

The Roles of Student Staff in Engineering Makerspaces

Dr. Audrey Boklage
Center for Engineering Education
The University of Texas at
Austin
Austin, TX, USA
ORCID: 0000-0003-0652-4270

Abstract— In recent years, substantial resources have been invested into makerspaces in the community, K-12 schools, and higher education based on the underlying assumption that their creation will lead to experience that ignite interest, engagement, and persistence in engineering. University makerspaces are thought to have the potential to support entrepreneurship, innovation, and design, alongside the undergraduate engineering curriculum [1]. Despite this pedagogical potential, research tends to focus on the organization and operation of the makerspace (e.g., the design and layout, the type of equipment, the role of administration) [2], [3]. One opportunity to dig deeper into the research on makerspaces is an exploration of the pedagogy with the makerspace, specifically, the role of student staff in these spaces. In this work in progress paper, we seek to understand how student staff interact with one another, other students, as well as university faculty and staff within the context of academic makerspaces. In partnership with a makerspace at two large, public institutions in the Southwest, we conducted twelve interviews with students who held various staff roles within the makerspace. The interviews were conducted in Fall 2021 and Spring of 2023 and lasted between fifteen and forty-five minutes in length. A team of two researchers used a qualitative analysis approach to identify themes and findings from the interviews in the Summer of 2023. The analysis of this data begins to uncover the ways in which students interact with others in makerspace as well as the various roles they occupy and their contributions to the space. Findings include the intersection of hierarchy within the space among student staff and spaces of inclusion or exclusion. Implications are discussed and include how these findings can inform education research practice in informal spaces such as academic makerspaces and formal spaces, such as classrooms, where student interaction occurs.

Keywords—*Makerspace, Student Staff, Interaction*

I. ACADEMIC MAKERSPACES

Academic makerspaces are increasingly popular in Science, Technology, Engineering, and Mathematics (STEM) education spaces, particularly in undergraduate engineering education [4]. A makerspace is a physical space for making, learning, exploring and sharing that uses technology, tools and services to promote hands-on experience and learning in STEM education and other academic areas. Makerspaces can be found in libraries, museums, universities, and other public or private organizations. The academic makerspace is a physical space designed to give students the opportunity to learn and explore topics not found in

traditional classrooms, as well as potentially build prototypes, develop creative solutions, and test ideas for potential applications in academic work. Access to the space is typically free, and the equipment and resources are often open-sourced, with many universities providing access to 3D printers, laser cutters, and other pieces of equipment. Additionally, many makerspaces provide learning opportunities such as workshops, seminars, and classes that offer guidance and support for students in their projects [5].

II. INTERACTIONS IN ACADEMIC MAKERSPACES

Interactions are an essential part of academic makerspaces. They help to create a collaborative learning environment, where participants can exchange ideas, share experiences and knowledge, and develop creative solutions to problems [4]. Through interactions, members of an academic makerspace can explore various topics and interests, working on projects together and expanding their understanding of different fields [6]. Interactions in academic makerspaces also encourage students to take initiative and develop their own projects, inspiring others to do the same.

Research suggests that interactions in academic makerspaces can provide a range of educational benefits to students, such as developing problem-solving skills, collaboration and teamwork, and creativity [7]. Makerspaces provide an environment of open inquiry and exploration, which can foster a sense of curiosity and give students the opportunity to explore their interests and make connections across disciplines. The social interaction among peers in makerspaces can also be beneficial, as students are encouraged to share ideas, borrow tools, and learn from each other. Additionally, students can develop a sense of pride and ownership in their projects and be rewarded with feedback and recognition from their peer [8].

A. Interactions and Outcomes

Interactions in academic makerspaces contribute to student academic outcomes by providing a collaborative and creative environment. Students are exposed to a wide variety of tools and techniques, while they simultaneously work together to solve problems, develop new ideas, and enhance their academic skills [9]. Additionally, making and taking risks in the makerspace promotes resilience, confidence, and self-esteem [10]. Ultimately, makerspaces have the potential to create a safe,

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inclusive environment in which students can learn and grow [11].

B. Student and Staff Interactions

Recent research has found that facilitating interactions in academic makerspaces can be a powerful way to support learners and drive learning outcomes [9], [10], [11]. This includes encouraging students to collaborate, debate, discuss, and share ideas. Such interaction and collaboration can be used to help foster creativity and engagement, while also giving students the opportunity to practice communication and problem-solving skills. Furthermore, providing feedback and support during interactions can help to build a sense of community and a shared sense of purpose in the maker space. Finally, having a facilitator to set expectations and help guide interactions can create a positive learning environment where students can experiment and explore.

Research also suggests that student staff are valuable in academic makerspaces, providing services such as teaching and support, organizing events, and connecting community members with resources [12]. They help to form a strong community for makers within the institution, which can enhance the educational benefits of the space and foster greater creativity. Student staff often have the advantage of being able to better relate to other students, as they are familiar with the same material or have recently experienced the same courses [13]. They may be able to give advice on career paths and access to local networks for further learning. In addition, student staff may also be involved in developing the physical spaces of a makerspace, helping to create an inviting and inspiring environment.

III. THEORETICAL FRAMEWORK

Even with the increased national attention on university makerspaces few studies take an in-depth and critical look at the pedagogy and practices within university makerspaces. Additionally, research in and of makerspaces is rooted in theoretical frameworks of constructivism and community of practice (e.g., [14]); which have the potential to exclude women, Black and LatinX students. This rooting is particularly important for students from marginalized identities in makerspaces within schools of engineering, where the lack of diversity in engineering environments sends a message opposite of inclusion and opportunity for all. This study proposes that the reality of these spaces is not as “magic” as hoped [11] and seeks to explore beyond the assumption of community.

