

Integrating Inclusive Pedagogy and Experiential Learning to Support Student Empowerment, Activism, and Institutional Change: A Case Study with Transgender STEM Students

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“It made me really passionate that I had this narrative that I could show or share with other people that would maybe broaden their social horizons. So after this project — or, I guess, it’s at the tail end of this project, when we had pretty much finished all our research and were tying up the paper— I went on to discover kind of what I feel is my calling in life . . .”

—A transgender WPI student reflecting on activism resulting from his experience with project-based learning

This paper describes some initial results from our NSF-funded project titled *Understanding the Conditions for Inclusive Spaces for LGBTQ Engineering Students*. The project, conducted at Worcester Polytechnic Institute (WPI), aims to understand those practices and spaces that best support the personal and intellectual growth of LGBTQ+ engineering students. We also identify conditions that prepare students to become empowered, lead positive change, and thrive while pursuing engineering degrees. This work-in-progress focuses specifically on an experiential educational experience that represents 25% of a WPI student’s junior-year academic requirement (9 credit hours) and is required of all WPI undergraduates. It is a non-traditional, outside the classroom, project-based experience involving interactions between society and technology. The work reported here used a case study methodology. We recommend caution when attempting to generalize to engineering education in general or to other marginalized student groups. However, we believe there are valuable and transportable lessons to be learned from these early results.

Research indicates that the emotional toll of remaining closeted to colleagues while studying or practicing engineering is so high that it threatens to drive LGBTQ engineers out of the field (Cech and Waidzun, 2011). Their departure from engineering for reasons that have nothing to do with qualification only makes the field more homogenous and therefore less creative, innovative, and risk-taking, while enacting a deep injustice on a population that is already underrepresented and marginalized in engineering. We are examining the practices and spaces that are most conducive to the growth, success, and self-confidence of LGBTQ+ engineers, as well as understanding how their multidimensional personal and professional growth transpires. In identifying those experiences, opportunities, and practices that are most supportive of LGBTQ+ engineering students, the research may also identify the same experiences that help develop the emotional intelligence and cross-cultural sensitivity and communication that will support all engineers, including, but not exclusively, those from other underrepresented populations.

Despite evidence of damaging aspects within engineering culture, we still know very little about how engineering cultures can support these same engineers. Our team began with the assumption that knowledge is as complex as lived experience, with

engineers being both mental and physical, individual and connected, free and determined. We focused on LGBTQ+ engineering students at Worcester Polytechnic Institute (WPI), a medium-sized engineering college with a surprisingly large number of openly LGBTQ+ students. Engineering majors represent about 80% of WPI's student body. Quantifying the fraction that is openly LGBTQ+ is problematic for many reasons (Gates, 2011). However, roughly 8% of all U.S. high school students report identifying as LGBTQ+ (U.S. Centers for Disease Control, 2016), suggesting that the numbers are larger at the college level, since college is a place where young people start to feel more free to express themselves and their identities. Beginning with data about student experiences from a 2016 campus climate survey, we explored the findings more deeply through individual and focus group interviews with students, staff and faculty. This qualitative research approach seeks to learn in some detail about LGBTQ+ students' experiences, probing whether and how a project-based engineering curriculum can contribute to individual student growth and perhaps more broadly, to changing the heteronormative engineering culture. For the CoNECD conference we chose to focus on two case studies because they illustrate the value and versatility of a curriculum that allows flexible participation of students and advisors. Based upon early results, the narratives likely support our hypothesis that appropriate project-based learning (PBL) experiences can provide opportunities for professional and personal growth, empowerment, activism, and even institutional change for LGBTQ+ students.

WPI's Philosophy and Pedagogy of Project-Based Learning

Some background on project-based learning (PBL) and its role in WPI's curriculum is important to set context for the work reported here. The WPI curriculum was designed upon established principles that support learning by doing, challenging students with open-ended ambiguous problems, overcoming segmented thinking by working outside of the major discipline, and exposing STEM learners to cultural, social, and intellectual diversity. Since the mid-1970's WPI has combined a traditional, course-based technical curriculum with a project-based program emphasizing teamwork, communication, and the integration of technical and societal concerns. We structure a curriculum that graduates socially conscious, globally literate engineers with student learning outcomes that are not limited to basic comprehension or simple application, but include analysis, synthesis, and evaluation (Woods, 1994). A required, 9-credit hour project explores the interrelatedness of society and technology. This is a 3-course equivalent project, not a project within a course nor a traditional course sequence. It is required of all students independent of major. It is typically done during the junior year, prior to the usual capstone or senior research project. This technology/society project is interdisciplinary, where small teams of 3-4 students work with faculty advisors (most of whom are engineers) on problems proposed by public and private agencies and organizations. Student teams research, solve, and report on a problem examining how engineering, science or technology interact with cultures, societal structures, and values. Project objectives include enabling students to understand, as citizens and as professionals, how their careers will affect the larger society of

which they are a part. Projects typically encompass 2-4 of the following attributes (DiBiasio and Mello, 2004):

