the climate change professionals identified during the focus groups as additions or areas requiring more emphasis within the previously developed One Health Competencies Framework (OHCF). Support from three other published One Health competency frameworks is provided to examine the inclusion of these additional domains in other competency frameworks

Support from present study	Support from other One Health competency frameworks	
	Source	Support for domain
Evaluative and reflective practice		
Costing and economics through “ <i>understanding the economic aspect of policy implications, but also on the costs of climate change impacts</i> ” (Ontario participant 4)	Frankson et al (2016), tab 1: USAID/RESPOND	“ <i>Planning and management; analysis and assessment</i> ”
Cost-benefit analyses and a “... <i>practical use of tools...[such as] PESTELs and SWOTs</i> ” (West participant 2)	Frankson et al (2016), tab 1: Stone Mountain Meeting	“ <i>Communicates lessons learned</i> ”
An ability to approach data sets, information sources, and narratives with “... skepticism and critical analysis ” (West participants 1, 6)	Togami et al (2018), tab 1	Professional characteristics: “ <i>Demonstrate scientific quantitative skills, such as the ability to evaluate experimental design, interpret scientific findings, and develop discussions, as well as provide implementable recommendations</i> ”
An ability to evaluate “... vulnerabilities and risks ” (Québec participant 3, West participant 6, Ontario participants 2, 4) and use risk assessment tools	Laing et al (2023), tab 2	“ <i>Collective learning and reflective practice: Demonstrates reflective practice, assesses and recognizes own values and knowledge, being a humble and active continual learner</i> ”
Environmental impact assessments while considering the “... social determinants of health... animals and humans ” (Atlantic participant 4)		
Personal resilience		
Equip graduates to better “ <i>manage some of [the] burden</i> ” (West participant 7), the stress and despair, the doom and gloom that occurs from working in the climate change field	Frankson et al (2016), tab 1: Bellagio working group	Ways of being (includes emotional intelligence)
	Laing et al (2023), tab 2	Collaborative and resilient working: Working with others across disciplines and sectors can generate negative emotions; “ <i>emotional resilience includes the ability to adapt under challenging circumstance, recover from adverse feelings, and to react adequately when challenges arise</i> ”
Action		
Committed to “... adaptive management ... So, being able to... <i>assess, integrate, and adapt, keep what’s working and drop what’s bad</i> ” (West participant 7)	Frankson et al (2016), tab 1: Rome Synthesis	“ <i>Systems analysis/thinking (external awareness and big picture); creating an enabling environment and advocating for change</i> ”
Have the “ ability to make decisions in the face of uncertainties , so I think that’s really key because as I mentioned earlier, we don’t have a great surveillance system for impacts of climate change on human health, but maybe we have enough. And sometimes we do have to make those decisions, you know, those tough decisions in the grey . So maybe it’s making decisions or making recommendations on policies and programs in like that uncertainty” (West participant 4)	Frankson et al (2016), tab 1: Bellagio working group	“ <i>Change makers/achieving results</i> ”
Creative and innovative: “... <i>there’s no miracle recipe, but rather [we have] to invent them as we go along... [we know] very well all the ingredients we have at our disposal to be able to create synergies, create new recipes... a bit like a chef... So, innovation and creativity</i> ” (Québec participant 1)	Togami et al (2018), tab 1	Professional characteristics: “ <i>Develop a plan to translate research findings and new discoveries into health policies, community programs, interventions, and public education in a manner that is sustainable, culturally relevant, and economically feasible</i> ”
Committed to service and accountability within society , “... <i>the university is trying to train people to make change, so it’s that service or that change agent... You’re trying to create leaders... [and who] also have that enthusiasms or that desire for contributing to society</i> ” (Ontario participant 4)	Laing et al (2023), tab 2	“ <i>Harnessing uncertainty, paradox and limited knowledge: Understands, considers and manages effectively that One Health challenges are complex, often wicked problems, for which the knowledge base is incomplete, contains a high level of uncertainty and potential incommensurabilities. Is aware and embraces that we have limited capacity to intervene in certain processes, and may act despite paradox, ambiguity and/or uncertainty</i> ”
Action: sustainability		
Sustainability: Graduates should appreciate the interconnections of sustainable development with “ <i>the construct of the environment and the biosphere... in a way that health professionals can relate to</i> ” (Atlantic participant 5)	Togami et al (2018), tab 1	Professional characteristics: “ <i>Develop a plan to translate research findings and new discoveries into health policies, community programs, interventions, and public education in a manner that is sustainable, culturally relevant, and economically feasible</i> ”

