The Experiences of Students as Peer Mentors in Engineering: Agency, Learning, Persistence, Uncertainty, and Culture.

Prof. Jill Davishahl, Western Washington University

Jill Davishahl is Associate Professor and First Year Programs Director in the Engineering + Design department at Western Washington University. Jill's teaching, service, and research activities focus on enhancing the first year student experience by providing the foundational technical skills, student engagement opportunities, and professional skill development necessary to improve success in the major. Her current research focuses on creating inclusive and equitable learning environments through the development and implementation of strategies geared towards increasing student sense of belonging.

Audrey Boklage, University of Texas at Austin

Audrey Boklage is research assistant in the Cockrell School of Engineering at the University of Texas at Austin. Her current work is focused on exploring pedagogical moves and interactions within university makerspaces to create a theoretical lens to info

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Abstract

This complete research paper explores the multiple facets of student mentorship in an academic makerspace with a focus on better understanding the experience and perception of being a peer mentor. The results of this study provide insight into the development of four students as mentors during their first year of employment. The students experienced learning, agency, persistence/commitment, uncertainty, and the culture of engineering in their role as mentors. They all found learning to be part of being a mentor and experienced personal growth over the course of the year. The peer mentors all developed a sense of agency because of being a mentor and described it as a positive attribute of the job. Commitment to the work, the makerspace, and the students they supported was something all four mentors found motivating and important. All four students experienced uncertainty in the role and sometimes struggled with knowing the path forward. Interestingly, the mentors experienced their roles differently across gender lines which could be attributed to how the mentors experienced and described the culture of engineering. Through these findings, we can gain insight into how best to support peer mentors in their role including hiring, training, and supporting them in the position. This study may help us to understand how students' stereotypes about the culture of engineering influence their experience as mentors. Additionally, future research can implement a refined and focused lens on the culture of these academic makerspaces and how peer mentors and students support (or ignore) the culture of engineering within academic makerspaces.

Introduction

Funded through the National Science Foundation Research Initiation in Engineering Formation (REIF) program, WWU university created a peer mentoring program focused on supporting students socially within an academic makerspace. The goal of the program is to increasing sense of belonging in undergraduate engineering students by engaging them in non-technical work while supporting social connection and developing community. This study is the first of its kind to explore how peer mentors develop and support makerspace activities explicitly focused on inclusive engagement and how those experiences impact their development as mentors. The purpose of this study was to better understand the experiences of students who work as peer mentors in an academic makerspace so we can better support them as employees. Through qualitative analysis, the study investigates the experiences of four students during their first year of employment as peer mentors. The findings provide insight into how the students experienced learning, agency, persistence, uncertainty, and the culture of engineering. Although not an original component of the research, the findings point to stark difference between how students interpret and respond to the culture of engineering based on their gender.

Literature Review

Makerspaces are defined by the process of making, which involves problem-solving, collaboration, discovery, and immersion in personally meaningful projects [1]. Well supported academic makerspaces provide students with open access to resources that help them develop their problem-solving skills, provide opportunities for collaboration, increase self-efficacy, and

develop sense of belonging [2] [3]. Sense of belonging generally relates to self-perceptions of fit within a given context [4] [5] and has the ability to positively impact academic achievement and persistence in STEM [6] [7] [8]. There is evidence to suggest that the presence of a non-intimidating, informal community established within an academic makerspace can potentially benefit student sense of belonging [9].

Creating an inclusive community within a makerspace that promotes belonging requires purposeful considerations. Research has shown that participating in academic makerspaces is associated with positive changes in students' design, engineering task, and innovation self-efficacies; motivation; expectations of success; interdisciplinary awareness; and belonging [10] [11] [12]. It is important that makerspaces are welcoming places that encourage a culture of sharing, appreciation of diversity of thought, and respect. Research exploring the support of inclusive and equitable learning environments in university makerspaces specifically point to the importance of a *making culture*. In a national study of university makerspaces, researchers recognized the importance of a social and collaborative atmosphere as components of an inclusive makerspace culture [13]. Another researcher identified the importance of developing expectations and guidelines that align with diversity, equity, and inclusion (DEI) best practices, along with a willingness to commit to continuous assessment and change, as being central to creation of a positive maker culture [14]. In prior work, the authors pointed to the importance of a simplified work environment and welcoming atmosphere to the development of an inclusive makerspace environment [15].

When students engage in learning opportunities in a makerspace, it has the potential to positively impact their educational experience and academic success. The term student engagement refers to the extent to which students invest, value, and participate in their educational experience in a meaningful way [16] [17]. The positive outcomes associated with student engagement include increased student achievement, decreased dropout rates, and more positive emotional experiences [18] [17]. Fulfilling academic and social needs via student engagement affects a students' college experience, which, coupled with a sense of belonging, increases the likelihood of persistence [18] [8]. On the other hand, when new students experience social isolation, it can lead to a lack of belonging which negatively impacts retention [19]. Common strategies to improve student engagement include increasing opportunities for students to interact with their peers and community; providing exploratory learning opportunities; engaging students in relevant, meaningful, and authentic work; promote students sense of ownership and sense of responsibility; and inviting students to be co-designers of their learning [20] [21].

