

Workshop Development as a Scaffolding for Co-Creation and Inclusivity in Makerspaces

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Introduction

Academic makerspaces create and offer technical training in a variety of ways. The mission, machines, and resources available also vary widely, but most focus on hands-on, project-based learning. Depending on the governance and structure of each space, most offer regular machine training sessions led by students or full-time staff to encourage and support this learning through making [1, 2].

Many also offer hands-on workshops to connect specific technical knowledge to the design process. These can vary in purpose, from encouraging student users to apply their technical skills, introducing them to new technical or design skills, or providing alternative pathways to making and makerspaces [3]. Examples often include basics of programming or computer aided design (CAD), or utilize common prototyping tools such as Arduino or Raspberry Pi [4]. Workshops are also offered by makerspaces with a variety of background and home locations: institutional libraries (general or STEM focused), business and innovation or entrepreneurship focused, or engineering schools.

Though many academic makerspaces offer workshops, few identify a clear process and structure for supporting student-led workshop development. Over the past 5-10 years, several spaces have provided examples of workshop topics and content. There has also been an emphasis on attendance outcomes, with several papers describing most attended or well received workshop topics. Other authors have presented a workshop design process or guide, but they do not make an explicit connection between that design process and peer-led workshop development [5].

Our early studies and interventions on the peer led workshop creation process emphasized the importance of a support system and building on the personal interests and strengths of the peer leaders [6]. Over the past two years, that support process has been developed iteratively and will be described. We have developed consistent programming and offerings that work with the NYU MakerSpace to create a structured, holistic co-curricular experiential learning environment.

Background

This paper builds on previous work supporting the co-curricular workshop learning process in an academic makerspace [6,7].

A. Community Development and Peer Teaching

Recently, several studies have utilized the Community of

Practice framework to study the interaction of users, or users and student staff, within makerspaces [8,9].

In a more recent study, the authors found that “learning happened formally through instructional courses as well as informally among peers,” contradicting the CoP framework [10]. They also suggest rethinking the role of educators to act more as managers and leaders within these spaces and emphasize that “the pedagogical challenge lies in organizing learning arrangements among students, as well as building norms, governance structures and cultures for learning over time” [10].

B. Inclusive Co-Curricular Learning

Several authors have identified the potential for asset-based curriculum integration and support within academic makerspaces to create a more inclusive environment and community [11,12]. An asset-based approach or framework recognizes the differing life experiences and skills or strengths that students bring to their undergraduate or graduate education [13,14,15]. Kellam et al studied 10 makerspaces at 7 different universities and identified potential practices to create a more inclusive space:

- “Increasing visibility;
- Integrating the makerspace throughout the curriculum;
- Encouraging interdisciplinary collaboration;
- Culturally relevant making;
- Deliberately designing space to encourage collaboration;
- Promoting inclusivity throughout the physical space;
- Fostering a risk-taking, fail-forward culture;
- Increasing accessibility for students with different abilities;
- Increasing accessibility through time that the space is open; and
- Hiring student techs and staff to develop a sense of belonging and encourage inclusivity” [12].

They provided either positive or negative examples and motivating questions for each of these findings. Finally, previous ISAM papers have also recognized the importance of personal relationships and inviting students or student groups who may not always feel welcome to a makerspace to reduce the barrier to entry [16]. These differing studies and findings represent a starting point for creating an inclusive, asset-based environment for informal student

learning and more formal workshop support within academic makerspaces.

Methods

A. Setting

NYU Tandon MakerSpace is a 10,000 sq-ft MakerSpace at an urban, Northeast private university. The MakerSpace is open to all students and faculty of the university, but is housed in the engineering school and building. There are three full-time administrators: a Director, a Design Lab Manager, and a MakerSpace Manager. In addition, there are two graduate students who support the Design Lab programming, called Design Lab Coordinators (DLC), 2-4 additional graduate student teaching assistants (TAs), and approximately 35 undergraduate TAs.

