

Core Competencies for Planetary Health Education: An AI-Assisted Review and Synthesis of Health Professions Literature

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Abstract

Background: Planetary health, which links human wellbeing with the state of natural systems, is increasingly recognized as essential content in health professions education and beyond. Scholars have proposed multiple frameworks and learning objectives. Yet, the core competencies that learners are expected to develop remain diffuse, inconsistently defined, and distributed across an array of diverse sources.

Methods: We conducted an AI-assisted review and synthesis of health professions education literature related to Planetary Health competencies. We identified peer-reviewed literature (using structured searches of Johns Hopkins University’s Catalyst database) and grey literature (using a structured Google search query to access websites, curriculum maps, etc.).

We screened records using predefined inclusion and exclusion criteria via a custom Python workflow that applied large language models to document-level screening decisions. We synthesized sources by constraining our model to look solely at our previously identified sources (as opposed to its own “knowledge” from pre-training). We then used prompting to extract and group competency statements describing what learners should be able to do upon completion of training, as well as what attitudes and dispositions they ought to cultivate. We generated the final list of competencies using two different large language models to assess stability across models.

Findings: The synthesis converged on 14 broad Planetary Health competency domains. Comparison with well-known human-curated competency frameworks revealed substantial overlap at the domain level. Simultaneously, we found gaps in granularity for specific health impacts and population-specific competencies.

Interpretation: This review identifies a convergent set of core Planetary Health competencies that can inform curriculum design in health professions education. Our approach introduces a replicable, AI-assisted methodology for synthesizing competencies in emerging and fast-evolving fields. Thus, as the field evolves, technologies change, and Planetary Health education develops, future scholars should be able to easily conduct future reviews using this approach. We underscore that our AI-assisted synthesis should not replace human interpretive judgment. Rather, it offers a scalable, replicable complement to traditional reviews from which specific programs can make decisions about which competencies they wish to prioritize for their students.

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Keywords: Planetary Health; competencies; health professions education; curriculum development; artificial intelligence

Introduction

As an emerging, multidisciplinary field of study, Planetary Health seeks to understand the deep connections between the sustainability of Earth’s systems, human health, and the role of human behaviors (Guzmán et al., 2021; Jacobsen et al., 2024; Redvers et al., 2023). Because knowledge development and dissemination

are integral goals of Planetary Health, education plays a pivotal role in the evolution of this academic field (Gehlbach et al., 2024).

As knowledge builds and momentum grows for educating a new generation of Planetary Health scholars, increasing attention has been paid to what this education should look like. Scholars have proposed compelling frameworks to inform the foundational domains and content of Planetary Health education (Guzmán et al., 2021). Influential thought leaders have collaborated to identify key learning objectives for Planetary Health Education (Jacobsen et al., 2024). Recently, attention has been given to *how* to teach Planetary Health, with an emphasis on the unique pedagogical tensions that Planetary Health instructors need to navigate (Gehlbach et al., 2024).

Yet, less attention has been given to the competencies that students must acquire. Competencies encompass “the set of knowledge, skills, and attitudes that learners are expected to achieve across an entire curriculum” (Jacobsen et al., 2024). We expand upon this conventional understanding of “competencies” to include learners’ dispositions. For example, an oft-mentioned competency among Planetary Health educators is a student’s ability to embrace systems thinking to solve problems. Although not a traditional competency, the extent to which graduates of a program engage this habit of mind signals an important element of a program’s efficacy. In other words, consensus is needed about what Planetary Health students should be able to do, what attitudes they might hold, and what inclinations they might develop.

This article has two goals. The first is to empirically identify the Planetary Health Education competencies most frequently identified in both less formal literature such as websites, syllabi, and PDFs, as well as formal academic journal articles. In addition to Planetary Health programs, others may benefit from identifying these competencies. Journalists, policymakers, nonprofit leaders, and other stakeholders may also value understanding which competencies are being emphasized in this critical field.

The second goal is to establish a methodology that can be easily replicated to capture the state of a rapidly changing field. Because the zeitgeist might be very different two years from now, an efficient methodology with a reproducible process will be a boon to scholars in this area. We expect this methodological contribution to be valuable for those seeking to rapidly review and synthesize emerging literature on novel or fast-evolving topics.

The process we developed allowed us to sort through information quickly — perhaps more akin to a rapid, rather than a systematic, review (Wollscheid & Tripney, 2021). At the same time, our process is explicit and systematic. Thus, we believe this review is best conceptualized on its own terms. Therefore, we will refer to this process as an AI-assisted Review and Synthesis. Its unique key components include (a) the document-by-document analysis procedure that something like ChatGPT will not reliably perform on its own if merely instructed to identify Planetary Health competencies and (b) the need for custom computer code that calls on a Large Language Model (LLM) through its Application Programming Interface (API). This workflow allows for much tighter control over the process and likely more accurate results.