Despite their potential, many makerspace environments do not readily support underrepresented minorities [22], create tensions between different student groups [23], often include bias messaging that presents barriers for broader inclusion [13], and could contribute to a work environment that feels exclusive [24]. Furthermore, recent research has shown that makerspaces are not always welcoming [25]. In addition, underrepresented minorities often develop negative perceptions of makerspace culture due to gender bias and marginalization [26].

The unique informal learning environment of a makerspace lends itself well to the development of flexible learning arrangements that can be supported by peer learning, peer mentoring, peer

coaching, and peer teaching [27]. There are many benefits of peer mentoring including improved student retention for students of color [28], increase in academic performance [29], improved communication skills, development of maturity and compassion, increased responsibility [30], appreciation for diversity [31], and the development of sense of belonging [32] [33]. There is limited research on the impact of peer mentoring in makerspaces specifically; however, one study indicates that mentors who work in makerspace environments experience an increase in maker skills, improved confidence, and positive connection with community [34]. Successful mentoring depends on the development of positive relationships between students [35] and has been shown to positively impact mentors. This research seeks to understand the experiences of peer mentors in order to create and support an inclusive makerspace culture.

Context

This project takes place at Western Washington University (WWU), a public institution with approximately 16,000 full-time undergraduate students and 160 academic programs. The Engineering & Design Department (ENGD) offers four undergraduate-only programs: Electrical & Computer Engineering (EECE), Manufacturing Engineering (MFGE), Polymer Materials Engineering (PME), and Industrial Design (ID). Students first enroll as pre-majors in the department and then apply for the major, typically in their second year. There are approximately 200 major-level students and 100 pre-major students. Over the past 5 years, the Engineering & Design department at WWU has spent considerable effort focused on supporting students with the goal of improving student sense of belonging and creating inclusive and equitable learning environments. These efforts were spurred by an internal research study that found 1. the percent of women-identified, first-generation, Pell-eligible, and underserved students declines from the pre-majors to the major; 2. there has been a decrease in diversity as the programs have become more competitive; and 3. pre-majors, women-identifying, and underserved students report a statistically significant lower sense of belonging than their counterparts [36]. Efforts have included updating the first year curriculum to incorporate social justice [37], integrating inclusive practices into the departmental makerspace [38] [15], creating a summer bridge program for engineering students [39], conducting research on impacts of curricular and co-curricular changes on belonging and identity [40] [41] [42], and an National Science Foundation (NSF)-funded project which seeks to increase student sense of belonging in undergraduate engineering students through the integration of social engagement activities into an academic makerspace.

The focus of this paper is related to an NSF-funded makerspace engagement and belonging project. There are two main components of the project: 1. Development and implementation of social engagement activities followed by research on the impact on the students participating in the activities [43] [44] and 2. Creation of a makerspace mentoring program to support student engagement in the makerspace [45] [46] [47]. This study detailed in this paper is an extension of the second part of the work and explores the experiences of the peer mentors themselves during their first year of employment.

A team of 4 peer mentors, called “Student Engagement Liaisons” (SELs), were hired to design, develop, and implement a series of social engagement activities that were integrated into an academic makerspace. Social engagement activities, in this context, are defined as events, projects, and workshops that have a strong emphasis on supporting the social and emotional

development of students. To ensure equality of access and to allow for flexibility it was important to maximize student ability to participate in the social engagement activities, regardless of prior knowledge or ability level [43].

The SEL team was hired through an open application process. The jobs were advertised through the departmental website, social media, physical flyers, the makerspace, and were announced in classes. Job requirements included being full-major status, having a positive attitude, and being able to commit to the job for 10 hours per week for a full academic year. Applications were reviewed and select students were interviewed for the position. The interview team included the two faculty members, the makerspace manager, and current SEL employees. The job responsibilities include 1. assist faculty and staff with developing, designing, and coordinating activities focused on social engagement; 2. utilize the department social media to share department news and events and to engage students in the department; 3. act as a resource, coach, friend, and role model to students; 4. provide support and encouragement to peers, and 5. attend & participate in department related events such as orientation sessions. The goals of the SEL program are to engage and support students, create inclusive department and makerspace culture, increase belonging for students (with a focus on pre-majors), promote cross program collaborations, and encourage student agency. Once hired, the SEL team engaged in faculty directed training on best practices of peer mentoring and inclusive work practices focused specifically on promoting and developing an inclusive maker culture and positive student support and engagement. The SEL program primarily utilizes a group mentoring format where the SEL team collectively mentors multiple students. Occasionally, the SELs mentor students on a 1:1 basis however, most of the time, mentors/mentees are meeting in small groups and are engaged in social support efforts. Mentoring programs that focus on providing this type of structure along with social inclusion and integration support has been shown be an effective mentoring framework [32] [48].

