

# Intentionally Cultivating Diverse Community for Radically Open Access Makerspaces

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## INTRODUCTION

Many academic makerspaces are discipline specific, and thus able to serve their student patrons with tailored approaches to the types of learning most likely to be relevant to students engaging with a more or less pre-defined range of subject-matter. Academic makerspaces which are discipline-agnostic face the daunting task of trying to meet the needs of a humbling array of approaches to inquiry while maintaining a sustainable and safe environment for making. Establishing a set of policies that does not place structural barriers based on discipline demographics is a substantially separate process from establishing a sociocultural environment that earnestly facilitates “the imaginative work of interdisciplinarity”[1] for faculty and student research within a simultaneous variety of departmental affiliations and backgrounds, though the former has a tendency to present as the latter. In the history of academia’s culture shifts, “even radical interventions in modes of pedagogical exchange, the nature of critical engagement, and the role of the university in democratic public life could [...] appear victorious [...] in the “marketplace of ideas” [while remaining] marginal to the university’s well-rehearsed commitments to ‘excellence’, ‘efficiency’, and ‘standards.’”[2] This paper explores the multifaceted efforts undertaken at the University of Texas at Arlington FabLab to legitimately serve as wide a cross-section of the campus community in the makerspace as possible, using a notably diverse campus community as a case study.

For institutional context, the University of Texas at Arlington is an R-1 doctoral research institution with an annual on-campus enrollment of over 40,000 students; UTA is among the top 10 most ethnically diverse national universities, and boasts a graduating population with the lowest student debt of any public national university. According to the makerspace classification system proposed by Wilczynski & Hoover at ISAM 2017, the UTA FabLab is: S-3, A-4, U-4, F-3, M-3[3]. As a department within UTA Libraries, and like many other academic libraries and academic makerspaces, the UTA FabLab relies heavily upon student employees[4]; operationalizing an 8,000 square foot space for 7 days/90+ hours a week would be prohibitively expensive with primarily full-time staff.

When our lab first opened, it was logical to hire these student employees primarily from the College of Engineering, as they were more likely to be familiar with the skillsets required to operate digital fabrication equipment. An unintended practical result of this decision, however, was that the culture of the space was not perceived as encouraging to students

from other disciplines or those not already somewhat accustomed to technological processes and/or our vision of such radical open access, unrestrained by departmental affiliation or ostensible curricular purpose. In subsequent rounds of hiring, we have made a conscientious choice to employ students who represent a broad cross-section of our diverse campus community, attracting well over a thousand applications from a wide range of majors, ages, backgrounds, and skillsets, all with the common desire to share knowledge and learn with others in a communal space.

Inherently, the choice to hire students who have perhaps never used a 3D printer or created a vector image (or even been introduced to keyboard shortcuts for copy & paste!) significantly increases the necessity for us to provide thorough training before they will be ready to meaningfully assist makerspace learners with their projects. This approach requires considerable time, consistent oversight, and empathetic mentorship to build not just strong technical abilities in these fledglings, but also the interpersonal, communication, and leadership skills necessary to do their jobs well. While training students with no prerequisite experience can be significantly more daunting than reviewing interfaces with students already conversant on similar equipment, the fullness of time has proven the benefits of this added labor; as the departmental constituency of our student staff evolved, we witnessed an enthusiastic response in the diversity of learners who now make use of the FabLab for curricular, entrepreneurial, and personal projects.

In addition to sharing data on how this shift in our hiring correlates to a shift in our user demographics, this paper will focus on actionable strategies for recruiting, training, and retaining student employees who may not have prior knowledge of makerspace technologies.

## INITIAL MAKEUP OF SPACE

When the UTA FabLab originally opened what we now call our “beta space” in October of 2014, the department had no permanent full time staff. This 800 sq. ft. space, which included 3D printing, 3D scanning, laser cutting, vinyl cutting, and electronics, was established by a small cohort of library staff who dedicated half of their time to the FabLab, and the other half to their regular job responsibilities maintaining all of the computers and other technologies throughout campus’s libraries.