Each of the TAs is responsible for the day to day running of the space, giving orientations and machine training sessions to students, running a minimum of one workshop per semester, and attending at least two workshop test runs per semester in support of the Design Lab at the MakerSpace. Additionally, each TA is a part of an internal team which supports the internal maintenance of the MakerSpace.

The Design Lab is the educational programming and support arm of the NYU MakerSpace. The lab focuses on a human-centered design approach and works with students to help them develop and embrace the design thinking process, focusing on the importance of keeping the people they're designing for at the center of their work. The Design Lab hosts weekly events and workshops, creates opportunities for students to showcase the skills they learn in the MakerSpace through our digital badging program, and provides mentoring help.

The Design Lab exists within the physical space of the MakerSpace, running all events and workshops in either the Design Lab within the MakerSpace, or the Event Space attached next door. It is a flexible working space for both student use and running workshops: the space is open to students to sit, talk, and work in when there is no workshop taking place. In addition to its physical presence, the Design Lab also offers a variety of digital resources, namely recorded workshops and interviews. The Design Lab also provides access to slides and resources with every workshop, and the MakerSpace website provides a variety of resources from machine information to DesignLab blog posts and project spotlights.

The Design Lab is run by the Design Lab Manager, who oversees the planning and managing of all educational programming along with two graduate workers: the Design Lab Coordinators (DLCs). DLCs are responsible for providing support to students, researchers, and faculty at the MakerSpace. The Design Lab Manager and DLCs work closely with the Communications team, made up of three to five undergraduate and graduate MakerSpace student staff.

The DesignLab as it exists today grew out of a student club called OpenIDEO (now Design for America - DFA). In the spring of 2012 it expanded into a physical space named the Greenhouse. The Greenhouse offered programming and support to students across NYU through in house workshops

and hosting clubs. By 2018, the Greenhouse had grown again to need more space and support and it moved into the MakerSpace and was renamed the Design Lab.

B. Creation Method and Theoretical Framework

The workshop development process both uses and seeks to teach the design thinking process for all of the Design Lab's offerings, including the workshops. Design thinking processes prioritize empathy, prototyping, iterating, experimentation, and redesigning as essential tools for a holistic process which develops better, more human centered solutions [17]. By using a design thinking process and human-centered design practices to inform and structure our workshop development process, we have developed a more inclusive and supportive process of prototyping, redesigning, and testing each workshop as further detailed in the Workshop Creation Process below.

Furthermore, building from an asset-based approach, we utilized the Community Cultural Wealth (CCW) model as our theoretical framework. Based on the tenets of critical race theory (CRT), this framework was developed by Dr. Tara Yosso to acknowledge the differing strengths, or forms of wealth, that a diverse group of students bring to their educational experience. It includes six forms of cultural capital:

1. Aspirational
2. Familial
3. Social
4. Linguistic
5. Resistant
6. Navigational [15]

This framework has been utilized to study the persistence, experiences and skill development of nondominant student groups in engineering education [18]. Valuing the unique experiences and expertise of the MakerSpace TAs, this theoretical framework supported and guided the co-creation process.

C. Workshop Creation Process - History

Over the past 3 years, primarily through the work of the Design Lab Manager (DLM), the process for creating, preparing, and running workshops in the MakerSpace Design Lab has been developed and refined to become an integral part of the MakerSpace's holistic, co-curricular experiential learning environment.

When the DLM position began, the workshop process included a meeting between the DLM and a TA to create their slide deck presentation and gather the necessary materials to create a cohesive presentation and activity together, then the workshop would be scheduled and take place. Through regular meetings and in response to TA feedback across the semester, the DLM and the communications team began to implement a *test run* in the workshop development process. The test run is a valuable testing experience in the workshop development process. The test run allows the DesignLab to ensure TAs are prepared in advance (they know what to say, and know the material and activity itself), and also ensures the TAs have an opportunity to both give and receive feedback on each

other's workshops before presenting to their peers. It is an opportunity to test the prototype workshop, and reiterate and redesign in response to feedback and needs from peers.

