Fostering Culture in a Student Volunteer Run Makerspace

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Introduction

While most undergraduate learning opportunities follow a typical teacher-student model, academic makerspaces provide the means for a unique educational method known as "peer learning". This community-based approach is grounded in informal hands-on interactions and equity among makers. Peers are crucial for makerspace functioning as they enable knowledge transmission [1].

However, most makerspaces are reliant not only on makers themselves, but also on staff members who guide users, ensure the safety of the space, and maintain equipment. Like the makers, these staff members prove to be "guardians of culture", spreading habits and customs.

In 2019, Joey A. Gottbrath and Ian C. Charnas [2] addressed the optimal staffing level in academic makerspaces. The survey they conducted showed that 81% of academic spaces are staffed by a combination of students and professionals and 11% are staffed by students alone. Additionally, they found that students' contributions to makerspaces are extremely valuable. Not only do students reduce staffing costs, but also they help to "*nurture an ideal shop culture*".

Makerspaces may question the compensation they should give to student staff. Some may choose to pay their students, while others may provide alternative incentives. No matter the compensation type, makerspace managers are looking for motivated students who will contribute to the culture of their makerspace and bring it to life.

This paper explores the literature to identify what motivational factors influence volunteers. It also discusses how the staff's motivation impacts the makerspace culture. It then builds upon this body of knowledge to develop principles and tactics that makerspace leaders could use to recruit and sustain student volunteers for a makerspace.

Additionally, as a preliminary validation of the principles developed, a case study is presented throughout the paper of a volunteer student-run makerspace, Invention Studio at Georgia Tech. The student staff there are referred to as prototyping instructors, or PIs, and volunteer a minimum of 3 hours per week in exchange for 24-7 access to the space [3] [4]. Students follow a multi-step training process in which they move from provisional PIs to full PIs. They also have the opportunity to serve as a tool group master or as a member of the 9-member executive board. The Invention Studio was created in 2009 and has increased dramatically in size over the past 13 years – both in terms of users and PIs. A variety of strategies have been used to recruit and retain volunteers and to establish a supportive, welcoming culture.

Motivation for Research

In *"The Impact of Makerspaces on the Students That Volunteer to Mentor Makers"* [5] Jonathan Hunt and Martin L. Culpepper showed that mentoring makers brings personal and professional benefits to the mentor. They notably emphasize the word 'mentor' rather than 'staff', as it highlights the community aspect of staffing in a makerspace. Mentors have two roles, ensuring security and creating a vibrant culture. In a survey conducted at MIT, respondents reported having increased their soft skills through mentoring. These soft skills (communication skills, organization skills, relational skills, etc.) are particularly valuable in the job market, especially in engineering students who were not necessarily taught these skills in their academic curriculum. Even though these students reported spending less time studying, they did not see mentoring as hindering their GPA, as they spent less time on consuming activities and found that mentoring provided a healthy break from their studies.

On the overall culture of makerspaces, a motivated staff, aware of cultural stakes, brings a lot to the space. First, the cohesion of staff members ensures efficient communication for rules and safety measures. It allows a better anticipation of needs and risks, as well as a common vision of the future goals of the makerspace. Makers are more confident, as they can rely on these members to provide all the required information and advice for them to achieve their projects. Since these staff members are students, they are better able to set a friendly tone and a pleasant atmosphere. By being inclusive and tolerant, they implement a trust relationship between makers and staff. As stated by E. Davies, R. Morris, and A. Jariwala in *"Trust as the Foundation for a Successful Balance of Power in a Student Run Academic Makerspace"* [6], the bases of trust are communication, transparency, reliability, and the ability to ask for help. These should be norms in a makerspace. Seeking advice and seeking for help when an issue arises, or a mistake is made should not be seen as failures. Rather, broken tools or communication deficiencies should be seen as evidence of trust and culture failures. Redefining failure through cultural norms is the major goal of staff members as it creates a secure and fulfilling atmosphere. While there is evidence of the benefits

of student volunteer-run maker spaces, there is a knowledge gap that leverages human psychology literature to determine how to best recruit, retain and support volunteers in a makerspace.

Background and Literature Review

It is typically intuitive for administrators to assume that students are extrinsically motivated (in the form of grades, monetary compensation, etc.) to conduct on-campus jobs like staffing a makerspace. Yet, to establish an optimal community and culture, it is necessary to recruit students with high intrinsic motivation, such as those who desire to improve their prototyping skills, who want to help students, or who are interested in spreading a maker culture. Intrinsic motives are satisfied by the activity itself (inherent interest) and are higher when the activity is volunteer-based.

