WIP: Professional Identity Formation in University Makerspaces

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Introduction

The University of North Carolina at Chapel Hill, a liberal arts and R1 research institution, serves 18,000+ undergraduates across a diverse set of disciplines. It features a network of campus-wide makerspaces called the Be a Maker (BeAM) network, which supports students, faculty, researchers, and university staff across more than 30 academic departments. Through the BeAM network, users have access to a range of industrial tools and machinery for physical fabrication, regardless of skill level or previous experience. To address the challenges posed by the complexity of these tools and the variability in users' expertise, BeAM employs 50-60 undergraduate student employees as Program Assistants (PA). During open makerspace hours, PAs are present on the floor to support users, provide basic machinery maintenance and facilitate a hands-on learning environment. After 6 months of employment, experienced PAs can apply to be Program Specialists (PS), a role that requires them to lead larger projects in areas like advanced tool maintenance, developing tool trainings for makerspace users, and leading professional development programs for inexperienced staff.

During their employment, both new staff in PA roles and experienced staff in PS roles iteratively develop their "professional identity" in different ways. The concept of "professional identity" often encompasses a mixture of technical skills, reflective practice, interpersonal networks, and self-directed learning. [1] The formation of a professional identity is described as an *ongoing process* that encompasses both *person and context*, where an individual has *agency* to self-determine *sub-identities* that compose their overall professional identity. [2] At BeAM, the professional identity of a PA or a PS is often defined by how they perceive their ability to embody professional roles and their interactions with other makerspace staff. For example, PAs must be able to safely operate makerspace equipment, teach makerspace users, perform routine maintenance, and provide support to other makerspace staff. As staff become more confident in these roles, they further develop and strengthen their professional identity.

Prior to 2020, the BeAM network provided very little formal job training to new staff, instead relying on their previous technology experiences and informal "just-in-time" interactions [3] with more experienced staff. The hiring period following the 2020 pandemic highlighted and exacerbated the weaknesses in this approach. Incoming student staff had less hands-on experience with makerspace tools, creating a discrepancy between what was expected from a PA and a new hire's ability to fulfill those expectations. New staff avoided asking other staff for help and expressed a lack of confidence in their ability to help others. Recognizing a need for intervention, experienced PSs worked with full-time staff to develop four Community of Practices (CoP) surrounding the main tool areas in the makerspace: Textiles, Woodshop, Laser Cutter, and 3D-Printer. During the 2022-2023 academic year, 4 cohorts of 4-6 new PAs met

weekly throughout the year, rotating through all four tool areas and working on projects alongside a PS facilitator.

The CoP model helped to frame participants' training as a *community* engaging together in *practice* within a specific *domain*. [4] These communities were formally structured (i.e. regularly scheduled, defined cohorts, etc.) but informally facilitated (i.e. PS staff changed sessions based on whole-group input and interests.) This allowed new staff to become *legitimate peripheral participants,* learning new skills alongside experienced staff while contributing to community dialogue. [5] These skills were organized within four performance objectives: Operation (safely operating tools), Teaching (training others), Maintenance (maintaining makerspace resources), and Contribution (creating value for others). After the conclusion of the 2022-2023 CoP rotations, participants reported an average increase in confidence of 66% across all four performance objectives. [6]

The program ran again during the 2023-2024 academic year, with 4 cohorts of 4-6 new PAs hired during Spring/Summer 2023. Confidence measures once again increased across all participants in all performance objectives. However, full-time staff noticed inconsistencies in the new PAs' actual ability to perform those objectives. Many PAs voiced feeling burnout from a year-long program of weekly sessions, and some expressed boredom with the lack of structured activities in some tool areas. PSs shared similar feelings of burnout with the year-long format, especially for those that facilitated the same tool area for all four rotations. Scheduling issues in the final rotation of Spring 2024 required some PSs to facilitate outside of their normal tool area, which they felt unprepared to do given the lack of formal planning. Based on these issues, full-time staff initiated a re-design of the Staff CoP program before the 2024-2025 academic year, with development and implementation led primarily by newly promoted PSs.

