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The Influence of Personal Experience and Identity on Design: Teaching Positionality to Engineers

Emily Lawson-Bulten, University of Illinois at Urbana - Champaign

Emily Lawson-Bulten is a PhD candidate at the University of Illinois at Urbana-Champaign. As a licensed civil engineer, she is concerned about equitable access to infrastructure, especially for WASH services in non-industrialized nations. Her research focuses on the influence of power dynamics between international NGOs, engineers, and their client communities on water system design. With a background in Contextual Engineering and International Development Studies, Emily utilizes participatory approaches to increase engineering awareness and community agency throughout the design process. Emily integrates feminist and anti-racist methodologies into the classroom as well, finding new ways to engage students' whole selves into engineering work.

Dr. Samantha Lindgren, University of Illinois at Urbana - Champaign

Samantha Lindgren is an Assistant Professor of Sustainability Education in the College of Education at the University of Illinois Urbana-Champaign. She is affiliated faculty in the Grainger College of Engineering in Agricultural and Biological Engineering and the Technology Entrepreneurship Center, and the Women and Gender in Global Perspectives program.

Dr. Ann-Perry Witmer P.E., University of Illinois at Urbana - Champaign

A teaching professor, researcher, lecturer, and professional civil engineer, Ann-Perry Witmer is the architect of the emerging discipline of Contextual Engineering, which merges technical design with societal understanding to improve adoption outcomes.

THE INFLUENCE OF PERSONAL EXPERIENCE & IDENTITY ON DESIGN: TEACHING POSITIONALITY TO ENGINEERS

INTRODUCTION

For more than a decade, scholars have called for the engineering profession to shift towards a more socio-technical approach [1, 2]. A majority of undergraduate engineering programs now require social science or humanities courses; however it is not evident that the engineering curricula systematically prepares students to meet the vision of the *Engineer of 2020* [3], an engineer whose societal impacts go beyond the technical to vastly improve the quality of life for people [4]. A recent study of engineering programs finds a large gap between the humanistic ideals of the inclusion of social science in the engineering curriculum and its practical outcomes [3]. That is, while most engineering schools' mission statements mention social benefits, the curriculum does not indicate how these benefits are defined or by whom, or how engineers contribute to or participate in the social context in which these benefits are realized [3].

Engineering education is rooted in a tradition that disregards or segregates societal considerations [5]. Even when educational programs emphasize human-centered design, they frequently present societal considerations as a topic isolated from technical processes, rather than integrating it into design actions [6]. This results in students being unaware that throughout the design process, value systems are being imprinted into each engineered item as a way of world building [2, 7]. The acknowledgement that the engineer is not neutral and that research and design changes as a result of the engineer's participation in the process challenges the methodological hegemony of traditional scientific empiricism [8]. Thus, the engineer must be conscious of their role as the designer/researcher and of their relationship to the community or client, as well as on-going research and engineering products.

In one of our upper-level engineering classes focusing on societal influences for technical design at a large Midwestern university, students are asked at the start of the semester to describe at what point their ability to make design decisions ends. Eighty to 90 percent of engineering students each semester indicate that at the end of project scope, once design has begun, external considerations are no longer incorporated into the technical development process. In other words, students are taught to believe that once they begin the design process, they must follow a prescribed engineering route that leads to a deterministic outcome. This lack of context awareness is consistent across literature [9]. The lack of contextual understanding and technical determinism has a tremendous impact on incorporation of societal context because it prevents engineering students from recognizing that they make many decisions during design and those decisions are strongly influenced by their own identity, experience, and position in their home society.

In community designs, the call to consider societal background and impact is even more prominent, highlighting how contextual factors affect the efficiency, justice balance, and adoption of any design [10, 11]. Addressing the societal context is important in any design, but especially in designs implemented in communities or to populations outside of the engineers' own experience. These are situations in which the designer(s) are most likely not to reflect an understanding or shared identity of end users' needs and conditions. While the field of engineering is diversifying, in the United States, nearly three-quarters of engineering positions are still held by men, two-thirds of whom identify as white [12]. Until there is greater representation in the sciences and engineering fields, new pedagogical approaches are required to ensure that engineering designs are inclusive and appropriate for the sociocultural contexts into which they are implemented.

Many institutions develop DEI education as a separate, focused course to assist engineers in understanding place-based context. Social science courses may go some way in helping engineering students understand historical and contemporary power dynamics, especially as it relates to working with marginalized populations when interdisciplinary teams are not possible. However, it is unlikely that these courses will include methodological explorations that will afford engineering students opportunities to develop reflexivity, a practice for examining their *positionality.* Additionally, by offering courses that solely focus on the diversity elements in engineering, or by requiring only a social science course, it can telegraph to the engineering student that societal considerations are external to the design process, rather than already integral in design decisions [5].

When engineers do not consider the diverse human experience, products do not properly serve the needs of everyone. In her book, *Invisible Women: Exposing Data Bias in a World Designed for Men*, Criado-Perez reviews many examples of how innovation and services designed for men negatively impacts other genders [13]. A male-default mindset has real world consequences on how others are able to navigate the world. For instance, women in the driver seat are 17% more likely to be killed and 73% more likely to be severely injured in a car crash due to the lack of information around how women's bodies respond in a crash, based on improperly sized crash test dummies [14]. In our classrooms, students identified other examples of how the traditional engineer, a cis, white-male default, reduced the experience of users in imaging software, pedestrian safety, and waiting in lines for the bathroom. It is clear that engineering teams need to adapt to a diverse perspective, one that can account for the diversity of human interaction with each technology.