Over the course of the academic year, the SEL team developed and directed social engagement activities in the departmental makerspace. The makerspace is a 1500 square foot facility that is open to all WWU students and provides access to equipment, tools, and training as well as opportunities for cross-departmental collaboration. It is open 45 hours per week and offers students open workspaces and access to 3D printers, sewing machines, laser cutters, and vinyl cutters. The makerspace equipment training program incorporates accessible and inclusive design elements that take into consideration students' varied backgrounds, prior knowledge, learning preferences, and interests [49].

The SELs were tasked with designing and developing the social engagement activities and, as such, decided on content, focus, length, and engagement strategies. The type of social activities was varied and included DIY craft nights, themed discussions, industry speakers, and focus groups to learn more about the experiences of gender minorities. The engagement activities were designed to encourage students of all backgrounds, majors, and ability levels to participate in the makerspace as they build connections with their peers. For each activity, student participation counts were recorded, and post-event evaluations were collected from the SELs [43].

Approach

This investigation uses a critical constructivist theoretical approach to explore the experience of the four peer mentors during their first year of employment as SELs. A critical constructivist

framework is about research and pedagogy, and the multiple ways in which they are connected. Kincheloe (2008) outlines the basic tenets of critical constructivist research as anchored in the understanding that 1) The world is socially constructed; 2) All knowers are historical and social subjects, everyone comes from a "somewhere" which is located in a particular and historical timeframe, this extends to spatial and temporal settings; 3) People possess knowledge and operate and construct the work on a particular social, cultural, and historical playing field; and 4) A deep concern about process through which knowledge and information is validated [50]. This framework was used as a foundation for data collection, data analysis, and framing our findings.

The primary research questions that guided this work were "What was the experience of the student engagement liaisons in their first year as mentors?" and "How do the student engagement liaisons perceive their roles as mentors?" Research methods followed federal standards for the protection of human subjects in research, including appropriate review by a registered internal review board.

Methods

Participants

This small-scale study consisted of 4 participants and used a qualitative design. Table 1: Participant information summarizes the gender identity, program major, and year of study of the study participants. All names are pseudonyms.

Table 1: Participant information

Student	Gender	Race/Ethnicity	Major*	Year of Study
A: Nolan	Male	White	MFGE	3
B: Louis	Male	Asian	EECE	3
C: Emily	Female	Hispanic	EECE	4
D: Anna	Female	Asian	ID	4

Data Collection & Analysis

Data for this study consisted of a total of four (4) semi-structured interviews and four (4) journal entries conducted at the end of the first year of employment (one interview and one journal entry for each SEL) between spring 2021 and spring 2022. The authors designed and conducted semi-structured interviews with open-ended questions to explore the experiences and expectations of being a mentor. These interviews lasted between twenty minutes and an hour long and were conducted in-person. The questions explored how the students found out about the SEL position, why they decided to apply, and questions about their experiences, including what they thought was going well and what they would like to change. Interviews were designed and conducted in accordance with internal review board policies and researchers ensured the confidentiality of the participants. The interviews were recorded and transcribed.

The journal entries were designed to gather insight on the mentor experience over the course of the academic year. Mentors were asked to summarize the work they completed and reflect on their experience of being a mentor. Questions were open-ended and prompted the SELs to reflect

on successes, challenges, what they were most proud of, and whether they felt supported in their role. They were also asked to describe how the job impacted them and what work, if any, they would like to continue working on in the future. The researchers were focused on learning about the experience of being the mentor in the context of the work itself, their perception of what it means to be a mentor, and their personal experience as a mentor throughout the academic year.

Qualitative analysis techniques of Grounded Theory [51] and thematic coding [52] were used to explore the SELs experiences as mentors in the space. This involved coding the interviews and journal entries through a process of open coding techniques followed by focused coding. Data were coded independently and then discussed during meetings to share interpretations and develop emerging themes. Two researchers analyzed the data through a series of coding and analytical memos. The coding process involved identifying emergent codes [51]. These codes were refined through a process of individual coding and research meetings explicitly focused on aligning and refining the research teams understanding and implementation of the coding scheme/schema. Included in this was a process of focused coding in which each researcher individually coded the data and then gave feedback and asked questions about each other's coding process. As a result, a valid and reliable coding process was established resulting in 100% agreement across all codes and coded data sources. After coding, the research team used analytical memos. This step served as a space and time for researchers to asynchronously make comparisons between the findings and concepts while allowing opportunities to explore new ideas about the data [53]. Memos included direct quotes from the participants to hold sacred the student experience. As a result of the coding and memo-ing, the research team identified and refined emergent themes, articulated below. Both interviews and journal entries were analyzed using these qualitative analysis techniques.

