Socio-Technical Mapping and the Built Environment: Creating a New Course to Foreground Social and Environmental Justice Frameworks in Undergraduate STEM Education

Karen A. Merritt, PhD MPH
Department of Ocean Studies, Maine Maritime Academy, Castine, ME
Department of Civil and Environmental Engineering, University of Maine, Orono, ME
karen.merritt@mma.edu | karen.merritt@maine.edu

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Abstract

With a demographically disproportionate percentage of STEM workers in the U.S. identifying as White or Asian, STEM professionals who identify as Black and Hispanic fight underrepresentation within the STEM workforce as a whole, as well as specifically within economically remunerated STEM fields including engineering; atmospheric science; and physics. One implication of this skew in Black and Brown (under)representation in STEM is that associated professions continue to be practiced in a manner that does not explicitly acknowledge how the social and economic advantage to which that STEM education affords access is proffered within a hierarchical framework that permits and perpetuates disparity across health, opportunity and resource access.

Consistent with the emerging framework in ABET certification to directly address Diversity, Equity and Inclusion (DEI) in STEM education, as well as to grapple with the social

inequities that STEM training can perpetuate, I am proposing a new general engineering course - Socio-Technical Mapping and the Built Environment - that foregrounds the often easily invisible disparities in health that result from how decisions regarding infrastructure shape access. This course is intended to introduce STEM students to the linked social and technical histories of built environments and the impacts of socio-cultural biases on the past and present shaping of these environments. Employing readings, group discussions, publicly-available demographic source data and ArcGIS, this course, develops skills in exploring the extents to which built environments facilitate or constrain access to resources, including health.

With respect to Learning Outcomes, this course develops knowledge and skills in relation to: (1) major socio-cultural movements that have shaped the U.S. urban landscape; (2) impacts of these movements on access disparities within communities; (3) links between disparities in access and disparities in health; and (4) ability to discuss infrastructure, access, health and disparity in cultural exploration.

Introduction

In *Black, Brown, Bruised: How Racialized STEM Education Stifles Innovation,* the author writes that one specific root of institutional racism in STEM fields is in the framing of STEM in Historically White Institutions (HWI) as comprising a set of fields in which the production and the dissemination of knowledge are "*neutral and unconnected to power relations*" (McGee, 2020). With the majority of STEM workers in the U.S. identifying as White or Asian (82% combined), Black and Hispanic STEM professionals fight underrepresentation within the STEM workforce as a whole (18%, combined), as well as further within economically remunerated

STEM fields including engineering (14%); atmospheric and space science (10%); environmental science (7%) and astronomy and physics (6%) (Funk and Parker, 2018).

One implication of this skew in Black and Brown (under)representation in STEM is that associated professions continue to be practiced in a manner that does not explicitly acknowledge how the social and economic advantage to which that STEM education affords access is proffered within a hierarchical framework that permits and perpetuates disparity across health, opportunity and resource access. A January 2023 article in The Progressive regarding the proposed re-siting of a metal recycling facility in Chicago from the significantly White and wealthy neighborhood of Lincoln Park to a predominantly Black and Latine neighborhood in Southeast Chicago highlights via three perspectives the impact of power relations and hierarchy on societal decision-making (Johnson, 2023):

- Southeast Environmental Task Force Executive Director [OB]: "*We're sick of having to put our lives on hold in order to fight back against a dangerous polluter because the state and city refuse to do their jobs. [W]e need the city to step up and prevent this threat from coming to a vulnerable community."*
- The City of Chicago 2020 Air Quality and Health Report: "*In Chicago, with its history of segregation and disinvestment in Black and Latinx communities, the differences between neighborhoods can be stark. Some communities have rates of poverty, cardiovascular disease, and chronic obstructive pulmonary disease (COPD) that are ten times greater than others."*
- Ohio-based Reserve Management Group spokesperson [RS]:*, "What should have been an apolitical permitting process was hijacked by a small but vocal opposition that [said] they would unconditionally oppose this facility, facts and science be damned."*

Methods

Consistent with the emerging framework in ABET certification to directly address Diversity, Equity and Inclusion (DEI) in STEM, I am proposing a new general engineering course - **Socio-Technical Mapping and the Built Environment** - that foregrounds the often easily invisible

disparities in health that result from how decisions regarding infrastructure shape access. This course is intended to introduce STEM students to the linked social and technical histories of built environments and the impacts of socio-cultural biases on the past and present shaping of these environments. Employing readings, group discussions, data aggregations and spatial mapping tools, this course is intended to develop skills in exploring the extents to which built environments facilitate or constrain access to resources, including health.

This course employs ArcGIS as the mapping platform, relying on the increasingly broad site license availability of this platform on academic campuses, and utilizes publicly-available, downloadable demographic source data for creating and presenting StoryMaps of racialized space. Previous experience with GIS is not required; learning and retention of course concepts and skills will be developed via course readings, self-paced GIS practice exercises available through ArcGIS (https://learn.arcgis.com/en/gallery/; drawn from exercises rated as Beginning or Intermediate) and group StoryMap assignments. Group StoryMap assignments are guided by prompts (example: *Ueland and Warf (2006) hypothesize a spatial correlation between race and altitude, concluding that in Southern cities (their focus area), topography is racialized. Does your group agree? Consider some examples of how topography could be (can be/is) racialized and create a StoryMap exploring this question for a city of your choosing*.) to facilitate engagement and discussion amongst student teams.

A Story Map (individual or group) focused on neighborhood-scale infrastructural frameworks and access disparities serves as the course final project [demonstration StoryMap linked; sample syllabus with tested GIS practice exercises and group StoryMap prompts available]. This course can be offered in-person or on-line, synchronously or asynchronously.

For any of the above possible formats, the readings, discussion postings, individual and group projects, presentations and recorded class content may be shared via on-line learning platforms.

Results

With respect to **Learning Outcomes,** knowledge and skills will be developed in relation to: (1) major socio-cultural movements that have shaped the U.S. urban landscape; (2) impacts of these movements on access disparities within communities; (3) links between disparities in access and disparities in health; and (4) ability to discuss infrastructure, access, health and disparity in cultural exploration. As described above, **Learning Outcomes** will be achieved through developing: (1) hands-on familiarity with geo-spatial mapping tools and types of downloadable publicly-available health and demographic data that can be used to evaluate access disparities across multiple geospatial scales; (2) skills in interpreting, presenting and combining multiple types of information in ways that use maps, graphs and visualizations (StoryMaps) to tell nuanced story of place; and (3) understanding of how social forces create measurable and mappable differences in health and access across geospatial scales.

Next Steps

Socio-Technical Mapping and the Built Environment will be piloted in Spring 2024 as a general engineering elective within the University of Maine College of Engineering and/or as a new elective course in the Environmental Sustainability minor within the Maine Maritime Academy College of Engineering. The proposed course framing and content described in this overview is available to be shared. The intention of sharing framing and content for this course is to contribute to discussion amongst STEM faculty and students on how best to incorporate more explicit focus in curricula on the spatialization of racial disparity and persistence of institutional racial bias in the study of STEM fields as well as in the practice of STEM professions.

References

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Karen A. Merritt, PhD MPH is an environmental and public health engineer with 15+ years experience in chemical characterization and evaluation of community impacts associated with contaminated sediment sites. In addition to consulting, she teaches coastal geologic processes in the Ocean Studies program at Maine Maritime Academy (Castine, ME) and chemical fate and transport in Civil and Environmental Engineering at University of Maine (Orono, ME).