In this study, we investigate the sociological concept of positionality and emphasize its importance within engineering. Then, we explore tangible methods for integrating positionality into a multitude of engineering design classrooms. The goal of the described activities is to assist students in understanding how their own identity and experiences influence their design work. We first present the classroom setting, to emphasize the conversation climate necessary to safely engage diverse students within identity work. Additionally, we situate ourselves within this work, as instructors should not be removed from the context of their institutions. We then walk interested readers through the in-class activity, bordering discussion, and impact assessments. Overall, Likert surveys and analyzed assignments indicate an improved understanding of positionality and application to engineering design by participating students. We conclude this study with a reflexive practice on the activity's success and how future instructors could utilize this methodology for their own integration of positionality into the engineering classroom.

Positionality

Positionality refers to the ways in which one's evolving identities and their intersections shape our understandings, perspectives, and ways of engaging in the world [15]. Social science research is seen as a process, rather than a product. In qualitative methodologies, the researcher is the instrument of data collection in which the cogency of the research, or in this case, design, process is believable because of the relationship between researcher/engineer and participants/community is well articulated [16]. The need for critical self-analysis becomes more salient when considering the power dynamics of fieldwork and working with populations of which the researcher is not a member since fieldwork is a dialogical process and inherently disruptive [8].

There has been a shift within engineering education research to consider positionality. In 2021, Hampton, Reeping, and Ozkan completed a review of engineering education literature, discovering only 16 explicit positionality statements from the three target engineering education journals [17]. Recently, the Journal of Women and Minorities in Science in Engineering began requiring positionality statements [18], pointing to the necessity of a reflexive practice within engineering education research and the engineering discipline. However, this approach requires a more vulnerable, often viewed as less rigorous, approach to engineering [19, 20]. Research still centers on researchers within education, overlooking the constant interactions that every engineer has with society, regardless of discipline.

Why Positionality Matters

While ideas related to positionality have been introduced in engineering education and even in engineering disciplines through concepts like empathy [21], the impact of considering positionality on design remains underexplored [22] and underutilized in practice.

Milner's framework [23] for researcher positionality recommends a multi-step process in which researchers are guided through reflections of self, their relation to others, representation and participation, and shifts of thinking about systems rather than self. While developed for education researchers seeking to avoid (un)seen or unforeseen dangers when working through tensions in their research around culture and race, this framework is useful for the engineering student and practitioner who wish to elevate the voices of the community for whom they work while avoiding the reproduction or reinforcement of inequalities associated with designing for others. Critical to the research and design process is the engineer's development of cultural knowledge [24, 25].This framework asks researchers and engineers to consider their own cultural and racial heritage and how it informs their interests, and to weigh that against the cultural and racial heritage and interests of the community with whom they work [23]. Reflection questions such as "*How do I negotiate and balance my own interests and research agendas with those of my research participants, which may be inconsistent with or diverge from mine? How do I know?*" and "*What are and have been some social, political, historical, and contextual nuances and realities that have shaped my research participants' racial and cultural ways or systems of knowing, both past and present? How consistent and inconsistent are these realities with mine? How do I know*?" [23] are especially salient for engineers working with diverse stakeholders. The focus on "how do I know" requires that engineers consider to what extent they understand their stakeholders and from where this knowledge comes, encouraging participatory approaches to engineering in which stakeholders are engaged as collaborators. Finally, the framework asks engineers to consider the systematic and organizational barriers that have shaped the community's experiences locally and globally.

An approach to engineering design cemented in positionality is directly oppositional to the pervasive ideology of technological determinism that is prevalent in engineering education today. Technological determinism as a theory believes that technology progresses autonomously and therefore drives social change [26]. This theory, although disputed for decades, has shaped how society views technology. Technological determinism separates the engineer from the responsibility of creating the technology and the social implications associated [27, 28]. Educating engineering students in positionality contradicts that engineering is an objective process, resulting in questions to the lack of rigor or merit within the field [18]. Instead, this education transitions popular thought towards a critical theory of technology with socially engaged engineers.

METHODOLOGY

Researcher's Positionality

As in all research, it is helpful to understand our positionality and, therefore, our lens on the data. The first author, Emily Lawson-Bulten, is a PhD student at the time of publication. She and Dr. Ann-Perry Witmer were the teaching assistant and instructor of record, respectively, of the course in which this research was completed. The following exercise was developed as a way to further integrate Emily Lawson-Bulten's research into the Contextual Engineering classroom. Dr. Samantha Lindgren served as the evaluator within the classroom and, having an education background, contributed significantly to refining the theoretical framework. We acknowledge that the diversity of our positions is somewhat limited, as we all self-identify as white, female, U.S.-born scholars. However, between the three of us, we have worked on international projects across the world, specializing in humanitarian and contextual engineering projects in low-resourced, rural, and/or non-industrialized contexts. Additionally, as women with engineering backgrounds, we have all experienced the impact of our subscribed identities and historical oppression, sometimes to the point of overt, gender harassment. As instructor for the lesson, co-author Lawson-Bulten attempted to be vulnerable in her privileges and oppressions, and as the youngest member of the research team, the intersection of her vulnerability, gender, and age further assisted students in being vulnerable themselves in classroom and throughout their assignments.