(Continued)

Table 1. (Continued)

Support from present study	Support from other One Health competency frameworks	
	Source	Support for domain
Other knowledges		
Indigenous knowledges: Graduates must understand, appreciate, and incorporate Indigenous knowledges, non-Western viewpoints, marginalized voices, and citizen science in meaningful and thoughtful ways as aligned to all other One Health competencies. The “...ability to listen to the people with whom we work, but also to the people in communities, to listen to the animals, to all the living beings in the territory, and to the territory itself” (Québec participant 1) will “...make processes a lot fuller, a lot more meaningful, and have social consideration that ... a lot of adaptation work [does not have]” (West participant 5)	Laing et al (2023), tab 2	“Theoretical and methodological pluralism: Understands, applies and combines knowledge, theories and ideas of multiple sciences. Acknowledges and can navigate across different epistemic and ontological standpoints and knowledge systems, including local and indigenous knowledge”
	Laing et al (2023), tab 2	“Effective communication: Engages effectively in respectful and reciprocal communication and partnerships with people from different backgrounds, disciplines, groups in society and sectors”

relation to participants stating that graduates “[lack the] willingness or courage to seek out and talk to people in the public when ... they don’t have all the answers” (Atlantic participant 4), and a “...lack of tenacity ... kind of feeling like “Oh, they didn’t respond to my email,” well you gotta email them again ... keep pushing” (Atlantic participant 7). Graduates themselves need to be accountable for improving confidence and persistence in working with others; however, workplaces also have a role to play in building confidence and competence. This idea relates to leveling top-down hierarchies such that recent graduates feel their voice is valid and useful amongst the voices of more senior employees. One participant said,

“A couple of things I’ve noticed ... is that [new graduates] don’t necessarily have the confidence to know that their input is useful and I think in climate change, and anything really, everybody’s skills can be brought to the table. So I would say just telling them that, you know, like what you have to bring is valuable and valid and we need your voice in this, too.” (West participant 5).

A caution from one participant, though, came from an experience where a graduate’s over-confidence impeded the level of professionalism owed to colleagues. This participant said, “I think young people now come out [of school] and they are very confident ... On the other hand, [they] don’t quite understand the relationships in an office sometimes ...” (Ontario participant 2).

Finally, participants also acknowledged a gap between how teamwork occurs in educational settings, versus the teamwork needed to tackle a complex problem, such as climate change. Teamwork in a degree program can present itself as groupwork that is tied to a grade, which can lead to conflict among members, disproportionate workloads and an unshared ability to learn because one student may assume responsibility for the entire project. This is especially true when peer evaluations are used as a “grade-grab” rather than a truthful source of reflexivity. In real-world settings, this type of teamwork practiced through their education can translate to a graduate failing to demonstrate, as one participant said, “humility and [a] sense of openness” (West participant 3) to and for co-workers, other professionals, and the public. Related, another participant stated graduates need to understand the importance of taking stock of personal privilege and how this can affect equity and inclusiveness in their work with others:

“One thing that comes up is the environmental racism part, about checking your privilege. That’s one thing that is huge in any environmental issues, climate change issues, like the location of these communities. A lot of communities are in poor regions ... they tend to be more vulnerable, and their ability to recover is less.” (Atlantic participant 4).

Transferable One Health-climate change competencies

The next part of the focus group discussions centered around strengths or gaps with the previously developed OHCF (Figure 1) (Parmley and Clow, unpublished manuscript). There was consensus that participants could see relevance of all competency domains and sub-domains within their employment roles and responsibilities. However, there were four major changes that participants wanted (Table 1).

