A Liberatory Co-Curricular Program for Engineering Students: Investigating Impacts and Limitations Through Alumni Perspectives

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Andres TREMANTE

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1. Introduction

Identifying and addressing the inequities marginalized groups face in undergraduate science, technology, engineering, and mathematics (STEM) education is commonly in the hands of faculty and staff rather than the students who experience them firsthand. Seeking to shift away from this dynamic and empower students to name and challenge the oppression they face, the authors of this paper collaborated to create and carry out the Justice, Equity, Diversity, and Inclusion (JEDI) Ambassador Program (or "JEDI" for short). JEDI is a co-curricular program that employs undergraduate engineering students, called "JEDIs", to engage in diversity, equity, and inclusion (DEI) projects across the domains of education research, K-12 outreach, and student programming with the guidance of a graduate student or university support staff mentor.

JEDI was designed as a liberatory space for participants to bring their whole selves, collaboratively explore ideas, and take action against inequities they observed or experienced. The attempted enactment of liberatory pedagogy is discussed through the perspectives of JEDI alumni.

2. Literature Review

This section includes a review of literature focused efforts that seek to improve the experiences of marginalized undergraduate engineering students or support them in creating change in their local university or community context.

2.1. Student Support Programs

Previous scholarship indicates that interventions offered by diversity engineering programs (DEPs) and minority engineering programs (MEPs) can improve marginalized students' undergraduate experience [1]. In particular, both faculty and peer mentorship programs for historically oppressed students have been identified as powerful support mechanisms in undergraduate engineering education [2]. Through peer mentorship, students establish community with one another, which builds their confidence as engineering students and helps them find a sense of belonging in engineering [3]. Faculty mentorship also supports marginalized students in increasing their confidence, as well as learning to confront the discrimination they face in engineering [4].

Support programs can also take place outside of formal institutional structures like the ones previously described. For example, Bowen et al. [5] created the "Undergraduate Engineering Collaborative Growth Series" to empower participants to organize for change within their engineering programs. The researchers found that the workshop series led participants to build solidarity-focused relationships with one another and formulate methods to take direct action against marginalization in their local context [5].

2.2. Undergraduate Research Experiences

Participation in undergraduate research experiences (UREs) have also been found to support marginalized engineering students and engage students in their local communities. Espinosa et al. [6] found that participation in UREs was significantly and positively related to the successful completion of a STEM bachelor's degree for Black, Latina/Chicana, Asian, Pacific Islander, and Indigenous women. Further, Chang et al. [7] found that Black, Latino/a/x, and Indigenous

students in STEM who participated in UREs were 17.4% more likely to persist as STEM majors compared to those who did not engage in undergraduate research.

Previous scholarship suggests that this increase in persistence could be due to research programs providing students with space to develop professional and technical skills and engage in the scientific community [8]. Additionally, UREs have been found to provide valuable mentorship experiences for marginalized students [2], [9]-[10]. Because faculty and graduate student mentors take on a collaborative, supportive role in research programs, they can give students guidance to support their overall development [2]. Also, when students' research mentors have marginalized identities that intersect with their own, the mentors can become supportive role models for the students, which may challenge negative stereotypes students have previously encountered [9]-[10].

In terms of local community engagement, Trott et al. [11] introduced a theoretical model to integrate participatory action research (PAR) into UREs, where researchers and participants collaboratively examine the issues that directly impact the participants and work together to create change. This approach contrasts with traditional STEM UREs which can limit students' autonomy over the research process [11]. The PAR-based URE model creates an opportunity for STEM UREs to address real-world issues in a local community context and moves away from detached and impersonal knowledge generation associated with positivist STEM research [11]. Trott et al. [12] and Weinberg et al. [13] described the implementation of the PAR-based URE model for a nine-week summer research program in which two undergraduate students co-constructed research projects on land loss alongside Indigenous communities in southern Louisiana. The researchers found that in addition to positively influencing the participants' desire to pursue a graduate degree and strengthening their scientific skill sets and knowledge, the PAR-based URE "empowered their determination to make a difference in academic and community settings" and taught them "to value and integrate local knowledge alongside scientific knowledge" [13, p. 1170].

2.3. Student Organizations

Prior research has identified student organizations, particularly identity-focused student organizations like the Society of Women Engineers (SWE), National Society of Black Engineers (NSBE), and the Society for Hispanic Professionals in Engineering (SHPE), as support structures that aid marginalized students' persistence and serve as cites for community-building [14]-[15]. In addition to being support structures, student organizations can also be sites for students to engage in DEI initiatives that aim to create a more welcoming environment in engineering programs and increase representation for minoritized groups. In a focus group study with LGBTQ+ undergraduate engineering students, Yang et al. [16] found that participants joined student organizations to take part in collective efforts to make engineering more diverse and inclusive [16]. Similarly, Latiné engineering students have shared that they utilize SHPE to "organiz[e] collectively with the goal of increasing the number of Latinas/os in engineering" [17]. And undergraduate students who worked as mentors for the Summer Engineering Experiences, an outreach program for elementary school students hosted by NSBE, reported that inspiring and supporting program attendees' engineering interests in order to increase the number of Black students in engineering, was a key motivator for them [18].

2.4. Students as Partners

Students as partners (SaP) is a conceptual model and approach that promotes students collaborating with other institutional actors, such as faculty, staff, and administrators, to guide research and practice in higher education [19]. Students may engage as partners in a variety of contexts within institutions of higher education, such as policymaking [20], community engagement [21], and extracurricular organizations [22]. However, the SaP model is perhaps most frequently implemented in the context of teaching and learning [23]. Within this domain, students work alongside faculty to shape curriculum design, pedagogical approaches, and/or assessment techniques utilized in their coursework [19]. SaP has become increasingly popular for those seeking to challenge transactional, hierarchical student-educator dynamics [24]. Within engineering education, SaP has been found to be conducive to positive learning experiences for students, improved course accessibility and the development of more trusting and empathetic relationships between students and instructors [25].