Classroom Overview

This study was implemented as a single day of teaching, with an accompanying assignment for students to complete. However, this single day of teaching was part of a larger unit on identifying the impact of the design practitioner within a semester long, 13-week engineering course on Context in International Investigations. This unit came after a unit on recognizing stakeholder roles, objectives, and motivations. It is important to note that although we propose the following positionality activity as applicable for any classroom, these particular students were already poised to consider their own effects on engineering design, given the class focused on understanding the context necessary when working in non-industrialized areas. Additionally, this course utilized a constructivist, co-production pedagogical approach. For example, while objectives are clearly stated, tasks are open-ended and students are encouraged to discover together. The emphasis is on the learning process in which the application of the subject matter is prioritized. Among STEM students this type of epistemic uncertainty can be quite difficult, as traditional engineering education often suggests there is one correct answer or decision-making process [29, 30]. In this way, the classroom benefited from being multi-disciplinary and having a large diversity of life experiences. Table 1 provides the demographics or the classroom as reported by the university. In addition to these demographics, there was a wide range of racial and ethnic identities, ages ranging from 18-35 years old, and a mixture of US-born and internationally born students, with one student having lived in the United States for less than a year.

Table 1. General demographics of classroom makeup*

Category	Sub-Category	N	Percentage
Gender**	Female	23	37%
	Male	40	63%
College Division	Agriculture, Consumer, Economics	9	14%
	Fine & Applied Arts	3	5%
	Engineering	34	54%
	Liberal Arts & Sciences	13	21%
	Other	4	6%
Degree Level	Freshman	13	21%
	Sophomore	18	29%
	Junior	11	17%
	Senior	12	19%
	Graduate Student	9	14%

* The above demographics represent the entire class and do not guarantee a specific percentage of students who participated in the in-class activity, as only 56 students were present to participate

** University statistics present gender demographic information in a sex, Male-Female Binary. However, the instructor is aware of at least three individuals who self-identified as gender non-conforming. At least two of these students investigated their gender social identity during the positionality exercise. To not assume or misrepresent any students, we have presented class demographics as reported by the university, including the category name.

In-class Activity

Before the activity, students were told that the class's activities would explore how our social identities affect engineering designs. To accomplish this, we first explored what a social identity was. Although Emily Lawson-Bulten was the main instructor for this lesson, Dr. Ann-Perry Witmer also participated in discussions as course instructor. The classroom set-up was very informal and conversational, meaning students were encouraged to discuss as many social identities as possible. This class was held during week 5 of the course, so students felt comfortable discussing politically charged topics within the course (as described by their own reflections and through observation of classroom interactions).

After collectively deciding on a working definition of social identity, students were asked to individually design a public restroom. No additional information was provided on location, budget, etc., although students were encouraged to include anything they wished to experience in a public restroom and to explain why they chose that item. After 5 minutes, we had students to pair with an individual near them and compare what elements the other individual had versus themselves. These pairs were then formed into larger groups of 4-6 students to create a new public restroom design that met all criteria and considerations of the group. Group designs were drawn on the board and presented to the class for further discussion.

Public restrooms were chosen intentionally, despite not every student being in an engineering field in which they would design a bathroom. It is reasonable to expect that students have interacted with a multitude of bathroom designs in their lives. Even individuals who grew up in similar situations, such as a Chicago Suburb, as many UIUC students do, will have had significantly different experiences at bathrooms. Around the world, bathrooms are an indication of culture. Walking into a restroom at a Japanese airport greets you with a significantly different experience than at an underfunded school in the United States. Due to recent anti-trans legislation, they can be perceived as a political space, one of identity testing. At clubs and bars bathrooms can become social spaces. As a woman, the sharing of sanitary products within a restroom is a collective experience that brings you closer to complete strangers. The access to restrooms can itself be seen as a privilege with 3.5 billion individuals still lacking access to managed sanitary systems worldwide. The range of personal experiences when using a bathroom in contrast to the universal need of a restroom is exactly why designing a restroom was utilized for this activity.

Corresponding Assignment

After in-class discussion, a positionality assignment was announced that would allow students to individually explore their own social identities. I first walked students through my own social identity map, designed by Jacobson & Mustafa [31] shown in Figure 1 below. This social identity map was designed from a critical, qualitative health theory. Level 1, the largest level, represents a social identity as either self-prescribed or societally prescribed to individuals. While Jacobson & Mustafa offer class, citizenship, ability, age/generation, race, sexual orientation, cisgender/Trans, & gender as starting points, there are additional Tier 1 social identities that could be considered. In the assignment, students were asked to complete three social identity maps, ensuring that students had to engage with multiple identities but allowing students to share what aspects of their identity they were comfortable with to ensure a feeling of safety within the classroom. Tier 2 requires a self-reflection onto how the specific social identity affects an individual's life. This includes ways that a social identity affords privilege or creates oppression. Finally, Tier 3 is a reflection of the emotions attached to these social identities. Identifying emotions is a key step for designers, as it can indicate where biases would arise.