Methods

Overview

We defined a “competency” as the tasks that students should be able to do upon graduation. We avoided synthesizing information about what students should *know*, as learning standards and objectives vary from program to program. Instead, we focused on the types of abilities, dispositions, and capacities a graduate needs to have to be a scholar who can put their Planetary Health knowledge into action and is disposed to do so.

To do that, we employed a multi-tiered literature review strategy and used Generative Artificial Intelligence to streamline the process. We began with wide search criteria, and, over the course of the process, narrowed down to a final set of competencies that met our standards.

Literature Search

Selection Step

To ensure appropriate results, we developed our search strategy to be wide enough to include the most important peer-reviewed articles on the topic, as well as the most important websites and PDFs that were unlikely to appear in academic literature. This strategy had two components:

- A Google search, limited to the first 50 unique results.
- Johns Hopkins University’s Library’s Catalyst system, using a narrow search criteria.

Query Construction Step

The initial search query we developed for the Google search was:

```
"planetary health" AND ("competencies"  
OR "objectives" OR "learning outcomes" OR "curriculum")
```

This query served as the conceptual foundation for the Catalyst search, which initially returned over 500 results. To reduce the corpus to a manageable size while preserving topical relevance, we asked Anthropic’s Claude chatbot to suggest a more focused query. Note that although our definition of competencies is distinct from learning objectives, much literature contains both.

Our query to Claude was: “My research team is conducting an automated systematic review to synthesize competencies, dispositions, and skills that would be associated with the successful completion of a Planetary Health masters program. We want to know what students should be able to *do* upon completion, not necessarily what they should know. We are using JHU’s Catalyst system to conduct this search, and the following query brings back about 500 results, but we would like to keep it to 150 or less. Can you please refine?”

Of Claude’s candidate queries (see Appendix A), we selected Option 3. It most effectively balanced specificity and coverage by explicitly requiring references to competencies and educational contexts within the health professions. At the same time, it avoided overly restrictive disciplinary or publication-type constraints. Moreover, the AI recommended Option 3, which validated our choice. The final query was:

```
"planetary health" AND competenc*  
AND (curriculum OR education OR training)  
AND ("health professions" OR medical OR nursing OR "public health")
```

This resulted in 113 results — narrow enough to process through our AI script, but wide enough that we would not miss critical details.

Article Retrieval Process

Since retrieving articles cannot easily be automated due to scraping restrictions, we manually downloaded all results. Google results were saved as HTML, MHTML, or PDF files depending on the source; Catalyst results were downloaded as PDFs. All files were stored locally in a dedicated folder on our hard drive.

Inclusion/Exclusion Criteria

Our inclusion and exclusion criteria were designed to eliminate documents that did not contain useful information, while retaining documents that contained competencies that matched our specific definition. To do this, we needed to widen our inclusion criteria beyond the eventual, final output. The distinction between useful and irrelevant information for the first pass is defined in Table 1. We embedded the criteria from this table into our Python script.

Criterion	Inclusion	Exclusion
Topic Focus	Articles discussing Planetary Health, climate health, environmental health, or One Health in educational contexts	Articles solely about clinical care, policy, or research without educational/training components
Competencies	Articles that describe, define, or propose specific competencies, skills, dispositions, abilities, learning objectives, or learning outcomes for practitioners/students	Articles that only discuss general concepts without specifying what practitioners should be able to do, know, or demonstrate
Educational Context	Articles focused on health professions education (medical, nursing, public health, occupational therapy, physiotherapy, nutrition, etc.) at undergraduate, graduate, or continuing education levels	Articles about K-12 education, general environmental education, or non-health professions
Content Type	Empirical studies, curriculum descriptions, framework developments, competency assessments, scoping/systematic reviews, educational innovations	Opinion pieces, editorials, or commentaries without substantive competency content; purely theoretical papers without practical applications
Competency Definition	Articles explicitly addressing what students/practitioners should be able to DO (skills), KNOW (knowledge), or demonstrate as VALUES/ATTITUDES/DISPOSITIONS	Articles only discussing the importance of Planetary Health or describing problems without identifying required competencies
Language	English language publications	Non-English language publications
Publication Type	Peer-reviewed journal articles, conference proceedings, grey literature (if describing implemented curricula or competency frameworks)	Abstracts only, posters without full text, unpublished dissertations
Time Period	No date restrictions (all years included)	N/A
Availability	Full text accessible through institutional access or open access	Full text not available despite institutional access attempts

Notes:

- Articles may include One Health IF they discuss it in relation to Planetary Health education and specify competencies
- Articles about healthcare sustainability (e.g., greening hospitals) are excluded unless they explicitly address competencies for practitioners
- Articles that discuss educational *gaps* or *needs* are included only if they also specify what competencies should address those gaps

Automated Screening System

To apply inclusion and exclusion criteria consistently across a large heterogeneous set of documents, we automated the screening process that would traditionally be conducted by human reviewers. We prompted Claude to generate Python code that enabled a document-by-document screening workflow with pre-defined outputs and logging. This automation substantially reduced the time required to screen articles while preserving transparency and traceability in screening decisions. Using this system, we:

- Scanned the download folder and generated a CSV cataloging each file's name and path.

- Extracted text content from each file, accounting for differences in file type (PDF, HTML, MHTML).
- Sent each document’s content to the OpenAI GPT-4o API with our inclusion/exclusion prompt, using a 50,000-token context window to capture sufficient document detail within budget constraints.
- Received and parsed a structured AI decision for each source, including: inclusion/exclusion decision, confidence level (High/Medium/Low), a 2–3 sentence rationale, and a list of key competencies identified.
- Saved all results to a CSV appending the evaluation fields to the original file metadata, and generated summary counts of included, excluded, and errored files.

Synthesis

Following automated screening, excluded documents were removed from the dataset, leaving a corpus composed solely of sources meeting the inclusion criteria. This curated dataset was then used as the input for the competency synthesis stage.

To extract and synthesize competencies in a structured, traceable manner, we employed a source-constrained, AI-assisted prompting approach. We provided the curated dataset to ChatGPT (version 5), and an initial synthesis was used to refine the prompt iteratively, clarifying the analytic goal and output structure (Appendix B). The final prompt required competencies to be grouped by domain and accompanied by in-file citations specifying their source. This structured prompting approach was designed to support consistent synthesis while preserving transparency and traceability between the synthesized competencies and the underlying literature. The final prompt used for synthesis was as follows:

Extract and synthesize all competency statements from this CSV file that describe what students should be able to do upon graduation in Planetary Health education.

Output format:

- Group results by competency domain (e.g., Systems Thinking, Advocacy, Ethics).
- Under each domain, list 2–4 action-oriented learning outcomes in plain language (starting with verbs like “analyze,” “advocate,” “apply,” “collaborate,” etc.).
- After each bullet, include an in-file citation in the format [Title, Row # or line #].

Source constraint:

- Use only text found in the columns Reasoning, Key_Topics, or Abstract in this file — do not draw from external knowledge.

Goal: Produce a concise Planetary Health competency framework reflecting what students should be able to do (skills, behaviors, applied knowledge), not just know.

Because screening outputs included model-generated summaries (e.g., Reasoning/Key_Topics), the synthesis reflects both extracted source text and structured screening annotations; in-file citations allow traceability to screened records, but not always verbatim passages.

Results

To assess the stability of these results, we generated outputs using two large language models (OpenAI’s ChatGPT 5.1 and Claude Sonnet 4.5) with identical inputs and constraints. We compared the results from each model (full comparison table and output in Appendix C) and found that the results mirrored each other, even if worded and organized differently. The resulting synthesis is shown in Table 2 below.

Table 2: Planetary Health Competency Domains

Domain	Core Competency Statement
1 Earth Systems Knowledge	Explain how Earth systems and planetary boundaries affect health
2 Clinical Assessment & Management	Assess and manage climate- and environment-related health risks
3 Systems Thinking	Apply systems thinking and complexity to health–environment problems
4 Sustainable Healthcare	Practice and improve sustainable, low-carbon, resilient healthcare
5 Communication	Communicate and counsel effectively on Planetary Health
6 Advocacy & Leadership	Advocate and lead for policy, justice, and systems change
7 Equity & Justice	Address environmental justice and inequity
8 Interdisciplinary Collaboration	Collaborate across disciplines and sectors
9 Research & Evidence	Use evidence and critical appraisal to guide action
10 Ethics & Reflexivity	Exercise eco-ethical reasoning and planetary citizenship
11 Food Systems	Engage with food systems and sustainable nutrition
12 Education & Implementation	Design, implement, and evaluate Planetary Health initiatives

To measure the quality of the output from the generative AI tools, we compared the results from the AI-Assisted Review and Synthesis process to a compilation of human-curated competencies from: Conceptual Frameworks Competencies Contents and Teaching Methods in Planetary Health Education; Canadian Federation of Medical Students Task Force (CFMS HEART) Planetary Health Competencies; University of Toronto Planetary Health Competencies; CUGH Planetary Health Competencies; and Johns Hopkins University’s Institute of Planetary Health.