Methodology

Revision and Implementation of New CoP Curricula

Four PSs, all experienced with facilitating training with new PAs, revised and redesigned the Staff CoP program during Summer 2024 with support from a full-time Education Program Manager. The process started with full-time staff identifying key learning outcomes within the four CoP dimensions (see Appendix A) that were expected from successful PAs. From there, the PSs began mapping out potential CoP activities and projects that could prepare new PAs to meet those outcomes. During this period of initial development, PSs attempted to balance preserving parts of the less-structured CoP model (instructor and participant choice, ability to adapt to cohort needs, etc.) with new goals identified through their previous experiences with CoP (consistency across cohorts, authentic / analogous / applicable to PA professional roles, truncated time period to avoid burnout, etc.)

Each PS started with a single tool area, drafted an initial document with a proposed outline for weekly activities, then swapped tool areas with another PS to continue refining and expanding that outline. During the drafting process, there were weekly review sessions as a group about changes that had been made from the previous week. After that, they passed a rough draft off to a third PA for testing activities and writing instructions. This resulted in a final product co-created with input from all PSs, a written guide that would allow any PS to step into any tool area and facilitate a CoP session with new PAs. In a final review session with PSs and full-time staff, the guides were approved for implementation during the Fall 2024 semester.

Overall, several significant changes were made to the previous CoP structure. 3D Printer and Laser Cutter were combined into a single 3DP/Laser CoP rotation, and the Textiles rotation included a brief practice activity with the Industrial Vinyl Cutter (in addition to the standard Sewing Machine and Desktop Embroidery Machine activities.) Rotations were reduced from 6 weeks to 4 weeks to enable 3 rotations in a single semester, although the duration of these sessions remained the same (3 hours per week.) Projects were reoriented towards practical makerspace applications rather than blank-canvas design, and troubleshooting exercises were drawn from PS experiences on the floor as former PAs. The formatting of the initial CoP and the formatting of the New CoP are compared in Figure 1 below.

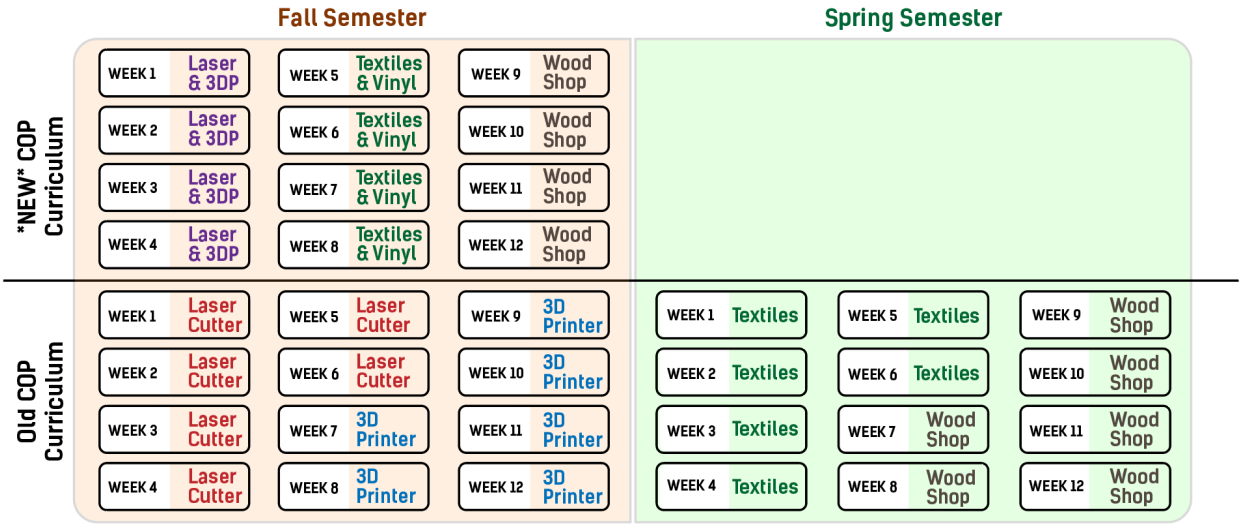

Figure 1. Comparison of New CoP Curriculum Timing vs Old CoP Curriculum Timing.