Importantly, SaP can also support STEM students' engagement in DEI efforts. For example, in 2015, Bunnell et al. [26] developed a course titled "Being Human in STEM (HSTEM)" at Amherst College, which engages students in action research projects on topics related to diversity and inclusion in STEM. In personal reflections, HSTEM course alumni noted that their participation in the course supported them in making sense of their own and other students' experiences of marginalization, combatting feelings of isolation, and feeling empowered as change agents within the Amherst STEM community [26].

3. Frameworks

The design of the JEDI was guided by notions of liberative pedagogy [27]-[28]. From a Freirean perspective, liberative education facilitates *conscientização*, or "learning to perceive social, political, and economic contradictions, and to take action against the oppressive elements of reality" [27, p. 38]. Within this model, teachers and learners engage in dialogical action to identify, understand, and challenge oppression. This is done to support teachers' and learners' engagement in *praxis*, or "reflection and action upon the world in order to transform it" [27, p. 46]. Further, as hooks [28] describes, it is the task of educators to recognize students as whole human beings and create participatory spaces for sharing and co-constructing knowledge.

Liberatory education stands in direct opposition to the dominant banking model, which positions students as empty depositories and professors as depositors of knowledge [27]. Riley [29] explains that pedagogical approaches commonly utilized in engineering education center on the banking model, and this authoritarian approach to teaching and learning limits engineering students' ability to think critically and leads them to believe that they should not think and act outside of what they are taught [30]. In contrast, liberatory approaches to education are non-hierarchical in nature, which allows teachers and learners to co-construct knowledge. One of the primary goals in creating JEDI was to challenge the banking model that dominates engineering education by providing students space to realize and name the oppression they face in engineering and supporting them in designing their own projects that seek to challenge oppression.

Prior scholarship has various highlighted that there are various challenges to navigate when enacting liberatory pedagogy within the established order of the university. In many cases of purported liberatory student-educator partnerships, relationships are contractual, power relations remain uneven, practices lack explicit social justice values and purposes, focus is placed on the individual rather than the collective [31].

4. Purpose

The purpose of this paper is to evaluate the attempted enactment of liberatory pedagogy in JEDI. As such, the research questions are as follows:

1. How do former participants of a co-curricular program informed by liberatory pedagogy describe the impacts and limitations of the program?
2. How do the participants' identified impacts and limitations help us refine our understanding of the enactment of liberatory pedagogy?

5. Program and Research Positionalities

The authors' program and research positionalities are summarized in the table below.

Table 1: Positionality

Author	Program Position	Research Position	Social Identities
Bond-Trittipo	Graduate student mentor, assisted with coordination	Led data collection, analysis, and dissemination	Cisgender woman, white, queer
Secules	Faculty lead, co-coordinator, overarching mentor	Mentored research process	Cisgender gay man, white
Garcia	Undergraduate participant (first cohort)	Interview participant, contributed to interview protocol development, verified accuracy of project narratives and data analysis	Non-binary, Latinx, bisexual, first-generation college student
Elaouinate	Undergraduate participant (first cohort)	Interview participant, verified accuracy of project narratives and data analysis	Cisgender woman, North African, international student, first-generation college student
Tinoco	Undergraduate participant (second cohort)	Interview participant, verified accuracy of project narratives and data analysis	Cisgender woman, Mexican, gay, immigrant, first-generation college student
Green	Former associate director of CD-SSEC, staff mentor, co-coordinator	Verified accuracy of project narratives, provided feedback during research process	Cisgender man, white
Tremante	Former director of CD-SSEC, co-founder	Provided feedback during research process	Cisgender man

6. Context

This section provides an overview of the first two years of JEDI, including the institutional context, program development and funding, training, and the student-led projects carried out by the participants of this study.

6.1. Institutional Context

Bond-Trittipo, Secules, Green, and Tremante implemented JEDI at Florida International University (FIU) in Miami, Florida. FIU is a large, public, R1 Hispanic-Serving Institution (HSI). JEDI was formed out of a collaboration between the Center for Diversity and Student Success in Engineering and Computing (CD-SSEC) and the School of Universal Computing, Construction, and Engineering Education (SUCCEED). CD-SSEC oversees engineering and computing student organizations, provides peer tutoring services for engineering courses, coordinates undergraduate research programs, and facilitates outreach initiatives for the College of Engineering and Computing (CEC). SUCCEED is an academic department in CEC that houses an engineering and computing education doctoral program and an interdisciplinary engineering undergraduate program.

In Spring 2021, Green and Tremante approached Secules with the idea to develop this program to engage students in creating change in the local CEC context. Bond-Trittipo joined the effort later in the semester as a graduate assistant, and together, the four launched JEDI in Fall 2021.

6.2. Program Structure and Funding

For the first two years of the program, the JEDI role was designed to be a 10-15 hour/week job, but there was some flexibility. JEDI mentors encouraged JEDIs to focus on their coursework, internships, well-being, and other obligations as needed, which often led to them working fewer hours. On the other hand, sometimes, JEDIs chose to work up to 20 hours/week if they were taking part in multiple projects or particularly eager to complete certain tasks. JEDIs were compensated $15/hour.

