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Expanding Interprofessional Education Beyond the Clinical Bedside to Address Planetary Health and the Sustainable Development Goals in the Anthropocene

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Expanding Interprofessional Education Beyond the Clinical Bedside to Address Planetary Health and the Sustainable Development Goals in the Anthropocene

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Abstract

Background and Motivation: The need for engineering education to integrate societal impact demands scalable, yet low-barrier, curricular innovations. Building upon foundational research demonstrating the Nurse+Engineer as a V-shaped professional, this study presents an innovative model for expanding Interprofessional Education (IPE). While IPE typically focuses on clinical collaboration for individual patient care, this module expands the concept to address Planetary Health and the Sustainable Development Goals (SDGs) (specifically SDG 13: Climate Action). This intervention directly fuses engineering and the liberal arts by integrating systems thinking into clinical professional training, which specifically addresses ethics, societal impact, and the evolving nature of professional work.

Methodology and Implementation: A single 75-minute lecture on environmental engineering, professional practice, and climate action in the context of the SDGs was delivered mid-semester as one session within an existing weekly IPE course, reaching more than 400 students across four semesters (Spring 2024, Autumn 2024, Spring 2025, and Autumn 2025). The five stated learning objectives aimed to shift student awareness from individual health to global socio-technical systems. Data collection utilized summative course evaluations where students responded to an open-ended question asking them to describe interprofessional impact in the Anthropocene/Climate Change context. A large language model (LLM) + human in the loop thematic analysis of the student responses identified core concepts emerging from student responses. Future work will employ quantitative methods to evaluate these emergent themes in great detail.

Results to Date and Anticipated Impact: The intervention appeared to encourage systems thinking among students of healthcare professions participating in an IPE course. Initial thematic results showed students consistently moving beyond clinical roles to propose multidisciplinary approaches, including: 1) education and community awareness; 2) policy advocacy and legislative action; 3) sustainable healthcare operations; and 4) disaster preparedness and emergency response. The results of this study support a tentative conclusion that introducing engineering concepts to future healthcare professionals as part of existing IPE coursework successfully cultivates essential professional, non-technical skills (policy engagement and systems thinking). This scalable, one-lecture module successfully introduces systems thinking to professional students in healthcare who often study the liberal arts, offering a highly transferable curricular design model for low-cost, high-impact integration across professional programs. The project confirms the immense potential of the Nurse+Engineer framework to advance ethics, societal impact, and the evolving nature of professional work.

Introduction

Interprofessional education (IPE) occurs when students from two or more professions learn about, from, and with each other to enable effective collaboration to improve health outcomes [1]. Often, IPE includes students studying to enter clinical professions such as physicians, nurses, and pharmacists as well as allied health professions and social workers. Often, IPE education emphasizes the health of an individual patient or client (for social workers).

Emerging approaches to curing sickness, restoring health, preventing illness, and promoting wellness emphasize "more than" clinical healthcare, including caring for society's most vulnerable [2] and caring in extreme situations such as disasters [3]. For example, emerging health and wellness systems are including families, populations, and communities of people (i.e., "the public") as well as "nature", which can include planetary processes such as climate change. As reported previously [4] [5] [6], existing IPE courses may be improved by introducing students of clinical professions (i.e., medicine) to the realities of global interdependence in the Anthropocene, which is an informal term that describes the period of time since 1950 when human activity is a dominant force for change on planet Earth.

Professionals responsible for the built environment, in particular engineers, have an important role to play in maintaining the health, safety, and welfare of the public and the planet [7]. Previously, the importance of convergence education – with engineers and nurses learning from, about, and with each other [8] – was described as important for addressing the societal challenges of the Anthropocene including the technology to live within planetary boundaries [9] as well as improved social contracts to improve health equity [10].

To improve the education of healthcare professionals – focused on clinical care – through interprofessional training with those professionals who could be considered to be part of healthcare – including engineers interested in the health, safety, and welfare of the public – a module entitled, "Anthropocene and Climate Change for IPE 2100 Interprofessional Collaboration and Healthcare in the Global Context" was developed and offered to an existing course of students at St. Louis University. This course is part of the degree requirements for students in the Doisy College of Health Sciences, the Trudy Busch Valentine School of Nursing, and the School of Social Work. It is also available to all students at SLU to explore the attributes of the SLU Undergraduate Core Curriculum [11] such as integrating knowledge from multiple disciplines to address complex questions as well as recognize transnational or global interdependence [5] [12].

