A Health Professions Curriculum on Sustainable Healthcare Education:

Dentistry, Medicine, Nursing, and Pharmacy

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Executive Summary

This report proposes a curriculum in sustainable healthcare education (SHE) for the health professions schools of medicine, nursing, pharmacy, and dentistry. Described by the Sustainable Healthcare Education Network, SHE is education about the impact of climate change, ecosystem alterations, and biodiversity loss on health as well as the impact of the health care industry on the aforementioned.[1,2] Nomenclature related to SHE has included "environmental sustainability",[3] "ecosystems and health",[4] "ecosystem health",[5] "climate change environment degradation, biodiversity and health",[6] and "environmental accountability".[7]

The curriculum was developed according to the framework proposed by Kern[8] and followed these steps: (1) problem identification and general needs assessment, (2) needs assessment for targeted learners, (3) goals and objectives, (4) educational strategies, (5) implementation, (6) evaluation and feedback, and (7) curriculum maintenance and enhancement. This project focused on steps 2, 3, and 4. Work to date on step 1 has been accomplished in the literature. [1,2] Steps 5 and 6 point to future directions in this area.

Methods used to develop this report included interviews with expert faculty and students across the professions, a Delphi process,[9] a comprehensive literature search, and examination of existing books and articles addressing SHE in the health professions.[2,4,10–14] Description of the methods are available upon request from the first author.

A systematically developed curriculum devoted to SHE will provide health professionals with the necessary awareness, knowledge, and skills to care for patients who experience the impact of climate and environment on health and advocate for the sustainability of the health systems in which they work. This report describes a shared curriculum for all health professions schools and when relevant, discusses individualized curricula for each profession. The report is a guide for those interested in designing and developing teaching material or courses on SHE. Although the original intent of the curriculum design was to focus on climate change, sustainability, and health, during the participant interviews the overlap between climate change and environmental health was underscore. Therefore the report prioritizes curriculum on climate change while also including exemplars from environmental health. The report is organized into the following parts.

1. Comprehensive list of SHE objectives from which educators can select/modify objectives that represent what they intend to teach
2. Recommended timing and curricular location/areas in which SHE objectives can be introduced including representative examples
3. Educational strategies most useful for teaching a range of topics in SHE
4. A list of recommended local, community, and institutional partnerships, description of the partner, and examples to educate for SHE within the context of local and community partnerships..
5. Existing SHE resources for health professions students and educators for learning and/or teaching materials.

Background and Significance

The human impact on earth extends over a vast majority of the planet, with it bringing pressure on the planet's resources, as well as consequences for climate and disease.[15,16] Given the wasteful, high ecofootprint healthcare system which has yet to fully embrace a culture of sustainability,[17] healthcare professionals must acknowledge the connection between climate change, environmental sustainability and health to drive the culture of health and healthcare towards greater ecological responsibility, and subsequently improve patient and population health.[18]

Currently, little SHE content exists within health professions curricula nationally.[6] In response to a charge by the General Medical Council in the United Kingdom, the Sustainable Health Care Education Network developed and refined priority learning objectives through a multi-stage process of consultation with experts.[2] Meant to provide a representative set of objectives to guide both undergraduate and graduate medical education in SHE, the Sustainable Health Care Education Network grouped the objectives into three priority learning areas:

1. Describe how the environment and human health interact at different levels.
2. Demonstrate the knowledge and skills needed to improve environmental sustainability of health systems.
3. Discuss how the duty of a physician to protect and promote health is influenced by the dependence of human health on the local and global environment.

Medicine and nursing have developed key SHE learning objectives.[2,9,19] However not all health professions have developed core objectives, and there is little data on which objectives should be taught how and when. The goal of this project was to design a SHE curriculum for the health professions of dentistry, medicine, nursing, and pharmacy. Built on the framework of social accountability and the Kern model[8] for curriculum development, the project's specific aims were:
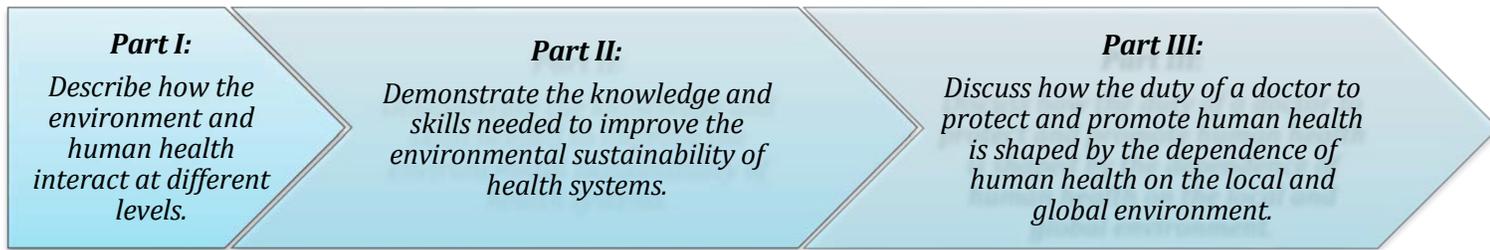
1. To identify a core set of learning objectives on the impact of environmental sustainability and health.
2. To determine the timing and location during the educational trajectory in which individual objectives should be introduced and the optimal educational methods for teaching each objective.

Learning Objectives

This section describes core objectives for SHE training in the educational continuum (undergraduate through post-graduate) of dentistry, medicine, nursing, and pharmacy. The objectives are described by priority area, objectives, and sub-objectives.

The priority areas and objectives were developed primarily by the Sustainable Healthcare Education Network in the United Kingdom[2] and secondly through a Delphi study conducted by UCSF researchers.[9] The objectives were elaborated upon through sub-objectives identified during interviews of faculty and students, and in consultation with key articles and texts addressing SHE. Objectives and sub-objectives with relevance to all health professions are listed below. The sub-objectives are meant to be representative and not comprehensive. References in parenthesis refer to the following: (1) SHE – indicates an objective already defined by the SHE Network.[2] (2) UCSF – indicates an objective already defined through earlier work at UCSF,[9] and (3) Profession name listed - when individual professions noted an objective was particularly important to their training.

Core Objectives

Part I:	Part II:	Part III:
Describe how the environment and human health interact at different levels.	Demonstrate the knowledge and skills needed to improve the environmental sustainability of health systems.	Discuss how the duty of a doctor to protect and promote human health is shaped by the dependence of human health on the local and global environment.

Part 1: Describe how the environment and human health interact at different levels

1. Outline the dependence of human health on global and local ecological systems, which supply essentials such as air, water and a stable climate. **(SHE)**
2. Discuss the contribution of human activity and population size to global environmental changes such as climate change, biodiversity loss and resource depletion. **(SHE)**
3. Describe the mechanisms by which human health is affected by environmental change, for example through changes in disease vectors, exposure to extreme weather (eg. extreme heat or droughts), migration and reduced food security. **(SHE)**
   - Describe the effects of climate change on health both at the individual and population level
   - Appreciate the impact of climate change on geographic spread of vector-born infectious diseases locally and globally including malaria, West Nile, Zika, and Lyme
   - Examine the effect of climate change on air pollution and how that influences prevalence and pathogenesis of chronic cardiovascular and respiratory disease

- Diagram the link between climate change and threats to food security, comparing the resilience of different agriculture and food production processes in counteracting these threats

4. Explain the concept of environmental justice and the core principles for addressing it. **(UCSF)**

5. Describe features of a health-promoting local environment, in community and healthcare settings, to include access to green spaces, clean air and an active travel infrastructure. **(SHE)**

6. Discuss medical, ethical, legal, and economic factors in caring for patients with environmental disease. (UCSF)

Part 2: Demonstrate the knowledge and skills needed to improve the environmental sustainability of health systems