Although the results were largely similar, several items appeared in the human-curated table that did not appear in ours. Most of these stemmed from differences in how we defined competencies. The competencies in the human-curated table included items that we would define more accurately as learning objectives, compared to skills/dispositions/capacities. Examples of this are “articulating,” “explaining,” and “discussing” specific Planetary Health related topics. See Appendix D for a comparison of our approach and a synthesis of these human approaches.

Discussion

Interpretation of Competency Overlap and Gaps

There were many similarities between the expert-curated list and the output from our AI-Assisted Review and Synthesis. Systems Thinking, Sustainable Healthcare, and Clinical Risk Management appeared in both results, confirming that the AI-produced results manifest a degree of alignment with what humans believe these competencies to be. On the one hand, this convergence may seem almost tautological — the AI-Assisted Review and Synthesis pulls from these sources. On the other hand, one might easily hypothesize that as the most prominent scholars in Planetary Health education meet at conferences, collaborate on research, and publish articles that are reviewed and read by other members of this group, a narrow consensus might emerge that overlooks some research traditions, the thinking of scholars who teach in less prominent programs, and

approaches to Planetary Health embraced by certain cultures. In this case, the broader approach we used might yield results that look quite different from prominent human-generated lists. Our results suggest that despite geographic and institutional differences, there is a largely unified understanding of what a competent 21st-century clinician should be able to do as a result of exposure to Planetary Health education.

Many of the critical differences emerged in the specifics. We found broad agreement on the domains (e.g., “Infectious Disease”), but more variation in the depth of specific clinical knowledge. Expert-curated lists emphasize highly specific pathogens (e.g., *Vibrio*, *Salmonella*) and localized air pollutants (e.g., PM2.5 from wildfires vs. cookstoves). By contrast, our framework does not prescribe specific content objectives; rather, the domains are intended as a starting point for curriculum development at a given institution. This distinction reflects a deliberate design goal: a globally applicable framework is well-suited for institutional buy-in, but to be clinically useful, competencies must ultimately be translated from environmental literacy — knowing about the problem — to clinical utility — knowing what to do when the patient is in front of you. That translation is necessarily local, and appropriately falls to the implementing institution.

It is also worth noting that our choice to capture dispositions in addition to more classically defined “competencies” was also reflected by the human lists. The expert lists’ emphasis on “appreciating” Indigenous knowledge and “internalizing” eco-ethics suggests that Planetary Health is not just a set of skills to be added to a checklist, but a foundational shift in professional identity. If curricula focus solely on the “doing” (the competencies) and ignore the “being” (the dispositions), we risk producing graduates who have the technical skills to manage a crisis but lack the ethical resilience to lead through it. Thus, we suspect it will remain important for future scholars examining competencies to also consider important Planetary Health dispositions.

Finally, the consistent appearance of environmental justice and Indigenous knowledge across all frameworks marks a definitive characteristic of the field. Justice is no longer a “special interest” topic; it is a core structural competency for Planetary Health education to infuse into their programs.

AI-Assisted Research Synthesis

One aspiration of this work was to provide future researchers with a specific process for how to use generative AI to assist with a rapid research synthesis.

The review process typically requires many resources, mostly in the form of time and energy. Researchers need to synchronize the coding of literature, development of inclusion/exclusion criteria, conduct literature searches, and synthesize the found information. In our generative AI-based procedure, we shortened the process by utilizing the LLM’s ability to parse text and create syntheses based on patterns in the resulting data. Our process saved the labor-hours required to sift through documents and determine which should be included or excluded.

An alternative and faster method to attain these competencies might have been to simply ask the LLM for the desired output without needing to do any literature search; after all, LLMs are trained on a vast amount of literature, and one can assume that this includes text on Planetary Health competencies. However, due to the nature of the design of LLMs, we cannot know for certain which documents have been used in its pre-training, nor can we control the nature of the outputs with such a broad prompt.

For example, two researchers using the same prompt on a general purpose LLM will receive different results, directly undermining the reproducibility and validity of the outputs. LLMs are also optimized to produce fluent, coherent responses rather than verified ones — a design that can yield confidently stated but unsupported claims (Bender et al., 2021; Ji et al., 2023). Furthermore, general purpose LLMs have a training data cutoff, and there is no way to inspect what literature was or was not included in pre-training. Taken together, these limitations mean that a framework derived from a direct LLM prompt has no documentable evidence base — no corpus to inspect, no inclusion criteria to scrutinize, and no way for readers, reviewers, or institutions to evaluate what the output actually reflects. Our approach, by contrast, grounds the synthesis in a bounded, documentable set of sources that can be reviewed, challenged, and updated as the literature evolves.