The purpose of this article is to share the details of the lecture on the professional practice of environmental health engineering to achieve portions of the United Nations' Sustainable Development Goals (i.e., Goal 13: Climate Action) as well as to share the results of a thematic analysis of the responses of more than 400 students in four offerings of the course, where summative evaluations included asking students the open ended question, "describe three ways interprofessional teams may make an impact in addressing the Anthropocene/Climate Change/Severe Weather."

While this pilot study was limited to four offerings of a single IPE class, future work should consider the use of quantitative methods with optional open ended responses to confirm the results reported in this pilot in future IPE courses at the same institution as well as in IPE courses at other institutions with different student populations.

The results of this study suggest that even a single lecture from an engineer can increase the awareness of beyond-the-bedside approaches to address the challenges of the Planetary Health among students of IPE. Collectively, the results of this study point to the benefit of convergence of engineering and clinical healthcare professions – such as nursing – to solve pressing societal challenges of the Anthropocene.

Methods

Institutional context. Located in St. Louis, Missouri, the Saint Louis University (SLU) was founded in 1818. A private, Jesuit research university, SLU is the oldest university west of the Mississippi River and the second-oldest Jesuit institution of higher education in the United States. During the 2024-2025 academic year from which the most recent comprehensive data is available, the total enrollment at SLU was more than 13,000 students, which included nearly 3,000 graduate students. Currently characterized as a Carnegie R1 as of 2025, a doctoral university with very high research activity, SLU operates 12 schools and colleges, including the Doisy College of Health Sciences, the School of Medicine, the Trudy Busch Valentine School of Nursing, the College of Public Health and Social Justice, and the School of Social Work. The Interprofessional Education Program, or IPE Program, at SLU engaged with nearly 1,500 students during the 2024-2025 academic year.

Course description. Interprofessional Collaboration and Healthcare in a Global Context, or IPE 2100, is offered every semester and includes both a weekly 75 minute lecture as well as small group exercises. The course description states:

> *This course is designed to introduce and develop the knowledge, skills, behaviors of effective collaboration and interprofessional teamwork. There is also a core thread of developing one's professional identity in the context of healthcare and care teams working on the shared goals of the Quadruple Aim in Healthcare. This course provides students with foundational skills and behaviors in effective teamwork and collaboration that will be further applied in IPE and profession-specific courses. Also, students are introduced to an overview of the influence of U.S. healthcare policy in shaping the structure, quality, financing, access, and safety of the healthcare environment while comparing to systems in a global context. Students will work collaboratively to develop an understanding of policy and advocacy and how to address barriers to equitable, quality healthcare to improve care and outcomes.*

For those unfamiliar with the quadruple aim in healthcare, the evolution of the concept is described by Bodenheimer and Sinsky [13] as an improvement over the prior triple aim – enhancing patient experience, improving population health, and reducing costs – to include a fourth aim, specifically, improving the work life of health care providers including clinicians and staff.

Details of teaching module. The lecture provided as part of this module is based upon prior published work [8] [9] [10]. The lecture was delivered by a full professor of environmental engineering who holds an earned Ph.D. in environmental engineering (awarded in 2002) and has more than twenty years of teaching experience. As an example of the lecture's experience with interprofessional healthcare, the lecturer was inducted as a Distinguished Public Policy Fellow of the National Academies of Practice (2025). The PowerPoint slides used in the lecture are included in the Appendix. An initial version of the lecture was first pre-piloted via Zoom on November 2, 2023. Utilizing student feedback from this pre-pilot, the lecture was improved and the final lecture format (Appendix A), was delivered as part of the pilot described in this current article. Two deliveries were via Zoom, on April 17, 2024, and on November 21, 2024. Two deliveries were in person on April 14, 2025, and on November 13, 2025.

Comprehension evaluations. As part of the regularly scheduled end-of-semester examination, students had an opportunity to respond to a short answer question, which evaluated knowledge gained during the lecture.

Human subjects. This project is considered Exempt Research based on Category 1. All research was conducted in an educational setting using normal educational practices including an end-of-semester comprehensive examination, which included an opportunity for students to respond to a short answer question. All data from the exam were managed by the instructors and deidentified before any further analysis was conducted for this article. All data were analyzed using an enterprise version of generative Artificial Intelligence, which is confirmed by the platform to support compliance with industry regulations like COPPA, FERPA, and HIPAA (including chats are never human reviewed nor used to train AI models).

Analytic approach. To identify emergent themes in deidentified student responses to the open-ended examination prompt, we conducted an inductive thematic analysis using a hybrid workflow that combined large language model (LLM) assisted coding with human researcher oversight and adjudication, also known as human-in-the-loop or LLM-HitL. This approach aligns with recent advances demonstrating that LLMs can accelerate qualitative coding while preserving interpretive rigor when humans maintain epistemic authority over meaning-making [14]. The decision to apply a hybrid workflow reflects the need for scalable review of more than 400 textual responses, while recognizing that interpretive judgment, reflexivity, and contextualization remain core responsibilities of qualitative researchers.