Evaluative and Reflective Practice

Participants from both the West (3/7) and Ontario (1/4) sessions acknowledged that *Evaluation* was a major component missing from the framework, specifically as a component of problem solving and critical skills or within quantitative and qualitative methods (Table 1). One participant used the following analogy to demonstrate that evaluation needs to be cyclical to revise current climate change actions and move forward with new solutions, “[t] here’s a concept in food safety called Hazard Analysis Critical Control Points, and those principles can be applied to many situations, but you look at a situation, you identify the hazards, you identify where you could implement changes to reduce those hazards, you evaluate them, and you go back ... it’s a very cyclic thing” (Atlantic participant 4). Reflexivity was also a major domain identified by participants (Figure 2) as needing a stronger integration in the OHCF, which included being adaptable, a life-long learner, and learning from those from different geographies and socioeconomic classes.

Personal Resilience

The second major addition was *Personal Resilience* within the domain of doing better and making positive change. Two participants directly used the phrase “doom and gloom” in relation to this type of work, one of which remarked about the importance of employees in climate change understanding and being able to manage stress and anxiety:

“[those] who work deeply in the climate change field who are starting to feel a lot of stress and despair ... having an ability to manage that in a way that is healthy ... [and] not fall down the doom and gloom” (Ontario participant 1).

The other participant discussed resilience as an important factor for stress management: “... having a resilient personality, being able to manage some of that burden efficiently” (West participant 7). Resilience, until this point, was only included in the OHCF as a

concept for making populations or ecosystems more resilient in the face of climate change, but not as a concept for the student's mental health. An Atlantic participant also remarked on the importance of understanding eco-anxiety in climate change, and how the sensitization to this "doom and gloom" creates a disconnect between someone working in climate change and the public,

"Sometimes I forget that I used to get upset, I wonder why there is so much pushback when talking about these issues . . . But I have to remember it takes a long time to digest. I might be past the early stages of eco-anxiety, but when engaging with the community, I have to reflect back on those early days and remember not everyone is at the point to discuss solutions-focused approaches." (Atlantic participant 6).

This suggests that competencies in reflexivity align well with personal resilience. The ability for any employee to reflect upon their own level of eco-anxiety upon entrance into the field *versus* years following relates well to understanding their personal level of adaptability and the growth in their ability to cope. This may also suggest that personal resilience can be built through working in the climate change space, which must be reflected upon to appropriately engage with communities at differing stages of resilience.

Action

A participant highlighted the OHCF felt theoretical and lacked an aspect of doing or applying of this theory: *"I think it's almost like there needs to be a fourth upper category that's the actual doing or applying, like a lot of [the framework] seems like it falls under the process of . . . thinking about things but . . . there needs to be an element . . . where it's actually [about] affecting the change"* (West participant 1). This led to the addition of *Action*, such that graduates are trained to be able to *do* something about climate change. Participants across all sessions made statements reflecting agreement with this addition (Table 1). Participants from the North session agreed on the importance of training students to be able to put theory into practice, but it was noted this task will be difficult. Climate change adaptation strategies, generally, were felt to be a lot of talk with little walk. One participant from the North said, *"the adaptation strategies [were] super fluffy . . . lots of what is going to happen, but nothing about how it's going to happen . . . what is the system being put in place to actually implement these objectives?"* (North participant 1). This sentiment was echoed in discussion about how action will be included in the framework or how it will be taught to students.

One participant remarked that *Sustainability* should be added as a foundational element, which would address sustainable development, interconnections and help bridge the gap between health professionals and the environment. This participant said sustainability involves competency regarding *"all these things that interconnect everything,"* and *"the construct of the environment and the biosphere [introduced] in a way that health professionals can relate to"* (Atlantic participant 5). Alternatively, sustainability could be added as a component of *Action*, such that implemented strategies are sustainable, and actions recognize and account for interconnections to improve and maintain the health of humans, animals and ecosystems.

Openness to other knowledges

The integration of *Other Knowledges* (i.e., Indigenous knowledges, non-Western viewpoints, marginalized voices, citizen science) as a lens or guiding principle was a sentiment shared across the majority of focus groups. Participants remarked that

Indigenous perspectives share similar values to those emphasized in OH and this approach is coherent with the worldview of Inuit Peoples, which considers the connections between people, animals, health and well-being. Training programs should thoughtfully integrate other knowledges to create more holistic and meaningful partnerships and actions. Working within a solely Westernized paradigm creates an approach that can be unsophisticated and unconnected. One participant reflected on their passion for learning from Indigenous communities due to the intricate connected nature of non-Western ideologies. They said,

"I've found that Indigenous communities have just a much more holistic and broader knowledge of climate change, and really the understanding of how it impacts community, how it impacts health, how it impacts education and interacts with that, and just the knowledge on the ground of what's happening is so much more intricate than with non-Indigenous communities, in my experience. So, learning from Indigenous communities and working with them, I found, has made processes be a lot fuller, a lot more meaningful, and have social consideration that I don't think a lot of adaptation work does" (West participant 5).

