Board 189: WIP: Staff Communities of Practice for Makerspace Professional Development

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WIP: Staff Communities of Practice for Makerspace Professional Development

Introduction

The "Be A Maker" (BeAM) Makerspace at the University of North Carolina at Chapel Hill exemplifies an inclusive makerspace, where users are welcome to design, prototype, and collaborate with others regardless of skill level, personal interests, academic major(s), and/or physical abilities. The space employs 50-60 undergraduate student staff to support its diverse community of 4,000+ users, which includes other students, researchers, faculty, and university staff. All student employees begin their role as Program Assistants, but they can later apply to acquire more advanced responsibilities by becoming Program Specialists. Program Specialists are not only tasked with their personal professional development, but are also responsible for applying these new skills towards instructional materials and programs aimed at teaching other staff members and makerspace users.

Due to reduced makerspace access during the pandemic, many new Program Assistants did not develop as much hands-on experience with makerspace equipment. For this reason, there was a noticeable difference in the skill-sets and comfort levels of those hired before and those hired during the pandemic. Many new staff members lacked confidence in their skills in comparison to other staff, but felt uncomfortable asking for guidance. The makerspace staff community seemed fractured and lacked the collaborative culture that had always been its defining characteristic. Eager to resolve this problem, Program Specialists worked with full-time staff members to propose a solution. After brainstorming several different options, they decided to implement four Communities of Practice (CoPs) to develop makerspace skills and build community amongst newer staff members.

The CoP model was selected due to its successful applications in improving confidence, encouraging problem solving, and identifying skill weaknesses among participants in both educational and workplace settings [1]. Historically, practitioners have also used this model to support peer-to-peer learning, in which community members learn from and encourage each other [2], in both teacher education [1] and technology use [3], two paramount components of a collaborative makerspace like the BeAM Makerspace. CoP research shows that peer-to-peer learning paired with product-based work yields better knowledge retention and personal accountability amongst users [2][4]. Eager to encourage these outcomes in its own staff members, the BeAM Makerspace designed CoPs that would incorporate adaptive teaching-projects to improve both the collaboration between, and the confidence of, workshop participants.

The initial launch of the CoPs in the BeAM Makerspace began in September 2022. Inspired by successful CoP models, which aspire to improve personal and technical development of users, each of the BeAM Makerspace's CoP sessions engaged participants in hands-on, project-based learning and professional skill development to allow members to gain experience with specific tool areas and better unite to resolve issues [4][5]. Each of these CoPs, facilitated by an experienced Program Specialist, focused on a different tool domain (3D Printer, Laser Cutter, Textiles, Wood Shop). Adopting tenets of peer-to-peer learning, the four CoP facilitators

tackled open-ended projects and discovered skills alongside new staff, disrupting the hierarchical notion of “expertise” in favor of modeling lifelong-learning and intellectual humility [2]. All members of the CoPs crowdsourced creative designs, investigated new tools together, and collaboratively developed a shared sense of pride and contribution to the BeAM makerspace.

Methods

The Communities of Practice (CoP) training program was adapted for the BeAM Makerspace based on the model proposed by Lave and Wenger, which synthesizes the three key components of community, domain, and practice [6]. The first iteration of the program was designed around four popular tool domains: 3D printing, laser cutting, textiles, and woodshop. The outcome goals for each community were defined as: safe tool operation, better facilitation and teaching, learning basic maintenance, and contributing to the Makerspace community. Program Specialists with domain-specific expertise facilitated the CoP programs with support from full-time supervisors.

Before launching the program in Fall 2022, the CoP facilitators and supervisors engaged in comprehensive planning sessions to determine the most critical tools and skills to be taught during the community sessions, as well as opportunities to practice these skills. They also developed facilitator rubrics to evaluate the community members' competencies. These rubrics, given in Appendix A, organized the hard and soft skills of each tool area associated with each of the aforementioned outcome goals into 5-point Likert scales. Following the training in a specific tool area, participants are assessed using the corresponding rubric. This enables trainers and administrators to gauge the level of competency of each participant and identify areas of improvement.