Following recommendations for methodological transparency in LLM-enabled qualitative inquiry, we structured the analysis around three iterative cycles- initial LLM coding, human review and refinement of the code book and representative quotes, and further LLM synthesis of revised thematic structure [15].

First, student responses were segmented and submitted to Gemini 3 Pro and ChatGPT-5.2 (using prompt templates adapted from published guidelines to ensure consistent task framing, domain-relevant scaffolding, and mitigation of over-generalization [15]. Outputs generated by the model consisted of descriptive codes and candidate thematic labels. Details for all of the steps that were part of this initial machine-driven approach are described in Appendix C.

Second, as described in Appendix C, human researchers reviewed the results of the LLM analysis to evaluate semantic accuracy, resolve interpretive ambiguities, and collapse overlapping concepts, in alignment with best practices for maintaining researcher reflexivity and domain awareness in hybrid thematic analysis [16]. This included human review of each step of machine results described in Appendix C (i.e., human review of each JSON output).

During this stage, responses were also independently coded by the human research team in *Dedoose* to establish interpretive grounding and ensure that model-generated themes reflected content present in the corpus, rather than artifacts of prompting or model priors.

Once we had the human verified results from the LLM and a comparison to Dedoose, a third step was performed. Specifically, we used a second LLM pass to summarize revised, consensus codebooks and generate thematic descriptions, producing draft analytic memos. This step followed evidence suggesting that multiple LLM runs and re-prompting can improve inductive coverage and thematic coherence when paired with human verification [17].

These final results were re-verified by human inspection and included in the final results (Table 1 and Appendix B).

Throughout the workflow, human researchers retained responsibility for adjudicating final theme boundaries, conceptual labeling, and interpretive meaning, in line with recommendations emphasizing that LLMs serve as accelerators of coding labor rather than determiners of thematic meaning [14] [15].

Final themes reported in Table 1 therefore reflect an LLM-HitL interpretation of the student corpus, which adheres to the recommendations of transparency, accountability, and verifiability required of all uses of generative Artificial Intelligence [18].

Results and Discussion

As part of a regularly scheduled end-of-semester, final exam, approximately 400 students (about 100 each in four different semester-length versions of the course) had the opportunity to respond to the following free response question: “Describe three ways interprofessional teams may make an impact in addressing the Anthropocene/Climate Change/Severe Weather. (6 points)”

These results were analyzed using an LLM-HitL approach (Appendix C). To independently verify the results, a human analysis using Dedoose was performed in parallel, and identified the same results (data not shown).

The most common responses offered are included in Table 1. Education resulting in behavior change among clinicians, patients, the public, and public officials appeared to be the predominant overarching tone of the responses (occurring in approximately 90% of responses, data not shown). This result may be unsurprising as the context for this lecture was a course on interprofessional education. Advocating at the level of policy change was the second most common response (occurring in approximately 70% of responses, data not shown). This result is consistent with the larger mission of St. Louis University as a Jesuit institution and the emphasis

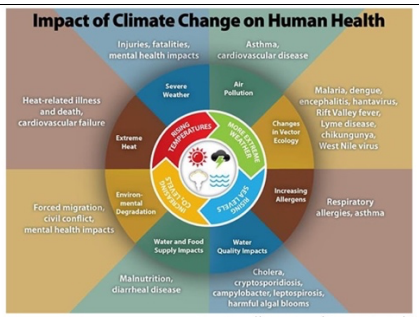
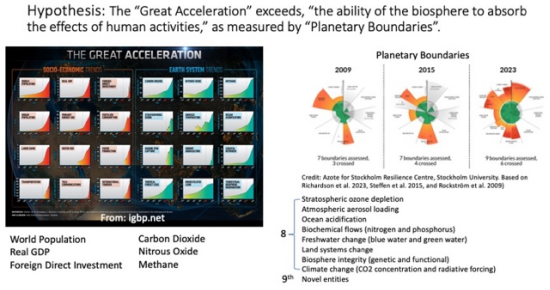
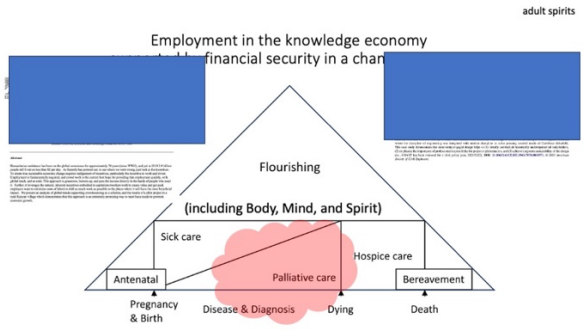
on political engagement. With approximately 55% of students including this response, adopting sustainable practice in healthcare operations was the next most abundant response. While nearly half of the participants included this response, the fact that only half included this answer suggests that students may be unaware of how they can individually have a positive impact of the operation of large healthcare facilities and systems; this suggests that future presentations may benefit from the inclusion of specific case studies of individual healthcare professionals positively impacting sustainable healthcare operations. Finally, while disaster preparation and emergency response is an important part of healthcare, only 35% of respondents included this answer. This may show a lack of awareness among students in connecting local disasters – such a tornadoes, heatwaves, floods, and wildfires – to the global phenomena of climate change.