1. Define environmental sustainability. **(SHE)**

2. Take a focused and detailed environmental history. **(UCSF)**

3. Identify patients most vulnerable to climate change and advise them accordingly. **(UCSF)**
   - Counsel patients on health effects of climate change
   - Communicate with patients on issues of environmental health exposures (e.g. discussing mercury in dental fillings and whether that poses a risk to health) **(DENTISTRY, MEDICINE, NURSING)**
   - Practice motivational interviewing to help patients engage in sustainable healthy behaviors
   - Explain to patients how to properly dispose of medications

4. Diagnose, treat, and/or prevent adverse health effects to attributable to global climate change or environmental causes (e.g. illness from extreme weather conditions, disease vectors, inspired air pollutants in particular ozone, particulate matter, and/or ingested pollutants from food or water). **(UCSF)**
   - Explain impact of climate change on soil, water, and air pollution and identify their effects on human health and development
   - Recognize clinical signs and symptoms of health effects of climate change and related environmental exposures
   - Demonstrate how to treat the health impacts (both direct and indirect e.g. via environmental harm) of heavy metals and chemicals used in medical and dental procedures.
   - Assess impact of climate change and environmental factors on health of the local community
   - Discern between myths and evidence-supported facts on environmental health impacts and be able to discuss with patients

5. Explain how trends in demographics, technology, climate, and resource availability may affect our ability to provide healthcare into the future. **(SHE)**
   - Participate in disaster preparedness training (e.g. in relation to climate events, to fill prescriptions when electronic systems are down)

6. Identify potential synergies between policies and practices that promote environmental sustainability and those that promote health. **(SHE)**

- Describe how sustainability aligns with preventative healthcare and health maintenance
- Explore how sustainable practices can improve our own health as learners and practitioners
- Partner with community leaders to address climate and environmental factors that affect health, promote sustainable practice (and consequently health benefits) in as well as outside of healthcare systems (e.g. community pharmacies)
- Partner with other health professionals to get the information needed to treat illness from climate and environmental exposures

7. Identify ways to improve the environmental sustainability of health systems - in individual practice, in health service management, and in the design of care systems. **(SHE)**
    - Weigh the health risks (both direct and indirect e.g. via environmental harm) of heavy metals and chemicals used in medical and dental procedures
    - Define system sciences and utilize it as lens with which to evaluate relationships between environment and health **(DENTISTRY)**
    - Identify areas in pharmaceutical production and procurement where sustainability could be encouraged and incentivized **(PHARMACY)**
    - Question and challenge unsustainable health care practices
    - Approach health practices with innovation- questioning traditional ways of doing things
    - Innovate with peers to find solutions to waste issues at all levels of medical care
    - Identify trustworthy sources to evaluate and compare environmental impacts, adverse health impacts, benefits, and indications between different ubiquitous chemicals and other environmental hazards present in health care materials

8. Describe, with examples, the different types of environmental impact resulting from healthcare provision, and how these may be measured. **(SHE)**
    - Evaluate environmental impacts of materials used in healthcare on climate change, groundwater, soil, and air
    - Understand contamination of groundwater by drugs: mechanisms, prevention, and treatment **(PHARMACY)**
    - Examine the byproducts of pharmaceutical production, including solid waste, hazardous chemical waste, and water and energy use
    - Trace life cycles of products such as pharmaceuticals, dental materials, following them through supply chains to health centers and then into the waste system. **(DENTISTRY, PHARMACY)**
    - Demonstrate how to handle acute chemical exposures and proper disposal of hazardous or chemical materials
    - Quantify environmental costs and waste in procedures (eg. dental) by procedure type
   - Appraise the financial burden of climate change on health

- Discuss antibiotic use in livestock and spread of superbugs, cross-resistance and ethics of antibiotic stewardship
- Evaluate their work environment for level of sustainability

Part 3: Discuss how the duty of a doctor to protect and promote health is shaped by the dependence of human health on the local and global environment.

1. Explain how the health impacts of environmental change are distributed unequally within and between populations, and the disparity between those most responsible and those most affected by change. **(SHE)**
   - Describe how extreme climate and environmental exposures disproportionately affect vulnerable populations
   - Explore how someone's environment can interfere with their health and treatment and the role environment and climate change plays in social determinants of health
2. Recognize, as a health professional, personal values concerning environmental sustainability and role as an expert and advocate, given the relationship between the environment and the health of current and future generations. **(SHE)**
   - Approach the role of the health professional as "a source of truth"
   - Understand, develop and improve policy related to climate change, sustainable practice, and health
   - Compare and contrast effectiveness of different advocacy techniques such as activism, advertising, education, and lobbying
3. Discuss ethical tensions between allocating resources to individual patients and protecting the environment upon which the health of the wider community depends. **(SHE)**
   - Observe waste created in hospitals and consider the factors such as infectious disease prevention that drive healthcare institutions towards single-use, disposable items (i.e. hospital gowns, bubble packs, gloves)

Elective Objectives

During interviews faculty and students in the professions listed the following additional objectives that may be taught in a core or elective setting.
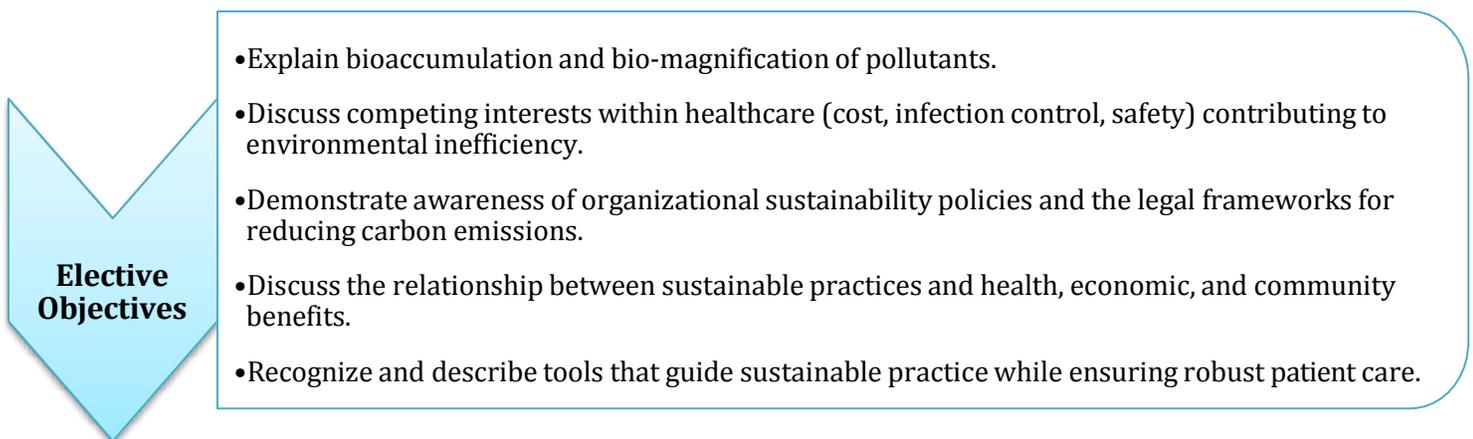
Elective Objectives

- Explain bioaccumulation and bio-magnification of pollutants.
- Discuss competing interests within healthcare (cost, infection control, safety) contributing to environmental inefficiency.
- Demonstrate awareness of organizational sustainability policies and the legal frameworks for reducing carbon emissions.
- Discuss the relationship between sustainable practices and health, economic, and community benefits.
- Recognize and describe tools that guide sustainable practice while ensuring robust patient care.

Timing and Location in the Curriculum

Respondents (faculty and students) recommended that SHE be taught <u>throughout health professions training in an iterative and integrated manner</u>, introducing it <u>early on</u> in professions school and continuing through post graduate training. Early introduction would emphasize the importance of SHE content to being a health professional and ensure its considered core to professional identity formation. Emphasis on SHE during post-graduate training and continuing professional education allows for education of individuals in practice who may have limited awareness or education in this area.