This social identity map is an excellent resource to assist students to begin to view their social position and the impact of that position on their location. Primarily, this tool was created for just that, as a starting point to visualize positionality. Jacobson & Mustafa are clear throughout their presentation of these social identity maps that these maps must be a part of a larger, reflexive process [31].

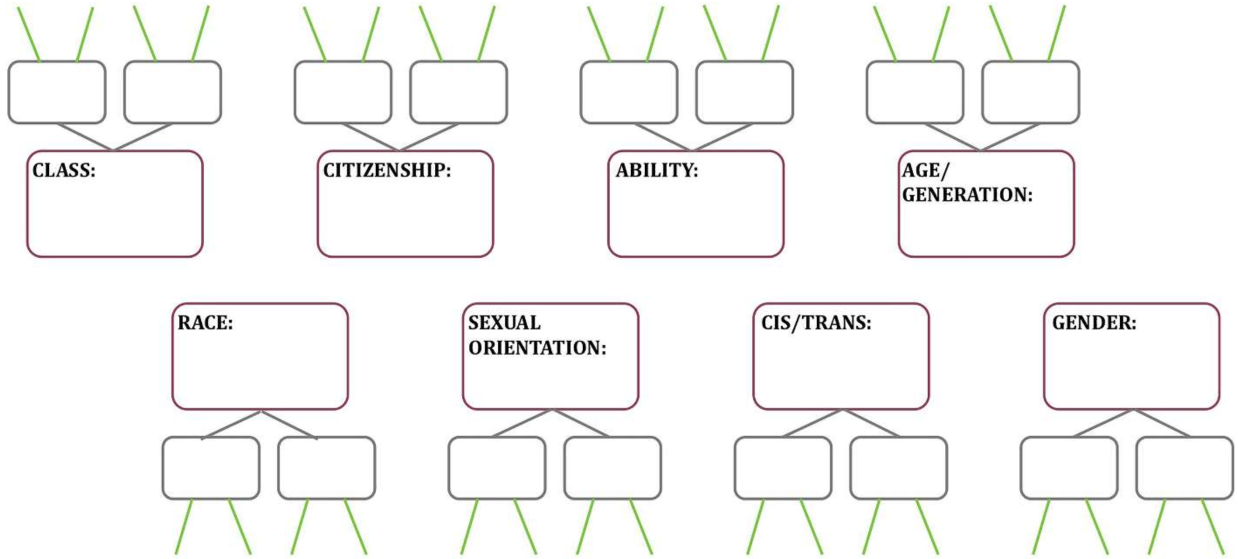

Figure 1. Empty Social Identity Map from [31]

In addition to the social identity mapping exercise, students were required to complete reflections (min. 500 words per question) based on their social identity maps and the in-class activity. This activity was largely inspired by Meagan Pollock and questions 1, 2, & 4 were sourced directly from Engineer Inclusion [32].

1. How do my social identities (including either privilege or marginalization) affect how I see and understand the world?
2. In what ways are my interactions, decisions, and interpretations affected?
3. Why do we discuss positionality in engineering? Provide examples.
4. How can I minimize how my biases affect my interactions, decisions, and interpretations?

These questions were stacked based on Bloom's taxonomy levels of understanding.

1. Question 1 provides an opportunity for the students to **explain & implement** (level 2- Understand, and level 3 – Apply) their existing knowledge into their own life, based on their completed social identity maps.
2. Question 2 requires students to **compare** (level 4 – analyze) their own experiences of the world with how they then approach navigating society.
3. Question 3 asks students to then **judge and defend** (level 5 – evaluate) why these concepts are related to engineering.
4. Finally, Question 4 requests students to **recommend** (level 5 – evaluate) methods for mitigating the negative effects of their bias.

Impact Analysis

Multiple analysis methods were utilized to determine the effectiveness of the teaching in achieving an analysis or evaluation level.

Immediately after the class, students completed a limited survey about the instructor and in-class activity. This survey included a total of 11 rank questions and 6 open answer questions in which all questions were optional to complete, as it also served as an Early Informal Feedback for the

Instructors and the Course. Because of the survey's multiple objectives, the survey only included two questions related to the activity, presented on a Likert Scale from 1 (representing Not at All) to 5 (representing Very Much so or A Great Deal):

1. The In-class Activity broadened my understanding on Positionality.
2. Today's lesson increased my understanding of how social identities affect perception.

As the activity was experimental, these results were utilized to determine if students needed additional training on the subject matter (in addition to the quality of discussion) before completing the positionality assignment previously described.

Answers to the positionality assignment were later analyzed utilizing a deductive coding process-based on our self-identified elements of self-reflection and positionality. It was imperative to understand what aspects of positionality the students most connected to. Through literature review, self-reflection, and years of practice, we identified the key aspects related to positionality in correlation to this assignment. This included:

- Understanding of identity, defining identity
- Self-identity versus ascribed identity
- Negative impact on life experience (oppression)
- Positive impact on life experience (privilege)
- Systematic recognition

Utilizing these pre-described themes, we organized student responses for further analysis and self-reflection.