To meet the level of service and access we knew our campus would desire, the libraries hired 16 student employees to help run the space – students who could both teach learners coming into the space about how to operate the software and equipment, and who could assist with maintenance and

troubleshooting of that equipment when inevitably necessary. At this stage in the maker movement[5] and in the development of our space, it was also prudent that these students be natural early adopters[6], people who were already conversant with and enthusiastic about the tools, mission, and possibilities of the space. Following these factors, of those initial 16 student employees, 90% were male, and 94% were from the College of Engineering.

While these student employees did a phenomenal job providing service in the FabLab, it also became apparent within our first year of operation that the majority of our users, whom we refer to as learners, were also male engineering students. By analyzing the paper receipts staff filled out each time a machine is used, we were able to break down our learner demographics to determine the percentage of total use by college for 2015. Because the information on these receipts was recorded manually, we do not have the accuracy and completeness of information that we have subsequently been able to gather for 2016 and beyond[7]. We are, however, able to reasonably deduce that the majority of the receipts lacking information about users' majors belong to the College of Engineering. This conclusion is based off of our direct experience working with our staff to improve data collection habits and helping those learners in the space, as well as by comparing the cumulative 2015 data to a representative sample using a more complete data set from the summer semester of 2015; assigning the Spring 2015 and Fall 2015 incomplete tickets to Engineering results in usage statistics that are within 2.25% of the Summer 2015 data. The graph below reflects that 74.24% of our student use was by students in the College of Engineering, with a distant second place of 10.28% from the College of Architecture, Planning, and Public Affairs (CAPPA). These percentages of use, as well as those presented in subsequent graphs, exclude the use of FabLab equipment by faculty, staff, and guests in the space; these user groups cumulatively made up only 2% of total use of the space for 2015.

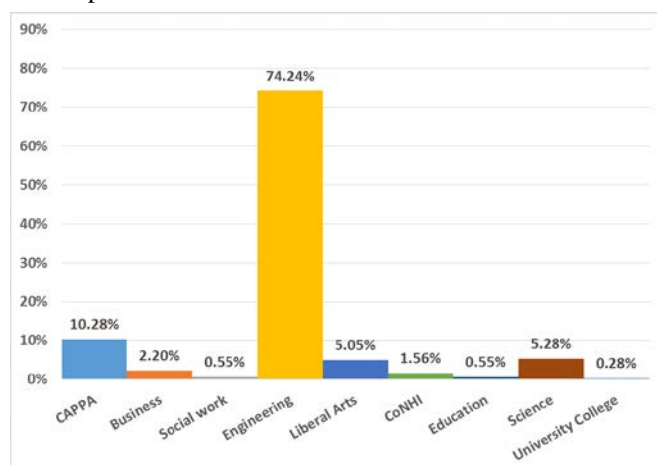


Figure 1: Percentage of Student Use by College<sup>1</sup>, 2015

The mission of the UTA FabLab has always been to serve all of campus, including faculty and staff, regardless of a

<sup>1</sup> UTA schools and colleges include: College of Architecture, Planning, & Public Affairs (CAPPA); Business; Social Work; Engineering; Liberal Arts;

person's major or year of study. We recognized through this analysis, however, that while we did not procedurally limit or exclude any user groups, our staffing model was not manifesting as overtly welcoming or inclusive[8]. Through the leadership of Associate University Librarian Suzanne Byke, the FabLab was able to hire a third full-time technician who had been a regular learner in the space while making sculptural components as part of his MFA thesis work[9]. An explicit intent behind introducing this dynamic into the FabLab staff was to identify and implement methods for helping liberal arts students feel more comfortable experimenting with digital fabrication[10]. One of the central methods we employed to initiate this culture shift was to intentionally and strategically hire for a more varied student employee pool for the spring of 2016, and to dedicate the requisite time to adequately train, guide, and mentor this cohort of student employees.