JEDI projects moved at the pace the students who led them set. JEDI mentors largely de-emphasized productivity and instead encouraged JEDIs to center their well-being, have in-depth conversations about their perspectives and experiences, explore their interests, make changes to their projects as they saw fit, and reflect. Further, though there is an inherent professor-staff-student hierarchy within the university and employer-employee hierarchy within (non-cooperative, capitalist) workplaces, JEDI mentors aimed to use their power constructively to create environments in which the JEDIs felt empowered to share and act on their ideas.

The primary funding for the first two years of JEDI came from corporate donations to CD-SSEC that were largely non-restrictive, Secules' faculty start-up funding, and Tremante's faculty salary savings. A smaller part of the program's funding came from a partnership with a National Science Foundation Engineering Research Center in Cellular Metamaterials (CELL-MET). CELL-MET provided JEDI with funding to conduct research on issues of graduate student inclusion at their core universities.

6.3. Training

Training for the first cohort of JEDIs consisted of eight two-hour training sessions over a four-week period led by Secules and Bond-Trittipo. The first sessions focused on JEDIs exploring the meaning of the terms justice, equity, diversity, and inclusion, reflecting on how their identities shape their experiences in CEC and society more broadly, and brainstorming DEI issues they

have noticed or experienced and how they might take action to address them. Then, the JEDIs received training on education research methods (including interviews, observations, qualitative data analysis, and quantitative data collection and analysis), educational design, and K-12 outreach.

Throughout the methods, design, and outreach training sessions, Secules and Bond-Trittipo encouraged JEDIs to continue reflecting on their own experiences and generating project ideas. Then, the training period concluded with a project matching session in which JEDIs rotated through one-on-one discussions to share their ideas and explore the projects they might want to join. After the session, JEDIs were asked to submit their final project ideas and teammates to the JEDI mentors.

The training structure for the second cohort of JEDIs deviated from the first primarily because of funding obligations associated with the CELL-MET partnership-- The new JEDIs joined the program in early May 2022, and the findings from the interview study on graduate student inclusion at CELL-MET's core universities had to be ready for presentation by mid-June. The two main phases of training described in the previous paragraph were condensed into two three-hour training sessions. Then, the new cohort dove into aiding with data collection, data analysis, and presentation for the CELL-MET study. After this, Secules and Bond-Trittipo facilitated the same project-matching process utilized during the first year of training.

6.4. Project Narratives

The projects highlighted in this section are ones that were led by the participants of this study (and co-authors of this paper), Garcia, Elaouinate, and Tinoco. There were three other projects led by JEDIs who did not participate in this study, and a handful of projects that Garcia, Elaouinate, and Tinoco explored but never saw through due to their limited capacity or shifts in their interests.

6.4.1. STEM Field Day Outreach Initiative

All JEDIs, including the two who did not take part in this study, demonstrated excitement about K-12 outreach during the training process. So, when Garcia proposed hosting STEM field day events at local K-12 schools and community centers to engage students in fun STEM activity stations and expose them to STEM career pathways, everyone decided to take part. Garcia originally had this idea when they were outreach chair for SHPE at FIU, but they were not able to bring the project to life due to the organization's limited capacity and resources.

Green met with the JEDIs weekly to aid them in developing their vision for the event, and Secules checked in with them every few weeks. Each project member developed an activity station based on their area of expertise (e.g., a JEDI who majored in environmental engineering came up with a water filtration activity).

With the help of the JEDI mentors, CD-SSEC staff and student assistants, and CEC student volunteers, the JEDIs hosted their first STEM field day for dozens of K-12 students at a local community center in March 2022. The project paused for the remainder of the Spring 2022 semester so that JEDIs could focus on their other projects and remained paused in Summer 2022 because the majority of JEDIs took a break during this time for internships. The project resumed in Fall 2022, at which time Tinoco joined as well. The group hosted more STEM field day events at local elementary schools throughout the 2022-2023 year.

6.4.2. LGBTQ+ Student Experiences Research Study
During the reflection components of training, Garcia discussed feeling like they needed to hide their queer identity in engineering contexts because they were concerned about how their peers and professors might react if they knew they were bisexual and non-binary. These reflections motivated them to study the experiences of other LGBTQ+ engineering students at FIU because they wanted to gain an understanding of the issues other members of community face and leverage the results from their study to create a more welcoming environment within CEC. Elaouinate elected to join this project because she was concerned about the challenges her LGBTQ+ peers faced.

The two spent the end of the Fall 2021 semester and the beginning of the Spring 2022 reading background literature on their topic and developing their research design with the guidance of Bond-Trittipo and Secules. Garcia, Elaouinate, and Bond-Trittipo met weekly, and Secules joined every other week. The group also received support from guest visitors and Secules' research group members who provided feedback on their study design. Garcia and Elaouinate ultimately decided to conduct an interview study because they wanted to gather in-depth insight into the perspectives and experiences of their participants.

The group undertook data collection during the Spring 2022 semester. Garcia and Elaouinate shadowed Bond-Trittipo for one interview each to support them in feeling more comfortable with interviewing. Then, the two conducted their own. Garcia and Elaouinate presented their work-in-progress study at FIU's annual undergraduate research conference in late March and spent the rest of the Spring 2022 semester finishing data collection and beginning their analysis. At the end of the semester, Garcia and Elaouinate decided that they wanted to share their findings by writing a paper for the Collaborative Network for Engineering and Computing Diversity (CoNECD), which aligned with Garcia's personal goal to publish a paper prior to completing their bachelor's degree.