- Examine impact of social issues on technological systems
- Examine impact of technology on social structures
- Cultivate questioning of social values and structures
- Raise value questions about social/technological interactions
- Develop skills of analysis in the societal, humanistic and technological disciplines
- Recommend policy changes in social/technological interactions
- Convey technical content to a novice or non-technical audience

Our PBL instructional design is based upon situated learning theory that includes authentic activities, contexts, and assessments. It provides collaborative knowledge construction and opportunities for explicit articulation of knowledge during the learning process (Herrington & Oliver, 2000; Brown & Palinscar, 1989; Brown, et al, 1989). Authentic learning environments seek to place students in situations that mimic the way knowledge will be used in professional practice. Learners have access to experts from both WPI and sponsoring organizations, and in some sense are engaged through a process of initiation much like the apprentice-learning model (Dewey, 1974). Collaborative activities provide multiple roles and multiple opportunities to engage material (Lave & Wenger, 1991; Rogoff & Lave, 1984; Bruer, 1993). For students to become full members of a community of practice, it is essential that they have opportunities for legitimate participation in the practices of that community. Our PBL experience is designed to start that process (DiBiasio and Mello, 2004). Given a general problem statement provided by an external sponsor, students must define the problem, develop specific project goals and appropriate methodologies, conduct the research, synthesize and analyze qualitative and quantitative data, and provide conclusions and recommendations in a formal report and presentation. The experience is meant to mirror engineering practice including the development and cognitive growth in both intellectual and affective domains.

Does PBL contribute to feelings of inclusivity among queer students? Our case study explores two transgender students involved in two separate socio-technical projects aimed at proposing changes to make campus more supportive for nonbinary and transgender people. We were interested in knowing about transformations of both the students and institution. What, if anything, did their transgender-themed projects contribute to their feelings of inclusion or exclusion from this institutional community? And what did these projects contribute to the development of their identities as STEM professionals? This last question is particularly important since there is evidence that the development of an identity as a professional or engineer is slowed in marginalized or minority populations that don't have appropriate access to mentors or people who look like them (Allen-Ramdial and Campbell, 2014).

We had some idea that these projects *might* lead to institutional change: WPI has a history of student-led initiatives originating with student academic projects. A bike share program, food waste reduction systems, library exhibits, a living “green roof” installed on a campus building, and many other campus initiatives demonstrate the college’s willingness to look to students as local experts. Many campus offices — student affairs, the library, the sustainability office, dining and residential services— work with student project teams to sponsor projects and then implement student recommendations. The possibility that student recommendations will lead to positive institutional change is a strong motivating force for students.

We also hoped to learn about the student experience —its impact on learning and personal and intellectual growth— from the students themselves. Because qualitative data from LGBTQ+ engineering students is difficult to get given the heteronormativity of most engineering environments, most sample sizes are small and interview and focus group data are rare. Our participants in various focus groups and individual interviews were remarkably introspective, articulate, and generous sharing their time and very personal experiences.

The two case studies we present here emerged from our larger research project that focuses on the queer student community in general at WPI-. Following a variety of recruiting methods, we have been conducting student focus groups and one-on-one interviews, and the resulting stories cover a range of themes. We focus here on two students representing two different but related interdisciplinary projects to make campus better for transgender and nonbinary people. For the first project, the Office of Multicultural Affairs (OMA) pitched a project to a faculty advisor (in the School of Business with engineering degrees) and recruited students for the team; the advisor screened them, looking primarily for strong motivation. The second project happened in the following year. The same professor advised this project and the same campus office sponsored it. In the second iteration, the topic was more open-ended: students could choose to pursue the work of the first project or to change the focus, provided they stayed with the general goal of improving campus for nonbinary and transgender people.

We encountered both students during the early phase of our research: one in a focus group and the other through the student project. Wanting to know how these projects affected their personal and academic development and their academic and career plans, we returned for more in-depth interviews with them, as well as two lengthy interviews with their project advisor. As we learned more about them and the project, a story started to emerge about their personal transformations as well as changes to our campus.