RESULTS

In Class Discussion

Ten groups formed to design public restrooms and draw their designs for the class. Representative figures are included within Appendix A as examples of what students included in their designs. The table below summarizes key elements that were or were not included in student bathrooms.

Table 2. Impact of Key Elements included in Classroom Bathroom Designs

Element	Associated Identity	Quantity (n=10)	Impact Engagement
Handrails	Physical Ability	9	Initially, students were surprised at how many of them included handrails and/or large, handicap accessible stalls. It was then pointed out that many students still utilized large, handicap accessible stalls and interacted regularly with handrails.
All-Gendered Restrooms	Gender	8	This included single-stalled restrooms and restrooms that were separated by gender but included a third, all-gender restroom.

Full-sized mirror/ multiple	Physical Ability/ Cultural Context	1	While full-sized mirrors could be considered an improvement to assist bathrooms in being more equitable for differently abled individuals, such as those in wheelchairs, the students who included multiple mirrors described the inclusion as an effort to “check out my outfit”.
Single stalled room	Gender /Social Anxiety	4	Many students who completed a room with a single stall spoke of another public restroom on the school's campus utilized for inspiration. They spoke that these restrooms solved many problems around gender, social anxiety, and access to proper hygiene elements.
Changing table	Parenthood	0	This omission was a significant ‘aha’ moment for students. It inspired discussion around how few changing stations existed on the college campus and how little restrooms were designed with parents in mind. Only 1 student in the class self-identified as a parent, and this student was a father, referencing how changing stations are more prevalent in women’s restrooms than men’s.
Social activities	Cultural Context	2*	Two groups included a sitting/lounging area within their bathroom design. The design created by one of these groups is referred to here as the ‘Roman Bathroom’, further discussed below.
Place-based Materials	Locational Context, Cultural Context	2	Two groups had significant consideration to where their bathrooms were located. One group, made up majority of international students, created two bathroom designs, one referred to as the ‘African Bathroom’ by the group.
Hand dryers/ bidets	Political	7	Students discussed the need for these based on sustainability concerns. It inspired a debate about information and whether hand dryers are clean.

Students were engaged and enthusiastic when discussing the bathrooms as a class. The only debate that occurred was around hand dryers versus paper towels. Amidst the sanitary debate, one student did call attention to the lack of voices in the room. “We’re talking about this from a sustainability perspective, but no group mentioned how their design would impact those who have to clean the restroom.” Upon a show of hands, only two individuals in the classroom had ever been responsible for cleaning a public restroom. This recollection inspired students to start considering what experiences were not considered within their restroom designs. At this point, the instructor acknowledged that no team had included family friendly facilities, including something like a changing table.

However, some bathrooms were unique enough to inspire further conversation. For example, the ‘Roman Bathroom’ group designed their bathroom around the idea of making restrooms more of a collective experience. This included a urinal fountain and a circle of toilets with no privacy barriers. Unsurprisingly, many individuals in the classroom said they would refuse to use such a bathroom. Additionally, one female student suggested that the 'Roman Bathroom' group, all male students, did not understand that restrooms are already viewed as a collective experience by some. For instance, she pointed to bathroom selfies as an example of how women utilize the space collectively without the need to disrupt the privacy or compromise safety.

Another bathroom that inspired significant conversation was the 'African Bathroom'. This activity required students to design a public restroom, though no further parameters were provided, including specified location. The majority of groups designed their restrooms with the assumption of a local, North American implementation. However, one group, with majority international students, built multiple bathroom models, including one that represented their place-based appropriateness for the West African context. Students talked about how few of them had even considered the culture to which the bathroom would be in, as they believed the public restroom was supposed to be designed 'for them'. Despite the class being centered on engineering designs for international, non-industrialized communities, students defaulted to the US as the cultural context. No bathroom designs, besides the African Bathroom, had materials questioned for effectiveness in class discussion, despite one design that included a marble floor 'because they could'.

Little discussion on privilege and politics occurred during the classroom discussion. One discussion that did include privilege discussions, was whether or not students believed their bathrooms to be equitable for all individuals who would use them. Although positionality is inherently political, we were okay at the time allowing the space to be casual and, at times, silly. The goal of this activity was to first and foremost show students that their own life experiences and social identities affected their perception of the world, and, consequently, the way they design.

Survey Responses

Survey responses were utilized to establish how much additional understanding students might feel they need before working on the Positionality assignment. Out of 56 responses, assumed to be the number of students present for that day's activities, 85.7% of students reported that the activity increased their understanding of positionality a good deal (much) or more.

Table 3. Likert Survey Results

Questions	1- Not at all	2- Little	3- Somewhat	4- Much	5- A Great Deal	Total (n)
1) The in-class Activity...	0	2 (3.6%)	6 (10.7%)	14 (25%)	34 (60.7%)	56
2) Today's lesson...	0	0	6 (10.7%)	15 (26.8%)	35 (62.5%)	56

While the responses from this survey are very positive, and overall promising, Likert scales can be misleadingly positive on how results are reported. To adjust for the disparity, we utilized best practices for Likert-type items, including an ascending presentation of choice from left to right [33]. Developed for quick data acquisition, these scales reduce a multitude of factors into a limited numerical understanding. It was for this reason that a more in-depth, triangulation utilizing the positionality assignment was also included.