To supplement the workshop development process, the DLM and communications team collectively iterated, tested, and developed a streamlined template for all slides and promotional materials. This allows the promotional process to move much faster, enables more clear communication with the public, and makes building the workshop slide deck much easier for TAs. The Design Lab Coordinators work with the communications team to coordinate when to schedule workshops and order materials with TAs across the semester.

Gradually, through iterating, testing, and redesigning according to the needs of the TAs, the workshop development process reached its current form, and is a shared effort supported by the DLM, the TAs, the DLCs, and the communications team.

D. Workshop Creation Process

We have identified 6 phases in this process: Ideation, Planning, Promotion, Preparation, the Workshop itself, all followed by Post-Processing.

These process parts are outlined in detail below, as well as in **Fig. 1**, and in **Table 1**

Ideation

- Ideation begins with a workshop proposal. TAs are able to propose workshops a few different ways: beginning of semester workshop survey, in the hiring process, through informal conversation.
- TA works with the Design Lab Manager to develop material to be covered, developing slides with the Design Lab templates.

Planning

- TA schedules with the communications team leader to set a time and date for the workshop to occur that works for everyone involved: the TA themselves as workshop lead, another TA co-lead, and a facilitator from the communications team.
- TA communicates any materials needed to run the workshop with the DLC at least three weeks in advance (materials arrive in time for the test run of the workshop)

Promotion

- Once the time and date are confirmed, the communications team will produce promotional materials for the event (eventbrite page, bit.ly link, flyers for instagram and emails, copy).
- DLCs promote across the university, sending out emails with all upcoming events and workshops to departmental contacts (when appropriate, they also promote to external contacts)
- The communications team promotes workshops across MakerSpace social media accounts.

Preparation

- TAs review the slides and activity and make any necessary edits with their co-lead.

- The test run is scheduled for one week before the workshop (usually at the same time as the actual workshop, just one week ahead).
- Test Run: TAs present the workshop to a communications team member and a minimum of two other TAs from the MakerSpace.
- The group provides feedback on the workshop, and send recorded notes after
- TAs have the week between the test run and the workshop to make any further necessary edits.

Workshop

- Before the workshop, the TA workshop leads and a facilitator from the communications team all set up the space in the DesignLab and prepare the tablet for tracking attendance.
- The workshop takes place. For a list of all workshops see **Table B**.
- In the beginning and after the workshop a survey link is provided to both request feedback from the attendees, and to provide the slides and resources from the workshop.

Post-Processing

- DLC looks at all documentation and analyzes survey feedback and attendance.
- All workshops require check in to track overall attendance and engagement over time.
- Synthesizing the data over time to understand what improvements are needed, what is or is not working, and ultimately to shape future workshop offerings and structures, reviewed in collaboration with the Design Lab Manager and MakerSpace Director.

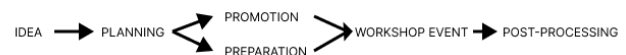


Fig.1 Flowchart of Workshop Process

The table below again outlines this process, as well as who is involved in each of the phases:

Phase	Steps	People
Ideation	Preliminary interest form Content Activity Finished Slides	TA DLC DLM
Planning	Ordering Materials Time/Date Coordinating TA facilitators	TA Communications Lead/Team DLM
Promotion	Emails Social media Newsletter Website	Communications team DLC

Preparation	Review of workshop + Materials Test run	DLC Communications team
Workshop	Facilitation (attendance) Workshop + activity	Communications lead TA
Post - Processing	Survey Attendance + analysis - iterative revision process	DLC DLM

Additionally, throughout the development of this system, there was a simultaneous development (through prototyping, testing, redesigning) of various necessary supporting materials which can be referenced at any time by anyone to supplement and support all parts of the process.