Respondents suggested many areas in which SHE content could be <u>integrated</u>. SHE could be woven into teaching about global health, population health, environmental and occupational health, infectious disease cancer, human development, organ systems (for the schools' with an organs-based curriculum), social determinants of health, evidence-based medicine, epidemiology, and ethics. Recommendations focused on including climate, ecosystems and health within the focus of courses that cover inquiry into the cutting edge and unknowns of science where more research is needed.

Figure 1 includes examples of specific course areas and years in education during which faculty and students suggested SHE content be introduced for medicine, pharmacy and dentistry. Table 1 provides a curriculum mapping example for including content on environmental health in specific course areas in nursing education.

Figure 1: Examples of Location of SHE Curriculum for Different Health Professions

Medicine	Pharmacy	Dentistry
• Policy curriculum in which trade off and cost benefit (as well as competing interest within health care) are discussed. • Include in primary care disciplines and in community health experiences thorough discussions of mechanisms by which environmental change affects human health. • Start in the basic sciences early on and interweave SHE throughout medical curriculum.	• Integrate within a health policy course and discussing in relation to the financial of health care and changing health care policy. • Business case for environmentally sustainable practices (should result in cost containment, rather than cost inflation). • Integrate in community pharmacy and supply chain management, procurement. Warming climate will change state of drugs; address the practice of waste here.	• Introduction to dentistry, early on in the first year of professions school. Reinforce early on so it sets the stage for becoming a dentist. • Core teaching about dental materials which addresses myths/ truths about chemicals and waste involved in production of materials • When you suction a mercury filling, where does the material go? • How does it impact our water supply?

Respondents suggested incorporating this SHE in education about <u>health care delivery</u>, including analysis of systems and consideration of waste and cost. For example, in pharmacy, this teaching should occur when learners are introduced to supply chain management and procurement. In dentistry, discussion of dental materials should begin to address the myths and truths about chemicals and waste involved in the production of these materials.

Discussion should cover, for example, where mercury fillings go after suction? How does disposal of that mercury impact our water supply? In the context of learning about prescribing medications, learners would benefit from discussion what happens with medications, pharmaceutical waste, and impact on the water supply.

Table 1. Curriculum Mapping Example for Environmental Health (EH) in Bachelor of Science in Nursing (BSN) Programs

Specific Classes/ Content Areas in BSN Curricula	Appropriate Environmental Health Content	Teaching Strategies and Resources (readings, questions, assessments, research articles, power points, etc.)
Fundamentals of Nursing	1. Avoidance of mechanical, biological, chemical, and radiological hazards 2. Personal care products	Identify which personal care products have ingredients that can have human health effects (see Environmental Working Group's *Skin Deep* site http://www.cosmeticsdatabase.com/)
	3. Infection: multi drug resistance, nosocomial 4. Equipment cleaning: chemicals used for cleaning patient care equipment	Introduce issues related to practice environment by visiting "hospital" site and learning about chemicals used in health care facilities. View ToxTown website for hospital

A separate example provided by one respondent advocated that learners touch upon the impact of plastics on the ecosystem as well as the child during the pediatric rotations. Experiential education during systems improvement learning allows learners to determine whether sustainable methods are incorporated into practice. This would create an opportunity to discuss the economics of stewardship in those systems or settings. Health policy education provides an opportunity to discuss the financial burden to the health care system and society of caring for increasing illness due to climate change. This discussion could be supplemented with the idea that there is a business case (cost containment) for being environmentally sustainable.

Respondents who recommended SHE be introduced during clinical training suggested that students learn the basics of environmental assessment early. History taking should consist of questions about risk factors based on where participants live, the impact on the ecosystem and environment around where they live, and the potential for climate related or ecosystem depletion health concerns. In later clinical years SHE could be covered during patient care rounds or in interaction with patients. Instruction on patient education should focus on how to educate the public about climate and health and language best suited to this type of patient education. Respondents recommended that the content be connected to patient's health regarding concerns of perceptions of SHE content as a politicized issue. Respondents also emphasized the importance of providing actionable information to patients in discussions of incorporating SHE education into patient care. As one respondent noted, the role of the health care professional as an advocate is vital and includes responsibility to discuss with patients their individual risk factors related to climate and the community in which they live:

> *"One major challenge that I see with it is the way people bridge this from being a*
> *public health, and unfortunately even a political issue, to being a patient care issue,*
> *and finding opportunities to learn about this truly in the clinic context would be really,*
> *really essential to bridging that gap in understanding."*

Table 2: Examples of Timing and Location of SHE Curriculum for Health Professions

Location in Curriculum	Health Profession	Description	Case-Studies and Examples
Organ Systems (Pre-clinical and Clinical Education)	Dentistry Medicine Nursing Pharmacy	Teach within the a single course even if course is not block based e.g. pharmaceutical chemistry	Discuss within context of environmental causes of cancer Discuss how climate change will affect respiratory illness. Address the role of pollution, climate, and childhood asthma during pediatrics. Discuss cardiovascular disease including impact of heat waves like the one in India in 2016 and how those with cardiovascular conditions succumbed to collapse
Infectious Diseases	Dentistry Medicine Nursing Pharmacy	Spread of infectious diseases due to climate change Teach students infection control, not paranoia	Case based discussion of Zika virus
Clinical Education	Dentistry Medicine Nursing Pharmacy	Introduce in primary care disciplines How to take a history & conduct a physical exam including environmental/ social history that gets at information that may help guide discussion on climate and health Integrate in a way that connects basic and clinical sciences to raise awareness and attention to this topic Organizational sustainability framework: include actionable learning objectives (Med) AS PART OF systems science introduced in clinical years (economics of stewardship)	Address community and risk factors to advocate for patient care Discuss the longitudinal care of patients in the clinical years which provides an opportunity to bridge public health and patient care and learning about the impact on an individual patient and patient care. Teach students how to educate the public about climate and health and language used to educate patients Provide students with experience in which they see that sustainability practices are not incorporated.

Human Development	Medicine Nursing	Climate change and climate justice Increasing violence during climate change	Discuss impact of cases such as Hurricane Katrina/Harvey and/or Syrian refugee crisis
Public Health Teaching and/or Lecture	Dentistry Medicine Nursing Pharmacy	When discussing social determinants of health, socioeconomic/cultural factors and care of underserved populations From a public health perspective, talk about who is most susceptible	Provide practical guidance on advising patients most vulnerable to climate change, providing anticipatory guidance (e.g. the elderly) on heat waves When analyzing research articles, focus on climate change when discussing articles that address the frontiers of science with focus on the unknowns of health that need to be researched further. Discuss epidemiology of cases that introduce impact of climate change (e.g. Hurricane Harvey) or environmental health impacts (e.g. case of Flint Michigan) on populations.
Environmental & Occupational Health	Dentistry Medicine Nursing Pharmacy	Use sustainability discussions as jumping point to introduce population environmental health	Discuss epidemiology of cases that introduce impact of climate change (e.g. Hurricane Harvey) or environmental health impacts (e.g. case of Flint Michigan) on populations.
Medical Ethics	Medicine Nursing Pharmacy	Ethics course in which the ethics of resource restraints and allocation of resources are included	Address, in practice, how being underserved impacts patients and makes them more vulnerable to climate change impact
Healthcare Materials Waste	Dentistry	Educate those who teach about dental Occupational Safety and Health Administration (OHSA) about sustainability	Teach students to reduce running water when providing dental care and reduce glove waste. Teach students to use plastics only when needed and if items have not touched patient, spray to disinfect instead of disposing immediately.

Educational Strategies

Many respondents perceived the SHE curriculum's fundamental goal as being <u>increasing awareness</u> in order for learners to understand the scope of the problem and think (or re-think) their professional practice. This was because many respondents felt that learners were not thinking about SHE.