Positionality Assignment

After bathroom design and corresponding discussion, we introduced the positionality assignment to students through the presentation of the instructor's (Emily Lawson-Bulten) positionality map, shown in Figure 2.

Overall, students produced in-depth social identity maps, including 6 students who created their own mapping structure and did not utilize the example structure produced by Jacobson & Mustafa [31] or suggested by Pollock [32]. Three of these students described their frustration with the template structures, as they could not parse which of their social identities led to which social impact. For instance, one student shared "You shared about imposter syndrome in class, but do I feel imposter syndrome because of my gender? Or as a racial minority? Or because of the not great schools I went to? I think it's too hard to tell and maybe all of them." Although the presented social identity map was helpful for some students in recognizing privilege or oppression, these responses illustrate how the presented map does not serve those with intersectional identities well.

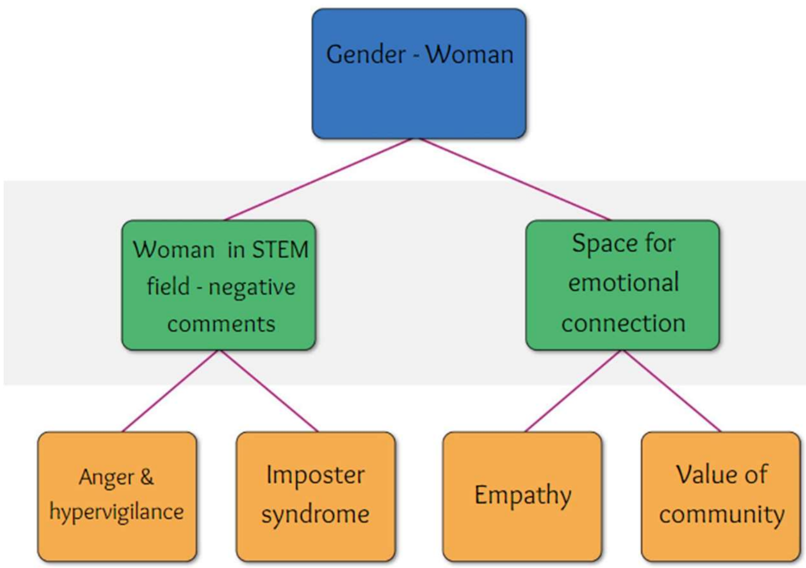

Figure 2. Completed Social Identity Map for Emily Lawson-Bulten, template from [32]

Question 3 showed the most promising result. A majority of students connected the importance of understanding themselves while completing engineering design work. Students were able to place this both in the context of the class and working with non-industrialized groups, and also within designs in the United States. Majority of responses that acknowledged systemic issues such as racism, ableism, etc. Were located within this question.

Student answers varied the most around question 4. This is unsurprising since class times included limited discussion around bias and no discussion on mitigation. Results show that just under a quarter of students (24%) believed that bias could be completely erased within an individual. Additionally, responses that did acknowledge the need to minimize bias lacked specific actions and were general suggestions, such as "be more open" or "create relationships." Analyzing these results suggests that more extensive, skills-based training around bias should be amended to conversations around positionality. In this activity, we did not include explicit conversation around bias, as it was seen as tangential to the main objective.

DISCUSSION:

This exercise demonstrated that positionality is not inherently considered among engineers when engaging with design, even though its impact is readily apparent when examined through self-reflection after the fact. While the majority of engineering students had explicitly stated that there is no latitude for individualistic decisions when undertaking technical design, the diversity of public restroom designs produced by a class of students demonstrated otherwise to them.

The analysis during class discussion of why certain features were highlighted in some bathrooms and not others led students to compare identities and speculate on what personal and team-dynamic perspectives may have steered their design. The 'Roman Bathroom' design, for example, was acknowledged as something males – who are accustomed to urinating in public restrooms without privacy – would accept more readily than females. The lack of sensitivity to transgender or menstruation considerations in a wide-open toilet facility, too, aligned with the team's reinforcement of each other's male-oriented experiences to unintentionally marginalize the needs of those outside of their experiences, and they were forced to confront or disregard this marginalization through the exercise.

The 'African Restroom' served as another example of identity's influence on design. Only one of the teams considered a public restroom in a non-industrialized setting, though the course specifically focuses on engaging with alternatively developed user populations. Given little guidance for the thought process associated with the restroom design, almost every student focused on what they personally would like to experience rather than considering for whom the design is intended or the multitude of identities that would need to utilize their restroom.

This restroom exercise also proved to inspire thoughtful discussion, one that engaged students' discussions of their identities in a safe environment, and one that did not place the burden of identity explanations on historically marginalized individuals. By allowing students to openly discuss the impact that parenthood status had on their perceptions of what was important in a bathroom, students were able to view the impact of identity without having to negotiate a traumatic identity in class. Then, by having the instructor share her own identity map, including privileges and oppressions associated, students were invited to consider the impacts within her life and her engineering work before exploring their own. This resulted in individual positionality assignments that were honest, and at times deeply reflective, with student experiences and realizations.