- Developed Support Materials and Documents:
 - o Slides, materials, documentation
 - o Slide Templates for all workshops
 - o How to create a workshop - slide deck
 - o How to run a workshop - slide deck
 - o How to give good feedback - slide deck
 - o Tracking attendees - NYU internal software
 - o Student evaluation survey - Google form for workshop feedback

Results

The above outlined and detailed workshop development process (which continues to be adjusted and tested) not only creates a collaborative tool for running all of the workshops at the DesignLab, but furthermore supports the development of student skills, leadership roles, and an inclusive co-curricular learning environment at the MakerSpace. Its structure and consequent support are a vital element in the continued success of the Design Lab and MakerSpace with clear results and benefits as follows.

A. Diversity & Inclusivity in Programming

The workshop process has created a greater diversity of knowledge and inclusion in the space. This is largely a result of the workshop survey, proposal, and ideation phase. TAs are encouraged to ideate workshops based on their own personal skills and interests; any skill, idea, or interest is valuable and able to become a workshop. When TAs bring their knowledge into the space, not only through their studies, but also from their hobbies, past experiences, and interests, it creates a space which prioritizes and promotes experiential knowledge [15]. We have had workshops on origami, screen printing, creating jewelry, plant based dyes, houseplant care, and more alongside the technical workshops such as Intro to Photoshop. The diversity of workshops also helps to promote a diversity of projects happening in the space: personal and research projects are equally supported and spotlighted pursuits at the MakerSpace.

Through our attendance data, we can see the community interest and investment in all forms of knowledge shared in the space, creative and technical workshops alike: in Spring 2022, the Hand Sewing & Embroidery Workshop had 24

participants and Intro to Arduino had 15 participants.

Through this process and its outcomes, there is emphasis and investment in the knowledge and resources of the community, and it is working to holistically develop and support community cultural wealth [15]: restructuring, learning, and growing the scaffolding and support needed - defined and designed by the community, for the community.

B. TA Leadership & Skill Development

One of our more popular creative workshops is the Origami Workshop. The TA who runs this workshop described his experience working with the DLM through the process:

“I think what I struggled with the most at first was finding a focus for the workshop and as I talked with [the DLM] about it, the focus became more clear. As for the slides, it's great we have the new template slides we can use to create a workshop, I think it makes it easier than before when we didn't, and helps to guide what content should be added and the format of it. Having everyone finish the hands-on project was what I enjoyed the most. It was through a fellow TA and my teaching that helped someone who may have zero origami experience complete two projects. It's a pretty great feeling knowing that I helped someone learn something new from the slides I created and hosting the workshop as well.”

The TA was supported in ideation, and left the workshop experience with a sense of accomplishment, ownership, and successful leadership in the space. This opportunity for TAs to learn valuable skills in organizing their ideas, developing ownership and sharing their skills, and leading in their workplace among their peers, as peer-to-peer learning in higher education has often supported and leveraged [19], is further supported and rendered more accessible and collaborative through the workshop development process.

C. Collaboration, Community, & Peer-to-Peer Teaching

The workshop development process spreads responsibility for the workshops across the collective team, as everyone has a role to play in the production of the workshops. The collaborative nature of the workshop development process results in it functioning additionally as a collaborative, team building tool in our community. Collaboration, as defined by Roschelle, cited in Richard and Giri's paper: “In this paper, we subscribe to Roschelle's (1992) definition of collaboration, which is “building and maintaining a shared understanding of a problem or task, distributing responsibility across members, sharing expertise, mutually constructing, and negotiating cognition” [20]. Here the workshop process is precisely that: a large shared task, expertise sharing, problem-solving responsibility, broken down into parts and distributed across the teams and TAs in the MakerSpace.