Findings

The data analysis identified five primary themes that emerged as being central to the experience of being an SEL: learning, agency, persistence, uncertainty, and culture of engineering. These themes were the result of emergent coding analysis. Table 2: Examples and definitions of themes summarizes the five primary themes.

Table 2: Examples and definitions of themes

Theme	**Definition**	**Example**
Learning	Growing, acquiring knowledge because of being an SEL	*"The SEL position has taught me what it means to work on an open-ended project, and what is needed to make those projects a success."*
Agency	Feeling a sense of making a difference	*"I didn't want to leave until I could do something- I didn't want to leave until I can contribute to lesson that problem"*
Persistence	Commitment to the role/job of being an SEL; identify with being a mentor	*"I'd like to continue working until I've accomplished the projects I have in mind and see the change in person"*

Uncertainty	Discomfort with variable, inconsistent nature of the work	*"So, that is one part of the job that I'm not sure how I would lead it. It's probably somebody else that will probably lead it. I'll just learn from it."*
Culture of Engineering	Engineering stereotype; personal or professional characteristic of engineering	*"[connecting] is not the easiest for engineering students, especially with the workload we have, or just like the kind of antisocial personality archetype"*

Learning was defined as growing and learning because of being an SEL. All four SELs experienced both professional and personal growth over the course of the academic year. They all specifically mentioned experiencing learning in relation to hosting events and what it means to create inclusive spaces. Agency, in this context, was defined as feeling a sense of making a difference. All four SELs related agency to making decisions, completing tasks, and formalizing the structure of the activities. Persistence was defined as commitment to the role of SEL and the act of being a mentor. All SELs expressed their commitment to the program itself as well as supporting other engineering students. Uncertainty relates to discomfort with the variable and inconsistent nature of the work. The SELs described this as being related to the open-ended nature of the program (i.e., will this activity be a success?) as well as the unpredictability of engagement (i.e., will people show up?). The culture of engineering is defined as personal attribute or characteristic common to engineering, either as a student or professional. All SELs recognized that engineering has associated stereotypes and that those stereotypes can impact perceptions.

Although not an initial objective of the work, one finding of this research the team explored was the differences of student experiences across gender lines. The male participants are more strongly motivated by internal factors, expressed primarily as to how the job impacts their personal/professional development and growth. This was seen across all themes though was more strongly connected to learning and agency. They were also most interested and focused on technical aspects such as making improvements to physical spaces, working on specific projects, and increasing their efficiency.

> *"SEL has gotten me to be more open and motivated to talk to people in the engineering department…the presence of the makerspace gave me opportunities to meet more people and learn more." – Nolan*
>
> *I'm interested in working on changing class environments whether its adding décor to rooms or updating furniture in the engineering space. – Louis*
>
> *There are several projects I would like to get to, and I'm excited about getting our team to a place where we can get through those projects more effectively. – Nolan*

The female participants, on the other hand, were motivated by external factors such as the impact of the program on students, specifically underrepresented student populations. In addition, they were most interested in work related to social components such as improving the interpersonal dynamics between students, especially those focused on creating connections and improving the sense of community and connection in the department. This trend aligns with often gendered dimensions of social technical dualism in engineering, where women tend towards the social and men tend towards the technical [54].

> *"I think our events evolved a little bit which makes me happy. The newer event is focused more on impacting students' quality of education and life in school." – Emily*

> *"I think that there are many ways to improve the student's life in the department, and I enjoy contributing to a positive change" – Anna*

> *"[our goal is] to get a little bit more of an interpersonal community instead of just a professional community" - Emily*

> *"I just want students who feel underrepresented to feel more comfortable and to be in this space in general." – Anna*

Although all four participants experienced learning, agency, persistence, uncertainty, and the culture of engineering through being a SEL, there were differences as to how they experienced these themes that aligned with their gender identity. These findings are summarized in Table 3: Thematic differences . For example, although all four students experienced learning in the context of personal growth because of being an SEL, the men expressed this learning as being related to specific actions (how to host events, how to use specific tools) where the women tended to express their learning through interpersonal relationships (impact of events on students; importance of inclusion to underserved student populations).