The newly redesigned Staff CoP program launched in Fall 2024, with a total of 36 newly hired PAs participating across six cohorts, each cohort led by a different PS for each 4-week tool rotation.

Data Collection and Analysis

Before each 4-week rotation, PA participants were asked to complete a pre-cohort survey (see Appendix A) before beginning each 4-week tool rotation, and a corresponding post-cohort survey (see Appendix B) after the rotation completed. These surveys included items that asked participants to rate their confidence in performing professional tasks related to the previously identified program outcomes (Operation, Maintenance, Teaching, Contribution) on a five-point Likert scale (Very Confident, Somewhat Confident, Neutral, Somewhat Unsure, Very Unsure.) Participants were asked to describe their expectations (pre-cohort) or observations (post-cohort) regarding their CoP experience. Participants were also asked at least one free-response question oriented towards reflecting on their professional identity formation (i.e. “What kind of BeAM Program Assistant do you want to be? What do you want to be known for?”)

During the cohort sessions, artifacts of work were collected from both the PS who facilitated each cohort (auxiliary resources or documents that they created beyond the instructor guide) and the PA participants (project photos, design files, and reference materials that they created.) After each rotation, the PSs met together with the full-time Education Program Manager to talk about what went well, what did not go well, and suggest changes to the CoP

instructor guides. Once the Fall 2024 semester had concluded, qualitative data on program outcomes was collected from PS facilitators via a small focus group and additional written reflections.

Four primary datasets were arranged for analysis: pre/post survey scores from PA participants, free-response survey data from PA participants, photos of artifacts made by PA participants, and reflections from PS facilitators (combined from focus group transcript and written responses). Quantitative analysis, including paired one-tailed T-tests and basic F-tests, was performed on the Likert-scale data from the pre- and post-cohort surveys. Qualitative analysis, including inductive and deductive systematic coding, was performed on the free response data from the cohort surveys and the reflections from PS facilitators. The artifact photos were treated with a mix of qualitative and quantitative methods – a grading rubric helped to convert them into simple numerical scores related to Operation and Contribution program outcomes, while grader notes about themes across each photo provided additional qualitative analysis.

Results

Pre-cohort and post-cohort survey results

Likert-scale data from pre- and post-cohort survey results for all participants was converted to numerical scores and paired into a single dataset in preparation for quantitative analysis. For all T-tests and F-tests, the P-value used to determine statistical significance is 0.05. The tool areas laser cutter (LC), 3D printer (3DP), textiles (TX), and woodshop (WS) have the stated acronyms.

	Pre/Post 1-tailed paired T-test P-values				
	Operation	**Teaching**	**Maintenance**	**Contribution**	**Total**
LC	9.38E-04	2.53E-08	2.40E-09	9.62E-05	6.81E-20
3DP	2.16E-03	7.26E-04	4.82E-06	4.10E-04	1.02E-12
TX	3.10E-07	6.10E-08	1.30E-10	3.37E-08	4.14E-29
WS	7.42E-08	3.74E-11	2.48E-12	1.12E-08	1.26E-34
Total	1.39E-16	4.87E-25	7.72E-32	3.77E-20	8.72E-86

Figure 2. Pre/Post 1-tailed paired T-test P-values.

1-tailed T-tests were performed across individually paired pre- and post-cohort responses to determine whether CoP participation and increased confidence were positively correlated (Figure 2). The results of these tests show statistically significant improvement across every cross section and aggregate of all four tool areas and evaluation areas, including a P-value of 8.72E-86 for CoP-wide improvement.