The TAs gain valuable teamwork and leadership skills as they have the opportunity to teach others and each other, and work together to make the workshop happen, as well as the opportunity to self-reflect on their performance and role in

the workshop. The expectations are clear for the TAs, and they have all the necessary support from the Design Lab Manager, DLCs, and communications team (as well as from available precedents and documents) to understand and fulfill expectations. Leading a workshop creates confidence and interdisciplinary working relationships for TAs in the MakerSpace.

In these ways, the holistic structure of workshop development we have created in the Design Lab at the MakerSpace promotes collaboration, community, diversity and inclusion.

We have divided the workshop support mechanisms into 3 categories:

Structural Support

- Workshop proposal form and open opportunities
- Accessible support documentation/resources
- Test Runs
- Defined and agreed upon timelines
- Clear expectations
- Existing precedents to build on
- Ongoing & available team support

Co-Creation

- Peer feedback
- collaborative one-on-one & group development sessions
- Peer-to-peer accountability
- Precedents: building off of existing knowledge & community resources
- Investing in existing TA interests/knowledge/skills

Reflection + Development

- Community accountability (peer to peer learning & feedback)
- Opportunities and time to reflect on feedback, incorporate, and improve
- Survey/peer feedback
- Ownership and sharing of skills, knowledge, and leadership
- Opportunity to participate on both sides of the process (presenter & reviewer roles & reversals)

Together these three categories balance and support each other to ultimately support the success of the workshop development process.

Some questions to consider in implementing a process for workshops or programming in a co-curricular experiential learning environment would be:

- Is there a community point person and/or team to facilitate, coordinate, and support?
- Is there a clear set of tasks and responsibilities?
- Are there precedents or frames of reference available for students to work off of?
- Is there a definitive, organized, and accessible space for shared resources and documents (google drive, dropbox, etc.)?
- Are there clear templates, checklists, or guides for any collective promotional/shared materials?
- Is there opportunity for collective feedback and

decision making?

- Is there opportunity for both peer feedback and self reflection?
- Is there opportunity for continued feedback on the process itself, to be able to make adjustments according to students/peers' needs?
- Is there a dedicated, accessible platform for communication (slack, email, etc)?

Conclusion

The workshop development process, co-created with full-time staff, undergraduate, and graduate students, based on design thinking and community cultural wealth frameworks, has become an essential tool for inclusive collaboration, and learning in the MakerSpace. It is not only the essential scaffolding for the successful programming of workshops, but furthermore supports inclusivity and diversity in the MakerSpace, working towards a diverse and equitable community of collaboration and shared knowledge within the MakerSpace [15]. Looking forward, the workshop development process will expand to establish clear learning goals and long term programming goals, as well as continued efforts expanding the existing inclusion and diversity practices within the MakerSpace. These goals will be ideated, defined, and worked towards collectively by the entire team. The DesignLab will most intentionally work on these goals, as well as support the continued development of the Digital Badging program as an outcome of the workshops, trainings, and experiential learning in the MakerSpace and DesignLab.

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Intro to Fusion 360	Hand Sewing & Embroidery	Houseplant Care 101
Intro to Arduino (3)	Intro to HTML/CSS (3)	Sustainable Food Wraps
Intro to Rhino	Advanced Figma	Biomimicry
Intro to Photoshop (3)	CS/Tech Interviews Preparations	Solar-Powered Phone Chargers
Intro to Illustrator (3)	Arduino with Motor Control	Plant Based Tie Dye Socks
Intro to Raspberry Pi (3)	PCB Jewelry Making w/Othermill	Plastic Identification
iOS App Development (3)	Iron-ons with Cricut	Food Waste + Compost
Intro to Figma (3)	Layered Stickers with Cricut	
Adv Illustrator	Vacuum Form Chocolate Molds	D+I Storytelling
Wireless Communication w/Arduino (3)	Modular Origami	D+I Ideation
Intro to Premiere	Screen Printing	D+I User Testing
Adv Fusion 360	Knitting/Crochet	D+I Portfolio Development Workshop