Best Practices for A Newly Established Academic Makerspace in a Nascent Maker Ecosystem

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INTRODUCTION

This paper discusses the different practices that can be infused in an academic makerspace's culture to enhance learning and to remove barriers to making. Best practices with examples and their corresponding results observed at an academic makerspace in Pakistan have been discussed. The makerspace in question is the first and currently the only academic makerspace in Pakistan, appropriately named Make-i-stan. It is based in Information Technology University of the Punjab (ITU) which offers STEM degrees at undergraduate, graduate and doctorate level.

Makerspaces are playing their role in many different learning landscapes as making has evolved itself as an adaptive concept that can be adapted to different cultures, regions and settings. In addition to being adaptive, a makerspace's culture is transformative. Makerspaces thrive in collaborative and open culture and in academia this culture makes the process of learning and making much more fun and rewarding for the students and educators alike.

1. Description of Setting

Since the practices and their results included in this paper are by and large based on the experiences, it is important to describe the educational setting Make-i-stan is based in. Make-i-stan is the first and only recognized makerspace in Pakistan. It is embedded in a public sector university named Information Technology University of the Punjab (ITU). ITU is based in Lahore, a populous city of 11 million people which is considered the cultural hub of Pakistan. Lahore is also the home to numerous high ranked universities of the country. Despite being the project of ITU, a major portion of the users of the makerspace come from other universities. We get visitors from outside of Lahore as well.

1.1. Description of Programs

Make-i-stan has multiple programs making it a hybrid of a workshop and a community makerspace. It does trainings and offers its space and tools for development of projects. Other than the trainings offered on specific technologies, customized trainings with external organizations have also been done. For people who want to work on their hardware projects, we offer our space and tools through open days every week and through the 2 months long designers in residence programs. All of its programs are currently being offered for free to ITU and non ITU students. Although a majority of our visitors are engineering and computer science students, the space is not exclusive. As can be seen in "Fig. 1," we get people having varying professional and educational back
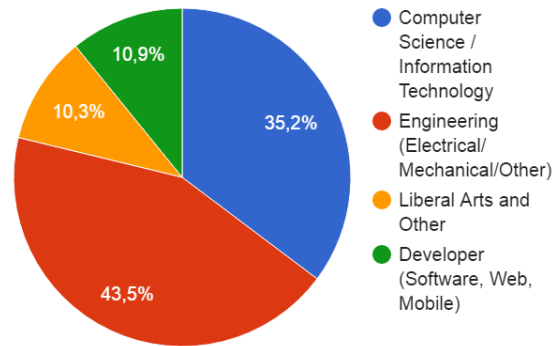

Figure 1. Make-i-stan's Visitors Educational Backgrounds

grounds.

1.1.1. Regular Events and Open Days

Make-i-stan has been holding free events and workshops since its inception. The idea of a community makerspace is still very new in this part of the world, so we have kept all of our events free so far. It has helped us remove a major barrier to engage a large number of students at our makerspace. Finding expert trainers for teaching specific technologies and tools becomes difficult at times without any monetary incentive but in an environment in which all the community members get the opportunity to learn for free, willingness to contribute back to the community remains very high.

a. Weekly Arduino Workshops

Arduino Nights are semi structured weekly workshops on Arduino. The reason for choosing the platform of Arduino for conducting regular free workshops is because it allows for reaching a wide audience. Kids, high school students, undergraduate and graduate students from varying disciplines and fields can all learn the easy to use open source platform. The loosely structured workshops allow for discussion and implementation of new ideas. Participants can come up with their own ideas or they can join a group lead by a facilitator. Anyone can become a facilitator provided that they have enough exposure of working with arduino and can help a group to follow a series of instructions from well documented project manuals. Participants are allowed to bring their equipment but a majority of them borrow the equipment for the duration of the workshop and return it back at the end of workshop. Arduinos and basic electronic components such as sensors etc are accessible to everyone. Although there is always a team of volunteers who facilitate this workshop, but the participants can borrow the equipment without asking anyone.

b. Weekly Open Days

Two days every week are designated to be open days. Anyone either with an idea for a project or with an ongoing hardware project is invited to come in and work. Visitors can use the space and the available tools for prototyping and testing, but they have to return the borrowed equipment before they leave the space. Currently the equipment that we have on offer is mostly inexpensive components and prototyping boards. In order to use fabrication tools such as a 3D printer they have to pay in cash for the materials they use. Visitors also get unrestrained access to inexpensive consumable components.