Table 1. Most common themes observed in student responses to an end-of-semester short answer question.

Theme number	Theme title and definition
1	**Education and Community Awareness:** Interprofessional teams leverage their authority to disseminate knowledge to patients, communities, and fellow professionals regarding the direct link between climate change and health outcomes. This involves teaching preventive safety measures for severe weather and promoting eco-conscious behaviors to mitigate environmental risks.
2	**Policy Advocacy and Legislative Action:** The use of collective professional influence to drive systemic change by lobbying government officials, proposing legislation, and advocating for policies that prioritize public health. This includes voting for environmentally conscious representatives and mandating sustainable practices to address climate change.
3	**Sustainable Healthcare Operations:** Implementing practical operational changes within healthcare facilities to reduce the industry's carbon footprint. Initiatives include minimizing medical waste (such as single-use plastics), implementing recycling programs, transitioning to renewable energy sources, and adopting paperless documentation.
4	**Disaster Preparedness and Emergency Response:** Collaborative efforts to develop and execute comprehensive emergency plans for severe weather events, ensuring rapid response and community resilience. This encompasses establishing shelters, coordinating treatment for injuries, and ensuring patient safety and continuity of care during climate-related disasters.

After completing the thematic analysis, the same LLM was prompted: “Determine which slide in the attached PowerPoint slide presentation is most strongly connected to each of the four themes (produce a table - 4 themes in columns vs 45 slides in rows - where you include most strongly connected to least strongly connected as rows; with each theme as a column).” The results are presented in Table 2.

Table 2. Linking specific PowerPoint slides to each Theme.

Theme 1: Education and Community Awareness	Theme 2: Policy Advocacy and Legislative Action
	
Theme 3: Sustainable Healthcare Operations	Theme 4: Disaster Preparedness and Emergency Response
	

Future presentations should take advantage of what has been learned through the LLM-HitL analysis of the data collected during past presentations and provide additional quantitative instruments to verify the results reported in this current study.

Limitations

While this pilot study was limited to a single IPE class, future work should reproduce the results reported here and examine students at different universities. Also, a significant limitation of the current study is the lack of an assessment of student knowledge prior to the delivery of the lecture. The lack of a baseline assessment confounds the ability to attribute any change in knowledge to the effectiveness of the lecture.

Conclusion

Although limited to a single lecture added to a single IPE course, the results of this pilot study point to the conclusion that even a single lecture from an engineer can increase the awareness of beyond-the-bedside approaches to address the challenges of the Planetary Health among students of IPE. Further, the analytic design reported in this study - pairing scalable computational support with interpretive human oversight - is consistent with contemporary qualitative scholarship that positions hybrid human-AI coding as a viable method for large-scale thematic analyses when transparency, reflexivity, and human governance are maintained. The inverse framing also merits attention: engineering students stand to gain from structured exposure to

clinical and public-health pedagogies - particularly around patient-centered communication, ethics of care, and health equity - as part of the Nurse+Engineer framework. Future modules will develop and pilot this reciprocal direction. Finally, the results of this study clearly point to follow-up questions of a quantitative nature that should be explored and confirmed with future courses. As a Work-in-Progress, this study now moves to instrument development and multi-site deployment, which should consider quantitative validation of the four emergent themes, together with a pre/post baseline assessment, as the next phase of this research.

Declaration on use of Generative Artificial Intelligence

Consistent with the recommendation of transparency, accountability, and verifiability (as described in [18]), Google Gemini version 3 Pro was used in the original drafting and editing of the manuscript. Specifically, the following prompt was used to improve the draft: “Assume you are the program chair for the American Society for Engineering Education. Evaluate the attached draft article considering the attached call for papers and the attached author kit. Identify any errors and evaluate if the paper should be accepted.”

