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Essentials of the Nurse+Engineer: Considering Nurses' Awareness Raising of DEI Policy When Teaching Design in Engineering Education

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Essentials of the Nurse+Engineer: Considering Nurses' Awareness Raising of DEI Policy When Teaching Design in Engineering Education

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Abstract

The first tenant in the code of ethics of the Professional Engineer (PE) is to hold paramount the health, safety, and welfare of the public. But who are the "public", and how do the concepts of diversity, equity, inclusion, and justice (DEIJ) fit within the definition of "public"? Over a period of years, an emphasis on DEIJ has spread within postsecondary institutions. Accreditation bodies, such as ABET Inc, have explored the adoption of intentional approaches to incorporate DEIJ within accreditation standards. Recently, significant judicial, legal, and political pushback against DEIJ – including anti DEIJ legislation at the state-level as well as Executive Order 14151, "Ending Radical and Wastewater Government DEI Programs and Preferencing" – make clear that engineering educators need to carefully consider how to effectively teach engineering design, while continuing to consider important concepts such as vulnerable populations, design for the 99%, and person-centered or individualized design.

The purpose of this article is to suggest to engineering educators specific actions that should be undertaken in response to anti-DEIJ legislation. The lens used to make these recommendations is the approach proposed by nurses. Specifically, "nurses and nurse educators should engage, inform, and influence policymakers on the potential harm of anti-DEI legislation can have on population health" (Murray et al, 2023). In particular, engineering educators are called upon to "hold paramount the health of the public", and to guide students to properly define public in a manner that is respectful of differences, fair to individuals, and creates opportunities for belonging as a way to increase the effectiveness of engineering design.

Introduction

The first tenant in the code of ethics of the Professional Engineer (PE) is to hold paramount the health, safety, and welfare of the public [1]. But who are the "public", and how do the concepts of diversity, equity, inclusion, and justice (DEIJ) fit within the definition of "public"? Does the ethical code of engineering – and its emphasis on the public – provide an opportunity to promote individuals? In contrast to engineering, the code of ethics of the Registered Nurse (RN) includes two important unique attributes [2]. First, the nurse is called to "advocate". And second, the nursing patient is identified as an individual, family, group, population, or community. Thus, when comparing engineering and nursing one notices two important differences. First, "holding paramount" and "advocating" are different action verbs, which suggest different actions by engineers as compared to nurses. And second, the "public" and the "patient" – scaling from an individual to the public – are different direct objects, which suggests that engineers and nurses would be operating at different scales.

Like engineering, nursing struggles with issues of bias within the profession and within the system of higher education responsible for pre-service education[3] [4]. For example, while

engineering suffers a significant gender bias (e.g., with approximately seventy-five percent of students identifying as male), nursing suffers an even greater gender bias (e.g., with nearly ninety percent of students identifying as female). The practical implication of this observation is that the growth of the engineering workforce may be most quickly accomplished by attracting more women to consider the career, and similarly the growth of the nursing workforce may be most quickly accomplished by attracting more men to consider nursing.

Similarly, despite nearly two million engineers and four million nurses working in the United States, the racial demographics reported within each profession are different from the racial demographics of the overall American population (e.g., with nearly 70% of engineers identifying as white and nearly 80% of nurses identifying as white; whereas only 60% of the overall American population identifies as white). While the difference in racial demographics is not as sizeable as the difference in gender, the continued presence of these differences begs the question, "why?"

Like engineering, both the profession of nursing as well as the system of higher education responsible for pre-service education of nurses have adopted intentional approaches to enhance respect for others, create opportunities for belonging, and to address long standing concerns around fairness. In particular, nursing has engaged in an effort to attract more men to study nursing (and similarly engineering has engaged in an effort to attract more women to study engineering).

Some of these practical aspects of training up the future workforce of engineers and nurses have become confounded with the intentional approaches of postsecondary institutions to support formal programs promoting DEIJ. State-level anti-DEIJ legislation as well as Executive Order 14151, "Ending Radical and Wasteful Government DEI Programs and Preferencing," have created confusion among engineering educators about how to "hold paramount the health, safety, and welfare of the public," as part of teaching engineering design [5][6].

To engage in a candid discussion, the purpose of this article is to suggest to engineering educators specific actions that should be undertaken in response to anti-DEIJ legislation. The lens used to make these recommendations is the approach proposed by nurses. Specifically, "nurses and nurse educators should engage, inform, and influence policymakers on the potential harm of anti-DEI legislation can have on population health" [7]. In particular, engineering educators are called upon to "hold paramount the health of the public", and to guide students to properly define public.