We believed that finding tangible and robust literature that we could actually reference, instead of relying on the LLM’s pre-trained data, was critical in developing this process. This supports our choice to use a document-by-document analysis procedure, which a chatbot (such as ChatGPT or Claude) cannot reliably do on its own without writing custom code that calls on the LLM’s API. This document-by-document approach ensures that each screening decision is made against the full text of a known, retrievable source, rather than against an unspecified amalgam of pre-training data. Our approach also has the benefit of producing a complete audit trail of inclusion decisions, model outputs, and reasoning that can be inspected, challenged, and replicated by other researchers.

Additionally, while the competencies identified in this review represent a convergent set of domains, programs’ choices about how to teach the competencies to students will necessarily vary across institutions, professions, and contexts. Appendix E illustrates example ways educators and program leaders may use AI-assisted approaches to extend and contextualize these competencies in alignment with local missions, populations, and curricular structures. Those seeking to replicate the procedure detailed in this paper could potentially use the values of their organization to further iterate on the results, or tailor the competencies of a specific profession within the Planetary Health domain. We listed more example extensions in Appendix E.

We hope our findings prompt further thought on how systematic reviews can be completed in the future with the help of AI. We do not advocate for using AI to replace scientific thought and research, but rather to be utilized as a supportive tool to reduce the time it takes to review and synthesize articles.

Limitations

This study has several limitations. First, there was no direct mechanism to verify the extent to which AI-generated outputs reflected specific passages from the included literature beyond source-constrained prompting and in-file citation requirements. Additionally, although a maximum context window of 50,000 tokens was specified for the inclusion/exclusion screening process, the proportion of each PDF or HTML document effectively processed by the model could not be precisely measured.

Additionally, while the search strategy was designed to be robust, the findings are bounded by the scope of accessible literature and likely underrepresent competencies emphasized in non-English publications or informal educational contexts. This is a meaningful limitation given that the majority of existing planetary health education frameworks originate from high-income, English-speaking countries (Carrion et al., 2025). However, the procedural strength of this approach is that it is repeatable: as the planetary health education literature expands across disciplines, languages, and educational levels, future researchers can apply the same methodology to an updated corpus and produce a revised competency framework that reflects that growth. Search criteria should be adjusted accordingly. For instance, the criteria could be broadened to include younger learners or non-health disciplines as planetary health education matures beyond health professions contexts.

Finally, although the AI-assisted synthesis captured broad competency domains consistently, it tended to produce less granular or context-specific competencies than those articulated in human-curated frameworks. As a result, highly detailed competencies related to specific health impacts or populations may be underrepresented in the AI-generated results.

Taken together, these findings suggest that AI-assisted review and synthesis can meaningfully support competency identification in rapidly evolving fields when paired with explicit constraints and human oversight. While this approach does not replace the interpretive labor central to systematic reviews, it offers a scalable complement that may be particularly useful in contexts where fields are emerging, literatures are diffuse, and timely synthesis is essential. As generative models and scholarly practices continue to co-evolve, approaches such as the AI-assisted Review and Synthesis process invite further exploration of how human judgment and computational tools can be productively integrated.

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Appendix A: Claude’s Candidate Search Queries

Option 1: Add education focus

```
"planetary health" AND ("competencies" OR "learning objectives" OR "learning outcomes")  
AND (education OR curriculum OR training OR "health professions")
```

Option 2: Require competencies AND education terms

```
"planetary health" AND (competencies OR "learning objectives" OR "learning outcomes")  
AND (curriculum OR "medical education" OR "nursing education" OR "health professions education")
```

Option 3: Most restrictive (recommended)

```
"planetary health" AND competenc* AND (curriculum OR education OR training)  
AND ("health professions" OR medical OR nursing OR "public health")
```

Option 4: Use framework language

```
"planetary health" AND ("competency framework" OR "learning objectives"  
OR "educational framework" OR "curriculum development")
```

Option 5: Exclude broad terms

```
"planetary health" AND (competenc* OR "learning objectives") AND (curriculum OR education) NOT (policy
```

The key changes in Option 3:

- Used `competenc*` (wildcard) to catch competency/competencies/competence
- Required education-related terms (forces focus on educational context)
- Specified health professions to exclude general environmental education

Appendix B: Refined Synthesis Prompt

The original prompt submitted to Claude was: “Can you extract from this list the competencies (things students should be able to DO upon graduation) you think any good planetary health program should have and cite where you got that info in this file? Don’t go external for this, just the file.”

The refined prompt used for final synthesis:

Extract and synthesize all competency statements from this CSV file that describe what students should be able to do upon graduation in Planetary Health education.