Further, because climate change is a space with much uncertainty in terms of solutions, integrating new knowledges and ways of being into Western science approaches is imperative for progress toward solution-oriented mitigation and adaptation measures. A participant described the need for graduates to be open to other knowledges,

"In a moment where we don't have any certainty, it's necessary to create knowledge and then to create new ways of doing things . . . I think that it's humility, then the openness towards new forms of knowledge, experiential knowledge, Indigenous knowledge, the ability to not only listen to the people with whom we work, but also to the people in the communities, to listen to the animals, to all the living beings in the territory, and to the territory itself." (Québec participant 1).

The OHCF requires an emphasis on not only the integration of *other knowledges* as a core component of transdisciplinarity and collaboration but also with other knowledges, perspectives and culture being integrated as a guiding principle of OH. Thoughtful integration of other knowledges also calls for programming to include unlearning of colonial ideologies. The North participants remarked on their discomfort with the over-use of the terms "reconciliation," "two-eyed seeing," and "Indigenous perspectives," without the willingness for learning to occur first:

" . . . especially in talking about One Health areas and climate change and that this . . . is a perspective . . . that needs to be integrated into the curriculum like hard core. [I] don't know what that looks like, is it guest lecturers of Indigenous elders? Practitioners? Spending time on the land? Going to – I guess in an Ontario context – going to sweat lodges? . . . We can't talk about that unless we're willing to learn." (North participant 2).

Types of training valued in applicants

Participants emphasized the value of communication training, experience in analytical methods and practical experience (Table 2). Three participants identified written and oral communication skills and presentation experience as being sought after in applicants to their organizations, while six participants acknowledged that conference or presentation experience was not necessary because they felt such skills could be built on the job. One participant shared the following quote, *"I definitely look for previous work [and] volunteer experience, [and] if somebody has enthusiasm and interest . . . presentation experience, you can teach that in confidence building . . . So, for me, when I look at*

Table 2. Training opportunities the climate change professionals identified during the focus groups as valued on an applicant’s resume, ordered from most to least identified through verbal or non-verbal agreement across the five sessions

Order of most identified to least identified ¹	Training opportunities	Examples stated by participants
1	Practical experience	Practicums, programs abroad, field experience, experience in diverse communities, experiential learning, experience with Indigenous communities, internships
2	Analytical skills	Big data, coding, spatial analysis, analytical skills, decision analysis, risk analysis, vulnerability analysis, cost analysis, SWOT analysis, health impact assessment
3	Communication ²	Written communication, oral communication, presentation experience, conferences
3	Computer proficiency	Microsoft Processing, Microsoft Excel, data visualizations
3	Knowledge synthesis	Literature review skills, concise summary of literature, critical appraisal of studies
3	Specific knowledge	Understand real-world implications of economics, understand policy implications for the report, basic understanding of climate change/science
3	Specific university, program, land claims	Credibility of university/program, combination of academic training and work experience, Beneficiaries of the Nunavut Land Claims Agreement
4	Volunteer experience	
4	Intrinsic personal qualities	Respectful, open, transparent, enthusiastic, engaged
5	Publications ²	

¹Order represents the popularity of the training opportunity amongst participants, as represented by verbal or non-verbal agreement. The numbers represent that some training opportunities had the same level of popularity. ²Two training opportunities (communication and publications) also had verbal disagreement that the stated training was important when reviewing resumes. Some participants thought communication could be taught on the job and publications were not important for their work.

presentation experience, yeah, it’s OK, but if they have some of the [other skill sets, then that is more valuable]” (Atlantic participant 5).

Practical experience was verbally or non-verbally agreed upon as an asset by all but four participants. This included experience working with diverse communities, including Indigenous partners, and understanding how to look through the lens of others instead of always from a public health perspective.