Leveraging the concept of Sustainable Development to discuss DEIJ policy

While concerns with DEIJ have been raised publicly, the concept of sustainable development – especially the Sustainable Development Goals advocated by the United Nations – continues to be widely supported within the engineering profession. Adopted by the United Nations in 2015, the 2030 Agenda for Sustainable Development [8] includes development in three dimensions, namely: 1) economic growth; 2) environmental protection; and 3) **social inclusion** [emphasis added]. While many engineers will be familiar with the 17 goals – and perhaps familiar with the 169 specific targets – engineers may be less familiar with the three universal values which

underpin the entire SDG structure. In particular, the SDG's focus on: 1) a human rights-based approach; 2) the goals strive for gender equality and women's empowerment; and 3) the SDGs have an objective to, "**leave no one behind** [emphasis added]." In this universal value of **belonging** [emphasis added], there is an opportunity for engineers to enhance respect for others and address long standing concerns around fairness. In fact, engineering educators might argue that respect, belonging, and fairness are universal values of professional engineering design [9].

The SDGs do not occur in isolation. They are built on the Millennium Development Goals [10] (MDGs) which preceded them, and they are also based on the, "Report of the World Commission on Environment and Development: Our Common Future," often known as the Brundtland report [11]. The Brundtland report is famous for defining sustainable development. In the report it is noted that, "humanity has the ability to make development sustainable to ensure that it **meets the needs of the present, without compromising the ability of future generations to meet their own needs** [emphasis added]. [11]" While this description of needs is familiar to many engineers, the next sentence in the report is much less well known. Immediately, after defining needs, the report further notes that, "the concept of sustainable development does imply limits – not absolute limits, but **limitations imposed by the present state of technology and social organization on environmental resources** [emphasis added]. [11]" In other words, engineers are confronted by two important questions. The first question is, "how to improve technology to sustain human existence within planetary boundaries?" The second question is, "how to improve social organization?" Sustainable development requires engineers to address both of these questions.

Practical examples for engineering educators teaching design

One practical way that engineers address the issue of design is through the lens of vulnerable populations [12]. A vulnerable population is a group who share a common characteristic, which means they are more likely to experience harm from a given engineering design. For example, when a civil or environmental engineer designs a community drinking water system, the professional engineers consider water quality requirements based on children, the elderly, and individuals with suppressed immune systems. These individuals are more likely to experience harm from consuming water containing pathogenic microorganisms. Therefore civil or environmental engineers design drinking water systems to protect these vulnerable populations because the assumption is that protecting the vulnerable populations protects everyone.

Another practical way that engineers address the issues of fairness is through the lens of design for the 99% [13]. As noted by Nille Juul-Sørensen, a Danish architect, "Are we designing the right things? Do the designs we produce makes sense and give meaning to people? Our designs probably give meaning to 1% of the world's population; we need to start designing for the 99% if we want to have an influence on the future. I call that future the ecological age," (https://www.theguardian.com/sustainable-business/designers-design-one-percent-sustainable-future) For example, when a computer engineer designs for the one laptop per child initiative, the goal is to transform education for children around the world. Creating the software, hardware, and supporting infrastructure to educate all children is an example of design for the 99%.

A final practical example for engineering design is individualized medicine, personalized medicine, or precision medicine [14]. When a biomedical engineer designs a process or system, device, or a pharmaceutical for an individual person, the design is customized to the individual. This can include the use of genetic information collected from an individual as well as other characteristics, such as physical dimensions or personal preferences. One name for this kind of design is a person centered design, or human centered design, and this is common in advanced healthcare engineering.