Output format:

- Group results by competency domain (e.g., Systems Thinking, Advocacy, Ethics).
- Under each domain, list 2–4 action-oriented learning outcomes in plain language (starting with verbs like “analyze,” “advocate,” “apply,” “collaborate,” etc.).
- After each bullet, include an in-file citation in the format [Title, Row # or line #].

Source constraint:

- Use only text found in the columns *Reasoning*, *Key_Topics*, or *Abstract* in this file — do not draw from external knowledge.

Goal: Produce a concise Planetary Health competency framework reflecting what students should be able to *do* (skills, behaviors, applied knowledge), not just know.

Appendix C: Cross-Model Comparison (ChatGPT 5.1 vs. Claude Sonnet 4.5)

Table C1: High-Frequency Competencies Across Models

High-Frequency Competency	ChatGPT 5.1	Claude 4.5
Systems thinking	Yes (explicit domain)	Yes (core competency #1)
Climate-sensitive clinical care	Yes (Domain 2)	Yes (Domain 1)
Sustainable healthcare	Yes (Domain 4)	Yes (Domain 1)
Advocacy & policy	Yes (Domain 6)	Yes (Domain 3)
Interprofessional collaboration	Yes (Domain 8)	Yes (Domain 4)
Communication	Yes (Domain 5)	Yes (Domain 4)
Equity & justice	Yes (Domain 7)	Yes (Domain 6)
Research/evidence	Yes (Domain 9)	Yes (Domain 5)

ChatGPT 5.1 Full Output

1. Explain how Earth systems and planetary boundaries affect health

Graduates should be able to:

- Describe major Earth system changes (climate change, biodiversity loss, pollution, land use, etc.) and explain how they affect human health.
- Use the planetary boundaries / Anthropocene / One Health concepts to make sense of health risks in specific contexts.

Supported by: Planetary health learning objectives: foundational knowledge for global health education in an era of climate change; CUGH develops planetary health learning objectives; The Planetary Health Education Framework; Population and planetary health.

2. Assess and manage climate- and environment-related health risks

Graduates should be able to:

- Assess environmental and climate-related exposures and risks for individuals and populations (e.g., heat, air pollution, vector-borne disease, disasters)
- Integrate climate/planetary risks into history taking, diagnosis, prevention, and management, including mental health impacts.
- Plan and manage disaster preparedness, response, and adaptation in clinical/public health settings.

3. Apply systems thinking and complexity to health–environment problems

Graduates should be able to:

- Use systems thinking / complexity-based approaches to map feedbacks between environment, social structures, and health.
- Frame problems and solutions at multiple levels (individual–community–system–planet) and anticipate unintended consequences.

4. Practice and improve sustainable, low-carbon, and resilient healthcare

Graduates should be able to:

- Measure and reduce the environmental footprint of healthcare (energy, travel, pharmaceuticals, waste, procurement).
- Design and implement quality improvement projects for sustainable healthcare in their setting.
- Integrate climate resilience into service planning (e.g., for extreme weather, supply disruptions).

5. Communicate and counsel effectively on climate and planetary health

Graduates should be able to:

- Provide climate-sensitive health counseling (e.g., pediatrics, chronic disease management, mental health).
- Explain risks and co-benefits (e.g., active transport, healthy diets) to patients, communities, and decision-makers in accessible language.
- Use digital and educational tools to teach others about planetary health.

6. Advocate and lead for policy, justice, and systems change

Graduates should be able to:

- Advocate for policies and institutional changes that promote climate mitigation, adaptation, and environmental justice.
- Lead or support change processes in health systems, communities, and professional organizations.
- Frame issues around climate justice, human rights, and environmental ethics and use these to guide decisions.

7. Address equity, environmental justice, and Indigenous/local knowledges

Graduates should be able to:

- Identify and respond to environmental injustice, environmental racism, and inequitable climate impacts on vulnerable groups.
- Integrate social and environmental determinants of health, including colonial and structural drivers.
- Work respectfully with Indigenous and land-informed ways of knowing and local communities.

8. Collaborate across disciplines, sectors, and cultures

Graduates should be able to:

- Work effectively in interprofessional and transdisciplinary teams (health, environment, engineering, policy, community orgs, youth, etc.).
- Co-design interventions and curricula with students, communities, and other stakeholders.
- Lead or participate in partnerships and networks for planetary health.

9. Use evidence, research, and critical appraisal to guide action

Graduates should be able to:

- Critically appraise planetary-health-relevant evidence (epidemiology, environmental science, social science) and apply it to practice and policy.
- Conduct or contribute to research/evaluation on climate and planetary health interventions, curricula, and policies.
- Use data for risk assessment and monitoring (e.g., health impacts, adaptation outcomes).