Depth of knowledge versus breadth of knowledge

When the focus group participants were asked whether they believe generalists are valuable in their organizations, 16 participants remarked that a student with generalist skills is something they value. Quotations to support generalists included: “... generalists are very successful due to the amount of background skills they have, and yeah, I love working with people who have kind of general knowledge ...” (West participant 5), and “I think that to form generalists [is] probably what is most wished for, then the bulk of the knowledge, the “know-how”... that’s learned on the job” (Québec participant 1). Another participant prompted that generalization is the goal of OH, “[the] One Health program, yes it is broad, but students are ultimately gaining skills across, like to basically bring together multiple disciplines with a view to ... tackling an issue” (North participant 1). Finally, a participant from Ontario (participant 1) even stated they consider themselves a generalist:

“I would probably put myself in the breadth category ... I know who to go to, I know the relationships that are there to tap into, you know, bringing the right people to the table ... , being able to facilitate conversations across a number of areas. So, I think there is value for having breadth, for sure, in a more depth role.”

While nine participants acknowledged disciplinary specialists and depth of knowledge to be important, these statements were typically made in the context of needing both individuals of depth and individuals of breadth on a team within their organizations. People who are trained in a specialty can learn to also appreciate

the value of working with those outside of that specialty, but a team requires people who are generalists in addition to people who are specialists, as one person likely cannot be truly effective at both. One participant said they believe specialized people may have difficulty identifying the links within a system, but that specialists are still very much needed on a team:

“[As a generalist] that’s one of the things I say very often, we are able to make links and then to see links where other specialized people have difficulty seeing them because they are specialists, and that’s what we want. We want them to be specialized ... We need them” (Québec participant 3).

The ability to identify links is an important component of systems thinking and systems mapping, which is a key feature of the OH approach.

However, because most OH graduates will be early career with little practical experience, it is only fair to recognize that being an individual of breadth and depth would be a massive ask. One participant advised, “... you must be realistic. How old is [the student]? 20? 22? 23? So, very little life experience. So that’s why I think it’s necessary to insist on, it’s okay to not have all the skills. You must give them a chance to make mistakes ... [to try] things” (Québec participant 3). Employers must also realize that each graduate encompasses unique strengths and capacity limitations, as another participant cautioned, “... we have to keep in mind ... that ... not everybody is going to have the capacity to do both – both be a specific operator and have a good grasp of or be a generalist ... I think it makes sense to be careful and not discourage anyone who’s struggling to keep up with such a demand” (West participant 1).

Durable skills versus technical skills or knowledge

In two of five focus groups (nine participants), there was specific inquiry regarding whether participants thought knowledge of climate science or technical skills were more important than the durable skills (also known as soft/transferable skills) prioritized in

earlier parts of the discussions. Two participants said a base knowledge of the environment or climate change is ideal, gained either through formal university education or through professional development opportunities. This is because climate change includes such a vast array of environmental, political, social and health considerations (i.e., climate change is a “busy sphere” [Atlantic participant 1]). Four participants disagreed with this notion and emphasized that you can learn about climate change on the job, but having an eagerness to learn:

“[Within our organization], we actually come from a pretty varied background. I think it’s the skill sets that we brought to the table and the eagerness to learn . . . some of those competencies we’ve mentioned might set you up better to do the job, and you can learn about climate change. Like I’ve taught myself everything I almost need to know to do my job to some base level in the last two years” (Atlantic participant 2),

and the durable skills that allow an individual to coordinate, communicate and build relationships:

“It’s those soft skills, like picking up the phone, jumping on a plane, that direct relationship. I think it’s so much more important than having the ability to crank out, like you said [Participant 2], a technical briefing note or whatever. You are more likely to advance your agenda if you’re engaging, and . . . you’re bringing in your partners and you’re talking, you’re connecting. I think [that is] endemic in how success occurs in the territory – is that interpersonal connection” (North participant 1),

are the important factors. Other focus group participants, although not probed, echoed this sentiment through the identification of competencies that were, for the majority, durable. Across all focus group discussions, coded references referred more often to a durable skill than to technical skills/knowledge.