Table 3: Thematic differences

Theme	**Nolan & Louis**	**Emily & Anna**
Learning	Internal/Personal: Experience hosting events, socially connecting with others, learning to use makerspace tools and equipment, development of communication & leadership skills	External: Evolution of the program (how it changed over time); impact on student participants; student experiences in engineering; culture of engineering
Agency	Planning focused: Making progress with projects & event planning	Student gocused: Supporting underserved students, Promoting inclusion
Persistence	Commitment to the job Progress & improvement	Commitment to culture change Promoting community & inclusion

Uncertainty	Technical: what to do when at work, how to plan successful events, setting goals, evaluating project progress	Social/Emotional: Facilitating challenging conversations, engagement from student participants, their own belonging
Culture of Engineering	Awareness & acceptance (desire to improve/change)	Surprise & opposition (resulting in action & focus)

Discussion

This small-scale study explored the experiences of peer mentors who were tasked with implementing social activities in an academic makerspace with the goal of improving student sense of belonging in engineering. The research looked to gain insight into the experience of the mentors in their first year of employment with a focus on better understanding how they perceive their roles as mentors. The findings from this research help us to better understand the mentoring experience and may be helpful to designing support students on their mentoring journeys in makerspaces. The findings indicate that the SELs experienced learning, agency, persistence, uncertainty, and the culture of engineering during their development as mentors.

> *"I didn't know I was passionate [about] STEM inclusion issues. I like what I contribute to work on these issues" - Anna*

Perceptions of Being a Mentor

The research team examined the themes of learning, agency, and persistence in exploring student perceptions of being a mentor. These findings suggest that all SELs shared they learned and grew, both professionally and personally, during their time in the role. One of the motivators all participants shared was seeing progress in their role, with other students, and the makerspace. Seeing results inspired students to continue in the space and motivated them to "go bigger" and "be brave" – they extended the work beyond what was required for the role. One example of this was the focus group the SEL team held to learn more about the experiences of gender minorities in the department, clearly showing their commitment to creating inclusive and accessible social environments. Hosting a focus group is above and beyond the responsibilities outlined in their job description and required many hours of planning, challenging conversations, and working with staff and faculty at the university. Agency and persistence are further supported by the fact that all four SELs shared that they wanted to return to the work the following year (which they did), which shows their strong commitment to program, especially elements connected to supporting inclusion. As one SEL shares, "*[I want to return] because I know our work isn't done. Last year, we really worked on including everybody. And we were focused on making sure that students feel welcomed and get excited about their future careers and being in the engineering department*" *(Louis).* A second SEL reflected that *"I think continuing this work of supporting students and increasing awareness of resources/ gender and financial inequality and building a welcoming community will be crucial*" *(Anna).*

It was also clear from interviews and journal entries that student mentors took the job and their roles in the space seriously. These shared sentiments resulted in the SELs developing strong relationships with each other as they considered themselves a "team." As one SEL says *"my*

fellow SEL members are great people I can work with, and I feel like I can speak my thoughts and do my job without any environmental setbacks." (Louis) They supported one another in the role and developed personal relationships that extended beyond their work tasks. It was clear from the interviews and journal entries that this helped build their sense of belonging in the department and to the SEL team. Being an SEL helped them feel connected to one another while giving them a sense of purpose within the department. One SEL states *"I've also found that I'm more invested in engaging with my classmates, and I care more about creating an inclusive community."(Nolan)*

Challenges of Being a Mentor

Serving as an SEL in the space was not without its challenges and participants shared this primarily through the themes of uncertainty and the culture of engineering. SELs shared that the open-ended structure of the program was challenging for them and resulted in feelings of uncertainty. This led participants to share that at times they struggled with the future structure and goals of the program. In addition, it was clear from our analysis that male and female SEL experienced the culture of engineering differently, which lead to differences in approach and priorities. This was especially true for the women SELs who described a need to challenge the status quo of engineering cultural norms and clearly prioritized work related to this goal.

Other Differences in Student Experiences

Other themes emerged in our analysis along the lines of social/technical dualism specifically in the identity and practice of engineering. This dualism presented in our findings as the division of social relating to the feminine and technology relating to the masculine. For example, when examining learning, Louis and Nolan were focused on technical aspects of event planning (how to host successful events) and physical tools in the space (learning how to use the makerspace equipment) whereas Emily and Anna were more focused on the holistic evolution of the program, experiences of students participating in the events (do students feel comfortable) and examining the culture of engineering.

Understanding how students shared their sense of agency, male students described this as "*doing*" (Louis) or producing and female students shared their sense of agency through "*making a difference*" (Emily). Similarly, when exploring persistence, we found a difference amongst participants in their commitment to the job and progress (Louis and Nolan) and also a commitment to promoting inclusion (Anna and Emily). When asked about what they would like to work on in future years, Louis stated *"I'm interested in working on changing class environments whether its adding décor to rooms or updating furniture in the engineering space"* while Emily shared *"[my goal is] to get a little bit more of an interpersonal community instead of just a professional community."*

While all participants did share a sense of uncertainty, how they experienced this unknowing also varied. Two SELs, Louis and Nolan, described uncertainty around technical tasks and organizational structure. Louis shared "c*reating non-themed events were pretty hard…there were some mishaps with underestimation of food or finding a date for when we can all work."* While the other two SELs (Anna and Emily) shared uncertainty around emotional elements,

"[discussions] can get heavy or heated. So, that is one part of the job that I'm not sure how I would lead it (Anna).