Though counter intuitive, it has been found that members of well-managed organizations are motivated by volunteering. In "*Intrinsic vs. Extrinsic Motivational Orientations and the Volunteer Process*" [7], Marcia A. Finkelsiten highlights the volunteer role identity as a key contribution to motivation. Volunteers are driven by five key motives: altruistic values (disinterested concern for the well-being of other), social values (approval from others), understanding values (learning of new skills), protective values (giving back to society to justify one's advantages), and enhancement values (self-esteem).

By developing a volunteer identity with a clear role in recognizing true competencies, an individual fulfills these motives. These values provide extremely strong and powerful reasons for action, beyond external motives. Not only does it allow them to produce high-quality work, but also it implies greater satisfaction and a stronger intention to continue. External rewards, such as monetary compensation, inhibit those intrinsic interests [8][9]. Similarly, mandatory volunteerism diminishes commitment and satisfaction [10].

However, while volunteering improves motivation and the quality of staff work, extrinsic motivation factors such as monetary retribution, gifts, and privileges, tend to provide a larger number of staff members. Indeed, Frey and Gotte suggest in *"Does Pay Motivate Volunteers?"* [9] that the size of the reward motivates individuals to provide more volunteering work. Some makerspaces may have issues with finding enough staff members to cover all open hours. In this case they may want to balance volunteering with some extrinsic motivational benefits. These extrinsic benefits are sometimes necessary to make progress, strive for higher goals and recruit more staff members.

At the Invention Studio, staff are recruited primarily on evidence of intrinsic motivation. However, to further motivate these volunteers and push them to help improve the space, a series of extrinsic rewards have been set in place.

Firstly, student staff are given 24-7 access to the space, which has an impressive number of tools. While the general student population may only come in during busy open hours, PIs can be found in the Invention Studio at all hours of the day (and night). This is a huge benefit for completing both academic and personal projects, while also creating a sense of ownership of the space.

Additionally, a point system was invented to keep track of volunteer's efforts and to reward dedicated staff members. Points are awarded based on the volunteer's role in the studio (exec member, tool group master, regular PI, etc.) as well as for leading tours, hosting workshops, and providing other valuable contributions (writing documentation, cleaning, etc.). At the end of the school year, students can use their points to redeem gifts. This is not a payment, as the point versus dollar conversion is not fixed and changes every semester based on the total number of points given. The gifts themselves are designed to foster a sense of community and creativity and include Invention Studio branded gear and a variety of small tools. This system has been effective in motivating staff members to go above and beyond the base requirements. Students want to accumulate as many points as possible and therefore are quick to sign up to help lead tours and events beyond their 3 hours of required staffing.

Another benefit given to Invention Studio PIs is the opportunity to apply for makergrants. Makergrants allow students to be refunded for the cost of their projects, provided that they submit detailed documentation including a schedule, bill of materials, and what will be learned in the process. They also agree to make their documentation publicly accessible, as a means to train and inspire the larger maker community. Makergrants not only incentivize people to become PIs, but also encourage creativity and larger scale projects that might not have otherwise been feasible for the students. Recent examples of makergrants include an electric guitar, a mini-camper, a drone, and an 8-drawer dresser. Watching students work on makergrants has helped propel others to want to tackle more advanced projects of their own. Fig. 1 shows a student showing off a drone he created via a makergrant and Fig. 2 shows a guitar that another student completed.

Fig. 1: Student PI showing a drone built through the Makergrant at Invention Studio

Fig. 2: Guitar created by a PI through a Makergrant

It has also been seen that makerspaces tend to accumulate a lot of administrative work (responding to emails, scheduling events, organizing the space, making an inventory, etc.). This work generally does not motivate staff members. It prevents them from focusing on users and does not require their technical skills. Therefore, it may be necessary to hire a few assistants whose role is clearly distinct from other staff members. These assistants would only perform low-skill and administrative tasks to relieve the executive board and other staff members.

To keep up with the more repetitive or administrative tasks, the Invention Studio hires 3-4 Studio Assistants each semester. While these assistants are students, they are not necessarily PIs and do not share the same benefits that PIs do. They are paid for their work which is comprised of weekly tasks such as maintaining inventories, cleaning/organizing the space, and performing tool maintenance. The studio assistants are led by the Shop Manager, one of the exec positions, and work directly with the masters for each tool group. The implementation of studio assistants has helped to decrease the more repetitive and less engaging tasks for PIs and hence increased PI enjoyment and retainment. It has also given valuable leadership experience to the exec board.