Limitations

Although this exercise shows promise for increasing the engineer's understanding of positionality, it is not sufficient in developing contextually minded engineers. There are multiple limitations to this activity, as it is just that – a singular activity. This activity first relies on a classroom atmosphere that is heavily interactive, safe, and unconstrained in discussion topics. This can be a challenge to curate with engineering students who traditionally seek clear objectives. As instructors of the class, we regularly encouraged disagreement within class, even between the two teaching instructors as demonstration to students. This allowed students more room to be uncomfortable, not fully sure of their answers, or to share their opinions without fear of retribution. We do not want to imply that creating a classroom atmosphere like this is easy to accomplish, particularly when working with students in traditional engineering programs.

The methods for reflection used, mainly the social identity maps, do not readily engage intersectional identities. While considering identities one at a time can be helpful for introductory identity clarification, it is an insufficient process. Historically, engineering research has struggled with how to approach intersectionality in diversity work, wanting to separate gender and racial initiatives into two separate categories [34]. Further research and classroom activities could prove to allow for a more comprehensive understanding of identity. We attempted to provide space for intersectional identities by allowing for a multitude of identity map submissions. However, these alternatives could have been better emphasized within the classroom to encourage students to explore how they experience their various identities in a variety of settings.

Finally, although topics like identity and even restrooms are inherently political, not much attention was given to political conversations or an overview of systemic issues. In reflection, such conversation would have improved the discussion significantly. Even though straying from power relations was a conscious decision by the instructors at the time, to not 'distract' from the core objective of having students understand how their identities impact their perspective, the impact of attempting to separate inseverable topics was clear in assignments. Multiple students did not understand the impact of systemic oppression, like a cis-white male student discussing how he believed his race made him less likely to get a job. Additionally, a significant number of students believed that bias could be erased entirely, setting a dangerous precedent that one can arrive at a just mindset or some type of 'color-blind' ideology. Conversations in class did address bias and privilege, such as the conversations around cleaning staff, but in a way that we never explicitly illustrated the systemic influence.

Understanding the limitations and acknowledging this omission within the curriculum is key to remembering that positionality is only one aspect of a more reflexive engineering practice. The goal is not merely to have students recognize the impact that their identities have on design, but to encourage and teach students to design in a more just and equitable way.

CONCLUSION:

A significant cultural shift is needed to transform engineering into a critically thoughtful, societally supportive profession. As the complexity of technology increases, a deterministic approach to engineering education focuses more deeply on the technical tools that create the technology and become more detached from the basis of engineering, which is to identify and solve problems that confront technology users. At the same time, it further separates the designers from their own humanity by focusing on tools and techniques rather than root identification of user need through interpersonal engagement.

Historical engineering educational approaches already segment the technical decision-making process from societal impact and the designer herself, resulting in this potential disconnect between the design intent and the user expectation. We believe that the classroom unit we present here is a stepping stone toward reuniting the technical tools of engineers with their humanistic responsibility to identify and solve problems. Given the limited time requirements and flexibility of the positionality unit, it can be integrated into a multitude of classrooms, independent of the framework utilized. Centering the impact of positionality in design is a shift from technological determinism and capitalistic practices and towards an economy of care, in which engineers are vital to societal wellbeing as world-builders.

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APPENDIX A – EXAMPLE BATHROOM DESIGNS

