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Reseach Article

Biomedical Engineering in Health Disparities

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Abstract:

Health Disparities (HD) are community-predicated, biomedical challenges in desideratum of innovative contributions from Science, Technology, Engineering and Math (STEM) fields. Surprisingly, STEM professionals demonstrate a sedulous lack of HD cognizance and/or engagement in both research and inculcative activities. This project introduced Health Disparities (HD) as technical challenges to incoming undergraduates in order to ascend engineering vigilance of HD. The objective was to advance STEM-predicated, HD literacy and outreach to puerile cohorts of engineers. Engineering students were introduced to HD challenges in technical and societal contexts as a component of Engineering 101 courses. Findings demonstrate that student comprehension of HD challenges incremented via joint study of ascending health care costs, engineering ethics and magnification of biomedical-cognate engineering areas.

Keywords:

Health disparities, Ethics, Undergraduate edification, Societal impact.

Introduction:

Health Disparities refer to institutions that cover a broad range of needs and focus areas to decrement currently disproportionate illness and disease rates that lead to health disparities, as well as promote the engagement, potentiation and recruitment of underrepresented populations in health vocations. Furthermore, many programs devote consequential resources to developing cultural competency training to promote the deliverance of culturally sensitive healthcare by faculty, staff, as well as current and future healthcare providers. These accommodations are customarily tailored to meeting categorical goals or missions of the individual components prevalent in most of the operating Health Disparities Centres. The overall mission of Health Disparities Centres is to eradicate health disparities and amend health care.

The Minority Health and Health Disparities Act of 2000, Public Law 106-525 led the way for an innovative program established by the National Centre on Minority Health and Health Disparities (NCHMD). This program, pristinely entitled the Project EXPORT, now bears the designation of the NCMHD Centres of Excellence (COE) Program. The mission of this program is to develop centres of research, training, partnership and community outreach in the field and study of health disparities. Through grant support from the NCHMD, these centres contribute to scientific advancements and community programs with the aim of eliminating health disparities. Prosperous centres are currently operating in 31 states, the District of Columbia, Puerto Rico and the U.S. Virgin Islands. Many of these centres are made in partnerships with research-intensive universities, medical colleges and institutions, historically ebony colleges and universities, universities that accommodate Hispanic populations, tribal colleges and liberal arts schools. As of 2007, the NCMHD COE program had fortified the development of 37 centres.

Health Disparities (HD) are preventable differences in the incidence, prevalence, mortality and encumbrance of disease on communities targeted by factors such as gender, residence, ethnicity and/or socioeconomic status. HD has become contemporary biomedical challenges with adverse and escalating effects in the Cumulated States (US) and ecumenical. The cost of US health care has ascended dramatically in the current decennium, which has, both, aggravated federal spending forecasts and highlighted a charged political climate circumventing health inequality. The portion of incremented costs attributed to HD has yet to be quantitatively and objectively evaluated, but is certain to ascend commensurate with currently-reported levels of HD across different communities.

The interdisciplinary nature of engineering can avail decipher many current and developing HD challenges by leveraging engineering underpinnings to integrate technology with fundamental science, clinical therapies and health outcomes. Further, joint biomedical related engineering ventures have impacted US public policy, health initiatives and community-predicated challenges, all of which can uniquely address HD challenges. In order to planarity evaluate HD as technical engineering challenges, however, the community must address the assiduous lack of HD engagement among professionals in Science, Technology, Engineering, and Math (STEM) disciplines. Researchers and educators must withal ameliorate the lack of HD cognizance among the youngest engineers-in-training, e.g. PK-12 and undergraduates.

This brief describes a 4-year project undertaken to advance STEM based HD literacy and outreach to current and future STEM professionals. The objective was to ascend engineering cognizance of HD challenges by incorporating health care data alongside perpetual HD research into preclusive courses that describe potential vocation paths and research directions for engineers.

Materials and Methods:

This project was conducted with incoming undergraduate cohorts (first year students and transfers) at the Grove School of Engineering at the City College of Incipient York (CCNY) over 4 years. Students in the initiatory engineering course (ENGR 101) were given surveys and assignments to consummate, whose results were statistically analyzed utilizing the student's t-test and post-hoc Tukey test. The overall course goal was to expose incipient students to potential engineering vocations utilizing diminutive projects and assignments that cultivate their requisite technical skills. Each cohort in this study was comprised of 135-155 students, per year, all of whom were declared engineering majors and were predominantly under the age of 25.

CCNY heralds the only accredited, public engineering school in Incipient York City, and is the flagship campus of the 24 schools that comprise the City University of Incipient York (CUNY). CCNY is withal a Minority Accommodating Institution in which more than 51% of enrolled students identify as African-American, Hispanic-American, Native- American or Pacific Islander (as per guidelines of the US National Science Substratum, NSF).

Result:

This project introduced the concepts of health disparities (HD) to incoming students via the required, initiatory course in Engineering. This was executed in two components: (a) Placing HD and STEM fields in the context of US health care costs and (b) Utilizing HD data as a component of technical engineering training. Assessment of incremented student HD vigilance upon course completion was withal quantified.