Finally, when examining how SELs experienced the culture of engineering, we saw differences across the SEL experience. Two SELs (Louis and Nolan) described the culture of engineering with a sense of understanding and acceptance. For example, Louis shared *"social interaction isn't like the easiest for engineering students, especially with the workload…a lot of students kind of hold back more socially…we didn't get a lot of participation in [the discussion] or like people didn't really have an opinion that they want to share and kind of held it back."* He went on to explain that because of the lack of ability for engineering students to discuss subjects openly, the SELs decided to pivot their approach to solicit student feedback using a survey instrument which *"helped a lot of engineering students kind of share more of their opinions on how we can better improve the engineering building."* On the other hand, Anna and Emily shared the opposite perception when it comes to culture, one of surprise and opposition. For example, when hegemonic gender norms occurred in engineering, both Anna and Emily were surprised and spurred to act through opposition. Anna reflected *"we were focused on making sure that students feel welcomed and get excited about their future careers and being in the engineering department. But then I'm seeing problems with non-traditional engineering students like female students or minorities, in general…and so we want to continue working on fixing that problem. It doesn't come to the surface at all, but sometimes it is there…I didn't wanna leave until I could do something… just overall, [I want] support for the underrepresented students. I wanted to do that."*

The findings are limited due to the small scale nature of the research project however, they are in line with hegemonic and stereotypical gender norms in engineering which contribute to gender disparities in the field [55] [56]. This is also consistent with the gendered dualistic thinking that separates social and technical practices in engineering. As Faulkner (2000) points out, technical elements of engineering, which are identified as masculine forms of engagement, are valued over social elements, which are identified as being feminine and this leads to gendered disparity within engineering [54].

Limitations

While this study represents important findings about student mentors in university makerspaces, its limitations should be considered. The research team positions this study as a descriptive study of student experiences as inaugural SEL cohort at one university makerspace. The small participant size (4) does not reflect all student mentor experience and we do not position this research with the intention to generalize the findings. However, these findings are revelatory in the nascent field of student mentors in academic makerspaces focused on inclusion. In addition, the context of a single site should be considered when interpreting results and designing future studies. This study is not meant to representative of gender roles in engineering as a whole though it does represent what happened in this particular context.

Conclusion

The first cohort of SELs at Western Washington University provided a unique opportunity to understand the student experience and perceptions of serving as a mentor in a university makerspace. After an in-depth process of qualitative analysis, important findings emerged about the student experience as peer mentors. Especially interesting was how the emergent themes were similar and different across student experience, specifically around agency, learning, uncertainty, and the culture of engineering. We view these findings as a starting point and call to action to conduct additional research and to implement a refined and focused lens on the culture of academic makerspaces and the student experience within them. These spaces are not immune or isolated from the culture of engineering, which historically has not even been a minimally inclusive space for historically marginalized students. Therefore, when designing programs and supports for students who work in the space and enter the space, it is imperative the culture of engineering not only be considered, but actively persuaded to one of inclusion. Future research should explore how to best support student peer mentors in their role in ways that help break down the cultural stereotypes that pervade the profession while supporting student agency and learning in the space.

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References

[1] K. Sheridan, E. Halverson, B. Litts, L. Brahms, L. Jacobs-Priebe and T. Owens, "Learning in the making: A comparative case study of three makerspaces.," *Harvard Educational Review,* vol. 84, no. 4505-531, 2014.

[2] M. Galaleldin, F. Bouchard, H. Anis and C. Lague, "The impact of makerspaces on engineering education," *Proceedings of the Canadian Engineering Education Association,* 2016.

[3] S. Vossoughi, P. Hooper and Escude M, "Making Through the Lens of Culture and Power: Toward Transformative Visions of Educational Equity," *Harvard Educational Review,* vol. 86, no. 2, pp. 206-232, 2016.

[4] S. Hurtado and D. Carter, "Effects of College Transition and Perceptions of the Campus Racial Climate on Latino College Students' Sense of Belonging," *American Sociological Association,* vol. 70, no. 4, pp. 324-344, 1997.

[5] K. Osterman, "Students' Need for Belonging in the School Community," *Review of Educational,* vol. 70, no. 3, pp. 232-367, 2000.

[6] L. Hausmann, J. Schofield and R. Woods, "Sense of Belonging as a Predictor of Intentions to Persist among African American and White First-Year College Students," *Research in Higher Education,* pp. 803-839, 2007.

[7] E. Seymour and N. M. Hewitt, Talking about Leaving: Why Undergraduates Leave the Sciences, Boulder, CO: Westview Press, 1997.