Subsequently, Claude Opus 4.7 was used in editing the final version of the manuscript. The following prompt was used with Claude: "Assume you are a program chair for the annual meeting of the American Society for Engineering Education. Offer any final feedback on the accepted paper - in final format - from corresponding author Professor Daniel Oerther of the Missouri University of Science and Technology (attached). Recommendations for improvements should include internal consistency of abstract, introduction, methods, results, discussions and conclusions; citations; and any additional bullet proof improvements as identified from the following: 1) instructions to authors for the meeting as originally published by ASEE (attached); 2) call for papers as originally published by ASEE (attached); 3) feedback from reviewers and program chair on the original abstract and subsequent draft versions of the manuscript."

In addition, ChatGPT-5.2 was used as part of this research as documented in the Methods. As part of best practice when using LLM for thematic analysis, we specifically acknowledge that LLM-assisted coding carries positionality risks, including that models often are trained predominantly on Western, English-language corpora that may over-weight certain framings of climate and health. Two models (Gemini 3 Pro and ChatGPT-5.2) were used to surface divergent priors, and the human adjudication step (Phase 4, Appendix C) was specifically designed to flag themes that appeared in only one model as “Low Reliability/Unique Insight,” reducing the risk that model artifacts were mistaken for emergent participant voice.

The author takes full responsibility for the content of the article.

Author approved TL;DR

Author approved TL;DR (as recommended by [19]): “A single 75-minute lecture from an environmental engineer, embedded in an existing interprofessional education course, shifted over 400 health-profession students toward systems-level thinking about climate action — demonstrating a scalable, low-cost model for integrating engineering perspectives into clinical training.”

References.

[1] WHO, Framework for action on interprofessional education and collaborative practice. World Health Organization: Geneva, Switzerland. Available [Online]: https://www.who.int/publications/i/item/framework-for-action-on-interprofessional-education-collaborative-practice, 2010.

[2] D.B. Oerther, and S. Oerther, "Improving Interprofessional Environmental Health Education Using the Leave No One Behind Framework," *AJPH*, vol. 112, pp. S250-S252, 2022. doi: 10.2105/AJPH.2022.306832.

[3] D.B. Oerther, S. Oerther, and D. Dyjack, "The Urgent Need for Interprofessional Environmental Health Education to Achieve Universal Health Coverage, Even in Disasters," *Environ. Sci. Technol.*, vol. 11. no. 11, pp. 1144-1146, 2024. doi: 10.1021/acs.estlett.4c00756.

[4] S. Oerther, A. Breitbach, S.A. Manspeaker, D. Pole, and K. M. L'Ecuyer, "Interprofessional education for nursing students in the age of the Anthropocene," *Nurs Educ. Pract.*, vol. 67, no. 103536, 2022. doi: 10.1016/j.nepr.2022.103536.

[5] S.A. Manspeaker, S. Oerther, D. Pole, H. Cobb, and A. Breitbach, "Learner experiences of identity and global interdependence following engagement with an interprofessional education course," *J. Interprofessional Care*, vol. 38, no. 6, pp. 1072-1080, 2024. doi: 10.1080/13561820.2024.2391979.

[6] S. Oerther, A. Breitbach, and D. Pole, "Teaching global interdependence to health professions students during the Anthropocene epoch: Findings from a documentary analysis of an interprofessional education course," *Nurs Educ. Pract.*, vol. 78, no. 104025, 2024. doi: 10.1016/j.nepr.2024.104025.

[7] D.B. Oerther, "Hold Paramount the Health, Safety, and Welfare of the Public and the Planet," *Journal of Environmental Engineering*, vol. 152, no. 2, 2026. doi: 10.1061/JOEEDU.EEENG-8532

[8] D.B. Oerther, "Using Nursing Theory to Improve the Teaching of Engineering Practice," in *ASEE Annual Conference & Exposition, Columbus, Ohio, 2017*. [Online] Available: https://www.doi.org/10.18260/1-2--29084. doi: 10.18260/1-2--29084.

[9] D.B. Oerther, "Using Modified Mastery Learning to Teach Sustainability and Life-Cycle Principles as Part of Modeling and Design," *Env. Eng. Sci.*, vol. 39, pp. 784-795, 2022. doi: 10.1089/ees.2021.0385.

[10] D.B. Oerther, L. Gautham, and N. Folbre, "Environmental Engineering as Care for Human Welfare and Planetary Health," *J. Environ. Eng.*, vol. 148, no. 04022029, 2022. doi: 10.1061/(ASCE)EE.1943-7870.0002013.