10. Exercise eco-ethical reasoning, critical reflexivity, and planetary citizenship

Graduates should be able to:

- Reflect on their own values, positionality, and professional responsibility in the ecological crisis.

- Apply environmental ethics, human rights, and climate justice principles in clinical, public health, and policy decisions.
- Demonstrate resilience, self-care, and adaptive capacity while engaging in planetary health work.

11. Engage with food systems, nutrition, and planetary health diets

Graduates should be able to:

- Explain how food systems and dietary patterns affect both human and planetary health.
- Advise individuals and communities on sustainable, healthy diets (e.g., planetary health diet), including practical culinary skills where relevant.
- Analyze global food systems and propose changes that produce co-benefits for people and planet.

12. Design, implement, and evaluate planetary health education and initiatives

Graduates should be able to:

- Design and deliver educational sessions, curricula, or community projects on planetary health (including digital formats).
- Plan and evaluate local sustainability or climate-adaptation projects in their institution or community.
- Contribute to institutional initiatives (report cards, curricula reviews, microcredentials).

Claude Sonnet 4.5 Full Output

1. Clinical Practice & Patient Care

Apply climate-sensitive health counseling in clinical encounters

- Counsel patients on climate-related health risks and adaptation measures
- Manage climate-related health conditions (heat illness, vector-borne diseases, respiratory impacts)
- Recognize environmental exposures as determinants of health

Implement sustainable healthcare practices

- Reduce the environmental footprint of clinical care
- Choose lower-carbon treatment options when clinically appropriate
- Apply sustainable prescribing and resource stewardship

2. Systems Thinking & Analysis

Analyze health-environment connections using systems approaches

- Apply complexity-based thinking to planetary health challenges
- Understand feedback loops between ecological and health systems
- Recognize cascading effects of environmental change on population health

Assess vulnerability, risk, and resilience in populations

- Identify populations at heightened risk from environmental health threats
- Evaluate community resilience and adaptive capacity
- Apply environmental epidemiology principles

3. Advocacy & Policy

Advocate for environmental health policies at multiple levels

- Engage in health advocacy related to climate and environment

- Communicate with policymakers about health-environment linkages
- Support climate-resilient health systems development

Lead and participate in transformative change processes

- Initiate sustainability improvements in healthcare settings
- Demonstrate leadership in climate mitigation and adaptation initiatives
- Serve as change agents within health systems

4. Collaboration & Communication

Collaborate across disciplines on environmental health issues

- Work effectively in interprofessional teams addressing planetary health
- Engage with non-health sectors (environment, agriculture, urban planning)
- Apply One Health approaches integrating human, animal, and environmental health

Communicate effectively about planetary health

- Explain health-environment connections to diverse audiences
- Educate patients and communities about climate health risks
- Translate scientific evidence into actionable health guidance

5. Knowledge Application & Research

Apply foundational planetary health knowledge

- Understand Earth system science and planetary boundaries
- Explain mechanisms linking environmental change to health outcomes
- Integrate ecological determinants into health assessments

Conduct or apply research in planetary health

- Use evidence-based approaches to planetary health problems
- Evaluate interventions for climate adaptation and mitigation
- Contribute to the evidence base on health-environment connections

6. Equity & Justice

Address environmental justice and health equity

- Recognize disproportionate environmental health burdens on marginalized populations
- Apply equity lenses to climate adaptation planning
- Incorporate Indigenous knowledge and perspectives

7. Emergency Preparedness & Response

Prepare for and respond to climate-related health emergencies

- Plan for extreme weather events and climate disasters
- Mobilize resources for disaster response
- Implement culturally appropriate interventions during emergencies

Summary: The “Must-Have” Competencies

If distilled to the most essential competencies appearing with highest frequency and strongest consensus across sources:

1. Apply systems thinking to analyze health-environment interactions
2. Deliver climate-sensitive clinical care including patient counseling
3. Implement sustainable healthcare practices to reduce environmental impact
4. Collaborate interprofessionally on planetary health challenges
5. Advocate for policy change at institutional and governmental levels
6. Communicate effectively about planetary health to diverse audiences

Appendix D: Comparison of AI-Assisted and Human-Curated Competencies

Table D1: Comparisons

Domain	Subdomain	Expert Table	AI Results
Domain 1: Systems Thinking & Interconnectedness		Analyze life cycle impacts of human actions on environment/climate with understanding of historical/current social, political, economic systems	Not explicitly identified
		Communicate urgency of climate change and need for evidence-based policies	Domain 5
		Understand who most vulnerable populations are and why	Equity & Justice
		Appreciate strength of Indigenous knowledge	Equity & Justice
Domain 2: Managing & Preventing Health Impacts	A. Food & Water Insecurity	Explain how climate change/ecosystem degradation leads to food insecurity, nutrition impacts (with specific links to refugee health, social determinants, Indigenous health, poverty)	Food systems competency identified (ChatGPT #11)
		Explain how large-scale agriculture, monocrops, fertilizers/pesticides contribute to soil degradation and water pollution	NOT explicitly identified
		Discuss regenerative farming and ecosystem restoration for diverse diets, food sovereignty, climate resilience	NOT explicitly identified
		Articulate water supply stresses from extreme weather (drought/floods) reducing freshwater quality/quantity	NOT explicitly identified as separate competency