[8] E. Tate and M. Linn, "How Does Identity Shape the Experiences of Women of Color Engineering Students," *Journal of Science Education and Technology,* vol. 14, no. 5/6, pp. 483-493, 2005.

[9] L. Nadelson, I. Villanueva, J. Bouwma-Gearhart, K. Youmans, S. Lanci and C. Lenhart, "Knowledge in the making: what engineering students are learning in the makerspaces.," in *ASEE Zone 1 Conference*, Niagara Falls, NY, 2019.

[10] M. E. Andrews, M. Borrego and A. Boklage, "Self-Efficacy and Belonging: The Impact of Makerspaces.," *International Journal of STEM education,* vol. 8, no. 24, 2021.

[11] E. Hilton, Forest, CR and J. Linsey, "Slaying Dragons: An Empirical Look at the Impact of Academic Makerspaces," in *International Symposium on Academic Makerspaces*, Stanford, CA, 2018.

[12] L. Rosenbaum and B. Hartmann, "Making Connections: Project Courses Improve Design Self-Efficacy and Interdisciplinary Awareness," in *International Symposium on Academic Makerspaces*, Stanford, CA, 2018.

[13] Y. e. a. Kim, "Making Culture: A National Study of Education Makerspaces," Drexel University, 2018.

[14] A. Vecchione, "Makerspace Culture and Its Impact on Learning," in *Makersapces in Practice*, Chicago, IL, ALA Editions, 2020, pp. 53-61.

[15] J. Davishahl, "Keep it simple, keep it real: Creating Inclusive Makerspace Enviornments," in *Proceedings of American Society of Engineering Education Collaborative Network for Engineering and Computing Diversity*, 2021.

[16] J. D. Finn, "Withdrawing from School.," vol. 59, no. 2, pp. 117-142, 1989.

[17] F. Newmann, Student Engagement and Achievement in American Secondary Schools, New York, NY, 1992.

[18] J. Fredricks, P. Blumenfeld and A. Paris, "School Engagement: Potential of the Concept, State of the Evidence," *Review of Educational Research,* vol. 74, no. 1, 2004.

[19] S. Kane, D. Chalcraft and G. Volpe, "Notions of belonging: First year, first semester higher education students enrolled on business or economics degree programmes," *The International Journal of Management Education,* vol. 12, no. 2, 2014.

[20] J. Willms, S. Friesen and P. Milton, "What did you do in school today? Transforming classrooms through social, academic, and intellectual engagement.," First National Report, 2009.

[21] N. Zepke and L. Leach, "Improving student engagement: Ten proposals for action," *Active learning in higher education,* vol. 11, no. 3, pp. 167-177, 2010.

[22] A. Masters, "How Making and Maker Spaces have Contributed to Diversity & Inclusion in Engineering: A [non-traditional] Literature Review," in *Collaborative Network for Engineering and Computing Diversity Conference,*, Crystal City, VA, 2018.

[23] M. Tomko, R. Nagel, M. Aleman, W. Newstetter and J. Linsey, "Learning in academic makerspaces: preliminary case studies of how academic makerspaces afford learning for female students," in *American Society of Engineering Education Annual Conference*, 2018.

[24] M. Jennings, B. Coley, A. Boklage and N. Kellam, "Listening to Makers: Exploring Engineering Students' Recommendations for Creating a Better Makerspace Experience," in *American Society of Engineering Education Annual Conference*, 2019.

[25] M. Andrews and A. Boklage, "Spaces and Practices within University Makerspaces," *IEEE Frontiers in Education Conference (FIE),* pp. 1-5, 2023.

[26] C. Lam, S. Cruz, N. Kellam and B. Coley, "Making space for the women: exploring female engineering student narratives of engagement in makerspaces," in *American Society of Engineering Education Annual Conference*, 2019.

[27] R. Vuorikare, A. Ferrari and Y. Punie, "Makerspaces for Education and Training," 2019.

[28] M. Haring and K. Freeman, "Mentoring underrepresented students in higher education," *Peabody Journal of Education,* vol. 74, pp. 5-162, 1999.

[29] S. Rogers and P. Tremblay, "The effects of a peer mentoring program on academic success among first year university students," *Canadian Journal of Higher Education,* vol. 33, pp. 1-17, 2003.

[30] S. Budge, "Peer mentoring in post secondary education: Implications for research and practice," *Journal of College Reading and Learning,* vol. 37, pp. 71-85, 2006.

[31] A. Peck, "Peer involvement advisors improve first-year student engagement and retention.," *About Campus,* vol. 16, no. 3, pp. 22-25, 2011.

[32] A. M. Heirdsfield, S. Walker, K. Walsh and L. Wilss, "Peer mentoring for first year teacher education students: the mentors' experience.," *Mentoring & Tutoring: Partnership in Learning,* vol. 16, no. 2, pp. 109-124, 2008.