Recruiting Volunteers to Run a Makerspace

In "*Intrinsic vs. Extrinsic Motivational Orientations and the Volunteer Process*" [7], Marcia A. Finkelsiten identifies the two key features of a prosocial personality: *empathy* and *helpfulness*. Empathy is a state of mind, the ability to share someone else's feelings by imagining what it would be like to be in that person's situation. It is correlated with agreeableness. Helpfulness is a behavior-oriented towards action, of making a task possible or easier for someone to do. It is correlated with self-confidence. In a makerspace, staff members need to possess these two qualities, as they enable users to rely on them for both emotional and technical support. Therefore, as makerspaces recruit staff-members, they should look for a prosocial personality and the five motives of volunteering discussed previously.

Additionally, the academic maker culture is constantly seeking to reduce barriers to entry and promote diverse interests. Many makerspaces suffer from stereotypes, as the typical maker is a male, undergraduate, mechanical engineering major student. To counter these preconceptions, it is important to ensure diversity in staff members' profiles. By promoting the space to their respective communities, staff members are very influential in shaping the communities that inhabit the space. Indeed, as described by Whyte and Misquith in *"By Invitation Only: The Role of Personal Relationships in Creating an Inclusive Makerspace Environment"* [11], face to face invitation is the most common experience that leads to discovering an academic makerspace. Personal invitation can be issued from a variety of individuals: professors, involved members, faculty, etc. Yet, staff members, being regularly active and visible in the makerspace, are the main catalysts for bringing in new makers.

In "*Intentionally Cultivating Diverse Community for Radically Open Access Makerspaces*" [12] Perry and Chivers measured a strong correlation between their student employees' demographics and their user demographics, after having transitioned to an inclusive hiring process reflecting campus demographics. For many makerspaces, it is more convenient to hire students in engineering programs (or to a lesser extent in STEM programs). Even though some makerspaces may be open to any major, they do not incentivize non-STEM major to apply. For instance, by asking prospective staff members to complete a set of skills before being employed, non-STEM majors are often discouraged. Makerspaces willing to change their users' demographics may decide to train their staff after being hired, making hiring decisions solely on the motivation requirement. As stated by Perry and Chivers: *"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".*

At the Invention Studio, prospective PIs go through a two-step training and interview process. First, they must be trained and tested on a series of short tasks in each of the main tool group areas. No experience is expected prior to beginning these trainings. Following the completion of this checklist, prospective PIs sit for a culture fit interview that screens candidates for volunteer motivation and prosocial personalities as well as for knowledge of safety protocol and basic capabilities within the space. This initial culture fit interview helps to encourage students from all backgrounds and majors to apply since they are not tested directly on their use of any of the machinery. Once students complete this interview, they become "provisional PIs" with limited privileges and staffing ability within the space. During this phase, the provisional must complete more rigorous training of more advanced tools in the space and then complete a technical interview before becoming a full PI. At this point, they are unrestricted in their use of the space.

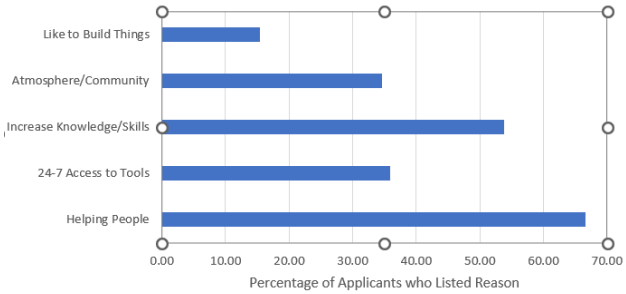

Fig. 3: Motivations of Prospective Prototyping Instructors

During the culture-fit interview, prospective PIs are asked a free response question about why they want to become a prototyping instructor. The answers to this question were recorded and examined for the 78 interviews completed in the 2021-2022 school year. The responses were categorized based on major themes seen in the responses. Most answers fell into five categories: interest in building things, appreciation for the atmosphere and community of the Invention Studio, desire to increase tool knowledge and skills, 24-7 access to the space, and interest in helping and teaching people. These results can be seen in Table 1. The percentage values represent the percentage of total interviewees who included that response in their answers. Since students could give multiple answers to the question, the percentage values do not add up to 100%.