Respondents recommended multipronged educational strategies for implementing SHE. Many respondents suggested drawing as much as possible on <u>existing resources</u>. Due to the similarity and overlap between fields, respondents suggested leveraging educational resources from the fields of environmental and occupational health including the Institute of Medicine Report Environmental Health, existing environmental health textbooks, screening tools, and online materials.

The development of a <u>cadre of faculty</u> educated and versed in teaching this material was deemed important to education in SHE. Respondents voiced concern that the expertise to teach this content was lacking both nationally and locally; hence development of a cadre of SHE teachers was necessity. Suggestions for building this cadre focused on imparting foundational SHE knowledge through faculty development efforts, building relationships with institutions with existing expertise, recruiting junior faculty members with SHE interest, and development of a SHE resource library for teachers to draw on. In addition, respondents recommended educating faculty about how SHE corresponds to content they are already teaching.

Respondents noted that SHE should be taught through the use of <u>real-world examples, repetition or spiraling of content, and employing diverse instructional methods</u>. It was recommended that SHE education be connected to events happening around the globe such as the occurrence of heat waves and subsequent health impact, the role of the physician as activist and advocate in environmental health circumstances such as the Flint crisis, and building relevance to the local context (e.g. the impact of climate change on food security and nutrition in local underserved areas). As described earlier, respondents recommended that the curriculum be woven throughout the continuum of health professions education and linked or integrated where relevant (e.g. population health). As one respondent commented,

> *"You wouldn't have a course on cardiology or a section of a course on cardiology, heart physiology or something, in year one and then never hear about it again. In the same way, you should be introduced when you are doing coursework and you should be talking about it on rounds when you are in your last two years, and you should be talking about it as a resident."*

The curriculum should be introduced via <u>multiple instructional modalities</u> to meet the needs of the learners as well as the type of content. Suggestions included experimentation with different methods from lecture to role-playing to assess which methods worked best to teach SHE. For example, the curriculum may be tied to cases so that students become accustomed to thinking about SHE as they think through patient care. The use of diverse instructional methods would teach to the level of the learner and ensure the content was relevant to the ongoing curriculum.

Respondents noted that SHE would be most powerful if it drew on <u>active and experiential learning</u> approaches. Essential to these approaches was instruction on how SHE applies to how one practices and how one creates waste. One related suggestion focused on bringing inter-professional teams to work together on projects that address the problem (e.g. teaching learners, within the context of care, about the appropriate disposal of waste). One student recommended that SHE be built into longitudinal patient care to connect clinical practice to public health and consider individual and community-based risk factors in patient care. Integration of SHE content in education should involve teaching learners how to talk to patients about how climate change affects health. Critical to this was teaching

how learners can influence patients' health even though the factors influencing health are beyond individual control. Teaching learners to be empowered to affect change in the care they provide would shift the focus from futility to empowerment and accountability.

Strategies suggested to streamline implementation included re-envisioning how and where to include this content. One faculty member described how an SHE elective she taught for many years was reconfigured into core curriculum during a recent curriculum change.

Examples of recommended teaching strategies

- Provide learners with air quality monitors and allow them to keep track of the air quality and connect what they find to the health of patients they are caring for.

- Deliver a presentation on climate change and health and connect it to subsequent sessions in the curriculum.

- Assemble learners groups to follow the amount of waste generated from care and propose methods for handling medical/pharmaceutical/dental waste

- Ask learners to follow the water system and how medical waste impacts the water system

- Charge learners to identify of populations at risk for negative health outcomes related to climate change issues and develop a plan for caring for those populations.

Figures 2 displays the 7 key educational strategies respondents identified for teaching SHE content. Table 3, in turn, provides detailed information on the strategy and where available, exemplar resources. Other mentioned strategies included streamlining basic sciences education by integrating clinical and basic sciences to teach this content.

Figure 2: Key Educational Strategies for Teaching SHE Content

Bring in individuals who know the content.

Discuss real world examples.

Use existing materials in the literature to teach content.

Repeat content.

Link various topics to each other.

Raise awareness.

Build education into longitudinal patient care and population-level health.
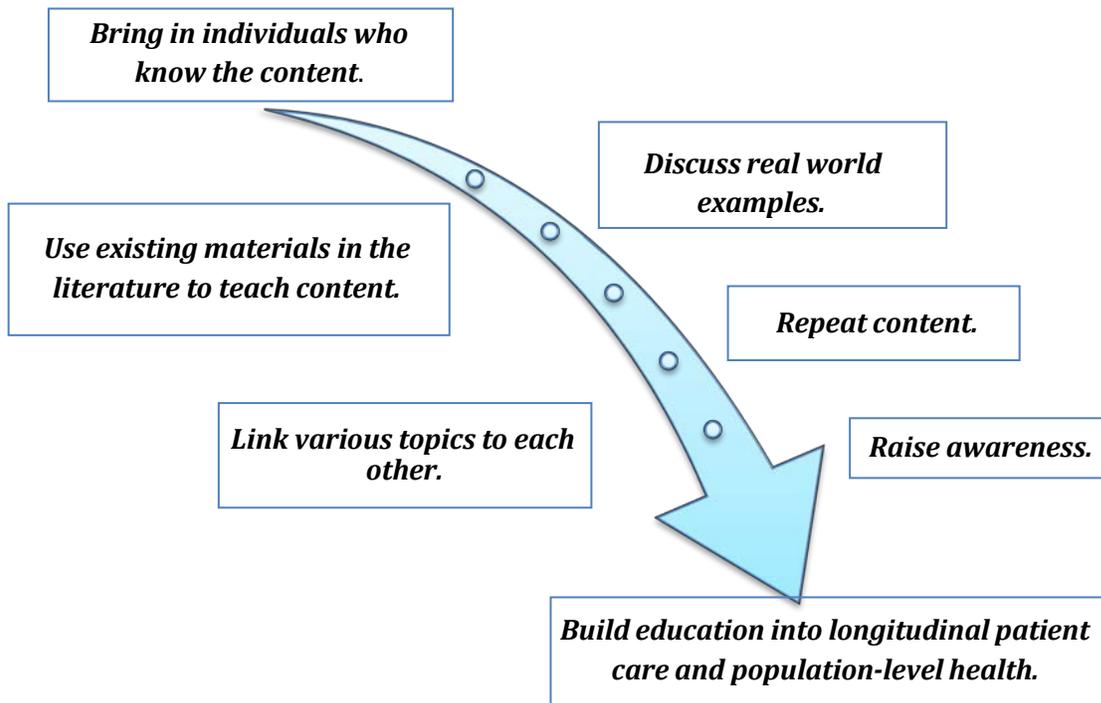
Table 3: Key Educational Strategies for Teaching SHE Content and Description of Strategy and Exemplar Resources

Key Strategy	Description of Strategy
1. **Bring in individuals who know the content to teach**	- Create a hotline for students and physicians who have patients with environmental health concerns that they don't know how to deal with. - Join forces with teaching at universities that have existing expertise (e.g. UCB, one health curricula). Bring those junior scientists working in this area to the forefront. - Utilize students who have just completed their education to further develop this curriculum.
2. **Use existing materials in the literature to teach content**	- Use online educational or practical application tools already in existence **Examples of resources** - IOM report on environmental health as textbook Environmental Medicine: The Missing Link as the basis to teach this material - Nursing online tool kit - Nasim Taleb's book "Antifragile" - One Health curricula (see Resources) - Teach about advances to cancer treatment through borrowing from ecological models - CalEnviroScreen
3. **Discuss <u>real world</u> examples**	- Connect the teaching to **local context** e.g. local environment, seeing where people live. Explain the power of the local context with examples like Flint and how they national attention. Tie teaching to experience and emotion. - Ex. heat waves in India and the impact on the health of the population there, Flint, high agricultural areas - Integrate with a more global focus on climate – while bringing back focus to what we can do to make our own local environments sustainable
4. **Link various topics to each other and repeat content**	- In discussions, describe how climate change, disease topic, population, and social health impacts relate to what students are already studying. - Utilize case-based curriculum so that students routinely think about issues they are seeing patients. - Students must be exposed early on, and content must be incorporated throughout education.
5. **Raise awareness**	- Describe the scope of the problem at a high level and early on to raise awareness. - Find ways to teach learners how they can develop methods to educate the community and start with educating friends and family.
6. **Utilize a diverse mode of teaching**	Engage in teaching in a way that capitalizes on multiple instructional methods (e.g. lecture, case based discussion, role playing) and makes the content relevant to location in curriculum. In labs and quizzes, throw in environmental questions and ask about cost. Incentivize students and practitioners to reduce carbon footprint.
7. **Build education into longitudinal patient care & population-level health**	- Allow students to get a sense of how everything works and how to bridge their work to public health, and assess risk of someone's community and risk factors. - Focus on teaching how climate change will change the way health professionals take care of the people and the way they get sick - Teach students how to talk to patient about how climate change will affect them. Team students how they can influence health especially when the source of problem is large and outside of an individual's control.