[11] A.P. Breitbach, D. Pole, H.R. Cobb, and E. Croswell, "Alignment and Assessment of University Core Curriculum with Interprofessional Education," *Jesuit Higher Education: A Journal*, vol. 14, no. 1, pp. 11, 2025

[12] V. Park, D. Lising, J.E. Thistlehwaite, A.P. Breitbach, A.L. Pfeifle, and H. Khalili, "Leveraging the strengths of a global network to adapt and sustain interprofessional education and collaborative practice during the COVID-19 pandemic," *Journal of Interprofessional Care*, vol. 39, no. 2, pp. 327-333, 2025.

[13] T. Bodenheimer, and C. Sinsky, "From triple to quadruple aim: care of the patient requires care of the provider," *Annals of Family Medicine*, vol. 12, no. 6, pp. 573-576, 2014.
[14] J.P. Wiebe, R. Khan, S. Burns and J.D. Slotta, "Qualitative research in the age of LLMs: A human-in-the-loop approach to hybrid thematic analysis," In A. Rajala, R. Hofmann, A. Jornet, H. Lotz-Sisitka and L. Markauskaite (Eds), Proceedings of the 19th International Conference on the Learning Sciences – ICLS 2025, pp. 1123-1131, 2025
[15] C.M. Montes, R. Feldt, C.M. Martos, S. Ouhbi, S. Premanandan and D. Graziotin, "Large language models in thematic analysis: Prompt engineering, evaluation, and guidelines for qualitative software engineering research," arXiv preprint arXiv:2510.18456v1, 2025
[16] S. Dai, A. Xiong, and L.W. Ku, *LLM-in-the-loop: Leveraging large language model for thematic analysis*. Findings of the Association for Computational Linguistics: EMNLP 2023, 10584-10596, 2023.
[17] A. Castellanos, H. Jiang, P. Gomes, D.V. Meer and A. Castillo, "Large language models for thematic summarization in qualitative health care research: Comparative analysis of model and human performance," *JMIR AI* vol. 4, pp. e64447, 2025.
[18] S. Oerther, and D.B. Oerther, "The importance of transparency, accountability, and verifiability when using artificial intelligence in nursing education," *Nurse Education in Practice*, 2025. [Online ahead of print]. doi: 10.1016/j.nepr.2025.104557.
[19] S. Oerther, and D.B. Oerther, "Every publication needs an author verified TL;DR statement," *Nurse Education in Practice*, 2026. doi: 10.1016/j.nepr.2025.104674.

Appendix A. Slides used as part of lecture to IPE course.

Discussion questions

1. What are some global health challenges of climate change?
2. How can we reimagine interprofessional teams to address those challenges?

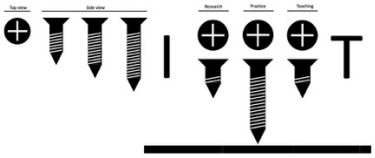
Do you recognize these figures from the "Great Sanitary Awakening"? chronological order from Poor Laws (1834), Broad Street Pump (1854), Notes on Nursing (1859), and Thames Embankment (1870)

Anthropocene and Climate Change for IPE 2100 Interprofessional Collaboration and Healthcare in a Global Context

Learning objectives

1. How should we define interprofessional practice?
   - HINT: Its much more than is currently being taught
2. What are the health challenges of climate change and how should the world respond using the United Nations Sustainable Development Goals?
3. Looking backward to move forward…
   - Sharing a few practical examples of the future of interprofessional practice
4. America's fascination with technology and equating health with medicine
5. How engineers are solving the problems of health

From "I"-shaped to "T"-shaped
From practice to practice + research + teaching (and policy?)
(aka evidence-informed practice)



How do we collect evidence to inform practice? Research!

Come up with an idea, share with others, and conduct experiments.

National Science Foundation (NSF) merit review principles (three) and criteria (two):

1. All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
   A. **Intellectual merit**: encompasses the potential to advance knowledge
2. NSF projects, in the aggregate, should contribute more broadly to achieving societal goals.
   B. **Broader impacts**: encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes
3. Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics…

From PAPPG, 2024

The NSF describes **Convergence Research** as having two primary characteristics:

1. **Deep integration across disciplines.**
   - As experts from different disciplines pursue common research challenges, their **knowledge, theories, methods, data, research communities and languages** become increasingly intermingled or integrated.
   - New **frameworks, paradigms or even disciplines** can form sustained interactions across multiple communities.
2. **Research driven by a specific and compelling problem.**
   - Convergence Research is generally inspired by the need to address a specific challenge or opportunity, whether it arises from **deep scientific questions or pressing societal needs.**

Text from: https://www.nsf.gov/od/oia/convergence/

vanishing point (n)