	Pre/Post F-Test P-values				
	Operation	**Teaching**	**Maintenance**	**Contribution**	**Total**
LC	4.57E-09	3.80E-05	2.11E-03	1.74E-06	7.75E-22
3DP	2.52E-04	1.19E-02	1.26E-03	1.77E-05	2.65E-11
TX	1.93E-06	8.92E-04	2.90E-02	1.15E-07	2.07E-14
WS	1.13E-09	2.42E-05	**8.56E-02**	4.98E-06	3.80E-14
Total	8.07E-30	2.11E-15	1.57E-08	1.36E-24	5.80E-64

Figure 3. Pre/Post F-Test P-values.

A similar F-test was done between pre- and post-cohort responses to demonstrate a statistically significant decrease in the variance of confidence scores after CoP participation. Note *Wood Shop (WS) Maintenance,* bolded in Figure 3 above, as the only cross section without a statistically significant difference in variance before and after CoP. This much wider variety of pre-cohort confidence levels than post-cohort confidence levels suggests effective spread of ideas and knowledge between participants, converging average post-cohort confidence levels towards the highest pre-cohort confidence levels in each area.

Note that laser cutter is the tool area with the lowest P-value, indicating a higher difference in variance before and after CoP and a more effective spread of ideas and knowledge between participants, especially compared to 3D printing's still-significant P-value 11 orders of magnitude higher than that of the laser cutter. Similarly, Operation has the lowest P-value among evaluation areas and Maintenance has the highest, indicating that the CoP program is most and least effective at promoting the spread of ideas and knowledge in these evaluation areas, respectively.

Pre-T-Tests	**LC**	**3DP**	TX
3DP	**3.18E-06**		
TX	**4.66E-02**	**1.09E-11**	
WS	**6.14E-03**	**2.57E-14**	1.81E-01

Pre-T-Tests	Operation	**Teaching**	**Maintenance**
Teaching	**5.97E-05**		
Maintenance	**8.52E-12**	**2.64E-03**	
Contribution	6.49E-02	**8.42E-03**	**6.57E-08**

Post-T-Tests	LC	3DP	TX
3DP	3.45E-01		
TX	**4.81E-02**	**2.16E-02**	
WS	**2.65E-02**	**1.14E-02**	3.74E-01

Post-T-Tests	Operation	**Teaching**	**Maintenance**
Teaching	**5.92E-05**		
Maintenance	**4.09E-11**	**2.69E-03**	
Contribution	1.09E-01	**2.98E-03**	**1.86E-08**

Figure 4. P-values for tool areas and evaluation areas tested against each other before and after CoP.

	Pre-Mean	**Post-Mean**
LC	3.13	4.65
3DP	3.94	4.68
TX	2.82	4.53
WS	2.66	4.50

	Pre-Mean	**Post-Mean**
Operation	3.65	4.80
Teaching	2.95	4.53
Maintenance	2.46	4.28
Contribution	3.38	4.73

Figure 5. Mean 5-point Likert-scale responses by tool area and evaluation area.

2-tailed T-tests show consistent statistically significant differences between tool areas and evaluation areas both before and after CoP participation. P-values bolded in Figure 4 above are

statistically significant. Tool areas and evaluation areas bolded above are significantly different from every other tool area and evaluation area, respectively. In tandem with the information on tool and evaluation area means from Figure 5, this paints a picture that woodshop and textiles have the lowest confidence levels both before and after CoP, followed by laser cutters in the middle and 3D printers at the highest confidence levels before CoP and tied with laser cutters afterwards. Similarly, maintenance has the lowest confidence levels both before and after CoP, followed by teaching, and then contribution and operation with the highest confidence levels. Interestingly, in each case of both tool area and evaluation area, the order of starting vs ending confidence levels is preserved despite the convergence demonstrated by the F-tests.