Challenges of Inclusion

Despite the issue of climate change being introduced into American culture, discussion of climate change has not made it into the mainstream of education. It is not integrated in our current education of health professionals. Respondents identified a number of primary barriers to inclusion of a SHE curriculum in healthcare professions' training. Primary barriers identified to developing and implementing the SHE curriculum included the following: (1) lack of institutional knowledge or interest, (2) reluctance to engage in sustainability discussions, (3) lack of resources, time, or expertise, and (4) practical challenges.

> ***Primary Barriers to Developing/ Implementing a SHE Curriculum***
>
> 1) Lack of institutional knowledge or interest
>
> 2) Reluctance to engage in sustainability discussions
>
> 3) Lack of resources, time, or expertise
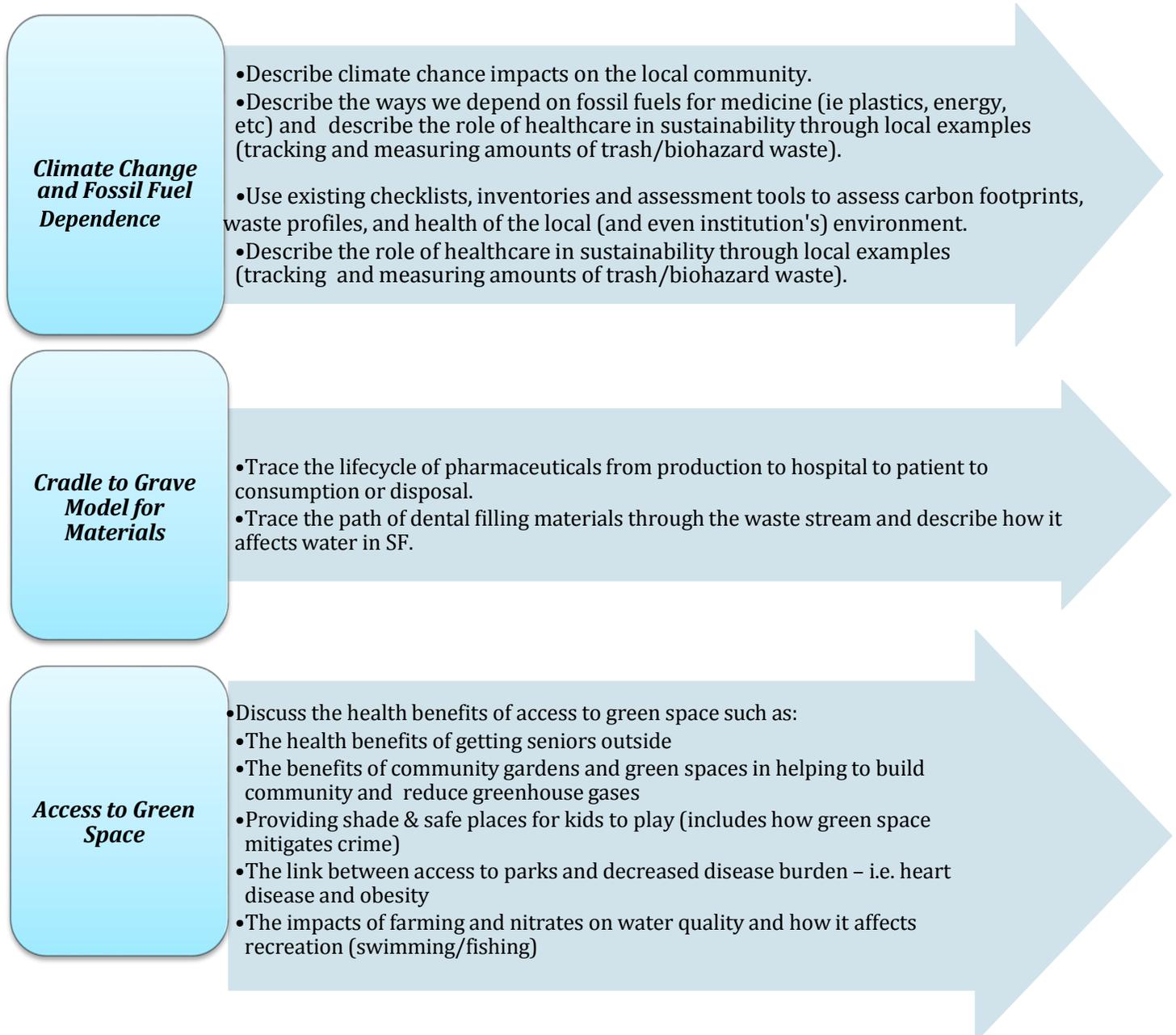>
> 4) Practical Challenges

Lack of institutional knowledge or interest was brought up as a barrier to incorporating a SHE curriculum into health professions education. Limited information on sustainability is available to health professional learners during their training and practice. This lack of exposure contributes to health professionals not viewing sustainability as an important topic. Examples of lack of institutional knowledge and interest described included disengagement of health professionals from campus sustainability issues, limited focus on sustainability in residencies, and lack of education on how to incorporate discussions of climate on health into good clinical care. Primary reasons identified for reluctance to engage in sustainability discussions included fear of politicizing the classroom setting, the trend of professions towards corporatization (specifically in pharmacy education), and a sense of hopelessness towards climate change as beyond one's control. However, one respondent described how healthcare professionals can be the neutral group to policy makers speaking to the importance of issues such as climate change and/or sustainability.

Logistic and practical barriers to integration of a SHE curriculum included the time constraints of health professions curricula and the already wide breadth of knowledge health professions students are required to master. An additional barrier described was lack of expertise in health professions faculty as well as a lack of a champion in the field. Finally, respondents also described how education may not change the way providers practice, and how real-life barriers such as accrediting and regulating bodies still influence the decisions and practice of providers.

Local Context and Community Partnerships

Making SHE relevant to the local context will have significant impacts on health professional students in areas such as knowledge and clinical mastery, advocacy skills, and clinical efficacy. Hearing personal stories directly from local community representatives is a powerful learning tool which emphasizes the immediacy of health issues impacting the local patient population. In addition, it can help didactic material be relevant and memorable. Connecting SHE to local examples and issues also provides opportunities for students to learn how to become advocates and build connections with community leaders. Finally, broadening people's knowledge of where their patients are coming from and what their daily life is like is essential to improving effectiveness and communication involved in health care provision. Examples of SHE content suggested by participants that can be taught in relation to the local content are described in Figure 3.