### HIRING PROCESS

The fall of 2015 presented numerous changes and challenges for our space. We had just begun our expansion across the first floor of the Central Library which would ultimately grant us a footprint of 8,000 sq. ft., a full order of magnitude larger than our original beta space, and with that would also be researching, purchasing, installing, and training on new pieces of equipment. Chief among these new technologies were: a textiles area including sewing machines, sergers, and a CNC embroidery machine; a printmaking area to include screenprinting and papermaking; electric kilns to work with glass and ceramics; and a shop room including: a CNC table router; CNC plasma cutter; CNC lathe and mill; SawStop table saw; scroll, jig, band, and compound miter saws; drill presses; sanders and grinders; abrasive media blasting; and various other hand tools. In addition to the tumult of unforeseen difficulties that inevitably arise with any construction project, the FabLab was in the midst of gaining a new Director when we learned that we would be losing one of our original technicians in the spring when he decided to pursue a PhD and his dreams of becoming a rocket scientist.

As is inescapable with all student employee models, we eventually lose our personnel to graduation, internships, or other attrition, both throughout and at the end of each semester. Not only were we needing to hire for a larger workforce than we had employed in the past due to our order-of-magnitude expansion of the space and the addition of several new technologies, only half our staff would be returning to work with us for the spring semester. We purposefully sought out students from non-engineering majors who still demonstrated a high degree of technical competencies and/or strong interpersonal skills. Some of the students we encouraged to apply because we knew them as former students or as regulars in the space, some of the students we approached about the prospect of working for the FabLab after we observed them working on a project in the space, and others saw the flyers we posted or heard about the openings via word of mouth but had never set foot inside the

College of Nursing & Health Innovation (CONHI); Education; Science; and University College

library, much less the FabLab, until they arrived for their interview; we meant it when we said familiarity with our equipment or prior use of the FabLab was not a prerequisite for consideration. From this pool of students who applied to be peer-mentors[11], we sought students whose “life-space”[12] demonstrated natural curiosity, a strong work ethic, the ability and patience to break down and explain a complex topic, and a commitment to providing exceptional customer service. We contextualized the job as primarily a customer service position; while each employee ultimately needs to have a solid understanding of the software and equipment in the space in order to aptly assist learners, this job is first and foremost about helping others and making sure they feel welcome, heard, and helped. The technical skills, we reasoned, could be taught; reforming attitude is a considerably stickier wicket.[13]

To glean whether or not our candidates possessed the skills we were looking for, we asked them each the following questions during their interviews after first explaining the context and mission of the FabLab:

- Tell us about yourself and why you’re interested in working at the FabLab.
- How would you describe your learning style?
- How do you go about explaining things to people who learn or think differently than you?
- What motivates you?
- What would your superpower be?
- Give us an example of a recent assignment you worked on that involved learning a new technical skill.
- Tell us how you managed a work-related problem that you created?
- Tell us about the most interesting thing you learned in the past week.
- Tell us about the project you are most proud of, and what your contribution was.

Depending on the student’s responses, we would follow many of these questions up with additional questions or clarifications. For example, we frequently clarify that by “learning a new technical skill” we do not mean to imply purely computer or software skills; this could include a technique a student recently learned in their art studio, or a methodology they needed to learn to successfully complete their nursing lab[14]. Having a broad array of skills and interests ourselves, we enthusiastically engaged with the interviewing students about the specifics of whatever topic they brought up, but the minutiae were secondary to the theme; we were listening for passion about the process of discovering the details required to do something well.

For the question about causing a work-related problem, we found interviewees were more open with their answers when we prefaced the question by noting that everyone – present company included - makes mistakes, large and small, and that regardless of whether those mistakes are intentional or inadvertent, we have to do our best to make amends for those missteps. The students’ responses elucidated their ability to self-reflect and their emotional maturity to own a mistake by

taking action to reconcile the situation; asking interviewees to reveal some professional vulnerabilities in this way enabled us to see through candidates’ “assertive and defensive impression management tactics”[15]. An additional, unforeseen legacy of this interview tactic has been the ability to refer back to this question when dealing with interpersonal issues with student staff when they inevitably need to be addressed, prompting student staff to think about the story they would want to tell in a future interview with a similar question.

After the long interview process, we extended offers and began the paperwork process. Ultimately, we hired 32 new students for a total of 41 student employees; 56% male and 44% female[16], with 42% majoring in an Engineering field, as opposed to the 94% from our initial hires.