The structure of the training program varied for each community, reflecting the facilitator's approach and the specific equipment utilized. For example, the textiles community followed a highly structured format with three weeks of co-learning sessions organized around short practice projects, followed by three weeks dedicated to open-ended individual projects. The woodshop community took a more unstructured approach, providing “just-in-time” training while diving into open-ended individual projects from the first week.

Each community cohort consists of an experienced Program Specialist facilitator and three to four new Program Assistants. In total, 18 new staff members have participated for a full year in the program. Each cohort meets weekly for three hours in the Makerspace, and new staff rotate to a new tool domain every six weeks. During the sessions, the participants would practice new skills through structured projects, design activities, and opportunities for peer teaching. At the time of writing this publication, new staff had completed two successful six-week rotations of the CoP program and a third rotation is in process. CoP facilitators monitored the program through multiple assessment methods, including participant self-assessment through pre- and post-cohort surveys. Facilitators also kept running logs for reflective practice after each CoP session, and generated summative evaluations of participant work at the end of each rotation.

Prior to beginning each six-week rotation in a tool domain, participants were asked to rate their confidence in their ability to achieve each of the four domain goals (operation,

teaching, maintenance, and contribution) using a survey, which is provided in Appendix B. Participants were also assessed for changes in their entrepreneurial mindset [7] and their 21st-century skills [8] with measures of the “Seven C’s”: connections, curiosity, creating value, creativity, communication, collaboration, and critical thinking. After the final session of that rotation, participants completed the same survey to reflect and measure their progress.

Throughout the CoP sessions, facilitators recorded their reflections on the proceedings and continuously adjusted their teaching practices. At the conclusion of each six-week rotation, facilitators used the rubric that was developed during the program planning stage to assess the participants' skills and final project deliverables. This allowed for a comprehensive evaluation of the participants' progress towards achieving the program's goals.

Preliminary Results

The preliminary results from the first two rotations of the CoP are encouraging. Participants reported an average 66% increase in confidence in performing all four objectives, as measured by the pre- and post-cohort surveys. Furthermore, the participants' scores on the Likert scale for the "Seven C's" increased by 33%, with the most significant increase observed in "Collaboration" at 68%. After the data from the third and fourth cohorts have been collected and analyzed in May 2023, a more in-depth and meaningful analysis of the results will be conducted.