Domain	Subdomain	Expert Table	AI Results
	B. Changing Infectious Disease Burdens	Explain how climate change contributes to emergence/spread of vector-borne diseases	Climate-related health risks (ChatGPT #2, Claude #1)
		Illustrate how rising temperatures, heavy rain, flooding, drought impact food/water-borne infections (specific pathogens: Vibrio cholera, Campylobacter, E. coli, Salmonella, norovirus, B. cereus)	General infectious disease mentioned; specific pathogens NOT identified
	C. Air Pollution & Health	Describe how air pollution (household/indoor and ambient/outdoor) causes deaths, linked to specific cardiorespiratory diseases (atherosclerosis, hypertension, CAD, CHF, arrhythmias, MI, asthma, COPD, lung cancer)	Air pollution NOT identified as separate competency
	D. Mental Health	Explain how climate-related extreme weather events result in PTSD, anxiety, depression	NOT explicitly identified
		Illustrate link between climate anxiety/eco-anxiety and increased mental health service use	General mental health mentioned; eco-anxiety NOT specifically identified
		Highlight how Indigenous communities' mental health tied to land/resource extraction and habitat degradation	NOT explicitly identified
Domain 3: Advancing Planetary Health Justice	A. Environmental Justice & Marginalized Populations	Articulate that environmental racism disproportionately subjects BIPOC communities to pollution/toxins and undermines their capacity to oppose politically/legally	Environmental justice & racism identified (ChatGPT #7)
		Describe how Indigenous communities disproportionately experience burden of industrial developments, exposure to water contamination, waste disposal, toxins	Indigenous communities & environmental burden identified
		Explain colonial policies of cultural genocide resulted in limited access to economic, social, cultural activities critical for Indigenous health	Colonialism mentioned generally; specific policy impacts NOT identified
	B. Indigenous Knowledge & Leadership	Integrate Western and Indigenous knowledge systems — systems-oriented, ecological, contextual, holistic, non-linear, relational, valuing observation	Indigenous knowledge integration identified

Domain	Subdomain	Expert Table	AI Results
		Explain how traditional/Indigenous knowledges are interconnected with nature to address planetary health disruptions	Identified in justice/equity competency
Domain 4: Leading & Collaborating on Mitigation/Adaptation		Emphasis on collaboration across multiple disciplines	Leadership, advocacy, collaboration all identified

Appendix E: Extension Prompts for Institutional Tailoring

Table E1: AI-Assisted Prompts for Contextualizing Competencies

Extension Goal	Input Provided by Institution	Example AI-Assisted Prompt	Intended Outcome
Align competencies with institutional mission	Institutional mission statement, values, and strategic priorities	<i>"Given this institution's mission statement, how might the following planetary health competencies be framed to align with its stated goals?"</i>	Mission-aligned competency language suitable for curriculum documents
Tailor competencies to a specific profession	Professional role (e.g., nursing, medicine, public health), scope of practice	<i>"Adapt these planetary health competencies for relevance to undergraduate nursing education, focusing on clinical and community contexts."</i>	Profession-specific competency interpretations
Localize competencies to regional context	Geographic region, population characteristics, dominant health challenges	<i>"How might these planetary health competencies be contextualized for a program serving rural Appalachian communities?"</i>	Context-sensitive competency framing
Map competencies to existing curricula	Course titles, learning objectives, syllabi	<i>"Map these planetary health competencies onto the following course sequence and identify areas of alignment or gaps."</i>	Curriculum gap analysis and integration planning
Translate competencies into learning outcomes	Selected competency domain(s)	<i>"Translate the following planetary health competencies into measurable learning outcomes for a graduate-level course."</i>	Actionable learning outcomes
Support faculty development	Faculty roles, teaching responsibilities	<i>"How could faculty development workshops be designed to support instructors in teaching these planetary health competencies?"</i>	Faculty-facing implementation strategies
Facilitate stakeholder communication	Audience type (students, administrators, accrediting bodies)	<i>"Reframe these planetary health competencies for communication to healthcare administrators unfamiliar with planetary health."</i>	Audience-appropriate competency framing