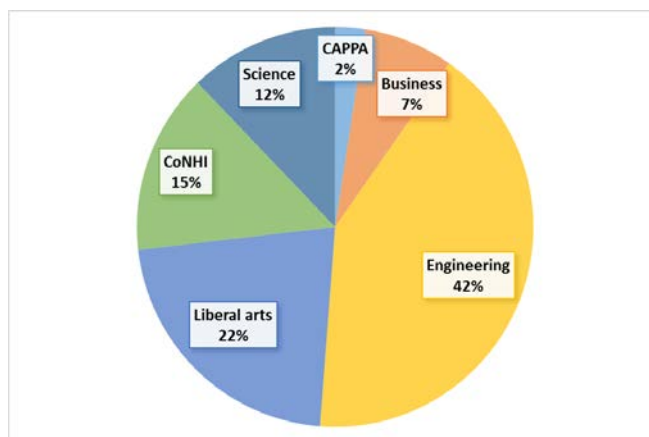


Figure 2: FabLab Student Employees by College, Spring 2016

## TRAINING AND ASSESSMENT

Once these students were on-boarded, the first order of business was to train them on both the technical and soft skills we would require of them to be efficient and well-rounded employees in our space. The students were compensated their regular hourly rate for participating in these trainings[17]. Typically, trainings were segmented into 2-hour blocks for 3-5 students led by one of the technicians or a capable returning student employee, covering the theoretical basis of the technology and the hands-on details[18] of best practices with each technology[19]. This necessitated a very involved scheduling cycle to find appropriate niches of time for cohorts between classes that made efficient use of trainer time[20], with scaffolded training as prerequisites on the more complicated pieces of equipment.

In a prior round of hiring in which only 4 students were hired, training had been done as one intensive week; this rapidity proved impossible to recreate with the larger group. Initially, we were disappointed in the apparent inefficiency of trainings dragging on over several weeks, though we came to realize that pacing out the trainings gave each student time to digest, practice, seek advice, and reflect on the information they had already been given[21] before proceeding on to more advanced content. In addition to the equipment and software trainings, they also went through trainings on how to effectively give tours of the space (customized to the audience

attending), how to answer frequently asked questions, exercises to help them articulate the mission and the vision of the FabLab, and a full-day of customer service training. Throughout all training sessions, “the focal point for learning [was] immediate personal experience, [contributing] to real-life meanings and texture[s] to abstract concepts.”[22]

Regardless of what skills a new student already possessed when they joined the team, we required that everyone go through all of the trainings to ensure (1) we weren’t assuming a greater skill level or understanding than the student actually had, (2) everyone was being trained on the same procedural and situational instruction needed to operate in the space, and (3) opportunities for organic social interaction with coworkers was intertwined with the learning process[23]. For example, even if a new student employee was already very familiar with 3D printing, they would still benefit from the training by bonding with their new coworkers while learning that we require our staff to change the filament and remove prints from the bed rather than learners, or soft-skills such as strategies for effective settings consultations with learners who may not have the slightest idea what any of the slicing jargon means. Throughout the training sessions, trainers facilitated the collaborative spirit among our employees by prompting some trainees to help convey recently learned concepts to other trainees who were not grasping the lesson as quickly, in the hope that this “experience [would] narrow the gap between how one thinks of a command and how it is specified to the computer system.”[24]

After several weeks of training, students were then assigned a self-directed project that required them to draft a proposal for an object they would like to make that would incorporate the use of 3D printing, sewing, and laser cutting; use of 3D scanning, vinyl cutting, electronics, and the mini mill were optional. Students received consultation on practical design issues as well as to ensure that each was pushing themselves into their respective zone of proximal development.[25] The intent of the assignment was to give each of our student employees direct experience having fun with their new skills[26] as well as navigating the inexorable difficulties and frustrations that iteratively bringing a design concept into reality entails for any learner, thereby allowing them to both better understand the equipment and the learners they would soon be assisting.