Deep integration across disciplines

a point at which receding parallel lines seem to meet when represented in linear perspective (Merriam-Wester)

Image from: https://www.youtube.com/watch?v=0tCyLN6l2CY

Anthropocene (n)

Driven by a specific and compelling problem

period during which human activity is the dominant influence on climate and the environment (Dictionary.com)

From… … To

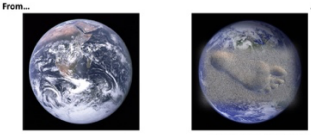
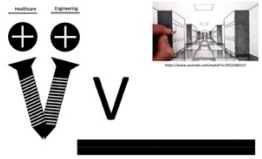
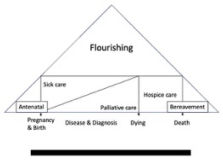


Image from: https://theanthropoceneadashboard.com

So what about something new? "V"-shaped professionals



We need V-shaped practice to scale up caring



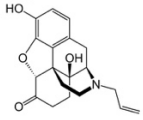
Covid-19 (from Wikipedia)

Artificial ventilation

Corsi-Rosenthal box

Opioids (from Wikipedia; Google)

Naloxone



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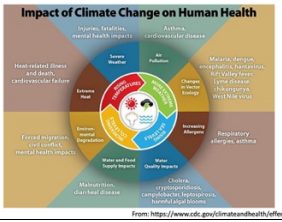
Henderson's Nursing Need Theory

and

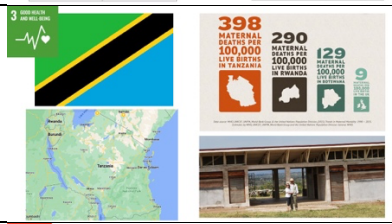
Engineering Grand Challenges

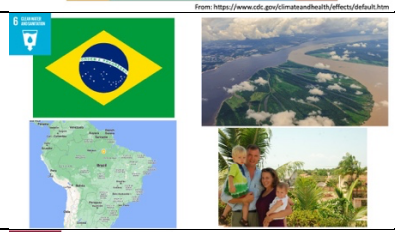
Impact of Climate Change on Human Health

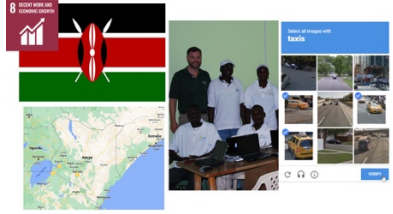


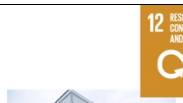
From: https://www.cdc.gov/climateandhealth/effects/default.htm

From: https://sdgs.un.org/goals









When you equate health with medicine, you create: Physicianeers = Physician+engineering

- "The EnMed physicianeer is an innovative **problem-solving doctor** uniquely qualified to address some of **health care's greatest challenges**. These graduates receive a Medical Doctorate and Master of Engineering degree focused on the design and implementation of **impactful medical technologies** in the same four years through a revolutionary curriculum."
- Texas A&M University School of Engineering Medicine

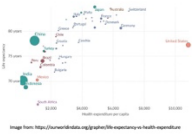
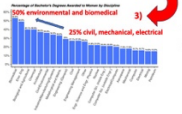


Image from: https://ourworldindata.org/grapher/life-expectancy-vs-health-expenditure

1->2->3) NAE Changing the Conversation

1) What most people think

- Engineers drive trains, are good at math and build things



2) How marketing improves diversity

- Engineers make a world of difference
- Engineers are creative problem solvers
- Engineers help shape the future
- Engineering is essential to our health, happiness, and safety

Text from DOI:10.17226/21463
Data from https://ira.asee.org/by-the-numbers/

Good, better, best…

- Good?
  - Civil engineers **plan, design, and supervise the construction and maintenance of building and infrastructure projects.**
  - Mechanical engineers design, develop, build, and test mechanical and thermal sensors and devices.
  - Electrical Engineers design, develop, test, and supervise the manufacture of electrical equipment.
- Better?
  - Biomedical engineers combine engineering principles with sciences to design and create equipment, devices, computer systems, and software.
- **Best!**
  - Environmental engineers use engineering disciplines in **developing solutions to problems of planetary health.**

https://www.bls.gov/ooh/architecture-and-engineering/

Environmental Engineering 3.0: Faced With Planetary Problems, Solutions Must Scale-up Caring

- "Two questions confront professionals in the Anthropocene – the current geological epoch where evidence strongly suggests human population abundance, affluence, and technology are among the major drivers of global change (Steffen 2021).
- The first question is, "**how does humanity continue to flourish while living beyond planetary boundaries?**" ([redacted]; Richardson et al 2023)
- And the second question is, "**how does humanity share the benefits of flourishing and the harms of the Anthropocene among individuals, families, groups, communities, and populations, local to global?**" ([redacted]; Wahlrab 2023)."