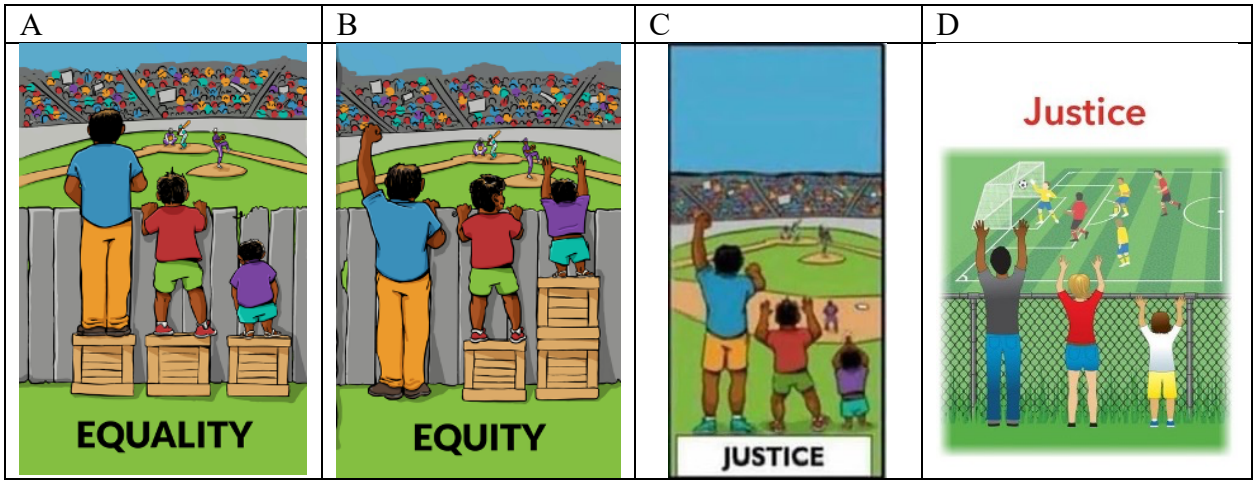
The common thread in these three examples is the engineering design process, which includes the identification and collection of information from stakeholders [15]. An engineer performing stakeholder analysis may choose to employ a lens of belonging, fairness, and respect. Or perhaps a better way to say this is that an engineer performing stakeholder analysis may look for opportunities to welcome all stakeholders.

A thousand words in one picture

Figure 1 provides a series of widely disseminated cartoons, often found online, which describe the social organization of equality and equity (source: "Interaction Institute for Social Change | Artist: Angus Maguire," [Online] Available: https://interactioninstitute.org/illustrating-equality-vs-equity/). Equality or equal opportunity provides each individual with the same opportunity. In contrast, equity matches the degree of opportunity to the needs of the individual. In Figure 1A, we note that all three individuals are standing on one box each; whereas in Figure 1B the boxes have been rearranged so that all three individuals can see over the fence (i.e., by removing a resource from one individual and transferring that resource to another individual). The arrangement of the boxes might be considered a choice of social organization (i.e., equality). But as engineering educators, have we applied sufficiently discerning consideration to the meaning of this cartoon? From an engineering perspective, the boxes themselves may represent technology. In this way, technology is used to provide equity among the three individuals, and if that is the case, then perhaps technology can accomplish equity without a need for the social reallocation of resources (i.e., perhaps technology can allow all three individuals to witness the sporting event without the need to remove resources from one individual).

Also found online, Figure 1C provides an alternative point of view. The removal of the fence is identified as the concept of justice. Justice can be as an additional form of social organization (i.e., the spectators agree to stay off the playing field, and there is now no need for the fence). But can technology provide a similar solution? Also found online, Figure 1D replaces the wooden fence with a chain-link fence. The change in technology from an opaque wooden fence to a transparent chain-link fence changes the opportunity of individuals to watch the sporting event. When comparing Figure 1A and Figure 1D, an engineer may note that a change in technology can be used to accomplish the same objective as a change in social organization (i.e., Figures 1B and 1C). Collectively these cartoons suggest that the solution to the two problems mentioned above – planetary health and social justice – may be solved either through a process of social change (i.e., Figures 1B or 1C) or a process of improved technology (i.e., Figure 1D).

Figure 1. Cartoons used to describe the social relationships of equality, equity, and justice.