One of the students was Jet, a person who identified as a member of the LGBTQ+ community, had been quietly questioning their gender, and at the time of the project was coming to understand themselves as agender but was not yet ready to share these thoughts with their advisor or other teammates. The project made

recommendations to campus leaders regarding gender-neutral bathrooms. The other student, Amos, was transitioning during the course of his project. His team was developing a proposal for campus programming and a LGBTQ+ resource center.

Methods:

In this paper we focus on the case studies of two undergraduate students participating in WPI's junior level project. We selected these two cases as illustrative examples after interviewing 12 administrators and faculty involved in different aspects of student life and diversity and inclusion, 4 LGBTQ+ student focus groups, and 4 students and 9 alumni who identified as members of the LGBTQ+ communities.

Administrator and Faculty Interviews

Beginning in the summer of 2017 and continuing to the Fall of 2018, we interviewed employees of WPI who were involved in campus diversity and inclusion initiatives, the Safe Zone (training for LGBTQ+ awareness; https://www.asee.org/DiversityNewsletter_Issue1_Spring_2014_FINAL.pdf) committee, or who were responsible for changes on campus that directly affected our LGBTQ+ students. We interviewed three administrators from the Dean of Students Office, one Associate Dean of First-Year Programs, two from the Office of Multicultural Affairs, one from Career Services, two from Student Counseling Services, one from Residence Life, and two faculty. While each interview was different based on the position and expertise of the interviewee, our interviews focused on a few main topics:

- How do you support our LGBTQ+ students on campus?
- Where does the impetus come from to make a campus-wide change?
- Are there ways WPI can improve how it supports our LGBTQ+ students?
- How did you learn about the needs of this community?

Student and Alumni Interviews

Based on our work with the LGBTQ+ communities on campus and our interviews described above, we reached out to specific students based on their work on campus, and for three of them, for their work on their junior year project. For the interviews based on the junior year projects we focused on a few specific questions in addition to the questions about the campus climate and their additional work.

- What was your role in your junior-year project?
- How and why did you get involved with that project?
- To what extent did you contribute to the development of the topic of the project and the purpose/defining the problem of the project?
- How did the project turn out? What kind of impact did the project have?
- Did you change in any way as a result of your work on this project?

Interview and Coding Protocols and Analysis

All interviews were recorded and transcribed. Transcriptions were completed by one of the research team, or by a transcription service. The case studies reported

here were interviewed twice. The first interview used the informal conversational interview protocol, and were conducted by 2 or 3 of the research team. For this type of interview the interviewer initiates the conversation with a general open-ended question, and the session tends to be fairly open and somewhat free-form, guided by the interviewee's responses. Those results informed a second, semi-structured interview with each person conducted by our project consultant. These interviews used pre-determined prompts designed to unpack specific topics that were identified, but not sufficiently developed, from the first interview. Both types followed procedures outlined by Turner (2010).

All interviews, including the two described here, are being coded and analyzed. We are using two different approaches, implemented independently by different members of the research team. We will then compare and contrast those results. The holistic or "content logging" approach described by Secules, et al (2018) focuses on highlighting the general themes of empowerment, activism, and institutional change. A second, much more fine-grained and detailed coding scheme (with up to 50 nodes) is in progress using the Nvivo© software package (<https://www.qsrinternational.com/nvivo/home>).

Amos's Story

"I felt good, not only in the fact that I was able to explore what activism means to me and my own gender identity through the project, [but I also felt] good about helping other trans students, especially people who are non-binary, on campus, which is magnitudes more difficult." Amos, transgender student

Amos, assigned female at birth, grew up in a small and homogeneous community where he'd never known any transgender people. Upon entering college, he found his new environment "extremely open" and diverse: "Oh my God," he recalled feeling. "People are different!" During a reception for incoming students sponsored by the Alliance, our campus chapter of oSTEM (the national organization Out in STEM), Amos noticed nametags with preferred pronouns and thought, "That's kind of awesome!" This experience at new student orientation helped Amos reflect on his own identity and eventually understand himself as transgender. During the summer after his first year he came out to a few trusted people and quietly began his transition. While he found the community supportive, Amos had difficulty managing the logistical details. "There was nothing anywhere online for the transition process," he recalls. "It was super unclear how to get my name changed [in the databases], what name is gonna be on rosters, can I change my name in the system if it isn't legally changed?" He visited the Office of Multicultural Affairs (OMA), where the director helped him find the people who could help, and after a six-month process, "everything got resolved."