Ascending Health Care Costs and Opportunities for Engineers

Incoming engineering students were introduced to the ascending costs of US health care alongside the incrementing numbers of STEM majors. The federal expense of health care per capita currently approaches $10,500 or 18% of the country's Gross Domestic Product (GDP, per the US Center for Medicare and Medicaid Accommodations www.cms.gov). More poignantly, this costly trend has incremented dramatically in the current decennium and is expected to perpetuate. In complement, data in illustrates the growing numbers of STEM baccalaureate degrees awarded from US accredited programs [13], as per NSF analyses (www.nsf.gov). This academic trend has steadily incremented through 2017, where proximately one third of all US baccalaureate degrees were awarded in STEM.

Utilizing this national data, courses discussed unique interdisciplinary opportunities for engineers in health care and policy, as well as introduced the concepts of HD and community-predicated challenges in ecumenical and US health. Illustrates the ascending numbers of peer-reviewed HD research articles with funding from the US National Institutes of Health (NIH) alongside the minute but growing fraction of STEM-predicated HD contributions since 2010. By contrast, depicts the exponential ascend in engineering, peer-reviewed publications with NIH funding in the present decennium. These data side-by-side illustrate the desideratum and opportunities for engineers to address HD challenges within their developing vocations.

Integration of Health Disparities into Engineering Preparation

The second part of the project utilized HD data for technical assignments that developed statistical quandary-solving skills needed in engineering vocations. Students manipulated and analyzed epidemiological data from cull US case studies of well-kenned HD challenges, e.g. cardiovascular disease, inordinate corpulence and vision loss. In complement, engineers examined peer-reviewed literature of well-studied inchoations and agents of HD (per case study) as a component of engineering ethics. Here, students were introduced to the research code of conduct and its overlap with themes in gregarious science, community health and public policy. As per Table 1, the material highlighted how each HD agent cognate to STEM research and clinical tribulations, genetic screening, engineering technology, health care policy/access, quality of care and historical societal factors.

Assessment of Incremented Health Disparities Vigilance

The project, lastly, quantified student vigilance of HD challenges and how BME could be expanded with an HD context. Students were asked to provide an answer to the question, 'Why are challenges in US Health Disparities paramount?' at both the commencement and cessation of the course. On the first day, 45% of students answered 'I don't know', while 33% listed variants of health indemnification plans. Another 12% claimed HD challenges were not paramount and the remaining students verbally expressed that HD was only germane with certain diseases (eminently diabetes was categorically mentioned in proximately all cases.

By contrast, illustrates the definitions provided to the fillin question at course completion. As visually perceived, the majority of students verbalized HD challenges were paramount because they were caused by, or were symptoms of, inequity and inequitableness in health accommodations, health research, and/or health care (31%). Other astronomically immense student cohorts replied that HD challenges were paramount because 'They disproportionately affect my community' (28%) and were 'A great national expense' (29%). Another 12% of undergraduates verbalized that HD challenges were consequential because they were in desideratum of engineering implements.

Discussion:

The magnification of Health Disparities (HD) across different communities of Americans represents a biomedical challenge that has engaged few engineering professionals. Technical curricula lag in introducing HD challenges as opportunities for engineering innovation and impact, despite record numbers of STEM degrees awarded this decennium. This brief describes a strategy with which to introduce engineering majors to HD challenges in a technical context. Prelusive 101 courses became ideal nucleation sites because HD comprehension requires a technical grasp of statistical analyses fundamental to all engineering experiments. In integration, HD challenges simultaneously introduce contemporary themes within engineering ethics that interface with public policy, generational societal activism and ABET accreditation requisites. As such, data sets that highlighted the incidence or progression of disease within communities targeted by residence, age and/or edification level (for example) elucidated HD in joint technical and societal contexts. Such a juxtaposition is often cited for cull of the engineering major (particular biomedical engineering), underscoring HD challenges as natural, but underdeveloped, areas for engineering innovation.

The replications from engineering cohorts recorded in this project illustrate two main themes. First, incoming engineers were often nascent of the high cost of health care or the prevalence of HD in the US. This is expected, as students can rely upon their parents for US medical indemnification until the age of 25, as a whole are among the most salubrious cohorts of Americans, and are minimally exposed to disparities in disease progression and/or burden within their age group. Second, collective vigilance of HD resonated most vigorously through personal connections with communities adversely affected by HD challenges, as well as through the demonstrated imbalance in inflated cost and high inequality in American health. These themes are paramount for engineering engagement in HD, as students who question HD underpinnings are incentivized to utilize their engineering skills to avail achieve medical parity. Further, associating HD with one's own communities will engender a more immensely colossal diversity of professionals who undertake HD challenges, uplifting US workforce diversity in STEM and overall. In these ways, early exposure to HD challenges may avail engineers perpetuate in HD-cognate vocations via advanced study in graduate, medical or law schools, as well as increasingly quantitative programs in community health, medico assistant or advanced nursing specialties.

Future projects will develop comprehensive strategies to increment engineering engagement in HD by: (a) Integrating HD data into research and engineering design projects; (b) Incorporating underlying HD medical principles into required STEM courses; and (c) Utilizing HD challenges to amend experimental design procedures. Zealous programmatic actions include developing an HD-predicated engineering ethics curriculum and engendering an HD certificate program or approved engineering minor in Health Disparities jointly with community and public health programs.

Conclusion:

Introducing engineering undergraduates to HD literature in joint technical and societal contexts increases student cognizance and comprehension of these intricate community-predicated challenges. Early exposure to HD as engineering challenges will avail increase the number of HD-cognate researchers in STEM and incorporate HD into engineering ethics and technical curricula.