Socio-Technical Understanding and Local Impacts: Developing a Community Health Assessment in Civil and Environmental Engineering Senior Capstone (University of Maine)

Karen A. Merritt, PhD MPH[§]; Edwin Nagy, PhD PE[‡]

[§]Department of Ocean Studies, Maine Maritime Academy, Castine, ME

[‡]Department of Civil and Environmental Engineering, University of Maine, Orono, ME

karen.merritt@mma.edu | edwin.nagy@maine.edu

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Introduction

With the majority of STEM workers in the U.S. identifying as White or Asian (82% combined), Black and Hispanic STEM professionals are underrepresented in the STEM workforce (18%, combined), most specifically within remunerative STEM fields including engineering (14%) (Funk and Parker, 2018). An implication of Black and Brown under-representation in STEM is that STEM professions, including engineering, risk continuing to be practiced in a manner that does not explicitly acknowledge how the decision-making frameworks embedded within STEM can serve to perpetuate biases that, in turn, result in disparities in access to health, opportunity and resources at the community level.

Methods

Consistent with emerging frameworks to address social justice in STEM education, as well as to grapple with the social inequities that STEM training can perpetuate, we have developed a teaching module and capstone deliverable within the Senior year two-semester Capstone sequence in the Department of Civil and Environmental Engineering at the University of Maine (Orono, ME). Overall, the module is intended to introduce engineering students to the linked social and technical histories of built environments and the impacts of socio-cultural biases on the shaping of these environments. By introducing this content in Engineering Project Management (CIE 413) during the first semester of capstone, our goal is to deepen student exploration into questions of how and where infrastructure has historically been placed (or not) in U.S. cities. Our approach has evolved iteratively as follows:

In 2021, Merritt created a one-week course module (Mapping the City) for CIE 413 that focuses on the 20th century infrastructural history of a city familiar to our students (Portland, ME), highlighting neighborhood-scale, social and economic legacy impacts of Urban Renewal-era decisions in the city. Following module presentation and discussion, capstone teams were assigned a U.S. city in which to explore both city-scale and neighborhood-scale engineering and infrastructure histories. Students researched how placement of rail lines and highways impacts community access; how the U.S. history of redlining can perpetuate disparity in housing quality; how land use history can impact neighborhood susceptibility to flooding and reliability of water and sanitation infrastructure; and potential for chemical exposures in drinking water, soil or air as well as excessive heat. Explorations focused on: Boston, MA (North End); New Orleans, LA (Tremé); Los Angeles, CA (Sugar Hill); Portland, OR (Albina) and Pittsburgh, PA (The Hill). In a subsequent oral report-out and with guidance from Merritt and Nagy, students discussed patterns in infrastructural decision-making, including noting substantive overlap amongst cities in the demographics of neighborhoods that continue to suffer health and socio-economic impacts as the result of where infrastructure was historically placed.

Based on student feedback, we moved this past year toward asking students to foreground the evaluation of local health impacts within each capstone design. To this end, we followed the case study module for Portland, ME with a more narrowly focused exploration of a Portland neighborhood (Bayside). In the city's current vision to redress an Urban Renewal-era highway placement, there are concerns that proposed neighborhood improvements remain overly focused on automobile transit. Following overview of the issue, including specific focus on a community garden that would be bisected by a proposed transportation re-design, and open class brainstorm on how pedestrian access could be improved in the vicinity of the garden, we introduced a Health and Local Environment Impact Assessment (HLEIA).

The HLEIA is a six-question framework designed to identify and evaluate community demographics and land use; potential health-positive and health-negative impacts of scoped projects; contextual details on the location in which a proposed work is scoped; and potential impacts and possible outcomes with respect to water and air quality, soil stability, local food security, community mobility, and exposure to hazards in the environment. The HLEIA exercise is intended to encourage technically proficient STEM students to consider socio-cultural dynamics and demographics within and adjacent to project area boundaries. In application, we walked the class through a model HLEIA for the Bayside transportation re-design, then provided teams with the HLEIA template as an assigned component of final capstone deliverables.

Preliminary Results

For the initial iterations of the module in which students researched infrastructural histories for selected cities, we received generally positive feedback, including mention from multiple students that the information we'd shared (for Portland, ME) and guided them towards (for their assigned cities) was wholly new within their engineering curriculum. For both years in which we asked students to present on U.S. cities, there were students who experienced ‘lightbulb’ moments regarding how cities are structured, including noting how absent socio-technical framing has been in other coursework. We believe that this exercise resulted in notable engagement within some capstone teams regarding how biases amongst technical practitioners can translate directly into impacts on community health. The opportunity to facilitate exploration and discussion amongst Civil Engineering students of impacts of engineering decisions on health within the U.S. is of significant value in the engineering curriculum. With respect to the new HLEIA component of capstone, overall student deliverables were encouraging, with many teams identifying potential community health concerns in the vicinity of their project locations that would likely have otherwise gone under-examined.

Next Steps

In working to incorporate the HLEIA into the capstone experience, Nagy has noted that in creating a 2nd semester deliverable for the exercise, students were completing the HLEIA in parallel with their engineering design without applying outcomes to inform final design-related decisions. We are continuing to advance the HLEIA for the upcoming academic year and are evaluating whether the deliverable can be accomplished during Fall semester to better facilitate integration of the results into final designs. Our hope with this exercise is to foster engagement amongst engineering students and faculty on how best to incorporate more direct curricular focus on spatialization of health disparities, as well as on persistence of biases in the practice of STEM professions.

Reference

Funk, C. and Parker, K. 2018. Diversity in the STEM workforce varies widely across jobs. Pew Research Center Report. Accessed on-line 06/21/24

Karen A. Merritt, PhD MPH is an environmental and public health engineer with a consulting background in chemical characterization and evaluation of community impacts associated with contaminated sediment sites. She is currently Assistant Professor of Coastal and Environmental Geology in the Ocean Studies program at Maine Maritime Academy (Castine, ME) with a focus on marsh habitat stabilization and social vulnerability in coastal cities. She taught previously as adjunct faculty in Civil and Environmental Engineering at University of Maine (Orono, ME).

Edwin Nagy, PhD PE is a structural engineer with a teaching focus in on structural design (steel, concrete, timber and masonry) and general civil engineering for first and fourth year students. Edwin has worked extensively with the AIT Bridge-in-a-Backpack (composite concrete) and has conducted experimental and numerical research on fracture in wood and concrete. Edwin is currently a Senior Lecturer of Civil and Environmental Engineering at University of Maine (Orono, ME), serves as vice-chair on ASCE’s SEI committee on design practice, and advises the UMaine ASCE Steel Bridge competition team.

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