During his meeting with the director of OMA, Amos learned about an interdisciplinary team project related to gender-neutral facilities on campus that was beginning that term and had room for another student. The project (LGBTQIAP+ Insights & Policy, 2017) was the second of two designed to focus on

issues relevant to nonbinary students; the first one had focused on a proposal for gender-neutral bathrooms (Gender Neutral Bathrooms, 2016). Even though Amos was just starting his second year at college, and typically students complete these interdisciplinary projects during their third year, he accepted the OMA director's invitation to join the project. The topic, he reasoned, "was something that I was passionate about," so he signed on a year early to "get to research this thing that's super relevant to me. I thought I couldn't pass the opportunity up."

The same motivation that prompted Amos to sign up early continued to propel him through the project. Several important factors also helped: a very supportive project sponsor (Director of OMA) and faculty advisor, both of them women of color, allies, and very comfortable talking with students about personal as well as academic issues; a sponsoring office that had a stake in seeing improvements to support services for underrepresented populations; an ongoing personal passion to make conditions better for other trans or nonbinary students who followed him; and the opportunity, given the team by their advisor, to choose a specific project goal within the larger topic of gender-neutral resources. "The overarching goal," Amos recalled, "was just to help [the] campus, or give [it] more tools to become a more inclusive space for the LGBTQIAP+ community." He described how the advisor had told the team that the project was "open-ended. . . . You don't have to continue the specific work of the previous year, but just stay within gender neutrality on campus and take your own ownership of the project." The three-person team discussed different topics and got excited about two: designing a gender-neutral pronoun training to be used in Safe Zone workshops, and advocating for a queer resource center on campus. "We couldn't decide" between the two, he told us, "so we just did both."

In reflecting on his experiences with this project, Amos understood that his intellectual and personal growth happened simultaneously and in some ways inextricably. "I thought that the subject was something I was really interested in," he told us, "considering that I was dealing with all of my feelings regarding my own gender identity and navigating that space, so the project was a great way for me to do that." Three months after the project ended, Amos recalled to us his learning experience and the process of developing competence and pride in his work:

Previous to this project I had never really done a research project before. . . . Not in high school, not in previous classes at WPI, so that was a huge learning experience. . . . It seems scary, right? [For the project] I'm gonna have no experience in that kind of work, and my advisor gave us all of the tools to be able to go out on our own and write this really awesome paper about this subject we're really passionate about. . . . I learned through this project how to submit an application to the IRB, how to write useful survey and interview questions, the process of transcribing interviews, of figuring out what to do with all of this data, all of that I learned through this [project]. And . . . once we started . . . identifying the problem and how we wanted to address that problem, the more staff and faculty that I talked to, . . . I would see in their eyes, 'oh that's a good idea!' I liked that. I realized, I'm doing this relevant, awesome

work and I can continue it on my own. So that was really what made me realize, oh, this . . . isn't some assignment I've been given from a professor that's very cookie-cutter This was all . . . my group's idea. It was very cool.

Amos's personal investment in the topic fueled his motivation to learn, and in turn his learning and feelings of competence strengthened his motivation. He explained to us that he had never considered himself an activist before beginning this project, but as he dug more deeply into his research he found it an effective channel for personal feelings. "I had just come out and I'm feeling angry about my gender identity and someone's like, 'Hey, do you want to make it better for trans students on campus?' Of course I'm gonna say yes." By the end of the project, he understood it as foundational to both his academic career and the course of his life. "This project was the first time where I felt fulfilled in the work that I was doing because it was so personal." The experience tapped for Amos a new sensation: the "passion and drive to take my lived experiences and turn them into something tangible and real," something he could communicate to other people so they might empathize with transgender people.

Amos entered college uncertain about his identity and not politically active. He will soon graduate an activist. His story, like his interdisciplinary project, illustrates the socio-technical orientation built into WPI's junior-year project experience. In the fall of his senior year, Amos gave a brief and powerful presentation about activism at a campus event. He explained that while doing his interdisciplinary project he had found his "calling in life": to create interactive games depicting the lived experiences of trans people. As he explained, all of us –cisgender as well as trans people— are "starved for representation in all kinds of media" (presentation at WPI, Sept. 2018). What did these new anti-trans bathroom bills mean for trans and nonbinary people? How might non-trans people understand the danger to trans people posed by this legislation? How might they recognize the humanity of trans people if they didn't know a trans person? "How are you supposed to empathize with something that you just don't have any knowledge of?" Amos asked. His solution — what he identified as his "life's calling" — was to "take the stories of people from these minority communities" and turn them into interactive stories. As he told his audience, he does his work "for anybody who has never had to wonder walking into a public restroom, 'Am I going to be safe?'"