Conclusions

This research attempted to help answer the question: *Is there an ideal curriculum and pedagogy to achieve an optimal OH practitioner capable of contributing to the growing expectations for OH?*

In competency-based education, university graduates must be able to meet the expectations of actors who are external to the program and the needs of society (Gruppen et al 2012). Education that is based upon demonstration of competencies, especially those that are co-developed with the external actors and potential employers, may help to reduce the skills mismatch between graduates and the workforce (Pichette and Watkins 2018). This study provided insight into the expectations that climate change professionals have for OH graduates entering their world of work and provided a starting point for the co-development of OH competencies with potential employers. The OH-climate change competency domains identified will need to be translated into core competency statements, serving a more useful connection to program- and course-learning outcomes to contribute to an ideal curriculum for OH practitioners, which would then be aligned to teaching and assessment methods (Gruppen et al 2012; Hooper et al 2014). Further, the focus group participants overwhelmingly identified the importance of durable skill development in graduates, which requires different pedagogy: “*. . . the growth of these essential characteristics in students may be either fostered and encouraged or inhibited and discouraged by the manner in which the school is organized and the subject-matter presented*” (Mann 1918, 107). The term “durable skills” was used in this study, as opposed to soft skills, to represent their durability across disciplines and their demand in employment – skills that are

rarely taught in higher education because they are difficult to measure (Pelosse 2022).

The development of the OH competencies will, in part, inform OH program development. These programs also require innovative pedagogical strategies regardless of the disciplinary area upon which the OH competencies are layered (Laing et al 2023). An example of such innovation is problem-based learning whereby students develop competencies through attempting to solve a real-world problem, providing a clearer connection between world issues and their classroom learning objectives (Leming 2020; see Tengku Rinalfi Putra et al 2016 for an example in a OH context). However, a question remains: how do we know whether our programs are delivering upon the competencies identified through this work and others? Some of the competency domains identified in this work, such as effective communication, teamwork, and drive for life-long learning, can be evaluated within university courses or through co-op opportunities. But the longer-term outcomes of OH programs, including identifying if OH graduates are contributing effectively to climate change mitigation and adaptation, require a longer-term assessment plan. An alumni survey is one way in which these long-term outcomes can be assessed in a relatively inexpensive format (Volkwein 2010). It will also be a challenge to isolate the effects the program has on long-term outcomes because characteristics of the graduate and their family/background will have an influence on their occupational success (Volkwein 2010). Program assessment metrics for students, alumni, or employers of alumni can target the development of the competencies identified in a student, if proper consideration for extraneous variables is in place (Volkwein 2010).

Although this study was conducted to provide an indication of the applicability of the OHCF within climate change, it is important to place these results among the work of others. In alignment with the competency domains identified by the climate change professionals in this study (Figure 2), a global survey of potential employers of OH graduates found that respondents ranked collaboration and partnership, and communication as the most important competencies for their organizations, with systems thinking and risk assessment also falling within the top ten (Sullivan et al 2023). Sorensen et al (2023) also identified knowledge and analytical skills, collaboration and communication and policy as key competency domains that would enable health professionals to respond to the climate crisis. Lastly, the results of this study largely agree with the core domains in the climate adaptation competency framework developed by researchers from Royal Roads University, such as science and practice literacy, leadership, working together, and contributing to adaptation planning and implementation (Cox et al 2020).

It is also important to place these results among the previously developed OH competency domains of others (Table 1). Focus group participants identified four thematic areas that were missing from the OHCF (Parmley and Clow, unpublished manuscript): evaluative and reflective practice, personal resilience, action and openness to other knowledges. Togami et al (2018) incorporated evaluation as a professional characteristic competency, quoting graduates should “*[d]emonstrate scientific quantitative skills, such as the ability to evaluate experimental design, interpret scientific findings, and develop discussions, as well as provide implementable recommendations*” (tab 1, 7). This type of evaluation aligns more with critical appraisal within science, as opposed to evaluating adaptation programs, policies, or interventions from an economic and effectiveness standpoint, as deemed important by the participants in this study. Action was hinted at in the latter part

of this competency through “... *implementable recommendations*” (Togami et al 2018, tab 1, 7); however, bridging the research-to-practice gap is known to be a lengthy process (Rubin 2023) and was noted as a barrier to true action by the participants in this study. Action was identified more pointedly by the Bellagio Working Group through “*change makers/achieving results*” as a role and responsibility of OH practitioners, as well as in the Rome Synthesis through “*creating an enabling environment and advocating change*” (Frankson et al 2016). Togami et al (2018) mentioned the word sustainable in relation to ensuring research findings were translated “... *in a manner that is sustainable, culturally relevant, and economically feasible*” (tab 1, 7), which is different (but no less important) to the environmental sustainability/sustainable development referred to by the climate change professionals. The other domains – personal resilience and openness to other knowledges – were not included in these other competency frameworks.