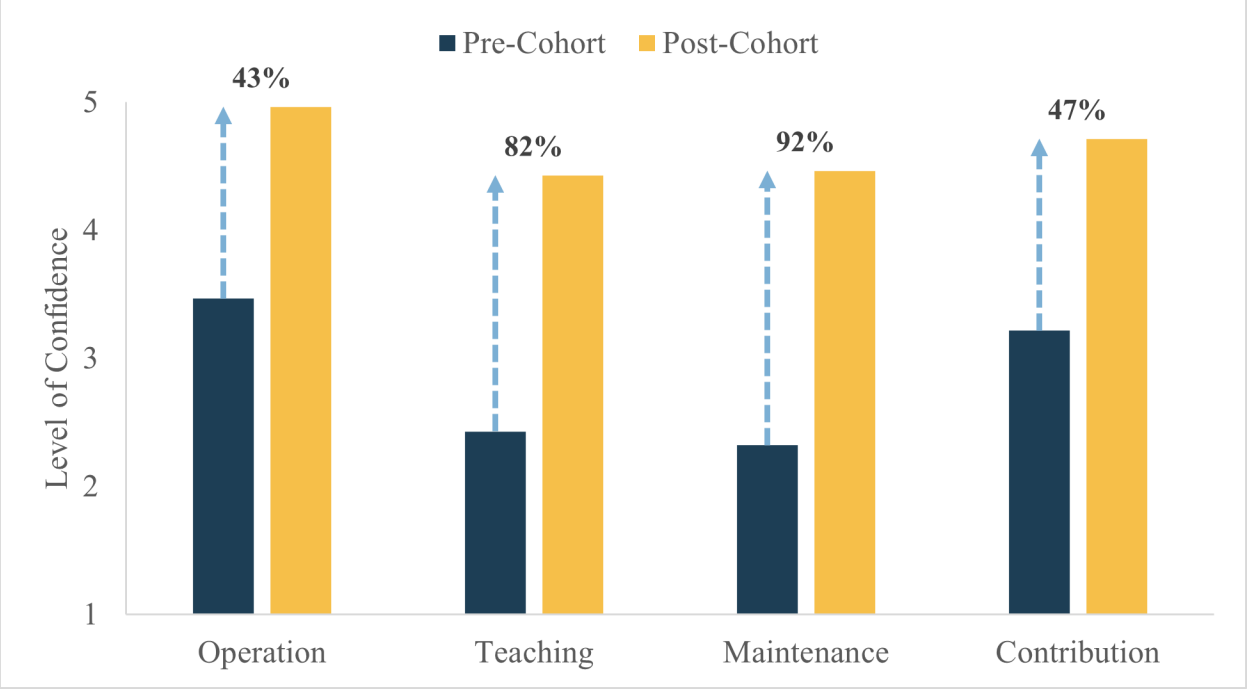

Fig 1. Average pre- and Post-cohort survey results, with percent change, evaluating confidence in performing each objective.

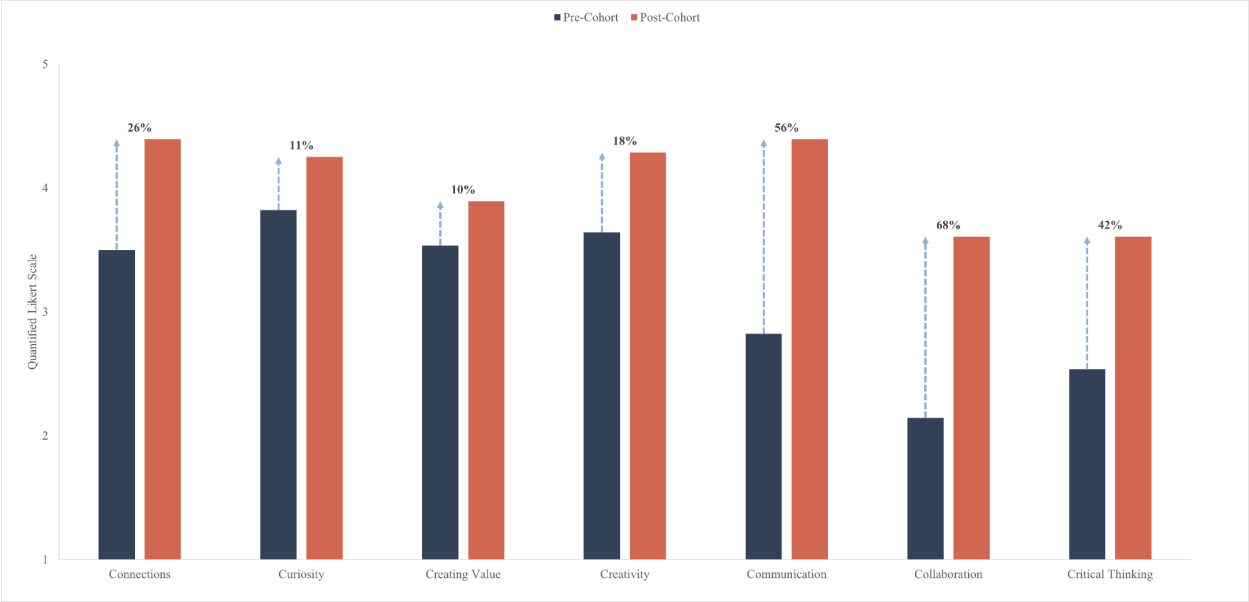

Fig 2. Average pre-and post-cohort survey results, with percent change, evaluating agreement on the Likert scale with the "Seven C's."

The impact of the CoP program on community building was also monitored through qualitative observations by the facilitators. As reported by one of the textiles CoP facilitators,

> "I can feel this sense of community get better…I remember the first community of practice, the first cohort. No one was talking to each other and I was like, this is kind of awkward. But then we started making, like, the tiny little [stuffed animals]. Suddenly people were, like, a little bit more talkative as they're making stuff."

During the second session, textiles CoP participants collaborated to design a hat on the embroidery machine, with the goal of finding the "funniest thing" to do next while learning advanced skills with the software and machine. By the end of the program, the participants reported voluntarily spending more time in the Makerspace outside of the sessions and scheduled work hours to collaborate on their final projects together.