Reflecting on how his project experience shaped him as a person, Amos described his frequent anger about the everyday difficulties and dangers that trans people face. "So to be able to actively do something that I feel has the potential for change, makes me feel better," he told us. When we asked him about the outcome of his project, he struck us as extremely satisfied, even though two of the main recommendations have not been implemented. The first, a campus resource center for queer students, has not come to pass because of a significant undersupply of spaces for academic and co-curricular activities. "All that, frustration aside, I can still say that I did that. I sat down and met with people from facilities, we brought a contractor." As for the pronoun training intended for Safe Zone programs, 16

months later it has not yet been deployed. One important recommendation from Amos's team has been implemented: the team proposed that a position on the Safe Zone committee be reserved for a student chair "because it was all faculty and staff talking about students and how they can make their experiences better without having a student voice, which didn't make sense to us. And they accepted it." Amos reflected on other changes to campus life since his arrival nearly four years ago. What had been for him a six-month process to change his name is now streamlined, allowing students to set a preferred name that goes on all documents including IDs. "The quality of life keeps getting better for incoming students," he told us. "99% of the experiences I've had on this campus are positive and good, but nothing's ever perfect. And it's definitely improved just in the four years that I've been here. All the different initiatives for the LGBTQ+ population is incredible, with the [gender-inclusive] housing and now you can get IDs with your [preferred] name on them and they don't even charge you the 25 bucks."

Jet's Story

"Having a leadership position maybe helped me figure out my gender, like two things happening at the same time." Jet, an agender science student

Our second participant, Jet, had been involved in a similar project: it was sponsored by the Office of Multicultural Affairs and advised by the same professor who advised Amos's project. Jet, who identifies as agender and uses they/them pronouns, was deeply interested in the sponsor's goal of proposing gender-neutral bathrooms on campus. Like Amos, Jet undertook this project one year early because of strong interest in the topic and "the opportunity to be an agent of change" on campus. Jet noted with gratitude the autonomy they'd had in project-based learning generally and particularly with their advisor: "It's the way I learn best."

In spite of the strong similarities, however, Jet's experience was very different from Amos's. When we first encountered Jet in a focus group with other student members of the campus's oSTEM organization — two years after completing the gender-neutral bathroom project— their feelings of frustration and anger about the project were still very raw. Jet recalled discovering that local codes and laws permitted gender-neutral bathrooms on a college campus. However, the many disappointing responses to the team's campus-wide survey continued to haunt Jet. An open-ended question inviting "concerns" about gender-neutral bathrooms turned up responses from people who claimed there are "only two genders" or inadequate numbers of people who need such a bathroom. Jet remembers many responses being "hateful and violent about it."

Jet also expressed deep distress that the project failed to reach its goal. "We came up against a lot of red tape with people who did not want these bathrooms." The most the team could do "without upsetting anyone" was simply to label as gender-neutral the handful of single-stall bathrooms already on campus. By the end of the project, Jet told us, they "had made no headway." "We fucking tried!" Jet said, pounding the table in frustration. For this student, the combination of a personally compelling

project and the human factors of project work made for a painful and unrewarding experience. Separating the project structure and experience from the campus response is difficult since the two are strongly connected.

We caught up with Jet for an individual interview seven months after that focus group. Although we'd planned on only a one-hour session, Jet was so introspective, articulate, and thoughtful that the interview continued for nearly two hours. Several things had changed dramatically since our last conversation.

For one thing, this student now recognized the important accomplishments of their project and saw its limitations within the larger context of longer-term societal change. "We started it out with some fairly lofty goals and had to sort of cut them back as we realized how much work everything was gonna take. So there is sort of a humbling sense too, like oh wow I can do stuff but within reason." The lofty goal was to develop a five-year plan culminating in multi-stall, gender-neutral bathrooms. "We ended up spending so much time on just getting our first step done [understanding and communicating building codes to the campus Facilities Department] that we didn't really have time" for the five-year plan. Instead, they added recommendations for future work on gender-neutral bathrooms. Jet is proud of these recommendations and hopes they'll be carried out, but emphasizes the team's more modest and essential goal: the "first generation . . . of our purpose was really just to introduce this concept to the school." Reflecting on the success of that goal, Jet told us that people in the Facilities Department, whom their team had consulted, later suggested gender-neutral bathrooms to the library administration when that building was scheduled for renovations, and now the library has a gender-neutral bathroom on each floor. "I did really like that we made a difference and got something done," Jet told us. "I wish we could have done more for sure."