The most comprehensive coverage of the four transferable OH-climate change competency domains identified as missing from the OHCF in this study occurred within the updated core competencies from the NEOH (Laing et al 2023). Recognizing that evaluation is an entire field of its own (Canadian Evaluation Society 2019), it may be reasonable to provide graduates with an introduction to evaluation theory and practice. Essential skills for evaluators appeared through a competency for “*collective learning and reflective practice*”, whereby the practitioner takes stock of what could have been done differently within a situation and critically reviews personal assumptions to enhance future practice (Laing et al 2023). However, the NEOH competencies did not include a domain for evaluation to improve interventions or programs. Next, the focus group participants’ version of action was well represented through the NEOH competency of “*harnessing uncertainty, paradox, and limited knowledge*” whereby a practitioner is required to take action in a space where limited data is available (Laing et al 2023). The NEOH framework also exemplified the integration of other knowledges through a competency domain that identified that the understanding, application, and combination of multiple world views and theories is a core competency for OH, elaborating that scientific inquiry that incorporates Indigenous knowledges extends beyond a positivist way of understanding (Laing et al 2023). Although this does not completely represent the focus group participants’ needs for the openness to other knowledges, specifically Indigenous knowledges, to be built into the OH competencies as a guiding principle rather than a single competency, it is positive to see this idea presented. Lastly, emotional resilience is defined within the NEOH competencies as “... *the ability to adapt under challenging circumstances, recover from adverse feelings and to react adequately when challenges arise*” (Laing et al 2023, 6), and was only referred to as a competency for practitioners when working with others – not in the context of bolstering personal resilience as a tool to combat the mental health adversities of working in climate change, as identified by the participants of this study.

It is not the intention to represent these areas as gaps within the published frameworks identified here; rather, it creates space to combine the recommendations from this study with those accepted by other authors. There is a clear opportunity to strengthen competencies in the areas of evaluative and reflective practice, personal resilience, and sustainability as identified by the focus group participants since these areas were not represented, or were represented in different forms, within published competency frameworks. Evaluation is a well-recognized core competency for public health in Canada (PHAC 2008), thus its integration in OH

could help foster connections between OH and public health programs in Canadian universities. Further, OH programs should better address the rising concern for well-being impacts of climate change and promote skills to enhance resiliency and coping capacity in graduates, such as optimism, proactiveness, problem-solving skills and cognitive flexibility (Ang et al 2022). Openness to the integration of other knowledges can also become a more holistic principle for all OH competencies, and not just be represented as an embodied way of thinking for practitioners.

A criticism of the previously identified OHCF was the lack of emphasis on turning theory into action, specifically highlighted in the West, Ontario and North sessions. Universities have a role to play in providing students an understanding of theory as applies generally to the field, but also in providing them with tools for recontextualizing theory to improve practice (Leinhardt et al 1995; Radović et al 2020). Focus group participants appreciated an applicant with prior practical experience, which are experiences that may better prepare graduates to harness uncertainty – an identified competency for OH practitioners (Laing et al 2023). A lesson can be learned from public health education where practicum placements are outlined in the guidelines for Master of Public Health programs in Canada (PHAC 2014), perhaps a feature that could be elaborated on for OH education to include a service-learning opportunity, where the benefit is equal between the student and the beneficiary of the service (Furco 1996).

This study had a limited response rate from recruitment to participation (22.6%). Additional climate change professionals should be engaged in further exploration of questions surrounding the OH competencies and the ideal curriculum that will enable OH graduates to lead and support climate action initiatives.

Supplementary material. The supplementary material for this article can be found at <https://doi.org/10.1017/one.2025.3>

Data availability statement. The data that support the findings of this study are not available publicly or upon request to respect the privacy and confidentiality of study participants.

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Connections references

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