Figure 1: Stuffed animal projects from the textiles CoP.

Figure 2: Woodshop CoP cohort at work.

Discussion and Future Work

Makerspace staff play a critical role in facilitating communities of practice with both users and fellow employees [9]. The staff CoPs at the BeAM makerspace have shown how peer mentoring and collaborative learning can improve confidence, skills, and community relationships. While this specific CoP initiative was primarily concerned with educating and mentoring new staff members, increased confidence and competence among employees at the BeAM Makerspace directly translates to improved service for other users. Once staff members feel more confident in specific tool areas, they become better equipped to help other users design projects, operate machines, and troubleshoot problems. Additionally, because this CoP taught participants how to perform necessary maintenance in different tool areas, staff members of the BeAM Makerspace can ensure that machines continue to function properly for users. The CoP model supports experienced staff, new staff, and makerspace users alike, allowing them to learn with and from each other.

As the different CoP cohorts continue to progress, so does the nature and instruction of the workshops themselves. This constant iteration underscores the idea that these CoPs are not stagnant, and demonstrate a responsive model for professional development. At their core, CoPs create a nurturing peer-facilitated environment that offer multiple modes of engagement across varying experience levels. Our goal in implementing the CoP model at the BeAM Makerspace is to dismantle the hierarchical nature of traditional professional training and skill development, where the content and format are designed solely by instructors without input from their colleagues.

The conventional teacher-student dynamic between makerspace staff and user, or Program Assistant and Program Specialist, can be intimidating or disempowering for those with less experience. At the BeAM Makerspace, we have found success in using CoPs to mitigate these barriers and eliminate the notion that participants need to learn everything on their own. While CoP facilitators were more knowledgeable about some aspects of their specific tool areas, they were also learning new skills alongside the Program Assistants. For this reason, the CoPs fostered an environment where facilitators and participants could be honest with each other about their respective knowledge and skill levels in order to better grow together.

As the inaugural CoPs conclude at the end of the Spring 2023 semester, the BeAM Makerspace is eager to analyze results and feedback from the first cohorts. Full-time staff members and Program Specialists hope to use these findings to expand CoPs to include other tool groups and invite new facilitators to host these workshops.

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Appendix A: Evaluation Rubrics for Participants

These rubrics were developed by student staff Specialists for use in observing and evaluating participant progress in their respective CoP cohorts. Each rubric criteria is tied to one of the four primary CoP objectives: operation, teaching, maintenance, and contribution.

Appendix A.1 3D Printer Community of Practice Rubric

3D Printer Community of Practice (Facilitator Rubric)					
Criteria:	Ratings:				
	1	2	3	4	5
3D-OPERATION Staff member can safely operate 3D printing equipment.	**Incomplete** Unable to operate equipment.	**Novice** Understands how to operate equipment, but often requires assistance.	**Intermediate** Can send prints, stop prints, and design/prepare files for printing with little to no guidance from experienced staff.	**Advanced** Can operate equipment without requiring guidance. Can explain proper operation.	**Leader** Can operate equipment without guidance and has made improvements to daily operation procedures.
3D-TEACHING Staff member can help patrons in safely operating 3D printing equipment.	**Incomplete** Unable to communicate basic 3D printing operations to patrons due to lack of understanding.	**Novice** Able to properly operate equipment, but is unable to direct patrons in doing so.	**Intermediate** Can properly communicate and direct patrons in safe equipment operation.	**Advanced** Can properly direct patrons in safe equipment operation and teach other staff members.	**Leader** Can direct patrons in safe equipment operation and can lead trainings without guidance from experienced staff.
3D-MAINTENANCE Staff member can perform basic maintenance on 3D printing equipment.	**Incomplete** Not able to perform any maintenance, but knows which staff to ask to begin their training.	**Novice** Able to perform daily tasks, but requires assistance or guidance from experienced staff.	**Intermediate** Able to perform daily and weekly tasks (bed level tests, leveling, cleaning buildplates) with little to no guidance from experienced staff.	**Advanced** Able to perform daily, weekly, and monthly maintenance with no assistance or guidance.	**Leader** Able to perform end of semester maintenance and reassemble entire machine without guidance
3D-CONTRIBUTION Staff member contributes to a 3D printer project that makes BeAM better.	**Incomplete** Project is incomplete.	**Novice** Project is completed, but the staff member did not contribute original ideas or original/modified files.	**Intermediate** Project is completed to satisfaction and utilizes unique ideas and original or modified files.	**Advanced** Project utilizes completely original files and has gone through several iterations to ensure its effectiveness.	**Leader** Project is completely original and utilizes multiple BeAM resources to greatly improves efficiency, outreach, or productivity of BeAM.