Jet's comments on the constraints on social progress reflect the learning outcomes this interdisciplinary project was designed to foster: ability to examine the impact of social issues on technological systems and the impact of technology on social structures, ability to question social values and structures, to ask normative questions about social and technological interactions, to develop skills of analysis in the societal, humanistic, and technological disciplines, recommend policy changes in social and technological interactions, and convey technical content to a novice or non-technical audience. If the goal of our junior-year interdisciplinary project is to help students develop an understanding of the complex ways human beings receive and experience technological interventions, then this project was a success for Jet, who demonstrates a subtle and mature understanding of how the people on our campus shaped this team's ability to accomplish its goals. Whereas seven months earlier, Jet saw the project as a failure because it fell short of delivering multi-stall, gender-neutral bathrooms, more recently they acknowledged that a more modest goal was actually necessary for longer-term change. "We ended up changing several single stall bathrooms from gender specific to gender neutral just by replacing the sign, but . . . we ended up having to really limit which bathrooms we chose so a lot of this project was really just trying to slide it into [campus] culture without creating a

lot of pushback so that in the future we could keep doing more.” Rather than seeing people’s anxieties as “hateful,” Jet was describing them to us as predictable human behavior. “So we only did bathrooms that didn’t have a urinal because people don’t want to see a urinal. I don’t know, it’s just another shaped toilet, like toilets are yucky to look at too. But people don’t want to see a urinal so we only converted bathrooms that didn’t have a urinal. So that knocked out at least half of our single stall bathrooms for conversion.” In talking about the longer-term and more ambitious plan for multi-stall gender-neutral bathrooms, Jet shared both confidence that it would happen and a psychologically nuanced suggestion about how to make it happen:

When we go for multi stall we’re gonna have to do floor to ceiling stalls and stuff like that. But the thing about multi stall bathrooms is that they’re already super uncomfortable and nobody likes them the way that they’re set up. There’s not enough privacy and that’s like pretty much if you asked someone that directly, they would agree with you that there’s not enough privacy. But then people think they have a problem with gender neutral bathrooms because they are used to this level of not private and to them another gender is a big deal, so they’re already super uncomfortable with it, they just don’t realize and then you’re adding one tiny slightly new element and they think that’s the problem when really the problem is that our bathroom design is super uncomfortable. . . . So stuff like floor to ceiling stalls, you know have the stall door designed so you can’t see through the crack or whatever. There’s a lot of stuff you can do. . . . I think it’s hard for people to conceptualize everything at once, like, yes, these would be multiple genders in one bathroom but we would make it a much better bathroom. I don’t think people can always quite get there. Some people can, but not everyone.

Jet’s comments on the human challenges to societal change —human beliefs, unrecognized feelings, and conventions— reveal not only a highly developed understanding of the human elements that make progress difficult but also some fairly expert ideas about how to move beyond the impasse between different points of view. We believe this is a result of several factors: project learning outcomes, the project structure, personal motivation, advisor mentoring, and student maturity.

Another important change since we’d first talked to Jet was that they’d begun attending an LGBTQ+ group therapy session as well as individual therapy with someone who has expertise in gender, including with transgender people. This helped Jet develop insights into their own psychology. Jet described their longstanding “embarrassment at being alive” and a more recent discovery, that this embarrassment comes from dysphoria, the misalignment between one’s sense of self and one’s appearance, or one’s felt identity and the signals from others about oneself. “As I’ve worked on that, my self-confidence I guess has gotten more sturdy.”

With this newer realization and stronger self-confidence, Jet explained to us why the survey comments affected them so deeply. “When I think about my [project], the

first thing is the survey and whenever anyone mentions gender-neutral bathrooms [on this campus] I groan and make angry noises because of the survey.” The team sifted through 880 surveys, including one open-ended question inviting respondents to express any concerns about gender-neutral bathrooms. Although many responses were “positive and supportive,” Jet told us that “a lot . . . were aggressively negative.” These were difficult for Jet to read because “I was just starting to . . . figure out my gender and identity this way and then I’m reading hundreds of comments saying stuff like, I don’t exist, I’m not real, I’m making it up, I’m not worth doing a project for because there’s not enough of me. This is a waste, I’m a waste of [the college’s] resources.” Because Jet was only coming to terms with their identity as a nonbinary person, they had no one to talk to about the feelings stirred by reading those comments. When the team counted the numbers of negative and positive comments, they came out roughly equal. “But the way brains pick stuff up and emphasize things,” Jet told us, “especially [my] brain that . . . already . . . has a tendency to emphasize the negative and you just read this onslaught of negative comments, that’s all I really remembered from the survey at least for a while.”