It is seen from the figure that the number one motivating factor is helping or teaching people, with 2 out of 3 prospective PIs mentioning this in their interview. While access to the space is also a key motivator, so are things like increasing tool knowledge and the atmosphere/community feel of the Invention Studio. Additionally, at least six students explicitly mentioned wanting to be like the PIs who had trained them. Hiring students with these goals helps to continue to foster the same values in the future.

One interesting note is that there are several makerspaces on Georgia Tech's campus and at least one that pays students to staff the space. Despite these competing factors, the Invention Studio did not see a drop in volunteer interest and has seen a consistent upward trend in the number of PIs since its beginning in 2009 (excluding two semesters due to COVID-19).

As presented by Noel et al [13], another useful measure in recruiting diverse and motivated students is tours and workshops. Numerous tours of the Invention Studio are hosted each week to a wide variety of groups including prospective students, local schools, sponsors, and Georgia Tech classes. These tours introduce hundreds of students from all backgrounds and majors to the Invention Studio and its capabilities every semester. Many students who attend tours as prospective students later report that it was a factor in deciding which school to attend and motivated them to want to become a PI themselves.

Fig. 4: Students Participating in Water Jet Pumpkin Carving Workshop

The Invention Studio also hosts many workshops and outreach activities. Workshops are led by PIs and include anything from small projects to software tutorials. Fig. 4 depicts students showing off pumpkins carved with the water jet during a workshop. Sometimes, these workshops are specifically targeted toward a particular organization or group of people. For example, freshman workshops and tours are hosted during the Week of Welcome. Other times events are held in collaboration with another club or event, such as hackathons.

Sustaining Makerspace Staff and Culture

Academic makerspaces often feature a high turnover of staff members. This is usually due to academic constraints (graduation, schedule conflicts, etc.), or the abundance of other opportunities competing for their time (jobs, other clubs, etc.) This turnover hinders long-term decisions and actions in the makerspace. Experienced staff members are extremely valuable in assessing needs, fixing issues, and implementing rules. Therefore, it is necessary to retain new hires by giving them incentives to remain in the space. When this happens to be in a volunteer-run makerspace, such incentives are motivation-based.

In "*Fostering Volunteer Satisfaction: Enhancing Collaboration through Structure*" [14], Jensen and McKeage provide five rules to follow to foster volunteer's satisfaction. The first rule is ensuring group integration. Staff members have to feel included in a volunteering group and have a joint purpose in mind. Second, volunteers must maintain a great relationship with the organization's hierarchy, notably those who are paid (academic advisors, full-time staff, etc.). This goes along with the third rule: support from the organization. This implies technical and personal support from other volunteers as well as from the rest of the hierarchy. It is particularly important to ensure an efficient training process, as well as to care for personal inquiries. The fourth rule is to implement all the conditions for friendships to be made. Friendships are extremely important in academic makerspaces; this is the ultimate bond to the space. It is important to be as inclusive as possible so that new staff

members make friends quickly. Lastly, the most important rule is the ability to do a good job. Volunteers need to feel accomplished and valuable to the space. An important aspect of this is ensuring thorough training, not only initially but also throughout the makerspace's curriculum.

The last rule, 'ability to do a good job', is further broken into 3 requirements by Edwin J. Boezeman and Naomi Ellemers in "*Intrinsic Need Satisfaction and the Job Attitudes of Volunteers Versus Employees Working in a Charitable Volunteer Organization"* [15]. The first requirement is to provide autonomy to volunteer staff members. Even though they must respect the makerspaces' rules in access and security, they also need the freedom to help makers with their own pedagogy and approach. The second requirement is competence through performance standards. Volunteers should feel empowered in their ability to carry out valuable tasks in the space. The final requirement is relatedness, which is accomplished through secured and respectful relationships to other members. Staff members need to feel supported and trusted by their peers. Trust-based relationships trigger the ability to communicate which is essential to security. Indeed, staff members should not fear to make mistakes, as they will eventually. Rather, relatedness through communication will allow staff members to grow from their mistakes.

Finally, J. C. Winniford et al. [16], framed similar ideas into three needs: need for achievement (being proud of one's work and contribution), need for affiliation (concern for one's relationship with others), and need for power (being impactful, influencing). Executive members should be implementing actions to fulfill these three needs. This requires establishing a personal relationship with each of the volunteers, being able to measure their impact, paying attention to their ideas, and providing some means for them to implement their ideas.