1.1.2. Designers in Residence Program

Designers in Residence program is a two months program where the selected DiRs are given access to the space for six days a week. Designers are selected on the basis of strength of their skill set and are required to commit for two months to work in teams on hardware projects. The induction to program is completely free and each team is given $100 credit for buying consumable components for their projects. As opposed to working on a predefined task assigned by someone else [1], DiR program allows students to work on projects of their choosing.

2. Best Practices and Processes

There are certain practices which have elicited exciting results at the makerspace in question. Following are the practices which can be adapted in a similar setting for creating a stronger community, creating an environment for enhancing educational impact of the makerspace and for lowering boundaries to making.

2.1. Forming a Strong and Diverse Community Through Culture of Openness, Equality & Responsibility

Creating a culture of openness which allows for free flow of information from management of the makerspace to each member of the community is essential for creating an environment in which each community member takes ownership of the space and its resources. There are multiple ways of communicating this information, and including the community in decision making process.

2.1.1. Steering committee

A committee consisting of the most avid contributors to community are part of the decision making process. Committee can consist of members of the institute administration, makerspace management, volunteers and interns or regular visitors of the space. Organization of the space; events and workshops to be organized; and assessment of the needs in terms of tools and equipment at the space should all be discussed in committee meetings. Makerspace management remains an important part of the decision making process, as they provide and arrange logistics for the implementation of the ideas.

Having a committee to oversee all the organizational decisions ensures that the community also takes ownership of the successes and failures. Since the committee members keep changing overtime, the organizational decisions keep evolving accordingly.

2.1.2. Organizational Hierarchy

The organizational hierarchy of a makerspace should be simple and the community as a whole should be able to delegate tasks to its members. Each community member is accountable to the community. From keeping the space organized and clean, to helping organize workshops and events, a community that feels empowered can keep a space up and running with or without any help from the university.

2.2. Transforming Learning & Making at Universities

Learning outside of classroom or informal learning helps students retain the content better than traditional education[2,3]. Working environment at makerspaces should take pressure away from students. Removing the administrative hassles that come with the typical lab equipment usage policies of universities can create an open and free environment that for a better learning experience.

2.2.1. Unrestrained Access to Space, Tools and Consumables

Though giving unsupervised access to expensive equipment to non registered members is infeasible but by providing unrestrained access to less expensive tools creates an environment of self accountability and is likely to increase the affinity towards the community space. Since students are not strongly prepared to take advantage of the hands-on time in the laboratory period [4,5] this policy of unrestrained access to less expensive equipment is one of the most important reasons that students prefer the community makerspaces over the highly equipped laboratory facilities of students' institutions.

2.2.2. Flexibility in Making

The weekly arduino workshops at Make-i-stan are loosely structured to cater to a wider audience having varying levels of expertise on the open source prototyping platform. Curriculum is not an overall order imposed on a course of material [6]. Even the most highly structured trainings which are conducted at a makerspace are adaptive to suit the needs of the audience. They are designed to be replicable and are short in duration. The adaptive and flexible curriculum elicits a higher level of engagement in students and is helping transform the traditional teaching methods at the universities.

2.3. Removing Barriers to Making

Students should be encouraged to engage with the academic makerspaces. There can be multiple barriers to entry depending upon the location and the social constructs of the region where the makerspace is located.

The biggest barrier to making in a nascent maker ecosystem such as Pakistan is the monetary cost associated with making. A major component of an academic makerspace's program should always remain free.