Figure A- 1. African Bathroom Re-creation

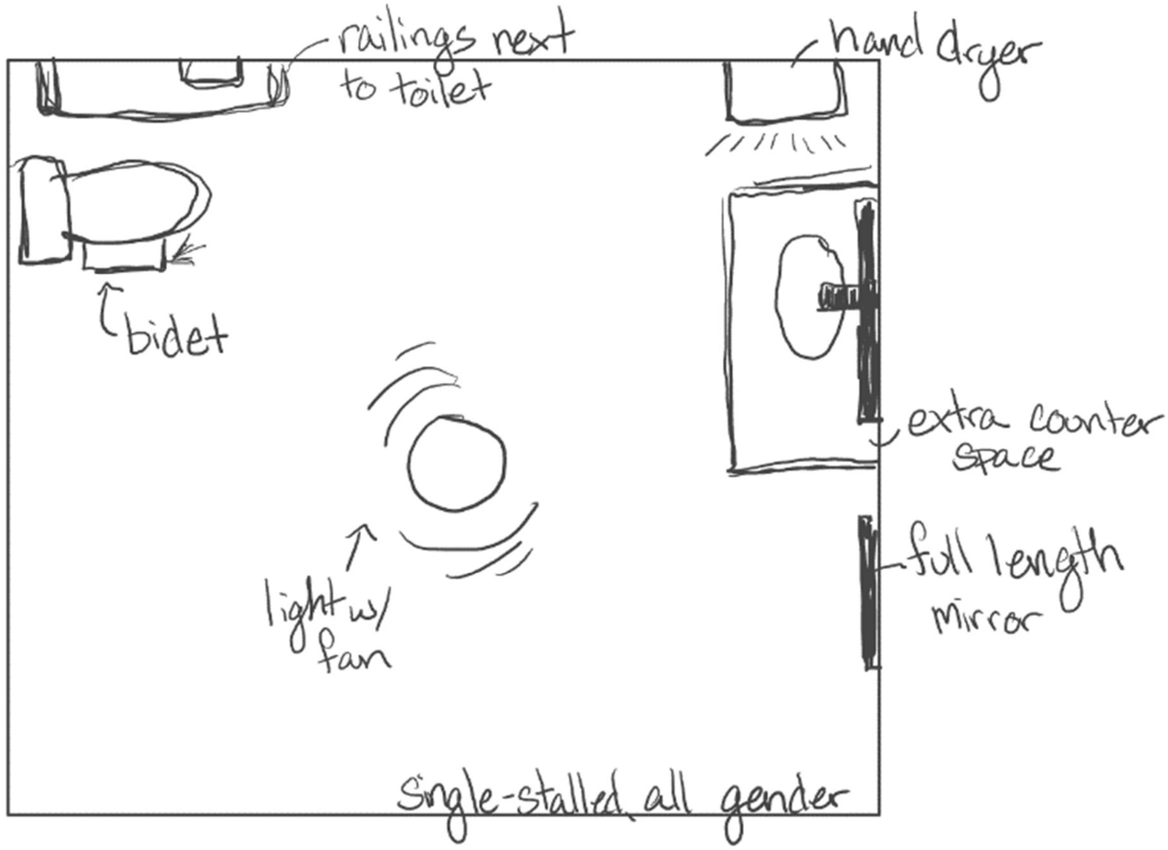

Figure A- 2. Single-stalled Example Bathroom Design

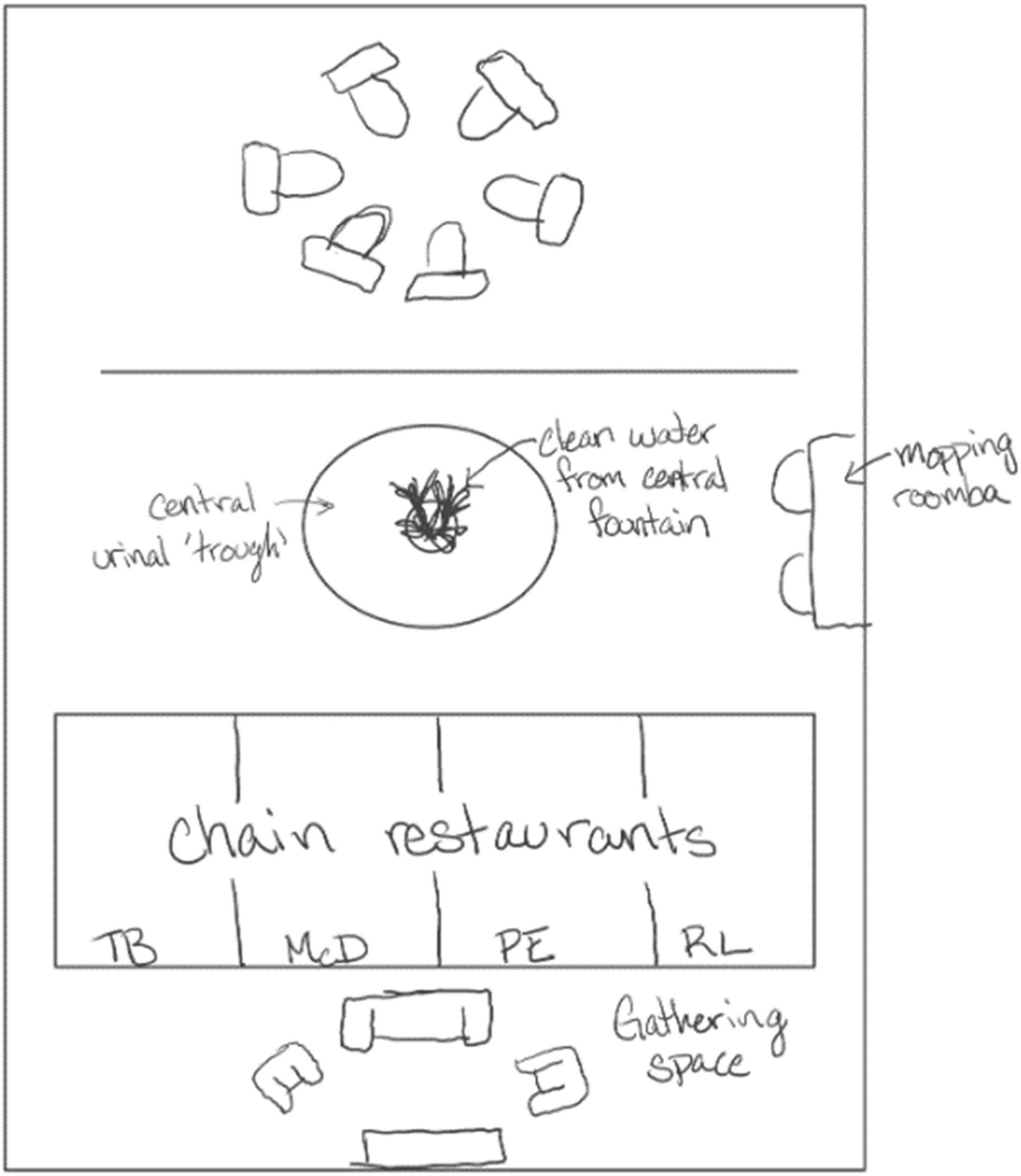

Figure A- 3. 'Roman Bathroom' Re-creation