The project then paused over the summer because Garcia and Elaouinate assisted with training the second cohort of JEDIs and then took a break from JEDI to focus on internships and intensive summer coursework. During the Fall 2022 semester, Garcia, Elaouinate, and Bond-Trittipo met weekly for two hours to finish data analysis and write the conference paper with Secules joining meetings occasionally to provide additional support. Garcia and Elaouinate presented their findings at the SUCCEED Research Symposium at the end of the fall semester and used the first part of the spring semester to prepare for their CoNECD presentation. Garcia, Elaouinate, and Secules co-presented their paper [32] at CoNECD. The group and Tinoco wrapped up this project by reviving Out in STEM (oSTEM) at FIU because participants of the study shared that they felt there needed to be more spaces for LGBTQ+ engineering students to connect with one another.

6.4.3. Reproductive Rights Workshop
Shortly before the project matching sessions for the second cohort took place, the United States Supreme Court overturned *Roe v Wade*, which classified access to abortion as a constitutional right, through their ruling on *Dobbs v Jackson*. Angered by this ruling and motivated to raise awareness about the issue and fight back, Tinoco that JEDI host a reproductive rights panel at the Engineering Center called "Know Your Rights". She felt that it was particularly important to

have this event on FIU's engineering campus because she had observed that engineering students generally lack concern for political issues.

To carry out this event, JEDI partnered with the FIU Women's Center. Tinoco met with their staff members regularly, and they generously provided guidance on designing the panel and assisted with recruiting attendees. Tinoco also met with Secules intermittently and Bond-Trittipo, Garcia, and Elaouinate weekly from the beginning of the Fall 2022 semester up until the time of the event to work on event planning and developing materials to promote the panel.

The event was held in October 2022 and included three panelists, a Florida Planned Parenthood employee, the faculty advisor for Medical Students for Choice, and the recruitment officer for Generation Action at FIU. The opening questions for the panel, which Tinoco wrote with the help of Secules and Bond-Trittipo, focused on the implications of *Dobbs v Jackson*, the state of abortion access in Florida, and actions FIU students, faculty, and staff get involved in the movement for safe, accessible reproductive healthcare. Then, the audience had the opportunity to ask the panelists questions.

6.4.4. Participation in Advocacy and Organizing in Response to State Legislation
In February 2023, the Florida legislature introduced several oppressive bills, including one that, in part, sought to eliminate in-state tuition waivers for undocumented students attending public Florida colleges and universities (S.B. 1718) and one that attacked academic freedom and DEI programs within public Florida colleges and universities (H.B. 999 / S.B. 266). Since Tinoco was part of the Deferred Action for Childhood Arrivals (DACA) program herself, she wanted to dedicate her time to advocating for undocumented students' access to affordable higher education with Tuition Fairness Florida. Further, Tinoco, Bond-Trittipo, and Garcia all joined Free FIU, a coalition of FIU students, faculty, and other community members that came together to organize a walkout to demonstrate opposition against H.B. 999 / S.B. 266.

These advocacy and organizing efforts did not fit cleanly into the original scope of the program since the projects were not developed by JEDIs. However, Secules and Green recognized the group's passion for these initiatives and the urgency around these issues, so they agreed to recognize this work as part of the JEDI roles.

Tinoco traveled to Tallahassee with other students and staff members from Tuition Fairness Florida several times to share her story as an engineering student with legislators and discuss how receiving an in-state tuition waiver enabled her to pursue her education. As for Free FIU Bond-Trittipo, Garcia, and Tinoco engaged in an array of activities, including attending weekly meetings with coalition members to plan the walkout, canvassing on campus and giving in-class presentations to raise awareness about H.B. 999 / S.B. 266 and promote the walkout, facilitating and attending organizing trainings, and serving as march leaders during the 400-person walkout in April 2023. Bond-Trittipo, Garcia, and Tinoco met biweekly to reflect on their experiences engaging in advocacy and organizing.

7. Methods

Participants were recruited for this study based on their participation in JEDI and graduation term. In July 2023, Bond-Trittipo sent an email to the four JEDIs who fully participated in the program during its first two years and graduated in May 2023 to request that they participate in an interview focused on their experiences in JEDI. Three of the four JEDIs (Garcia, Elaouinate,

Tinoco) responded to the request and agreed to participate in an interview. Bond-Trittipo then sent each participant an interview protocol draft and invited them to revise it, including adding new topics or throwing out existing items. Additionally, Bond-Trittipo informed each interview participant that she planned to facilitate a visual activity during the interview and requested that they upload any photographs from JEDI that are meaningful to them to a OneDrive folder that they both could access.

The interview protocol focused on participants' experiences in JEDI with attention to constructs from liberatory pedagogy. Protocol items covered topics such as impactful, surprising, and challenging experiences the participants had in JEDI, how they would change JEDI moving forward, how their views on DEI issues and oppression changed as they participated in JEDI, the extent to which they felt they had agency over their projects, and their perspectives on the relationships they had with their mentors and other JEDIs. Ahead of the interviews, Garcia also requested to discuss how the skills they gained through JEDI have aided them in their career as an electrical engineer, so this topic was integrated into the interview protocol.

Bond-Trittipo conducted individual semi-structured interviews with Garcia, Elaouinate, and Tinoco via Zoom that ranged in length from 80 to 150 minutes. All three participants elected to upload photographs, so each interview began with the participant sharing the photographs they uploaded and explaining why they found them meaningful. The use of photo elicitation served to support participants in guiding the conversation around their meaningful experiences in program and foster a collaborative researcher-participant dialogue [33]. Additionally, the semi-structured interview approach allowed for conversation to openly flow while also remaining consistent across the topics covered in the three interviews [34].