Figure 3: SHE in Relation to the Local Context

Climate Change and Fossil Fuel Dependence

- Describe climate chance impacts on the local community.
- Describe the ways we depend on fossil fuels for medicine (ie plastics, energy, etc) and describe the role of healthcare in sustainability through local examples (tracking and measuring amounts of trash/biohazard waste).
- Use existing checklists, inventories and assessment tools to assess carbon footprints, waste profiles, and health of the local (and even institution's) environment.
- Describe the role of healthcare in sustainability through local examples (tracking and measuring amounts of trash/biohazard waste).

Cradle to Grave Model for Materials

- Trace the lifecycle of pharmaceuticals from production to hospital to patient to consumption or disposal.
- Trace the path of dental filling materials through the waste stream and describe how it affects water in SF.

Access to Green Space

- Discuss the health benefits of access to green space such as:
- The health benefits of getting seniors outside
- The benefits of community gardens and green spaces in helping to build community and reduce greenhouse gases
- Providing shade & safe places for kids to play (includes how green space mitigates crime)
- The link between access to parks and decreased disease burden – i.e. heart disease and obesity
- The impacts of farming and nitrates on water quality and how it affects recreation (swimming/fishing)

Food and Agriculture

- Discuss the health and environmental impact of food choices such as:
  - Nutrition and reduced carbon emission benefits of a plant-based diet
  - Dangers of honey-bee collapse on agriculture and food security
  - Pesticide exposure of local agriculture workers

Environmental Exposures

- Discuss exposures in the community and home:
  - Health risks of lead
  - Mold and asthma
  - Threats to clean air and water in the Bay Area

Social Justice and Advocacy

- Discuss the correlations between income, race, and environment.
- Compare and contrast neighborhood safety and walkability
- Learn about San Francisco's Pier 90, the legacy of the naval shipyards, clean-up and local health effects from contamination in that area.
- Understand and communicate to public impact of policy and industry on sustainable practices

Local context was <u>defined</u> by participants as the university campus itself, or it was used to refer to the surrounding local communities and patients. In some cases, using local context can be helpful even when the local context referred to is outside the community's immediate geographical region. SHE issues affect vulnerable populations the most, so social justice was perceived to be an important part of making SHE localized and relevant. Figure 4 lists instructional techniques and strategies organized by the various definitions of local context provided by participants. Table 4 lists additional concrete strategies for having students engage with SHE content within the local context.

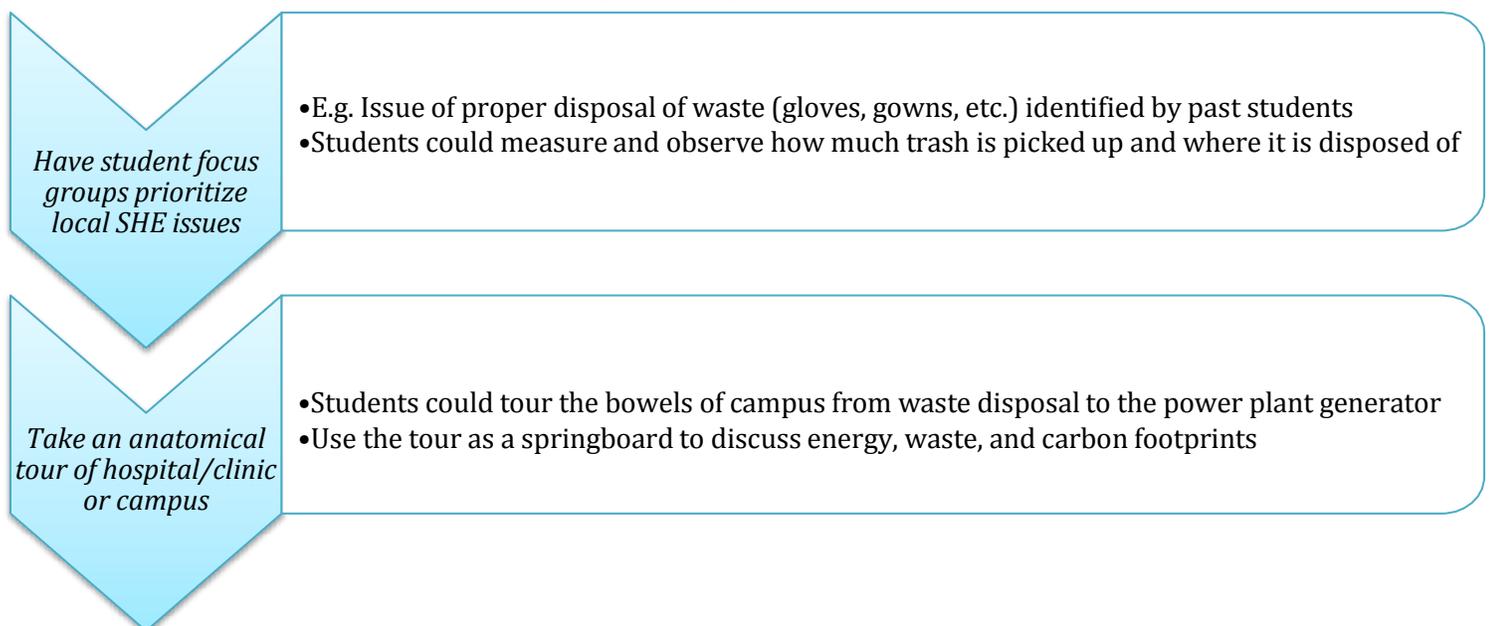## Figure 4: Instructional Techniques for SHE Education within the Local Context of the Campus/Hospital/Clinic

Have student focus groups prioritize local SHE issues

- E.g. Issue of proper disposal of waste (gloves, gowns, etc.) identified by past students
- Students could measure and observe how much trash is picked up and where it is disposed of

Take an anatomical tour of hospital/clinic or campus

- Students could tour the bowels of campus from waste disposal to the power plant generator
- Use the tour as a springboard to discuss energy, waste, and carbon footprints

Table 4: Local Context Outside of Campus in the Community

Local Context Example and Description	Examples
Use of Metaphor Linking SHE Concepts to Local Changes	• Point to the growth of home prices and subsequent growing income gap and resulting inequities • Challenges the paradigm that growth is always necessarily good
Organize a SHE Lecture Series or Short Course	• Students could discuss or write an essay from the prompt: "How can you take the things that you learn in this course to the community?"

Derive SHE Topics for Discussion from Current Events/ Specific Places	• Frame SHE education around current events in conjunction with the general community to alert and educate the public to current exposures and opportunities for taking action
	   • In the context of Flint, Michigan, describe how nitrates in farm water in California and/or coal toxins in rivers affects water quality and recreational fishing
	   • Use the gas leak in Southern California to discuss energy, fossil-fuel dependence, and climate change

Site Visits	• Guided walkthroughs with specific environmental health-related observation points or interviews with members of surrounding communities. Students would broaden knowledge of their patient populations. Students would have a chance to connect SHE content to real examples
Community Mapping	• Look at air quality, proportion of surface area covered by concrete, number of trees, etc. • Use database information from local hospitals to compare and contrast disease burden by neighborhood. Look to see if there were any patterns of disease the reflect exposures from air pollution or distance from superfund sites
Community Meetings or Local Committees	• Committees of local health professional societies • Opportunity to learn about local water, air, and soil quality issues and observe which issues seemed most important to the local community • Have health professional student educators at local schools, service learning community centers, health fairs, and farmers markets
Education Techniques	• Ask what community members know and don't know about climate change, which issues they care about • Elicit environmental concerns about their community, whether that is access to green space or issues at work and home

Settings for Educating the Local Community	• Exam room or hospital
	    • Could be used to reinforce preventative care and health maintenance (which is inherently more sustainable)
	• Community pharmacies
	    • Frequently and widely visited by the public
	    • The main way pharmacists connect with community members
	• Volunteering in schools and health fairs
	    • SHE could be integrated into discussions and education at all of these locations
	    • Highlight the importance of tying in ESH concepts to material that is already being discussed at location
	• Housing tours
	    • Setting for discussions with community members about the health risks of indoor exposures (ie lead and mold)
	    • Larger environmental and social justice issues like sustainable housing

Local and Community Partnerships

Individual Partnerships

Respondents suggested that SHE education may be accomplished within the context of local and community partnerships. Local, community, and institutional partnerships may include those with local or national health professions societies, As described previously, examples of establishing a community awareness and developing local community partnerships might include having health professions present at local schools, community events (health fairs and farmers markets). Appendix A displays a list of recommended partners, description of the partner, and examples. In addition, we provide in Appendix B examples of existing resources for health professions students and educators for learning and/or teaching materials.