[33] J. Kiyama, S. Luca, M. Raucci and S. Crump-Owends, "A CYCLE OF RETENTION Peer Mentors' Accounts of Active Engagement and Agency," *College Student Affairs Journal,* vol. 32, no. 1, pp. 81-95, 2014.

[34] J. Hunt and M. Culpepper, "The Impact of Makerspaces on the Students That Volunteer to Mentor Maker," *Choice,* vol. 3, no. 2, 2017.

[35] J. Colvin and M. Ashman, "Roles, risks, and benefits of peer mentoring relationships in higher education.," *Mentoring & tutoring: partnership in learning,* vol. 18, no. 2, pp. 121-134, 2010.

[36] *WWU Institutional Data, Engineering Department,* 2019.

[37] J. Davishahl, "Centering Social Justice in Engineering: A new course model for first year engineering education," in *American Society of Engineering Education Annual Conference*, Baltimore, MD, 2023.

[38] J. Davishahl, C. Boland and N. Crow, "Increasing Inclusive Access to Makerspaces using Digital Badges," in *International Symposium on Academic Makerspaces*, Atlanta, GA, 2022.

[39] J. Davishahl, J. Brobst, S. Alqudah, A. Klein and L. Litzler, "Math to Makerspace: Evolution of a bridge program to support cohort development.," in *Proceedings of American Society of Engineering Education Conference*, Baltimore, MD, 2023.

[40] J. Brobst, J. Davishahl, L. Litzler, S. Alqudah and A. Klein, "Examining first-year engineering programs' impacts on sense of belonging across gender," in *Proceedings of American Society of Engineering Education Annual Conference*, Baltimore, MD, 2023.

[41] J. Brobst, E. Litzler, S. Alqudah, R. Barber DeGraaff, J. Davishahl, P. Fizzano, D. Hartenstine and A. Klein, "Developing sense of belonging in isolation: insights from two projects supporting STEM undergraduates," in *American Educational Research Association*, San Diego, CA, 2022.

[42] J. Brobst, E. Litzler, J. Davishahl, S. Alqudah and A. Klein, "Impacts of supports on student affect in an engineering-focused S-STEM," in *Transforming STEM Higher Education Conference*, 2020.

[43] J. Davishahl, A. Boklage and M. Andrews, "Development of Social Engagement Activities to Increase Belonging," in *Proceedings of the 127th American Society of Engineering Education Conference and Exposition*, Minneapolis, MN, 2022.

[44] J. Davishahl and A. Boklage, "Making Space in a Makerspace: Increasing Belonging through Social Engagement," in *American Society of Engineering Education Annual Conference and Exposition* , Portland, OR, 2024, under review.

[45] J. Davishahl, A. Boklage and M. Andrews, "Peer Mentors Forging a Path in Changing Times," in *Paper presented at 2022 ASEE Annual Conference & Exposition*, Minneapolis, MN, 2022.

[46] J. Davishahl, E. Mediavilla and A. Nelson, "Cultivating community for first year students: Experiences in adapting a peer mentoring program to remote format," in *Proceedings of the First Year Engineering Experience Conference*, Virtual, 2021.

[47] J. Davishahl, E. Mediavilla, A. Nelson, L. Shibata and N. Winney, "Cultivating Community through Student Engagement," in *American Society of Engineering Education Zone IV Conference*, Vancouver, BC, 2022.

[48] N. Glaser, R. Hall and S. Halperin, "Students supporting students: The effects of peer mentoring on the experiences of first year university students.," *Journal of the Australia and New Zeland Student Services Association,* pp. 4-19, 2006.

[49] J. Davishahl, C. Boland and N. Crow, "Increasing Inclusive Access to Makerspaces Using Digital Badges," 2022.

[50] J. Kincheloe, Critical Pedagogy Primer, International Academic Publishers, 2008.

[51] M. Miles, M. Huberman and J. Saldana, Qualitative data analysis: A methods sourcebook. 4th edition, SAGE Publications, 2019.

[52] G. Gibbs, Thematic coding and categorizing. Analyzing Qualitative Data, London: Sage, 2007.

[53] K. Charmaz, Constructing grounded theory, London, England: Sage, 2014.

[54] W. Faulkner, "Dualisms, Hierarchies and Gender in Engineering.," *Social Students of Science,* vol. 30, no. 5, pp. 759-792, 2000.

[55] A. Master, A. Meltzoff and S. Cheryan, "Gender stereotypes about interests start early and cause gender disparities in computer science and engineering," *Psychological and Cognitive Sciences,* vol. 118, no. 48, 2021.

[56] U. Akpanudo, J. Huff, J. Williams and A. Godwin, "Hidden in plain sight: Masculine social norms in engineering education," in *IEEE Frontiers in Education Conference (FIE)*, Indianapolis, IN, 2017.