Fostering a sense of community and trust is a major emphasis of the Invention Studio. Social events such as game nights, cook-outs, networking activities, and workshops all help to bring PIs together. In recent years, a mentor-mentee program has been developed to pair new PIs with PIs who are more established in the space. This not only helps newcomers get trained on more advanced tools, but also it helps them become connected in the space. Mentors and mentees may choose to complete a project together or sit with one another in general body meetings. While the program is primarily geared toward helping integrate the new PIs, the mentors also benefit from and feel a sense of accomplishment and influence as they teach and help others.

Another method used to encourage a supportive culture in the space is a shout out system referred to as "Brownie Points." Once a month all PIs attend a General Body Meeting where the exec board and masters update the group. At the beginning of the meeting, new members are introduced, and PIs have the opportunity to award other PIs "Brownie Points", recognizing them for something they did that went above and beyond expectations. Both the PI who gives the award and the PI who receives the reward get a brownie thrown at them from the front of the room, resulting in many laughs in addition to encouragement.

To help foster a sense of achievement, an Invention Studio "Follow-Through Club" was also created. This club has taken different forms over the years, ranging from a physical club that met weekly to discuss current projects, to a channel in the Microsoft Team where people post pictures of completed projects or partially completed projects. In either form, the motto of the club has always been "no project too small". PIs share everything from a 10-minute craft to a semester long project. This both gives PIs a sense of pride in their work and helps encourage others to try new projects.

At the end of each semester, the Invention Studio hosts a banquet to celebrate the achievements of the previous months. PI nominated awards are given for best PI, best master, and best new PI as seen in Fig. 5. Additionally, a series of crowd-sourced superlatives are awarded including everything from "most likely to be in the Invention Studio at 4:00am" to "most likely to cannibalize an electric scooter". These light-hearted awards, though silly in nature, promote the culture and community of the space. Fun projects, such as the soda-can samurai costume shown in Fig. 6, are also highlighted in a slideshow.

Fig. 5: Student Awards at End of Semester Banquet

Fig. 6: A Creative Halloween Costume Created at the Invention Studio from Recycled Soda Cans.

Summary and Conclusions

This paper provides insight into the balance between intrinsic and extrinsic motivations for makerspace staff members. A staffing body is a crucial element of a makerspace: it sets the cultural tone, the safety requirements, and the technical expertise. A motivated staff leads to a safe, knowledgeable, and pleasant space.

First, it is important to decide the right balance between extrinsic and intrinsic rewards that will be given to staff members: pay, gifts, special access, responsibilities, awards, support, etc. Second, it is necessary to recruit and to train staff members that represent and embody the makerspace values. A makerspace willing to be diverse and inclusive has to recruit staff members that come from different backgrounds and that are aware of these specific stakes. A makerspace willing to be technically efficient will favor staff members with already existing skills in prototyping. Third, it is mandatory to ensure that staff members, once recruited, are encouraged and that they transpose their motivation to the entire makerspace.

Future work and experiments could be conducted to provide a measurable insight into this qualitative work. Indeed, measuring motivation is a difficult task, but it would reinforce these recommendations. First, it is necessary to define metrics for motivation, which could be: weekly time spent in the makerspace by a staff member, average number of years spent by a staff member, and number of awards (or points for instance). These metrics need to relate to the rules implemented in the makerspace (hiring system, reward system, social integration). Second, it would be interesting to compare the different hiring systems and how diverse are the respective staffing bodies of various academic makerspaces. A comprehensive survey could confront the hypothesis presented regarding pre-recruitment training and post-recruitment training.

Finally, friendship is a key retaining and motivating factor for staff members and needs to be explored. The ability to make friends and to be included in the community is a powerful intrinsic motivator in volunteering. It is not inherent to a makerspace, but rather needs to be well supported. Indeed, a high turnover brings fresh faces every semester and leaves knowledgeable members' contributions. This is particularly true in academic makerspaces. Some events can make a difference in staff inclusion: general assemblies, internal communication, maker events (workshops), social events, etc. Using a mapping strategy to design a social network map of interactions, acquaintances, and friendships among staff members of a makerspace would enable the visualization of central groups and assess the cohesion between members. Makerspaces are fairly new microcosms with a very unique set of learning processes, social interactions, and rules. They are not innate to a makerspace, nor to the individuals opening makerspace doors for the first time. Staff members play a key role in shaping these.

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