The Zoom video and audio recordings were saved, and the audio files were uploaded to Otter.ai for transcription. Bond-Trittipo manually corrected errors in the software-generated transcripts. Bond-Trittipo analyzed the interviews using a three-cycle thematic coding technique [35]. For the first stage, Bond-Trittipo listened to each interview and created content logs partitioned into 2-5-minute increments. During this process, she made note of codes related to liberatory pedagogy. Once initial codes were established, she conducted focused coding for all interviews by tagging the content logs and then interview transcripts with codes from the first cycle. Finally, recurrent themes across the three interviews were identified. The interview participants, Garcia, Tinoco, and Elaouinate, reviewed Bond-Trittipo's analysis and verified its accuracy.

8. Findings

There were two research questions for this study:

1. How do former participants of a co-curricular program informed by liberatory pedagogy describe the impacts and limitations of the program?
2. How do the participants' identified impacts and limitations help us refine our understanding of the enactment of liberatory pedagogy?

This section is primarily organized around interview participants' responses that address the first research question. The second research question is addressed through analytical commentary and the discussion that follows.

8.1. Impact 1: JEDI as Welcoming, Safe Environment

Across the three interviews, participants shared that they felt JEDI provided an environment where they could embrace their marginalized identities and freely share their ideas. This welcoming space, in turn, allowed JEDIs to form close, supportive relationships with their mentors and other program participants.

First, regarding self-expression within JEDI, Tinoco said:

> *I felt like I could bring all of my identities because I felt like it was a safe and welcoming environment and very understanding. Honestly, it was very refreshing. . . . In STEM, I wasn't hiding who I was, but I wasn't like showcasing like, "Oh, look at me!" because I didn't really feel comfortable. I didn't feel like that at all in JEDI. . . . Like, yeah, I am an immigrant. I am gay. I am a woman. I am first-gen. All of these things do affect me, and they all have played a huge role in my life. . . . It's nice to be able to embrace all of those identities. One of the biggest ones I struggled with was being queer in STEM. I'm confident in my sexuality. . . [But] still, in the back of my mind, I'm like, "Oh, snap, it could be dangerous". . . and people are not like socially aware, or they're quick to make homophobic remarks. Even towards women, they do a lot of objectifying. I don't really like being around that environment.*

In the above quote, Tinoco discusses that she could freely express and embrace her identities within JEDI. She describes being able to do so as "refreshing" and contrasts this feeling with her perspectives on other STEM contexts, saying that she worried about the potential danger of being openly gay and disliked being in environments where people made homophobic remarks and objectified women. Garcia echoed a similar sentiment:

> *I definitely feel like I was able to be my 100% myself within JEDI. . . . The first thing that comes to mind is Andrew [Green] because I had times when I just sat at his desk and he just allowed me to talk to him about how I was feeling about being non-binary and just provided very much that safe space. . . . He was always there to listen. . . . I feel like JEDI was the only place where I could be myself within engineering and within FIU, but you guys also gave me the confidence to be myself. So, like whether people accepted that I [use] they/them [pronouns] or not didn't stop me from still having it on my email or telling people, "Hey, this is the situation. I use they/them pronouns. I'm non-binary. Since we're going to work together, this is something that you need to understand."*

Like Tinoco, Garcia shares that they felt like they could be themselves within JEDI. They recount specific memories of their mentor, Green, providing a safe space for them to discuss being non-binary. Garcia describes that JEDI was the only place within engineering and FIU more broadly that they felt they could fully be themselves. But at the same time, the support they received from their fellow JEDIs and mentors empowered them to openly share their pronouns and communicate their non-binary identity with their engineering peers.

In addition to JEDI providing a safe space for participants to freely share and embrace their marginalized identities, interview participants also felt that their peers and mentors constructed an environment where they were free to share their ideas and ask for support when they need it. In discussing her relationship with her fellow JEDIs, Tinoco said:

> *I felt really supported by J [Garcia] and Malak [Elaouinate]. . . . I felt like we could speak only about things, and I really appreciated their input on things, and their ideas helped guide me as well. . . . We would help each other. I thought it was really good. Also, being able to be open with each other about our identities and all of that and feeling like there was a safe environment to speak openly and provide and receive feedback was nice.*

Here, Tinoco notes that she could be open about her identities with her peers, Garcia and Elaouinate. Additionally, she highlights the cooperative relationship the three shared. Similarly, Elaouinate discussed feeling supported by her JEDI peers, especially Garcia, who she worked most closely with:

> *Every time I needed an explanation, they would always offer to help and explain things to me, even if I needed like extra time to ask some questions. . . . At the start [of the program], when I asked if I could meet with [them] to ask questions about the LGBTQ+ community, they were so happy to do that. Small things, and even personal stuff, they would always be there for me.*

Here, Elaouinate says that Garcia would always take time to offer her extra support when she needed it. She also highlights a memory from the beginning of JEDI when she arranged a separate meeting with Garcia to learn more about the LGBTQ+ community and discuss the issues they face to prepare herself for the research study she planned to assist Garcia with.

During her interview, Tinoco also described feeling free to share her ideas. Specifically, she shared the following regarding her relationship with her mentor Secules:

> *Any idea I would come up with, I would share with him, and he would be really supportive of it. . . . It was nice because he was also like a friend as well. I could talk to him openly, and it was okay. I didn't feel like I had to, you know, be professional in a way. I understand it was a job and all of that, but it was nice to feel like I could talk to him about anything. . . . And just him being supportive of us doing the advocacy stuff, I thought that was really great because I wasn't sure if that was going to be viable. So, when he let us do that, I thought that was really awesome. . . because that was something I really wanted to focus my time on.*

Tinoco emphasizes that she appreciates the support Secules provided when she shared her ideas with him or wanted to take on a project that fell outside of the original scope of JEDI. Specifically, she highlights being grateful that Secules permitted her to participate in advocating for in-state tuition waivers for undocumented students with Tuition Fairness Florida and organizing against H.B. 999 / S.B. 266 with Free FIU because the work was meaningful to her and she had limited time to pursue it due to her extensive commitments. Perhaps most importantly, Tinoco calls Secules a "friend" and mentions that despite her role as a JEDI being a paid position, there was not pressure to be professional like there is in most workplaces.