Appendix A.2 Laser Cutter Community of Practice Rubric

Laser Cutter Community of Practice (Facilitator Rubric)					
Criteria:	Ratings:				
	1	2	3	4	5
LC-OPERATION Staff member can safely operate laser cutter equipment.	**Incomplete** Uninterested in learning and operating laser cutter equipment from start to stop. Unsafe use of equipment with improper practices.	**Novice** Requires guidance to operate from start to stop on the laser cutter. Needs guidance to properly use the equipment.	**Intermediate** Competently operate from start to stop full operation of the laser cutter equipment. Minimal guidance needed.	**Advanced** Fully autonomous operation from start to stop of the laser cutter equipment. Displays safe practices.	**Leader** Autonomously operates laser cutter and rotary tool from start to stop and can identify unsafe practices.
LC-TEACHING Staff member can help patrons in safely operating laser cutter equipment.	**Incomplete** Low motivation to guide others to operate the laser cutter safely. Leaves information out and regularly encourages incorrect practices	**Novice** Cannot lead LC safety training. Adlibs to safety information and sometimes encourages incorrect practices.	**Intermediate** Fully memorized laser cutter safety training. Minimal errors when operating LC equipment.	**Advanced** Enthusiastic leadership of LC safety training. Encourages ideal practices in a clear manner.	**Leader** Suggested improvements to operate the laser cutter safely. Excellent communication and safety knowledge.
LC-MAINTENANCE Staff member can perform basic maintenance on laser cutter equipment.	**Incomplete** Unwilling to follow maintenance program/process. Risk of damaging equipment.	**Novice** Requires reference knowledge of maintenance program. Can troubleshoot basic/common issues.	**Intermediate** Retained and comprehended knowledge of maintenance program. Can trouble shoot most issues. Minimal guidance needed.	**Advanced** Fully memorized maintenance program. Able to troubleshoot laser cutter issues with ease. No guidance needed.	**Leader** Adding knowledge to maintenance program. Displayed initiative to learn and improve maintenance resources.
LC-CONTRIBUTION Staff member contributes to a laser cutter project that makes BeAM better.	**Incomplete** Low motivation and effort on project. Project was not finished even with assistance.	**Novice** Progress made on project (75-80% complete) and potential to finish. Willing to learn and work.	**Intermediate** Successful project completed with some guidance. Self-motivated throughout the CoP.	**Advanced** Successful project completed with no guidance. Highly self-motivated throughout the CoP.	**Leader** Took initiative to create an excellent project. Effort made to improve community and practice.