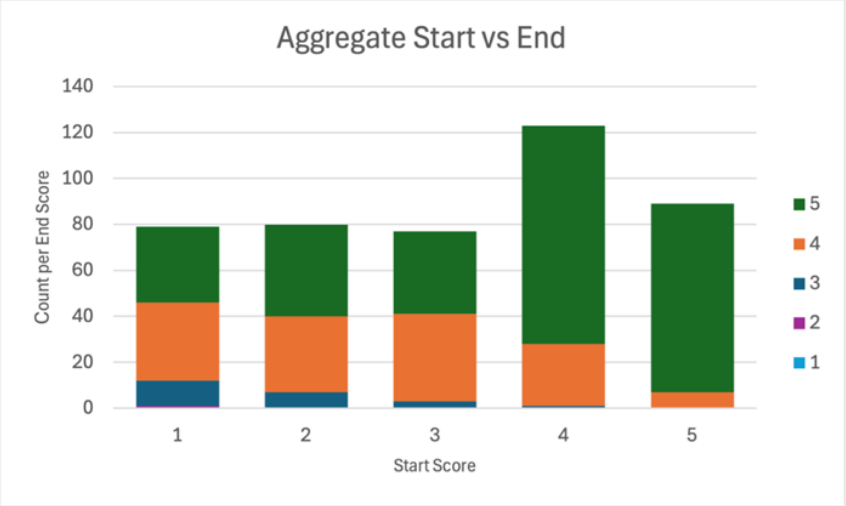

Figure 6. Aggregate distribution of post-cohort scores by corresponding pre-cohort score.

Figure 6 above shows pre-cohort scores of 1, 2, and 3 all approach higher post-cohort scores of 4 and 5 in similar proportion. Those that start with highly confident pre-cohort scores of 4 or 5 show a much higher proportion of post-cohort 5 scores with very little regression to 3 and no regression to 1 or 2. See Appendix B for similar figures isolated by tool and evaluation areas. Particularly notable are high pre-cohort confidence in 3D printing and safe tool operation and low pre-cohort confidence in woodshop and tool maintenance both following similar patterns in post-cohort distribution as in Figure 6.

PA participants' artifacts of work

During each CoP rotation, participants in each tool area worked on a specific project that required them to apply various skills related to Operation and Contribution outcomes for that tool area. The Wood Shop project was building a box out of a single piece of plywood, the Textiles project required participants to sew and customize a tote bag, and the 3D Printer/Laser Cutter project involved designing and 3D printing a lithophane, then designing and laser cutting a stand to display it.

At the end of each 4-week rotation, most participants submitted photos of the artifacts that they created via the staff Canvas site or the CoP Slack channel. Of the 108 project artifacts (3 per person, 1 for each tool area), we were able to collect 92 submissions across the staff Canvas site and staff Slack channels. With input from several of the authors of this paper, a

scoring rubric was created to evaluate these photos on two criteria: Operation and Contribution (see Appendix C). The Operation criteria judged the technical skills and appropriate tool use demonstrated by the participant through their project artifact. The Contribution criteria acted as a measure of participants' creative effort and initiative in acquiring new skills as a BeAM Program Assistant. For example, a box created during the Wood Shop CoP might score high in Operation if it was fundamentally well-made (pieces aligned, no crooked corners, etc.) but score low in Contribution if it did not show any effort beyond the basic requirements (e.g. painting or staining, unique assembly, etc.)

The rubric and artifact scoring were performed by a PS who also served as a facilitator for several CoP rotations. We have attempted to mitigate bias through testing the rubric and scoring process with other non-facilitator BeAM staff using the same dataset and comparing to the original scores (which were found to be within a 1-point standard deviation across all tool areas.) However, due to the potential for bias, this dataset should be considered as complementary context to the other datasets, rather than serving as a primary source for investigation. We will also refrain from including individual scores in this paper, and will instead report on aggregate trends across groups.