Tinoco was not the only participant who described having a close relationship with mentor or other JEDIs. Garcia described the relationship with their mentor, Bond-Trittipo, and fellow JEDIs, Elaouinate and Tinoco, as one between siblings:

> *With all of you, like you [Bond-Trittipo], Maria [Tinoco], and Malak [Elaouinate], even though-- I know like you were technically our mentor-- I always felt like a sibling bond between us. . . . You guys were like the sisters that I never had. We could relate to each other a lot even though we have different identities. . . I felt like we all had this one goal in mind of DEI, and it just blossomed into a really amazing friendship. . . . You guys have such a special place in my heart.*

Here, Garcia highlights the "sibling bond" they formed with Bond-Trittipo, Tinoco, and Elaouinate despite Bond-Trittipo "technically" being a mentor. Additionally, they spotlight that the common goal the group shared around improving DEI issues enabled them to form "a really amazing friendship" despite holding different social identities. Later in their interview, Garcia describes the friendship as "the best thing that came out of JEDI".

Prior research has highlighted that LGBTQ+ engineering students often experience a lack of community and support within their programs [16], [36]-[37], and the experiences shared by Garcia and Tinoco are consistent with these findings. But through JEDI, participants found a safe, welcoming environment where they could embrace their queerness and the other marginalized identities they hold and reflect upon how their identities have shaped their experiences. In Garcia's case, having this support enabled them to become more confident outside of JEDI as well. This outcome underscores the importance of counterspaces for marginalized engineering students.

Participants also felt free to express their ideas and described working collaboratively with one another to carry out their projects. This openness and collaboration extended into mentor-mentee relationships as well. By taking an anti-hierarchical approach and rejecting professionalism, JEDIs and their mentors formed meaningful relationships as they addressed DEI issues in their local context. The participants' insight about forming friendships and sibling-like bonds with one another and their mentors emphasizes two core components of liberatory pedagogy: love and shared commitment to equity.

8.2. Impact 2: Growth and Learning

All three interviewees emphasized growth and learning as part of their experience in JEDI. For instance, Garcia shared:

> *I just think JEDI was amazing. I think it provided an opportunity for me. . . I didn't know I could learn so much about the DEI and gain a new passion for it as well. . . . There's definitely that room for growth. . . and a lot of learning. I feel like that is one of the biggest things, it helped me learn. Learn about different research techniques, learn about different events that we can do, but it also allowed me to learn about different cultures and different people and just be more like, aware of like other people's identities and lives.*

In the above quote, Garcia describes that JEDI allowed them to learn about DEI and fostered their passion for it. They also comment on how the program helped them learn about research and event-planning, as well as people's cultures, experiences, and identities. Elaouinate similarly found that JEDI provided space for growth. When asked how she would describe JEDI in her own words, she said:

> *Liberating is one word I would use to describe JEDI because it gave [you] your own time to make you feel comfortable enough so you can express what you want to change. . . And also [it gave me] the ability to see from different perspectives. . . . It was just welcoming and comforting and like an environment where you could grow. . . . I was very open, and I wasn't afraid to express my views on stuff and share about me. At first, I really wanted to join the program because it was something different than what I do on a daily. The only thing that you bring into [the classroom] is your mind. But for JEDI, it was more than just what skills I needed for tasks to be completed. It was more about me as a person. I feel like anything we had to work on required your entire [self] to be present.*

Similar to Garcia, Elaouinate discusses that the work she undertook in JEDI allowed her to "grow" and better understand other's perspectives. Interconnected with the first theme, she describes this growth as being enabled by the JEDI because there was a welcoming, safe environment for her to share information about herself and express her ideas about what she wanted to change in the local context—She even describes this as a "liberating" experience. Lastly, Elaouinate contrasts experiences of bringing her whole self into JEDI with those of engineering classrooms where "all you bring is your mind" and the skills you need to complete tasks are the main concern.

Tinoco also touched on growth as part of her JEDI experience:

> *[The Know Your Rights event] gave way to my interest in advocacy work. Prior to that, I would always hear about problems, and I would be like, "Damn, that sucks." I always wished I could do something about it, but this was the time when I actually started to do something about it. It definitely helped me grow and learn a lot. . . about abortion rights. . . Also, doing this event was a learning curve as well because I'd never created an event like this before. It definitely put me out of my comfort zone, to say the least. I had to reach out and talk to people and plan things accordingly.*

Here, Tinoco says that planning and facilitating her reproductive rights workshop made her feel like she was a part of addressing attacks on reproductive rights, and she contrasts this to her prior experiences of wishing she could do something to confront social issues. Further, she explains that this project helped her learn more about abortion rights, pushed her to become more comfortable reaching out to and coordinating with others, and gave way to her future advocacy work.

As shown above, participants described JEDI as an environment that supported learning and growth. In addition to learning about education research techniques and event planning, participants reported learning about and gaining a passion for DEI and social issues. In Tinoco's case, this new knowledge and passion piqued her interest and eventual involvement in advocacy work.