Appendix A: Recommended Partnerships, Description and Examples

Partner	Description	Examples
Specific Professional Societies	• Professional societies may be powerful tools for disseminating SHE content to practicing HPs at a statewide and nation-wide level	• California Medical Association (CMA) • National Medical Association (NMA) • Network of Ethnic Physicians Organizations (NEPO) • California Nurses Association (CNA) • Monthly phone calls to discuss issues such as climate change with other nurses involved in National Nurses United (NNU) • Alliance of Nurses for Healthy Environments (ANHE) • Practice Green Health • Healthcare Without Harm • Physicians for Social Responsibility • Physicians for a Sustainable Future • American Public Health Association (APHA) • Advocacy groups (eg. American Lung Association) • Global Consortium on Climate Change Education • Global health organizations for free open access medical education
Specific community partnerships	• Community activists and organizations can serve both as powerful current and potential new partners	• Have health professional student educators at local schools, service learning community centers, health fairs, and farmers markets
	• Partnering with local activists embeds SHE themes in local context and allows students to engage outside of the classroom	• Engage with neighbors in efforts such as the cool block challenge
Institutional partnerships	• Partner with academic institutions, hospitals and healthcare institutions, state organizations, as well as administration/ faculty, learners, staff or researchers	• Faculty collaboration with experts outside of healthcare such as ecologists, soil scientists, microbiologists, gastro-neurologists, researchers in natural and earth sciences, biologists, veterinarians

| Institutional partnerships (continued) | • Reference prior examples of successful work integrating SHE content into health professions students education and environmental health advocacy and activism | Specific examples of institutional partnerships:
• Harvard: Medical School/ public health/graduate students and doctoral students share classes in the Environmental Science and Public Policy Concentration
• University of Minnesota: MN DPH and MN pollution control gives researchers grants to study ESH-related subjects
• UCSD: students volunteer with the Environmental Health Coalition - doing community advocacy projects, petition signing, etc.
• Partner with local elected officials, legislators in Sacramento and even farm workers in the Central Valley to promote ESH friendly legislation
• Examples of partnerships
  • Department of National Park Service
  • CDC One Health
• Companies involved in climate change initiatives:
  • National Pharmacy Chains (CM)
  • Pharmaceutical Companies: Roche, Janssen, and
  • Genentech have climate change initiatives (TB)
  Public Health Institute (PHI) |

Appendix B: Climate Change and Health Teaching Resources

Resource Type	Title	Description	Link
Definitions	UN Sustainable Development Goals (SDG)	This provides a big picture, global, multifaceted, and multi-disciplinary perspective of sustainable development.	www.un.org/sustainabledevelopment/sustainable-development-goals/
Online Website Resources	University of California Carbon Neutrality Initiative	Video resources, learning resources, and social media posts regarding sustainability issues	http://climate.universityofcalifornia.edu
	EcoAmerica: Building Climate Leadership	Multiple research/guides and blog posts on up-to-date issues in climate change	https://ecoamerica.org/research/
	George Mason University: Center for Climate Change Communication	Yearly reports on current climate change key issues.	https://www.climatechangecommunication.org/reports/
	Children's Environmental Health Symposium 2015 – Impacts of Climate Change on Children's Health	The California Environmental Protection Agency (CalEPA), Office of Environmental Health Assessment, along with the UCSF Pediatric Environmental Health Specialty Unit*, and the UC Berkeley Center for Integrative Research on Childhood Leukemia and the Environment, sponsored a symposium on "Impacts of Climate Change on Children's Health." This is part of our continuing series of children's health symposia conducted as part of the Children's Environmental Health Program	https://oehha.ca.gov/risk-assessment/presentation/childrens-environmental-health-symposium-2015-impacts-climate-change
	9 Questions on Climate Change and Health Every Candidate Should Answer	Climate change remains the greatest health challenge of this century—but the candidates aren't talking about it	**9 Questions** on Climate Change and Health Every Candidate Should Answer

Readings	USAID: Emerging Pandemics (One Health in Action)	University of California, Davis, Veterinary Medicine One Health Institute Resource	http://www.vetmed.ucdavis.edu/ohi/local_resources/pdfs/one-health-in-action.pdf
	Helping Healthcare Professionals Think through Health and Climate Change Impacts	Learning resource/handout (20 page booklet) detailing the health effects of climate change (Living with Environmental Change can be contacted for hard copies while stocks last).	Helping Healthcare Professionals Think through Health and Climate Change Impacts
	A Physician's Guide to Climate Change, Health, and Equity	Resource to strengthen and inform voice of health professionals on climate change, health and equity. The Guide explores the complex and multifaceted connections between climate change and health, disproportionate burdens and the impacts on health equity, and opportunities for solutions. Resource can be used to prepare for media interviews, visits with legislators or policymakers, news media articles, or presentations such as Grand Rounds, conferences, community talks and more.	A Physician's™ Guide to Climate Change, Health and Equity
	NWEI Discussion Course Books	Resource to help frame topics in a way to inspire thoughtful discourse and interpretations on Climate Change	https://www.nwei.org/discussion-course-books/
	Four Challenges of Sustainability (Orr)		https://sustain.ku.edu/sites/sustain.ku.edu/files/files/Orr_4%20challenges%20of%20sustainability.pdf
	NurSUS Project on Education in Sustainability and Nursing	The aim of the NurSus project is to enhance the availability/relevance of a sound learning offer in Sustainability Literacy and Competency (SLC) in nurse education by developing innovative teaching and learning approaches and materials. Available in multiple languages.	http://nursus.eu/
	Teaching Medical ethics: useful or useless	Might environmental sustainability renew the teaching of medical ethics	See BMJ article by Daniel Sokol,: http://www.bmj.com/content/355/bmj.i6415/rr-4

Readings (continued)	Case study: Greenhouse gas and Dental Clinical Waste	Case study and teaching material for dental students	Richardson, J., et al. "What's in a bin: a case study of dental clinical waste composition and potential greenhouse gas emission savings." *British dental journal* 220.2 (2016): 61-66.
	Connecting Global Priorities: Biodiversity and Human Health (Summary of the State of Knowledge Review)	World Health Organization summary document of current state and need for inter-sectoral collaboration to address needs of biodiversity in relation to public health and human health challenges.	https://www.cbd.int/health/SOK-biodiversity-en.pdf
	A Story of Health	Case-based learning has long been used in medical education. Our eBook grounds the science of health in stories of fictional people, their families, and communities to enable readers to explore the risk factors for disease as well as how to prevent disease and promote health and resilience. Using the setting of a family reunion as a backdrop, we explore how multiple environments influence our health across the lifespan.	https://wspehsu.ucsf.edu/for-clinical-professionals/training/a-story-of-health-a-multi-media-ebook/
	Report to the Legislature and Governor

Children's Environmental Health Center | The Center is responsible for ensuring that CalEPA's programs specifically protect children's health in California. In 2012, CalEPA delegated responsibility for the Center to the Office of Environmental Health Hazard Assessment (OEHHA). This report to the Legislature and Governor highlights the activities and some of the scientific understandings of children's environmental health developed by the Center over the past two years. The Act requires regular reporting on children's environmental health at CalEPA, particularly on the development and use of numerical guidance values that account for child vulnerabilities. | https://oehha.ca.gov/media/downloads/risk-assessment/document/2017childrenenvhealthlegreport.pdf |