In more recent semesters, we have de-formalized this self-directed project in favor of folding the students’ experimentation with equipment into their time on shift staffing the lab. Today, our new student employees go through the same initial trainings, and work as “shadows” on shift in the open lab throughout the training weeks. They are encouraged to engage and assist learners entering the space as they are able, but also have the opportunity to observe more experienced staff as they offer design consultations to learners and problem solve equipment. When these new students are not assisting or observing, they are practicing design skills by making their own creations themselves under the guidance of the student leads (student employees in charge during a shift) and their full-time supervisor. New hires are also assigned a

workbook [Figure 3] that guides them through how to think about and interact with each tool in the space after they have gone through the initial trainings. These workbooks, which have the feel of an engaging activity book, strike a balance between directing the students’ learning while still giving them enough freedom to be creative and feel excited and invested in the projects that they work through.

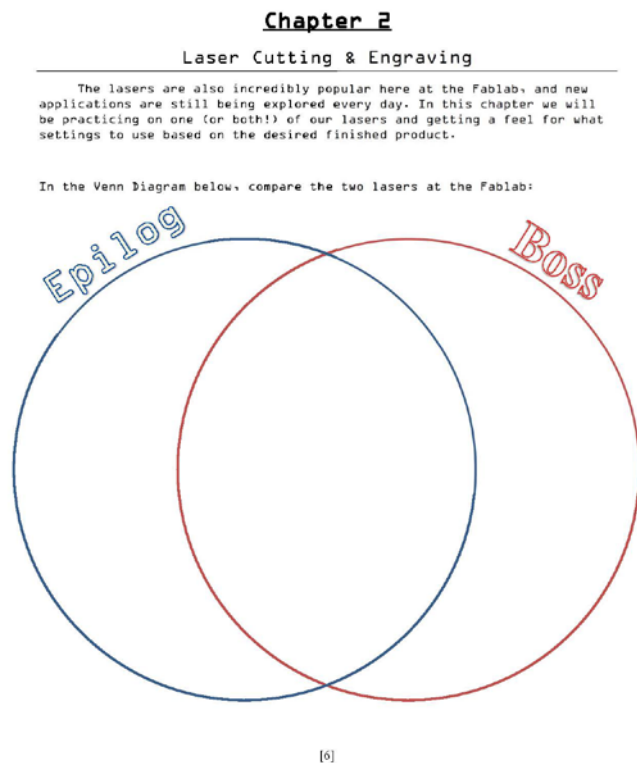


Figure 3: Example from Workbook for Student Employees

Once students have completed their trainings and have had a few weeks to shadow, practice, ask questions, and make on their own, full-time staff will conduct an evaluation consisting of a written short answer test and a series of practice case studies *in situ* with the machine interface to assess how well the student has digested the trainings, assess their “recognition-primed decision-making”[27] and to give them formative feedback for their continued improvement. Those students who pass the assessment are given the instructions for customizing a supplied Solidworks model and then 3D printing their own nametag (with a filament swap!) and are moved from the “shadow” schedule to being able to actually fill shifts in the lab and engage in student service learning projects; those who still need to practice further are reassessed after a few more weeks of shadowing and further mentoring.

By far, this training regimen is the most time consuming and demanding component of our student employee model. Such could be said for the instruction phase of any technical job[28], but it is certainly compounded by the fact that we are training people who often have little to no prior experience with the technologies in the FabLab. We have witnessed

phenomenal growth in these students we work with[29] and sense the impact this diversification has had on the dynamics of our team and the makeup of our user base.

### IMPACT

While other factors inherently influence the culture shift of our space, we undoubtedly have a strong correlation to connect the intentional shift in our student employee demographics to a similar shift in our user demographics. For 2016, the percentage of use by Engineering students dropped from 74.24% to 49.64%. The College of Liberal Arts rose to be the second highest user, jumping from 5.05% in 2015 to 14.62%. The College of Business rose from 2.20% to 7.03%, and the College of Nursing & Health Innovation (CoNHI) rose from 1.56% to 6.28%. The slight decrease in usage by the College of Architecture, Policy, and Public Affairs (CAPPA) is due in large part to the CAPPA digital fabrication studio also growing in their capacity to accommodate their own students.