Although Jet would not start therapy until more than two years after finishing this project, they did make important self-discoveries during the process. Jet had begun thinking about gender identity during their first year, when introducing themselves with a given name that “just felt not right.” They were drawn to the bathrooms project because of these new thoughts about gender, and the project gave them opportunities to learn more about what it means to be agender, to identify with neither male nor female. When the position of team leader fell to Jet, it was a new experience for them, provoking thoughts about self-confidence and gender issues. “And I think having a leadership position maybe helped me figure out my gender, like two things happening at the same time.”

Jet’s account of what it was like to develop a sense of identity as neither male nor female is strikingly similar to their description of project-based learning, where the students take responsibility for their learning because they must frame the questions, decide on a methodology, and process their findings into recommendations. From knowing nothing, students become experts. “Because you have to . . . ask the right questions, right?” Jet explains. “You start out knowing absolutely nothing and . . . so first you have to learn how to ask the right questions and then you have to learn how to find that information and then you have to learn how to use that information to make your own new questions.” Once you know the process of project-based learning, Jet explained, “you can take that process and apply it to anything at all.”

Would it be too much to claim that Jet applied this same process of project-based learning to the project of themselves? We don’t think so. In a leadership position, Jet suggested, “you get to know yourself a little bit better. . . .And it’s just sort of natural as you begin to acquire more information you notice patterns. And you start to investigate within yourself, like ‘oh, what’s up with this pattern?’ And you figure it

out.” Self-discovery, Jet proposed, is an open-ended question when the familiar answers don’t apply. “Because my gender is . . . not really a gender, it’s . . . the absence of available genders, . . . figuring that out and figuring out my sense of self is my gender because it’s not any of the other available genders. So it’s my own sort of to define and mold. . . . The crazy part of the non-binary experience is trying to figure out what you want to be when there’s no template for it. Because there’s a template for man and there’s a template for woman and then you can kind of say ‘I want these parts and not those parts.’ When you’re non-binary, there’s no template.”

From the vantage point of someone who is building a sturdier self, Jet’s reflections on the project’s outcomes tip between pride and optimism about their work and dissatisfaction with the outcome. The optimism comes from a more nuanced understanding of what it takes to pursue social change. Doing good work to advance social progress, Jet reflects, “doesn’t necessarily [require] a gigantic change, just moving the world in the right direction. Especially in science, you learn to be very, very happy with very, very tiny progress. In my lab we just figured out, we’ve been trying to find this sequence within a protein, and we just figured out within 48 amino acids where it is, which narrows it down by –from 207 to 40. So, we’re really excited about that. And in the grand scheme of things, this project’s been going on for 10 years and we’re this much closer to the overall goal, but we’re so excited about this because it’s further than we were before. So it’s really cool to make that kind of progress, to be further than you were before, and to do something that no one has actually done before.” On the other hand, Jet continues to wish their project had had a more dramatic impact on campus life. “I don’t know if I’ve reflected on the [gender-neutral bathroom] project really that much, partly because it was painful,” they note. “I did this project to create space for myself (and people like me) on our campus, and it’s disappointing that I still feel like there isn’t enough space.”

The Personal Costs of Activism and Institutional Change

Whatever the positive outcomes for Jet’s personal and professional development and for the growing inclusivity of our campus, the process was difficult and painful for Jet. In spite of a deeply supportive and caring faculty advisor and project sponsor who describes herself and is widely known across campus as “an advocate for all people for all things,” in spite of the possibility that this project might result in long-term positive institutional change, and in spite of —*because of*— their deep personal commitment to the research topic, Jet struggled deeply, and largely in isolation, with the comments about nonbinary people revealed in the team’s campus survey. At the time of the project, Jet “wasn’t quite ready” to come out to their advisors and therefore had a hard time processing the feelings aroused by the more ignorant and negative comments in the surveys. As Jet explained to us, “when you’re a scientist like me, I can’t deny the data. So the survey, especially that last question, was very very hard.”