Language can also be a barrier to entry for some in a country such as Pakistan. Its reason is rooted in post colonialism. Language does not only create a communication gap but can also be a cause of discomfort for the audience. A community space should make its visitors feel comfortable while communicating in whichever language they communicate their
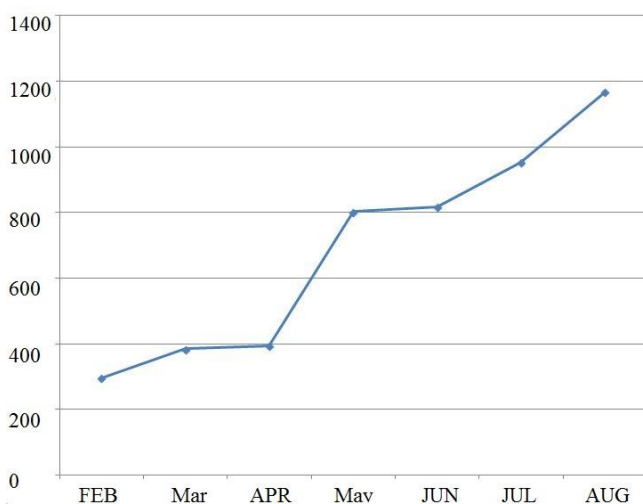
Figure 2. Number of Unique Email Subscriptions by Month

Table 1. Summary of Visitor data for last 8 events

Number of participants (last 8 events)	Registered returning visitors	Unregistered returning visitors (estimate)	ITU students
260	28%	>25%	37%

reasons. 1. Showcasing the long-term hardware projects made by our users, 2. Having an expert over to do training or talk on a topic outside of our area of expertise. 3. Doing partnerships with external organizations having good social media reach.

Other than the increased student engagement, we have been able to engage students from outside of ITU including students from outside of the city of Lahore. Students from Wah, Gujrat, Layyah, Faisalabad, Okara and Hafizabad have visited us in order to seek help in last 6 months. They visit us because of the unavailability of makerspaces in their respective areas. These students are still in contact with our community members and can potentially play a pivotal role in introducing maker culture in their respective towns and cities.

4.   Conclusion

The practices presented in this paper have elicited positive results. Similar practices can be adapted in similar settings to create an open and free environment which enhances learning; increases student engagement; and get students excited about these spaces.

The first and the biggest challenge for any new community makerspace is to form a community which takes ownership of space, resources, decisions and results of those decisions. Openness, equality and responsibility are the cornerstones of any strong community and the makerspace management needs to build the community on these values.

An academic makerspace should adapt to its setting but it should also work towards transforming the learning methodologies of the institute it's based in. Removing barriers to joining the community and giving unrestrained access to less expensive tools separates a makerspace from a university laboratory.

ideas in the best way possible. In case of Make-i-stan, we prefer using the national language Urdu and sometimes English, depending upon the type of audience present.

3.   Results and Discussion

The practices described in this paper have performed well in our setting and can be replicated and adapted in a newly established academic makerspace. These practices are not new in their entirety but are highly effective in producing desirable results and can be used as a framework that makerspaces in similar settings can use. The application of these practices has produced positive results which can be quantifiably measured. Due to the limited capacity at our space, we send out confirmations to the selected participants for each event, but to keep things simple we avoid doing a roll call. We sent out a survey to the selected participants of our previous 8 events. Based on this survey and on the basis of headcount for each event, a summary of member data for these 8 events is given in table 1. People who attend our workshops are mostly students and through the survey we found out that reason for attending the event for an overwhelming majority was to add a new skill to their resume. Almost half of these participants are the returning visitors. We have found out that many of the returning visitors either do not wait for confirmations from our side or do not even formally register for the event. This shows that making the space more accessible encourage people to engage with us after their first visit. "Fig. 2," shows organic increase in the number of email subscriptions by month. "Fig. 3," shows number of organic facebook likes. We have analyzed the social media activity and found out that whenever we have we have seen an unusual increase in social media engagement; it has happened due to the following three

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Figure 3. Organic Facebook Likes