The theoretical perspective used for this study will be a critical realist perspective (CRP). The CRP adheres to existence of a reality that is “open, fluid, and shaped by how people interpret it” [15]. This perspective specifically focuses on humans and the structures, processes, and social relations that shape events and outcomes. For the purpose of this research, the CRP applies to the makerspace student staff within university makerspaces and create a multifaceted frame for exploring the pedagogy and interactions within these spaces.

IV. METHODS

This study used a grounded theory methodological approach to produce more conceptual clarity about the interactions that occur within university makerspaces. The methods within a grounded theory approach represent the tools and procedures to engage with the research questions at hand [16]. The methods employed in this study are inductive in their approach, meaning that the understanding of phenomena and processes emerging from the data are grounded in the data. To do this, the use of lightly structured, open interview protocols and observations were used employed. This study also used observations of makerspaces as a source of data. These observations can provide insight into the phenomena and processes of the makerspace.

Twelve interviews with students who held various staff positions were analyzed by the research team. These interviews were conducted at two large, public institutions in the Southwest between Fall 2021 through the Spring of 2023. Interviews lasted between fifteen and forty-five minutes in length. A team of two researchers used a qualitative approach including analytical memos, initial coding, and theming of data [17].

A. Analysis

Data analysis began at the beginning of the study and continued throughout. This was intended as a process of “making sense of the data...[which] involves consolidating, reducing, and interpreting what people have said and what the researcher has seen and read- it is the process of making meaning” [17].

The research team used Basit’s framing of the iterative process of coding as both a method and analysis, recognizing that, “coding and analysis are not synonymous, though coding is a crucial aspect of analysis,” [18]. Once all interviews were completed, the research team listened to each of the audio recordings and “pre-coded” the data, this included finding instances of “codeable moments” [19]. Next, the research team examined and descriptively coded each interview transcript; “descriptive coding summarizes in a word or short phrase ... the basic topic of a passage of qualitative data” [19]. This process allowed the team to identify the basic concepts present in the dataset, building a vocabulary of data [19]. For this work in progress paper, the research team paused the analysis process at themes, which we recognize as an “outcome of coding, categorization, and analytical reflection” [19].

V. FINDINGS

At the time of submission, this work in progress paper has yielded a descriptive codebook consisting of over 25 codes to identify the interactions between student staff and others in a university makerspace. At this point of analysis, the research team followed Saldaña’s coding advice to search for “three (and only three) major codes, categories, themes and/or concepts” [19]. Using this framing paired with the theoretical framework, the research team focused on one code in particular, *hierarchy*. The team defined hierarchy as an *inherent or explicit organization of people or groups in the makerspace according*

to perceived or real status or authority. When examining instances of the hierarchy code, the research team identified multiple instances of double coding, or instances in which an excerpt of an interview was coded with more than one code. For the instances in which hierarchy was coded, the team also coded for inclusion, defined as *an action or state of including or being included within a group or structure* and exclusion, defined as, *the process or state of excluding or being excluded from a group or structure*. It was through these instances of coding and recognition of patterns that the research team recognized examples in which the student staff in engineering makerspaces supported a welcoming or unwelcoming environment for other staff or students in or outside of the makerspace.

An analytical memo from a research team member describes instances of the intersection of these codes:

From these interviews, the student staff recognize a hierarchy ranked from lowest to highest as, student staff, senior student staff, area leads, vice president of student staff, president of student staff, full-time university staff, and at the top of the hierarchy- director. One student recognizes the hierarchy as ingrained when she describes herself as "a normal staff member." In instances when students are discussing their role in the space, they describe having a sense of community and feeling included saying things like, "I just know that they are my friends and we talk about a project we want to build and we did it," as well as instances of feeling outside a particular group describing themselves as "just student staff."

While the codes and themes in from these interviews are nascent in their development, they do articulate the importance of recognizing and supporting student staff as important to creating a space of inclusion or exclusion through their interactions with others. This interaction can be visible and purposeful through training and working with other students and student staff or somewhat intangible though creating and supporting hierarchical structures.

VI. DISCUSSION AND CONCLUSIONS

Using critical frameworks to examine norms and interactions in academic makerspaces is a way to examine how these spaces can design, implement, and support inclusive practices [20]. While efforts to implement inclusive practices in these spaces are ongoing [13], the maker movement remains an adult, white, middle-class pursuit, led by those with the leisure time, technical knowledge, experience, and resources to make [21].

There is not a one-size-fits-all approach or proverbial magic wand to support inclusivity in engineering makerspaces. However, shifting the notion from one of a need for policies or practices to one of training and supporting assets in the space, notably from this paper, student staff. We propose to frame student staff as the innovation in engineering makerspaces. Understanding how those who can work alongside their peers,

in this case student staff, to support a welcoming environment is essential to understanding what inclusive environment looks like in practice in academic makerspaces. Student staff who do or do not perpetuate hegemonic norms contribute to this sense of exclusion or inclusion amongst their peers and students who might not or might enter the space.

Further research is necessary to understand how student staff are hired and trained to staff makerspace. Additionally, a closer look at what is happening in academic makerspaces through observations or ethnographic studies can more clearly articulate the specific moves and actions that student staff enact in academic makerspaces.

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