Appendix A.3 Textiles Community of Practice Rubric

Textiles Community of Practice (Facilitator Rubric)					
Criteria:	Ratings:				
	1	2	3	4	5
TX-OPERATION Staff member can safely operate textiles equipment.	**Incomplete** Embroidery Machine: cannot create or complete own basic design without significant guidance. Sewing Machine: cannot correctly set up and operate a sewing machine without significant guidance OR cannot complete an 'easy' level provided pattern without significant support.	**Novice** Embroidery Machine: with support, can create and complete a basic design on the embroidery machine (up to give colors, extra threads may be present, simple text, only fill/satin/walk normal stitching). Sewing Machine: with support, can correctly set up and operate sewing machine to create a basic straight stitch on medium weight cloth (includes correct top and bobbin threading, needle weight, and other settings) AND can complete an 'easy' level provided pattern with some support.	**Intermediate** Embroidery Machine: with minimal guidance, can create and complete a basic design on the embroidery machine (up to five colors, extra threads may be present, simple text, only fill/satin/walk normal stitching). Sewing Machine: with no guidance, can correctly set up and operate sewing machine to create a basic straight stitch on medium weight cloth (includes correct top and bobbin threading, needle weight, and other settings) AND can complete an 'easy' level provided pattern with minimal guidance.	**Advanced** Embroidery Machine: with minimal guidance, can create and complete a complicated design for the embroidery machine (no extra threads, more than six colors, advanced text, at least three types of stitching.) Sewing Machine: can correctly set up and operate sewing machine for any auxiliary stitches available on machine for any cloth weight AND can complete an 'intermediate' level provided pattern with support.	**Leader** Embroidery Machine: with minimal guidance, can create and complete an embroidery project using either a specialty hoop or specialty backing (patches). Sewing Machine: can correctly set up and operate sewing machine for any auxiliary stitches available on machine for any cloth weight AND can complete an 'intermediate' or 'advanced' level provided pattern with minimal guidance. Other: can correctly set up and operate a textile machine other than a sewing or embroidery machine.
TX-TEACHING Staff member can help patrons in safely operating textiles equipment.	**Incomplete** Embroidery Machine: cannot lead an embroidery machine training. Sewing Machine: cannot identify all parts of the machine OR not able to accurately explain steps of setting up and operating the machine.	**Novice** Embroidery Machine: can lead embroidery machine training with guidance. Sewing Machine: can identify all parts of the machine but may not be able to explain every part's purpose OR not able to effectively guide patron through basic set-up and operation of the machine without backup.	**Intermediate** Embroidery Machine: can lead embroidery machine training by oneself at a satisfactory level. Sewing Machine: can confidently identify all parts of the machine and explain its purpose AND can guide patron through basic set up and operation of the machine.	**Advanced** Embroidery Machine: can lead embroidery machine training at an excellent level AND can assist patrons in more advanced Design Shop and Melco functions. Sewing Machine: can perform functions described in 'Intermediate' level AND can walk patron through all steps of completing an 'easy' provided pattern.	**Leader** Embroidery Machine: can perform functions described in 'Advanced' level AND can assist patrons in the use of specialty backings, specialty hoops, and very advanced design shop/Melco functions. Sewing Machine: can perform functions described in 'Advanced' level AND can effectively explain an advanced skill on the sewing machine. Other: can help patron with operation of a textile machine that is not a basic sewing machine or embroidery machine.

TX-MAINTENANCE Staff member can perform basic maintenance on textiles tools.	**Incomplete** Embroidery Machine: cannot complete processes covered in the basic embroidery machine training without significant support.	**Novice** Embroidery machine: can complete processes covered in the basic embroidery machine training with no guidance (threading the top and bottom thread, hooping and loading correctly.)	**Intermediate** Embroidery Machine: can perform all functions described in 'Novice' level PLUS with minimal guidance, can switch to the appropriate Melco UI menu and follow the maintenance instructions (for daily maintenance) AND can switch out and align needles AND can change out thread colors. Sewing Machine: can thread the needle and bobbin correctly AND can reload the bobbin AND can switch out the needles AND can switch out pressure feet.	**Advanced** Embroidery Machine: can perform all functions described in 'Intermediate' level PLUS can accurately identify problems with Actifeed settings and designs with some guidance. Sewing Machine: can perform all functions described in 'Intermediate' level PLUS can set the machine for any available stitch type.	**Leader** Embroidery Machine: can perform all functions described in 'Advanced' level with no guidance. Sewing Machine: can perform all functions described in 'Advanced' level PLUS can troubleshoot machine with no guidance by opening the full bobbin compartment and top thread compartment.
TX-CONTRIBUTION Staff member contributes to a textiles project that makes BeAM better.	**Incomplete** Final project is incomplete.	**Novice** Completed final project from an existing pattern with much guidance OR final project is sloppily completed OR embroidery machine gateway project is incomplete.	**Intermediate** Completed final project satisfactorily from an existing pattern with some guidance AND completed embroidery machine gateway project.	**Advanced** Completed embroidery machine gateway project, AND with some guidance, created final project with one or more of the following criteria: 1) Created own pattern, 2) Use of at least one textile machine other than the embroidery machine or sewing machine.	**Leader** Completed embroidery machine gateway project at a high level (complicated design or use of alternate hoops/backing), AND/OR with minimal to no guidance. Created an advanced final project with one of more of the following criteria: 1) Created own pattern, 2) Use of at least two textile machines other than embroidery machine and/or sewing machine, 3) Incorporation of at least one of the following: hand embroidery/cross-stitching, needle felting, crocheting/knitting, quilting.