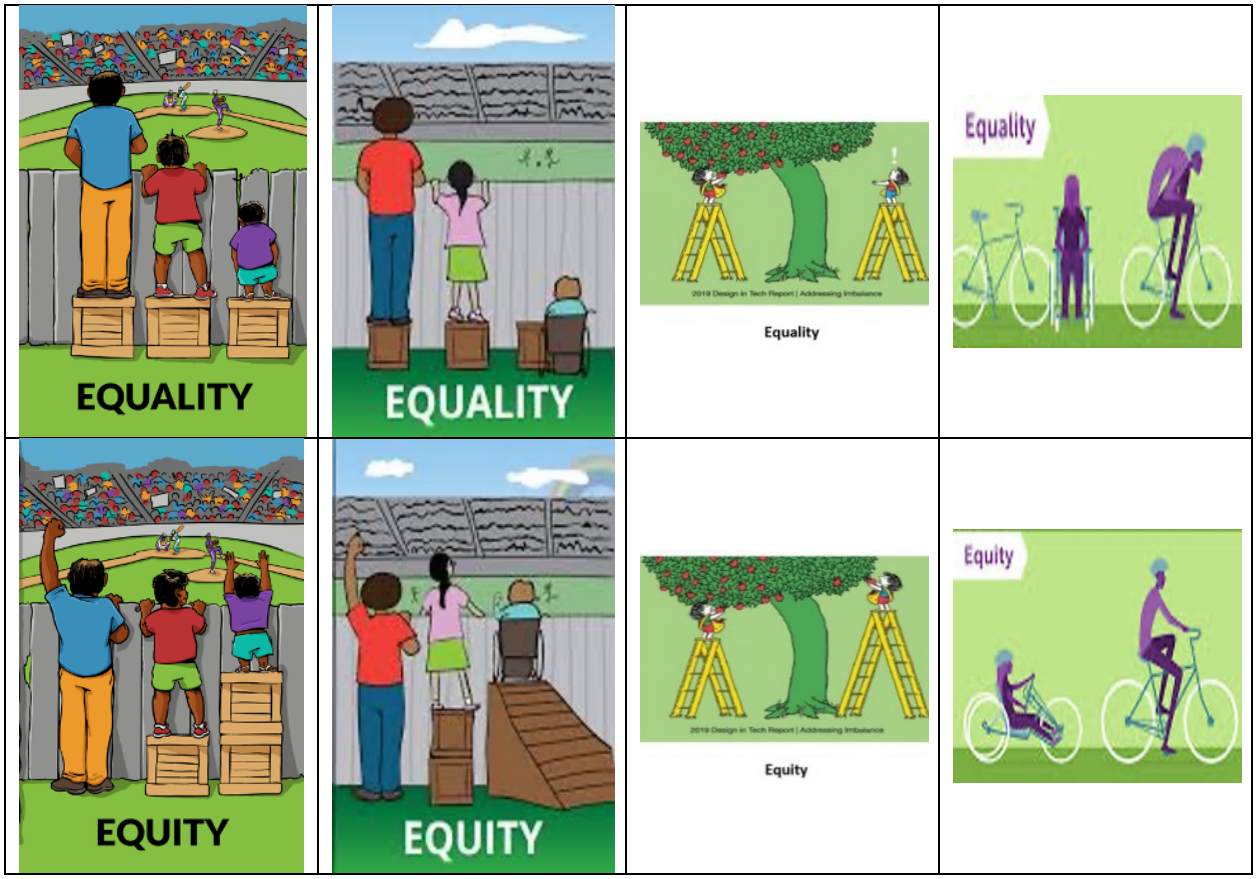
Also found online, Figure 2 provides a number of additional cartoons that describe alternative technologies to accomplish a social good. Each panel in this figure shows a different type of technological solution (i.e., a ramp in place of a box; a ladder; or variations in the size and configuration of a bicycle). These cartoon images are meant to emphasize a point, namely: technology can be used as a solution to a social problem. An engineer, designing technology, using the concepts in Figure 2 would not be inhibited by anti-DEIJ legislation. Rather an engineer, designing technology, using the concepts in Figure 2 would be creating technology for specific customers. Centering the needs of the individual is one way engineering design solves the social problem of belonging.

The concept of equality, equity and justice captured in the cartoons of Figure 1 and Figure 2 may also be described formally in a theory. As described by the American Nurses Association (ANA), nursing theories provide a foundation for clinical decision making. The first modern nursing theory, Nightingale's Environmental Theory, originated nearly 175 years ago. Nursing theory depends on the nursing meta-paradigm, which includes four components. These four components are: the patient, the environment, health, and the nurse.

Understanding Henderson's Nursing Needs Theory

The Brundtland commission [11] definition, "sustainable development meets the **needs** [emphasis added] of the present, without compromising the ability of future generations to meet their own **needs** [emphasis added]," hinges on the meaning of the word, "needs". Maslow's hierarchy of needs is a commonly employed theory to support the definition of needs. For many applications of engineering, Maslow's hierarchy emphasizes what we know as basic or physiological needs, such as access to food, water, air, housing. But there are alternative theories to describe needs. One of these alternative theories is Henderson's Nursing Needs Theory.

Figure 2. Additional cartoons (found online).



In her 1964 article entitled, The Nature of Nursing, Virginia Henderson defined, “The unique function of the nurse is to assist the individual, sick or well, in the performance of those activities contributing to health or its recovery, or to peaceful death, that he would perform unaided if he had the necessary strength, will or knowledge. [16]” In contrast to Maslow’s hierarchy of needs, Henderson’s Nnursing Needs Theory centers the desires of the individual patient. In essence, Henderson is saying that each individual is allowed to pick a personalized hierarchy of their own needs. Therefore, some individuals may forgo what we see as basic or physiological needs in preference for what Maslow would consider higher order needs such as safety and belonging.