Resource/ Guide			
	Lancet Countdown: Tracking Progress on Health and Climate Change	The Lancet Countdown's 2017 report tracks 40 indicators across five areas, arriving at 3 key conclusions: The human symptoms of climate change are unequivocal and potentially irreversible The delayed response to climate change over the past 25 years has jeopardized human life and livelihoods. The past 5 years have seen an accelerated response, and in 2017 momentum is building across a number of sectors; the direction of travel is set, with clear and unprecedented opportunities for public health.	http://www.lancetcountdown.org/the-report/
	Leadership for Sustainable Health Care Teaching	Stefi Barna Case-Studies and Teaching Materials Is climate the change the biggest threat of the 21st century? Learning Material and Teaching Note Leadership for Sustainable Health Care Teaching (Learning Document and Teaching Note)	Contact: Stefi Barna, Associate Professor of Public Health and Sustainability,Azim Premji University, Bengaluru, India (stefi.barna@apu.edu.in)
	Pediatric Environmental Health Toolkit	Presentation by Mark Miller, MD, MPH (Director of the CA EPA Program for Children's Environmental Health) at the UCSF Sustainability meeting June 2016	http://sustainability.ucsf.edu/upload/sustainability/files/Pediatric_Env_Health_Toolkit_7_16.pdf
	Sustainable Pharmacy	Article presents a curriculum for pharmacy students that addresses the role of pharmaceuticals with climate change and sustainability.	Gruenberg K, Apollonio D, MacDougall C, Brock T. Sustainable Pharmacy: Piloting a Session on Pharmaceuticals, Climate Change, and Sustainability within a US Pharmacy Curriculum. Innovations in pharmacy. 2017;8(4):3-.
	Sustainable Health Care Education Network (UK)	Online resource of published documents related to SHE curriculum teaching	https://networks.sustainablehealthcare.org.uk/network/sustainable-healthcare-education

	Teaching about Climate Change in Medical Education: An Opportunity	Resources on Education on Climate and Health from the United Kingdom's Sustainable Health Care Education	http://networks.sustainablehealthcare.org.uk/networks/sustainab le-healthcare-education/teaching- about-climate-change-medical- education
Curriculum Design Tools	Environmental Health in Nursing	Outlines teaching objectives and materials for environmental health in nursing	Leffers, Jeanne M., et al. "Developing curriculum recommendations for environmental health in nursing." Nurse educator 40.3 (2015): 139-143.
	Exploring attitudes and knowledge of climate change and sustainability in a dental practice: A feasibility study into resource management	1. Review current purchasing and identify whether some items could be bought closer to the practice 2. Work with local manufacturers to improve packaging 3. Encourage staff discussion about internal processes 4. Invite infection control experts and waste management companies together to discuss safe working practices 5. Revisit the interpretation of current guidance about all items inside treatment rooms being treated as clinical waste 6. Reduce packaging of sterile instruments 7. Reduce tissue and glove use.	
	One Health for Action Decal	Syllabus example of student-piloted course on One Health at the University of California, Berkeley, taught at the undergraduate level.	https://decal.berkeley.edu/courses/74
	Identification of core objectives for teaching sustainable healthcare education	Systematic determination of which and when a set of SHE Objectives should be included in the medical education curriculum.	Arianne Teherani, Holly Nishimura, Latifat Apatira, Thomas Newman & Susan Ryan (2017) Identification of core objectives for teaching sustainable healthcare education, Medical Education Online, 22:1, 1386042, DOI: 10.1080/10872981.2017.1386042

Curriculum Design Tools (continued)	Clinical sessions with evidence-based health and sustainability scenarios	**Example of session for nursing students: Learning outcomes**: • Describe where plastic comes from. • Assess the effect of loss of crucially important items on service delivery. • Allocate items to the appropriate waste facilities	Richardson J et al (2014) Effect of climate change and resource scarcity on health care. Nursing Standard. 28, 45, 44-49. Date of submission: October 7 2013; date of acceptance: February 6 2014.
	Dr. Barbara Sattler Materials	<u>**Objectives**</u> 1. Describe the historical environmental health discoveries that have had extraordinary impacts on public health. 2. Explore the concept of risk and the nature of environmental media – air, water, soil, and food – as they relate to human and ecological risks. 3. Identify environmental health risks in our everyday lives – in the home, school, workplace and community environments. 4. Consider the multidisciplinary nature of environmental health practice and the role of public health practitioners. 5. Evaluate web-based sources of information for environmental health science and practice. 6. Examine US policies that address the relationship between human health and the environment, from an environmental and occupational health perspective. 7. Consider environmental health from an international perspective.	Contact bsattler@usfca.edu
	USAID Lowering Emissions in Asia's Forests program (LEAf) Regional Climate Change Curriculum Development Training Workshop Report	Report summarizes a regional workshop by USAID's Lowering Emissions in Asia's Forests program and the U.S. Forest Service in 2013 in Bagkok. Its aim was to examine Regional Change Curriculum Development	https://www.climatelinks.org/resources/leafs-regional-climate-change-curriculum-development-training-workshop-report

		Standards	
	ANA 2010 Scope and standards of practice: Nursing	• Attains knowledge of EH concepts, such as implementation of EH strategies. • Promotes a practice environment that reduces environmental health risks of workers and healthcare consumers. • Assesses the practice environment for factors such as sound, odor, noise and light that negatively affect health. • Utilizes scientific evidence to determine if a product or treatment is a potential environmental threat. • Advocates for the judicious and appropriate use of products used in health care. • Communicates environmental risks and exposure reduction strategies to health care consumers, families, colleagues and communities.	ANA (2010) *Scope and standards of practice*: *Nursing*
Curriculum Design Tools (continued)	NurSusTOOLKIT: A Teaching and Learning Resource for Sustainability in Nursing Newsletters	**Sustainability-related knowledge:** e.g. broader concepts of health (including ecological public health and social determinants of health); various impacts of nursing activities on the environment; strategies for reducing these impacts; **Sustainability-related skills**: e.g. to integrate sustainability considerations into daily nursing practice; to explain the interrelationships between sustainability and health; and to discuss how the duty of a healthcare practitioner is shaped by the dependence of human health on the environment. **Sustainability-related cognitive and functional competence:** e.g. the ability to show ownership, responsibility and capability to justify professional decisions (in view of sustainability); applying the knowledge/ skills to improve sustainability of health systems. **Sustainability-related personal and ethical competencies:** e.g. to be motivated to contribute to the sustainability of the nursing profession; to show responsibility and willingness to change (in view of sustainability).	

Miscellaneous Resources	Do No Harm	Do No Harm is a small group of doctors, nurses, and health care leaders realized that, in violation of the Hippocratic Oath to "first, do no harm", some hospital practices were harming patients and the planet. This small effort grew into a global movement advocating for change on the critical environmental health issues of our time. As we live and work within the reality of climate change in the 21st century, our voice is growing even louder. Film.	As part of their 20th anniversary celebration, Health Care Without Harm is excited to release **Do No Harm**, a short film telling the inspiring story of this global movement.
	Healthy people, Healthy ecosystem conference	Conference for those interested in learning more about climate, ecosystems, and health	https://www.eiseverywhere.com/ehome/cugh2017/program/
	One Health Commission	A collaborative effort of multiple health science professions, together with their related disciplines and institutions – working, locally, nationally, and globally –to attain optimal health for people, domestic animals, wildlife, plants, and our environment.	https://www.onehealthcommission.org/
	Planetary Health Alliance	A consortium of universities, NGOs and other partners with a shared mission—supporting the growth of a rigorous, policy-focused, transdisciplinary field of applied research aimed at understanding and addressing the human health implications of accelerating anthropogenic change in the structure and function of Earth's natural systems.	https://planetaryhealthalliance.org/

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