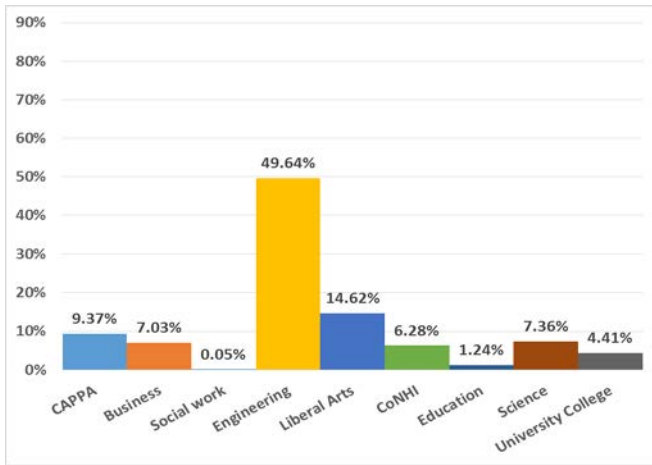


Figure 4: Percentage of Student Use by College, 2016

These figures remained relatively the same for our 2017 user demographics as well, with most colleges increasing or decreasing less than 1%. The College of Engineering did continue to decrease in their percentage of use from 49.64% to 46.17, for a difference of -3.47%. Liberal Arts continued to increase in their percentage of use from 14.62% to 17.62%, for a difference of +3%.

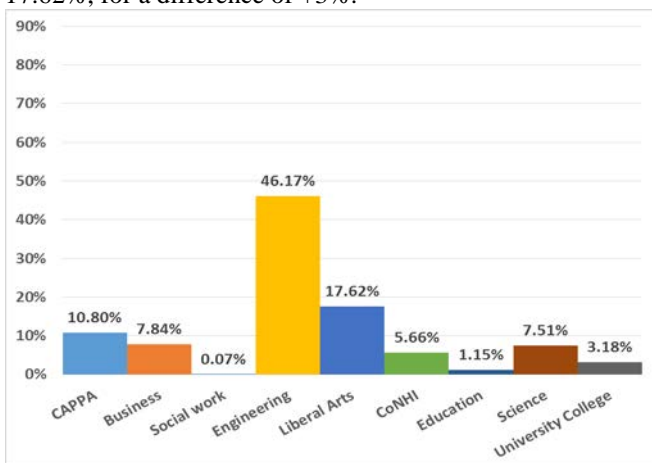


Figure 5: Percentage of Student Use by College, 2017

While we now have a more even distribution of learners across majors, the previous figures represented in this paper do not reflect the overall growth in use we have experienced across all areas of study. Though the FabLab's percentage of student use by college only changed nominally between 2016 and 2017, the number of tickets created by students in each college rose significantly. Excluding faculty and staff use, we had a total of 2,178 tickets created in 2015, 6,444 tickets created in 2016, and 11,060 created in 2017. Thus, while our overall percentage of usage by Engineering students has fallen over the years, this is only in relation to an increase of use by other colleges; as evidenced by Figure 6, the number of tickets by Engineering students has risen from 1,617 in 2015, to 3,199 in 2016 to 5,106 in 2017 – an overall increase of 3,489 tickets. Furthermore, while we do have a cadre of regular users in the space, we have seen a dramatic increase in the number of unique users for every college between 2016 and 2017; the previously discussed increase in number of tickets is not a simple result of the same users using the FabLab more often – new users are continuing to come into the makerspace.