[redacted]

Anthropocene and Climate Change for IPE 2100 Interprofessional Collaboration and Healthcare in a Global Context

[redacted]

Discussion questions

1. What are some global health challenges of climate change?
2. How can we reimagine interprofessional teams to address those challenges?

Appendix B. Representative quotes supporting each theme identified through an LLM-HitL approach to analyzing student responses to the question, “Describe three ways interprofessional teams may make an impact in addressing the Anthropocene/Climate Change/Severe Weather.”

Theme number	Theme title and two representative quotes
1	**Education and Community Awareness:** Quote 1: "Patient education can increase awareness about the impacts of human activities on the environment, emphasizing the connection between individual choices and climate change." Quote 2: "Interprofessional teams can engage with communities to raise awareness about climate change, its impact, and potential adaptation strategy."
2	**Policy Advocacy and Legislative Action:** Quote 1: "One-way interprofessional teams may address the Anthropocene and climate change is to lobby the government to help make change." Quote 2: "Three ways interprofessional teams may make an impact... are through advocating about the need for new healthcare technology and funding for that technology to state legislators."
3	**Sustainable Healthcare Operations:** Quote 1: "Three ways inter-professional teams can tackle climate change is by working to decrease carbon footprints of big corporations such as hospitals." Quote 2: "Interprofessional teams impact climate change by reducing the amount of stuff the patient uses. The patent needs less printed paper instead of getting multiple packets of the same material."
4	**Disaster Preparedness and Emergency Response:** Quote 1: "Interprofessional teams can contribute to developing disaster preparedness plans considering the diverse needs of communities affected by severe weather." Quote 2: "It is important for healthcare providers and patients to understand proper protocol... knowing what to do in a given situation could potentially greatly impact the outcome of a situation that involves severe weather."

Appendix C. Prompts used to perform LLM-HitL thematic analysis.

Phase 1: Structured Theme Extraction
Input the following prompt into each LLM (Gemini pro 3.0; and ChatGPT-5.2):

System Prompt: Act as an expert qualitative researcher. Analyze the provided transcript thematically, following Braun and Clarke's 6-step framework (Qualitative Research in Psychology, vol. 3, no. 2, pp. 77-101, 2006).
Task: Identify 3–5 core themes, including a name, detailed definition, and three supporting quotes for each.
Output Format: Respond strictly in JSON using this structure:

```
{
"model_name": "[Insert Model Name]",
"themes": [
{
"theme_name": "string",
"definition": "string",
"supporting_quotes": ["string", "string", "string"]
}
]
}
```

Phase 2: Pairwise Semantic Comparison
Use a "Referee LLM" or a Python script with the following prompt to compare outputs between Model A and Model B:

System Prompt: Act as an expert qualitative researcher. Analyze the provided transcript thematically, following Braun and Clarke's 6-step framework (Qualitative Research in Psychology, vol. 3, no. 2, pp. 77-101, 2006).
Task: Compare the two lists of themes provided below. Calculate a Semantic Similarity Score between 0.0 and 1.0 for each pair of themes based on conceptual meaning.
Criteria: A score of 1.0 means the themes are identical in meaning; 0.0 means they are entirely unrelated.
Input:
List A: [Insert JSON from Model A in attached file]
List B: [Insert JSON from Model B in attached file]
Output Format: Provide a JSON matrix of similarity scores for every combination.

Phase 3: Consensus & Threshold Filtering
Use this prompt to identify themes that meet your 50% appearance threshold:

System Prompt: Act as an expert qualitative researcher. Analyze the provided transcript thematically, following Braun and Clarke's 6-step framework (Qualitative Research in Psychology, vol. 3, no. 2, pp. 77-101, 2006).

Task: Based on the similarity matrix, group themes with a score > 0.70 into "Equivalence Classes".
Analysis:
1. Identify which Equivalence Classes appear in at least 50% of the total model runs.
2. For each class, synthesize a final consensus name and definition.
3. Flag any themes that appeared in only one model as "Low Reliability/Unique Insight" for human review.

Phase 4: Human-in-the-Loop Validation
The final step is a human review of the "Equivalence Classes".

Final Step: Present the consensus themes to a human researcher with the prompt:
"The following themes reached a consensus across [X] models. Please review the raw transcripts to confirm these themes accurately represent the participants' voices and have not been oversimplified by the models."