In contrast to Jet’s, Amos’s emotional experience with his project was relatively easy. The main challenge his team encountered was a scarcity of space, which meant that their proposal for a queer resource center remains only a recommendation.

Their encounters with people were mostly untroubled: “mostly who we dealt with were members of Safe Zone. Who were well informed about the topics that we were trying to discuss. Thankfully, we didn’t have any sort of challenges when bringing up our project to members of staff and faculty at WPI. They were all pretty supportive of the ideas that we had and thought that we were doing good things.” Amos was also open with his teammates and advisor about his gender identity, so he could take specific advantage of their support as allies.

What can we learn from these students’ experiences? Projects like these almost require the involvement of a nonbinary person— as Jet says, “to make sure [they don’t] get completely mishandled.” Jet describes the faculty advisor as both “a very warm person” and an expert in survey design, “which was really helpful because . . . our survey was very important to the project.” The advisor told us a bit about the meetings following the first project’s survey results, how the advisor and project team began with personal feelings and transitioned into academic decisions, without ever losing the thread of the personal:

I remember us having this really long conversation about what some of the comments meant, or how it made them feel. Then I remember us talking about how they really wanted to know, "What do we do about this?" Like, "This isn't fair. This isn't right. People shouldn't feel this way. They have it all wrong." I can remember saying to them, at this point I really did put my academic hat back on and I said to them, "This is data. This does not mean that the project you're working on could never work on this campus. It just means that this sentiment exists, amongst all the positive ones, and that actually you want to be aware of the negative. You want to not only be aware of it for your own knowledge's sake, but be aware of it so that you can come up with solutions that will ease some of those fears."

During our interview, Jet contemplated the discord about needing the expertise of a particularly vulnerable person whose very vulnerabilities would be exposed during the project:

That's something I've . . . thought about a lot because it's very valuable for this type of project to have someone on it who really understands the matter, but it's really hard for that person because they're so deeply involved in it. So any gender-neutral bathrooms project should have a gender-neutral person on it for the sake of that project, but for the sake of that person they should go nowhere near that project. And I don't really know to reconcile that. I think we partly need to work on our project structure.

Jet suggested to us the value of offering student support as a necessary part of projects like these, akin to what the institute offers to student preparing for overseas project work. “Going into this project I didn't really expect that side of it at all, so I think something like . . . preparing the project members for it and some stuff beforehand like tools to use when things come up . . . would really help.”

Both Jet and Amos have become campus leaders, even if they're not visible as leaders to all parts of the campus community. Amos holds the first student seat on the campus Safe Zone committee and has helped pave the way for future programming and a resource center, even if the funds and location are not yet available. Jet's team, completing its project just months before Amos's team picked up the thread, had changed the campus climate perceptibly and exactly *because of* the difficult work of starting a conversation about gender-neutral facilities. Amos's team was able to work exclusively with allies because of the prior work of Jet's team, charged with understanding how the campus community felt about gender-neutral bathrooms. The faculty advisor surmised that many of the responses were negative because of "ignorance":

I think that nobody had ever asked that question of them before, so that was their gut reaction. Instead of taking a moment to sit and think about the topic and how relevant it is, . . . and to remove their biases. . . . That survey started a conversation, so there were other conversations outside of what my students were doing, that contributed to people changing their mind or realizing, 'Oh, this is not a bad idea.'"

Like other activists during times of dramatic cultural and social change, Jet experienced the solitary pain often felt by those who become the first to demand equal justice of a society that either deliberately or unintentionally withholds it. Amos learned to build on the activist work of those who preceded him, helping the campus community to imagine and, we expect, one day realize more ambitious aspirations. In some cases the personal pain of such activist academic work may be inevitable, but our students are helping us understand what we can do to mitigate the pain and encourage the successes for both our institution and the personal and professional development of our STEM students.

As stated earlier, generalizing case study methodologies to engineering education in general and to other marginalized groups must be done with caution. However, when triangulated with other analyses and results reported elsewhere, (Boudreau, et al 2018), we believe a pattern is emerging. It is well established in engineering that undergraduate research has great learning value. What is less well-known is the value of undergraduate research that integrates engineering and societal and human values. The early stages of our research show that a pervasive academic structure and culture that is team-based, that is grounded in collaboration, that includes authentic problem solving and project-based learning, and that emphasizes discipline-specific learning integrated within a human, social, and cultural context can have profound effects on student learning and progress toward their professional goals. The path may at times be difficult but the absence of the human-technology tension may not produce the kind of engineering student we desire as graduates.

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