Appendix A.4 Wood Shop Community of Practice Rubric

Wood Shop Community of Practice (Facilitator Rubric)					
Criteria:	Ratings:				
	1	2	3	4	5
WS-OPERATION Staff member can safely operate wood shop equipment.	**Incomplete** Shows lack of interest and/or displays negligent behavior with tools. Not retaining knowledge and needs to be completely retrained. Might benefit from a 1-on-1 session.	**Novice** Does not meet criteria to pass woodshop training, but shows potential if given more guidance. Exhibits a desire to learn, despite struggling with the skills.	**Intermediate** Demonstrates proper, safe use of tools with minimal support. Meets training requirements of woodshop. Can be trusted to use shop appropriately.	**Advanced** Demonstrates proper, safe use of tools and displays confidence to work with full autonomy. Capable of teaching skills to other people.	**Leader** Excels at required skills and shows initiative to learn more advanced techniques and/or learn other tools not covered in training.
WS-TEACHING Staff member can help patrons in safely operating wood shop equipment.	**Incomplete** Does not display adequate understanding of concepts to teach them. Lacks knowledge of policies and procedures.	**Novice** Mostly capable of teaching patrons but has gaps in knowledge. Struggles to communicate but shows potential with additional practice.	**Intermediate** Demonstrates ability to instruct others on use of tools per key points described in instructor guide. Communicates effectively and monitors patrons for safety.	**Advanced** Articulates well and helps patrons who are struggling/challenges patrons who are bored. Elaborates on instructional material beyond required talking points.	**Leader** Shows strong ability to multitask while teaching/assisting multiple patrons. Engages patrons to help tailor their experiences to their specific needs. Serves as a strong resource (subject matter expert) in the woodshop.
WS-MAINTENANCE Staff member can perform basic maintenance on wood shop equipment.	**Incomplete** Results of cleaning efforts look like a “rush job”. Lack of appreciation or understanding of why maintenance is important.	**Novice** Demonstrates a mostly comprehensive ability to clean the shop, but misses certain tasks/areas. Can achieve desired maintenance state with some guidance.	**Intermediate** Meets required understanding of routine cleaning and basic maintenance, but might benefit from occasional pointers on how to improve maintenance efforts. i.e. sweeping sawdust, cleaning sanders, emptying vacuum bags, stowing tools away, etc.	**Advanced** Able to conduct thorough, routine cleaning and basic maintenance will full autonomy.	**Leader** Performs more in-depth maintenance and deep cleaning. i.e. treating corrosion-prone surfaces like bandsaw and spindle sander, cleaning sawdust filter, calibrating laser guides on drill press & miter saw, etc.
WS-CONTRIBUTION Staff member contributes to a wood shop project that makes BeAM better.	**Incomplete** Only completes bare minimum training & staffing requirements. Shows no initiative to improve the woodshop or hone skills via projects.	**Novice** Displays some efforts to contribute but may not have finished anything tangible. Could finish a contribution to the woodworking community with a little more support.	**Intermediate** Successfully produces outcomes that improve the organization, operation or appearance of the woodshop. i.e. drawer labels, wood storage system, maintenance schedules, etc.	**Advanced** Produces resources, educational tools, or inspirational examples that have a wider spread impact on the BeAM woodworking community. i.e. info posters, example projects with guides, etc.	**Leader** Produces new, quality content that expands woodshop opportunities available to BeAM community. i.e. new tool trainings, hosting workshops for advanced techniques, etc.

Appendix B: Survey Instruments

These survey instruments were developed by the Education Program Manager for CoP participants to self-assess their confidence levels and professional skills before and after each cohort rotation. Each confidence measure is tied to one of the four primary CoP objectives (operation, teaching, maintenance, and contribution) while each professional skill measure is tied to one of the 7Cs (curiosity, connections, creating value, creativity, communication, collaboration, critical thinking.)

The example given below was used with the 3D printer CoP participants, but these questions were used with minor changes across all four of the CoP cohorts.