Furthermore, as Elaouinate points out, the person- and growth-centered space that JEDI provided contrasts with engineering contexts that solely focus on skill application and development. A thorough discussion of the influence of neoliberal rationality on engineering education is beyond the scope of this paper; however, it is important to recognize that the ascendence of neoliberalism has positioned the purpose of universities as creating human capital, which reduces

them to job training sites rather than spaces to engage in critical thought and have transformative experiences [38]. This reduction is especially prominent in engineering education, which often emphasizes technical knowledge to prepare students for their careers and devalues social justice considerations [39]. JEDI meaningfully challenges this dominant pattern by moving away from narrowly focusing on technical knowledge and skills acquisition and toward promoting students' engagement in activities that support their development as democratic citizens, namely advocacy and activism.

8.3. Limitation 1: Time Constraints

A challenge Tinoco and Elaouinate mentioned during their interviews was time. Both participants conveyed that they felt overwhelmed between JEDI, their coursework, and outside employment. Elaouinate said:

> *I just felt like with managing my time, I was so bad. . . . Last summer was so hard for me and I would reach out to you, and you were so understanding.*

In this quote, Elaouinate expresses that she felt like her time management was an issue. Also, she notes that it was difficult for her to participate in JEDI during Summer 2022 (due to her intensive courseload and internship), but Bond-Trittipo was understanding when she reached out about this issue.

Relatedly, when Bond-Trittipo asked Tinoco about the biggest challenge she faced as a JEDI, she responded:

> *I would say juggling being a full-time student and [working] my internship was probably the biggest [challenge] for me. . . . I mean, thankfully, with your and everyone's support, I was able to manage just fine, mostly, even though, you know, it was hard, no lie.*

Here, Tinoco shares that it was difficult for her to balance her roles as a JEDI, full-time student, and mechanical engineering intern. Additionally, like Elaouinate, she mentions that the JEDI mentors' support helped her navigate this difficulty.

Other points in the interviews with Elaouinate and Tinoco provided more insight into how JEDI mentors' approaches helped alleviate their concerns about time management. Elaouinate shared:

> *I never felt looked down upon or like, "You haven't done your task" or something like that. Whenever it was very overwhelming for me, I was never afraid to share stuff. . . . I could tell you, and you were always so understanding. All of you are very understanding.*

In this quote, Elaouinate describes that her mentor, Bond-Trittipo, did not shame her if she did not complete a project task and that she would be met with an understanding attitude if she told her JEDI mentors she was overwhelmed.

Further, as Tinoco discussed her relationship with Bond-Trittipo, she said:

> *My words couldn't describe like how much you impacted my life or how much support you offered and how meaningful that was to me. . . with my projects and also as a friend. . . I felt like sometimes I was kind of like all over the place or just kind of falling*

behind and stuff like that. . . . And then to have you-- Even just like do an outline for me. . . It was so nice because it would set me on course and help me so much. And like all of the advice that you gave me, being a coworker, friend, and mentor, I thought that was really awesome. I really liked how I could just be honest with you about where I was at, how I was doing, and what I wanted to do moving forward. We could have a conversation and plan things out. In some relationships, you hold back, but I didn't really feel like that. I felt like I could be myself and be open about my thoughts and what I wanted, and I felt like you were super supportive of that.

In this quote, Tinoco emphasizes the positive relationship she had with Bond-Trittipo as a mentor. She describes that the support extended beyond the JEDI projects into friendship as well. Like Elaouinate, Tinoco shares that she felt comfortable being honest with Bond-Trittipo about her progress on her project tasks (or lack thereof), how she felt, and her ideas. Additionally, Tinoco communicates that Bond-Trittipo's simple gestures, such as outlining her project tasks, made her feel supported and helped her carry out her projects.

Prior research indicates that the credit-heavy nature of engineering majors and the intensity of engineering coursework often hinder students' co-curricular engagement [40]-[41]. Elaouinate and Tinoco encountered this issue, as well as time constraints due to internships and other external commitments. However, because JEDI was concerned with the process of collaborating to address DEI issues rather than any final product, JEDIs could take breaks as needed and were always welcomed back with open arms. As a result, participants could balance their multiple commitments and sustain their engagement in the program.

8.4. Limitation 2: External Impact

The previous findings demonstrate that Garcia, Elaouinate, and Tinoco felt positively impacted by JEDI as individuals. Throughout their interviews, the three also described having some positive impact on the engineering education community. For example, Garcia said:

I think [we had a] positive impact at the conference, at least people had a good response. At the end, our moderator [came] up to Malak [Elaouinate] and me and was like, "Thank you for creating this type of study." She really enjoyed it, and it seemed like she had resonated with it. . . . It was nice to see this type of research, an LGBTQ+-focused research [project] and qualitative research, be praised and appreciated.

Here, Garcia discusses how they felt that they had a positive impact on the engineering education community by sharing the findings from their research project on LGBTQ+ engineering students' experiences at CoNECD.

Also, Tinoco shared that she felt that she was part of creating change when she helped facilitate a STEM field day event and conducted interviews for and presented the findings of the CELL-MET graduate inclusion study as part of her JEDI training:

It was nice to see the kids' enthusiasm. [STEM field day] was meaningful to me because we didn't have stuff like that to expose us to STEM when I was in school. I was really glad we could provide that because, ultimately, that's how you diversify engineering, by exposing kids to [engineering] careers.

> *I thought it was really dope that we got to interview people and hear their stories. Then [we were] able to represent their problems, their identities, and the struggles that they go through to people who are higher up and can do something. In a way, we're helping fix the problem. That felt really good.*

In the first quote, Tinoco discusses how co-facilitating a STEM field day event at a local community center was meaningful to her because she did not have access to this type of programming when she was a child, and she sees outreach as a way to increase diversity in engineering. In the second quote, Tinoco describes that she enjoyed hearing participants' stories through the interviews she conducted and sharing those stories with people who could enact change.