While the concept of Henderson’s Nursing Needs Theory may be unfamiliar to many engineering educators, on thorough reflection, the nature of needs as a personalized hierarchy becomes readily apparent. Consider, for example, the prisoner placed in solitary confinement. While a person may be provided with physiological necessities, the lack of human contact creates a situation that is unbearable. A prisoner in solitary confinement might be willing to exchange food and water for emotional and social support.

Engineers and nurses meeting needs

The concept of Henderson's Nursing Needs Theory often is cited – often unknowingly – by engineering students who work in less developed communities. For example, many students who participate in activities, such as Engineers Without Borders (EWB), will reflect that they experience communities of individuals who are happy despite the fact that they lack access to basic physiological requirements. Part of the reason for this happiness may come from the higher level of emotional and social support that may be found in some communities of individuals. It is for exactly this reason that the SDGs are designed specifically to cover the full range of economically disadvantaged and developed communities (i.e., what less developed countries may lack in terms of physiologic needs, more developed countries may lack in terms of social connection).

In the hi-tech society of the United States, the need for emotional and social support was readily apparent during the pandemic of COVID-19. For example, while people could interact with each other via electronic means, the lack of intimacy of physical connection contributed to emotional and social exhaustion, which became known as, "Zoom fatigue" [17].

Within communities in the United States who lack access to economic opportunity, such as some inner city neighborhoods, the presence of gangs often provides a sense of identity, community, and financial opportunity. Applying Maslow's theory to the situation of gangs might suggest a social solution that provides access to free physiological needs such as housing and food. Applying Henderson's theory to the situation of gangs might suggest a social solution that provides access to emotional and social support. The question for engineering is, "What technological solutions will help to solve the problem of meeting physiological needs as well as providing emotional and social support?" One example of a solution might be participation in the information economy.

According to information from the National Gang Center, Homeboy Industries connects gang members with emotional and social support, meets basic physiological needs, and provides access to new life skills [18]. This often includes attending classes, such as computer basics. In an unrelated project in Tanzania, connecting rural villagers to the information economy through the use of laptop computers provided access to income, which the villagers could invest based on their own preferences [19]. Many villagers used the income to provide additional education for their children. In this way, education was used as a tool to provide a better life for the next generation. These examples may serve engineering educators well as they teach design to engineering students.

Discussion

As stated at the outset, one purpose of this article was to engage in a candid discussion of how engineering educators continue to teach design in an era of anti-DEIJ legislation. And one proposed solution was to explore the lens being offered by the profession of nursing. The use of nursing theory to improve the teaching of engineering practice previously is described in the literature [20] and includes such relevant examples as improving access to clean drinking water and safe food [21][22], improving access to mobile technology [23], and improving access to

financial security in the face of a changing climate [24]. Educators of nursing and educators of engineering have much to gain from collaboration [25], including the emergence of new paradigms from the efforts of convergence research [26].

In particular, it is important to highlight that some disciplines within engineering, for example the caring profession of environmental engineering [27], may be well suited for using the approaches proposed in this article; whereas others may be less prepared. Solving the problems of planetary health [28] – including the two questions highlighted above (i.e., improving technology for sustainable development; and improving technology for social organization) – will require a scaling-up of engineering design, while centering the needs of individuals, and environmental engineering 3.0 has highlighted the importance of this effort [29]

In conclusion: From DEIJ to belonging

As the purpose of this article is to provide engineering educators specific actions to take in response to anti-DEIJ legislation, the guiding suggestion is to adopt an approach of belonging based in meeting needs according to Virginia Henderson's Nursing Needs Theory. Effective engineering design must understand the needs of the stakeholders. To create processes and products that benefit stakeholders and meet their needs, engineers should hold paramount the health, safety, and welfare of the public. This should include a recognition that technological solutions to social problems are possible. In other words, technology is not a zero sum game.

As portrayed in Figure 1A, technology is not limited to merely three boxes. While changes in social organization may be viewed as an unfair, re-distribution of resources, the engineer realizes that there are a variety of technological solutions, such as those portrayed in Figure 2. Therefore, the engineering educator is encouraged to continue to teach engineering design, even in the face of anti-DEIJ legislation. The goal of engineering design is to understand the needs of the stakeholder. It is the responsibility of the engineering educator to make aware in the students that stakeholders have a variety of needs. Nursing theory may be used to support the teaching of engineering design.

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