Appendix B.1 Pre-Cohort Survey Instrument (3D Printer CoP)

1. **How Confident are you with performing the following tasks?** *Choose one answer from each dropdown.*

- Safely operating the 3D printers.
    - *Very Confident, Somewhat Confident, Neutral, Somewhat Unsure, Very Unsure*

- Training others on how to operate the 3D printers.
    - *Very Confident, Somewhat Confident, Neutral, Somewhat Unsure, Very Unsure*

- Performing basic maintenance on the 3D printers.
    - *Very Confident, Somewhat Confident, Neutral, Somewhat Unsure, Very Unsure*

- Using the 3D printers for BeAM-related projects.
    - *Very Confident, Somewhat Confident, Neutral, Somewhat Unsure, Very Unsure*

2. **Rate the following statements for your experience.** *Choose one answer from each dropdown.*

- I seek out opportunities to learn new 3D printer skills.
    - *Strongly Agree, Somewhat Agree, Neutral, Somewhat Disagree, Strongly Disagree*

- I use multiple resources to troubleshoot 3D printer issues.
    - *Strongly Agree, Somewhat Agree, Neutral, Somewhat Disagree, Strongly Disagree*

- I think about how my 3D printer projects will impact others.
    - *Strongly Agree, Somewhat Agree, Neutral, Somewhat Disagree, Strongly Disagree*

- I use my ideas to design my own 3D printer projects.
    - *Strongly Agree, Somewhat Agree, Neutral, Somewhat Disagree, Strongly Disagree*

- I can clearly articulate how to use the 3D printers.
    - *Strongly Agree, Somewhat Agree, Neutral, Somewhat Disagree, Strongly Disagree*

- I frequently work with others on 3D printer projects.
    - *Strongly Agree, Somewhat Agree, Neutral, Somewhat Disagree, Strongly Disagree*

- I make objects with the 3D printers to solve problems.
    - *Strongly Agree, Somewhat Agree, Neutral, Somewhat Disagree, Strongly Disagree*

Appendix B.2 Post-Cohort Survey Instrument (3D Printer CoP)

1. **How Confident are you with performing the following tasks?** *Choose one answer from each dropdown.*

- Safely operating the 3D printers.
    - *Very Confident, Somewhat Confident, Neutral, Somewhat Unsure, Very Unsure*

- Training others on how to operate the 3D printers.
    - *Very Confident, Somewhat Confident, Neutral, Somewhat Unsure, Very Unsure*

- Performing basic maintenance on the 3D printers.
    - *Very Confident, Somewhat Confident, Neutral, Somewhat Unsure, Very Unsure*

- Using the 3D printers for BeAM-related projects.
    - *Very Confident, Somewhat Confident, Neutral, Somewhat Unsure, Very Unsure*

2. **Rate the following statements for your experience.** *Choose one answer from each dropdown.*

- I seek out opportunities to learn new 3D printer skills.
    - *Strongly Agree, Somewhat Agree, Neutral, Somewhat Disagree, Strongly Disagree*

- I use multiple resources to troubleshoot 3D printer issues.
    - *Strongly Agree, Somewhat Agree, Neutral, Somewhat Disagree, Strongly Disagree*

- I think about how my 3D printer projects will impact others.
    - *Strongly Agree, Somewhat Agree, Neutral, Somewhat Disagree, Strongly Disagree*

- I use my ideas to design my own 3D printer projects.
    - *Strongly Agree, Somewhat Agree, Neutral, Somewhat Disagree, Strongly Disagree*

- I can clearly articulate how to use the 3D printers.
    - *Strongly Agree, Somewhat Agree, Neutral, Somewhat Disagree, Strongly Disagree*

- I frequently work with others on 3D printer projects.
    - *Strongly Agree, Somewhat Agree, Neutral, Somewhat Disagree, Strongly Disagree*

- I make objects with the 3D printers to solve problems.
    - *Strongly Agree, Somewhat Agree, Neutral, Somewhat Disagree, Strongly Disagree*

3. **How would you describe your experience in the 3D Printer Community of Practice?**
    - What did you find most useful? What would you change?
    - What's next in your 3D printing journey? What do you want to learn?