Though program participants saw themselves as having some external impact, as Tinoco discussed what she would change about JEDI, she highlighted a program limitation, the university community's lack of awareness about it:

> *I would create more events so that other people can familiarize themselves with JEDI. . . . We were doing a lot of stuff, but not a lot of people knew what the program was and what it entailed. So, [I would have] more events. . . to [increase] exposure and get more volunteers. . . . And I think [it's] important to create more community so other people can feel included. . . . And maybe [JEDI could] be more involved with other organizations on main campus to help put the Engineering Center on the map because I feel like people aren't even aware that we exist.*

Here, Tinoco discusses what she would change about JEDI. Specifically, she mentions hosting more events so members of the FIU community could learn about JEDI and become involved in program efforts. Additionally, she draws attention to the potential JEDI has to create a community and help others feel included. Lastly, she suggests that the JEDI become more involved with organizations on FIU's main campus to raise awareness about the DEI efforts being undertaken on the engineering campus.

In her interview, Tinoco did not directly discuss the impact limitations of the projects developed within JEDI. However, she did share that the work she undertook advocating for in-state tuition waivers for undocumented students and fighting again H.B. 999 / S.B. 266 with Free FIU, which were broader movements she engaged in as part of her JEDI role, was her favorite because she felt that it was the most impactful:

> *Getting involved with the tuition fairness campaign and Free FIU was my favorite because I felt like I was doing the most impactful work. . . We were trying to raise awareness and bring the community together and stand against something that we didn't want and didn't believe in. I feel like it taught me how much strength and power our voices actually have. . . . Even though the laws still went through. . . we're not gonna stop fighting. . . . By being involved in advocacy work and fighting against these bills that are meant to oppress us further, I feel like I can do something about [oppression]. I feel like we all can. We have strength in numbers, and there's strength in our voice.*

In the above quote, Tinoco recounts “bring[ing] the community together” and collectively taking a stand. Reflecting on this experience, she shares that these actions made her feel that we can challenge oppression because there is strength in numbers and our collective voice.

As discussed above, Garcia and Tinoco noted that they had some positive impact on the engineering education community and local community through their research, student programming, and outreach projects. However, change-making through these avenues is inherently limited. For instance, sharing the results of a study that highlighted issues of graduate student inclusion represents a top-down theory of change in which institutional leaders still hold control over whether to make changes based on the information presented to them. Such an approach to improving inclusion for engineering graduate students is limited compared to building power from the bottom up to demand equitable change through efforts such as graduate worker unionization and striking [42], and this type of collective action more closely aligns with Freirean notions of liberatory praxis.

Further, Tinoco spotlights the small size of JEDI and its relative disconnectedness from other organizations across FIU as limitations of the program. The seclusion of JEDI and, consequently, the projects developed within it was a barrier to collective transformative action. However, because of JEDI's flexibility, Tinoco advocated for tuition fairness for undocumented students with Florida Tuition Fairness, and Tinoco and Garcia participated in Free FIU to organize a walkout in opposition to H.B. 999 / S.B 266 as part of their JEDI roles despite these efforts being formed outside of the program. And by doing so, they were part of a broader movement to challenge oppression.

9. Discussion

Our findings indicate that participants felt invited to bring their whole selves to JEDI, and this experience contrasted with what they experienced in engineering classrooms-- In these contexts, participants felt that technical skills and knowledge were all that mattered, and they did not feel comfortable fully expressing or embracing their marginalized identities. In addition to having a safe space for self-expression, participants freely explored their interests, guided their projects, and shifted their focus as they saw fit. Ultimately, this freedom allowed participants to create projects they found meaningful within JEDI and engage in broader movements as part of their JEDI role and take part in collective action, which mitigated the issue of JEDI being small and somewhat insular. As JEDIs and mentees shared ideas and worked collaboratively, they learned about DEI issues and cultures and perspectives that differ from their own. They also uncovered their passion for DEI and advocacy, and most importantly, formed close, long-lasting bonds with one another. We see these outcomes as successes of implementing liberatory pedagogy through JEDI.

As highlighted in the findings, the program also had limitations, particularly around time constraints and external impact limitations. In terms of time constraints, participants’ insights revealed that mentors’ practices can help alleviate concerns about limited time. In particular, they emphasized that mentors did not shame or scold them for not completing tasks, and this helped them stay engaged in the program. As for external impact, attempting to create change through formal institutional structures is inherently limited. However, JEDI perhaps promoted change in small ways through facilitating outreach events, sharing research findings, and engaging engineering students in political issues through a workshop. And most importantly,

JEDI led participants to get involved with broader collective efforts to challenge oppression from the bottom up rather than top down.

10. Conclusion

This paper investigated the impacts and limitations of JEDI, a co-curricular program inspired by liberative education models that aims to support undergraduate engineering students in addressing DEI issues through education research, student programming, and outreach. The program alumni who participated in exit interviews and co-authored this paper highlighted that JEDI provided them with a safe space to embrace their marginalized identities, learn, and grow. Through the program, participants and mentees formed friendships, uncovered new passions, and became engaged in broader advocacy and activist efforts. The participants also revealed some program limitations, including difficulty with time constraints and limited external impact due to JEDI being small and isolated. These findings provide insight into the positive outcomes of operationalizing liberatory pedagogy in co-curricular engineering contexts and the challenges of doing so within formal university structures. Ultimately, we hope that sharing this work will aid the engineering education community as we continue to search for ways to support students and create more equitable, just futures.

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