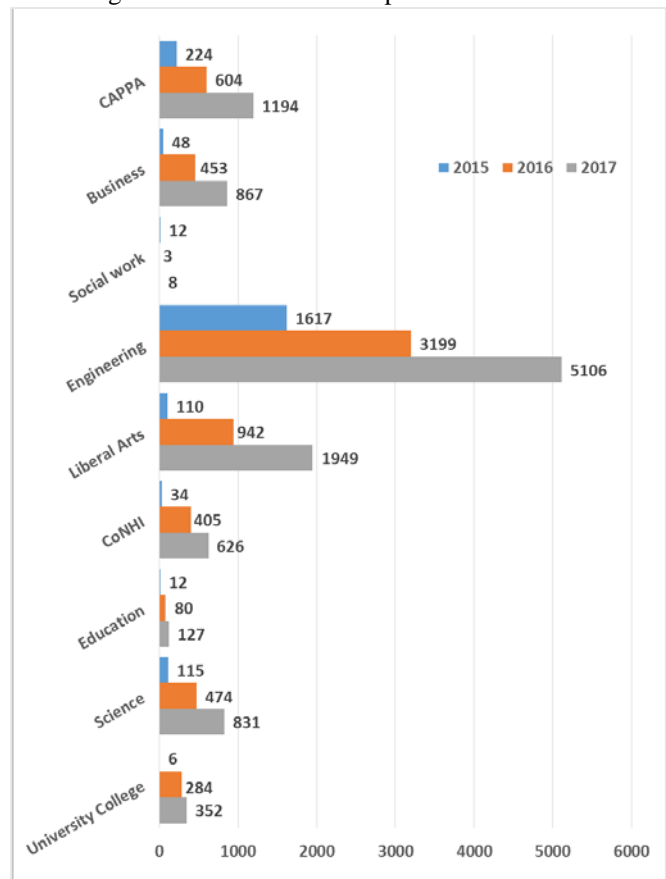


Figure 6: Number of Tickets by College, 2015, 2016 & 2017

### OTHER CONTRIBUTING FACTORS

In addition to the diversification of our student workforce and tuning our learner workflows through various types of projects, the FabLab increased outreach efforts and implemented other changes that bear noting as potential factors to this shift in our user demographics. Perhaps of greatest significance is the number of UTA courses

integrating use of the FabLab into their curriculum. In 2015, after the lab had first opened, we had no formal partnerships with faculty on campus who wanted their students to use the lab, though we do know of a handful of courses that were encouraged to use our facility as a resource, and we observed learners who were using the lab for their curricular research and assignments. By 2016, however, our full-time staff began to partner with faculty to design assignments that would incorporate FabLab technologies while still meeting the intended learning outcomes for the course. In the latter half of 2016, UTA Libraries launched our Maker Literacies program to assess the transferable skills students gained by using the FabLab, partnering with courses from a variety of majors, such as English, History, Education, Engineering, and Art[30]. We have not evaluated the students in these courses to track if their use was sustained or increased after the cessation of their required course, though we have observed anecdotally that students first introduced to the FabLab through a required course assignment gain the comfort and familiarity necessary to return voluntarily, and we have hired several such students who showed promise.

The FabLab has also increased outreach and inreach efforts to build awareness of the accessibility of our facilities in the minds of students, professors, and staff across campus[31]. We have hosted tables or given presentations for occasions such as New Maverick Orientation, Library Fun Fair, or the Activities Day Fair, designed to educate new students about all that campus has to offer. Within the past year or so, we have become a standard stop for the library tour portion of each MAVS1000 class (a course designed for incoming, traditional freshman students to teach them study skills and orient them to different campus services). We are also involved with specific departmental in/outreach events and are actively engaged in UTA recruitment efforts so that potential new students will be aware of, drawn to, and inspired by all that the FabLab has to offer. Especially when “creating strategic partnerships with entities not traditionally involved in making”[32], we make it a point to emphasize our foundational principle of democratized access to relevant technologies in a teaching facility that aims to help cultivate digital literacies[33], and explicitly reiterating that learners don’t have to enter the lab already knowing how to do what they want to do.

### CONCLUSION

Our research and exploration of best practices for intentionally inclusive and diverse makerspaces is ongoing. There are many factors and methods that can influence this process, but we have found that cultivating a student staff that is reflective of the campus community we serve has had a strong influence on the proportionality of the demographic presence in the space. It is vital that the users you wish to welcome into your space feel invited with more than just words, and that they can identify with the students who are there to assist them. While finding, hiring, training, and retaining talented students to serve in this capacity can be time consuming and strenuous, we have quantitative data to show the difference these efforts are making. We would encourage the adoption of this model at other institutions, and would

welcome a data comparison to prove this research’s applicability in other settings.

### ACKNOWLEDGMENTS

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