The Wood Shop final projects had the highest number of submissions (32 documented projects), followed by Textiles (30 projects) and 3D Printer/Laser Cutter (30 projects). Average Operation scores were lowest for Textiles (3.17 out of 5) with 3DP/LC close behind (3.26 / 5) with Wood Shop having the highest scores (3.55 / 5). Average Contribution scores were lowest for Wood Shop projects (1.55 / 5), with Textiles and 3DP/LC nearly tied (2.45 and 2.46 out of 5, respectively.) This suggests that while participants were able to develop and deploy technical skills in Wood Shop for their projects, they were not able to go beyond the basic project (perhaps due to time constraints). Conversely, Textiles and 3DP/LC were able to customize their projects across multiple tools, but the variety of options may have distracted from the technical execution of the projects compared to Wood Shop.

Most of the average scores were consistent across all six cohorts with one notable exception. Cohort 5 scored above the average in every single category, with ambitious projects flagged by multiple PS facilitators throughout this paper's other datasets. Members of this cohort took extra steps to demonstrate the functionality of their 3DP/LC projects in their photos, and sought out alternative projects to work on (e.g. making patchwork pants in the Textiles rotation.) PS facilitators reported that this cohort rapidly developed an unusually high level of camaraderie with each other, despite little-to-no prior work experience with each other, which may have positively contributed to their overall project outcomes.

In addition to analyzing the numerical scores, there were also qualitative themes observed across the photos. A key goal of the CoP program was to foster a sense of community among the staff, and many projects provided subtle but meaningful glimpses into these relationships. Of the 92 graded projects, 10 featured other staff members in the background—some unintentionally captured, others clearly photobombing or intentionally posing together. Beyond the final project submissions, additional evidence of community appeared in the form of group photos and Polaroids shared in staff group chats, often showcasing smaller collaborative projects or social moments between members. Notably, Cohort 5 appeared frequently in these candid and group photos, further highlighting their strong social bonds.

The photos also revealed varying levels of pride and engagement with the projects. Some participants showcased their work enthusiastically, submitting multiple images or videos demonstrating functionality, such as lithophanes glowing under light or tote bags being modeled in use. Six of the 30 lithophane submissions highlighted functional aspects of the designs, and two of the 32 woodshop projects were photographed in use on personal desks. Conversely, a few participants appeared less invested, with photos taken in dimly lit settings, such as on their walk home, or featuring cropped faces and ambiguous expressions. These visual and contextual details add richness to the data, illustrating not just technical outcomes but also the social dynamics and personal connections fostered within these CoPs.

PA participants' free response survey data

In addition to the Likert-scale questions, the pre- and post-cohort surveys contained several free-response questions. Responses revealed distinct themes linked to the program's four outcomes—Operation, Teaching, Maintenance, and Contribution—as well as the foundational elements of a community of practice: Community, Domain, and Practice. In pre-surveys, the language of participants predominantly emphasized Operation, with specific mentions of personal goals and anticipated projects tied to their chosen domains.

"Negative" themes often reflected challenges with machine operation or limited prior experience, particularly in supporting patrons. For example, participants in the Wood Shop (WS) focused heavily on Operation due to the traditional and tactile nature of the domain, whereas those in 3D Printing and Laser Cutting (3DP/LC) showed a greater focus on Maintenance, suggesting a mindset shift from "user" to "supporter." In contrast, Textiles (TX) participants frequently referenced Teaching, aligning with the higher number of questions they received in this domain and their limited experience answering them.

Post-surveys highlighted notable growth across the program outcomes. Maintenance emerged as a major area of improvement, with participants attributing their newfound skills to their CoP experience. 3DP/LC remained a focal point for Maintenance mentions, consistent with pre-survey trends. Confidence in Teaching also increased, particularly for TX participants, who reported both positive growth and challenges. Some participants highlighted gaps in teaching methods and outdated resources, reflecting a desire for improved instructional practices. WS participants often discussed specific ways the CoP content could be better aligned with their experiences, potentially tied to their lower familiarity with the domain.

When prompted to reflect on their personal development, participants provided introspective responses that fell into two categories: descriptions of their desired PA persona or strategies for achieving goals, often tied to specific tool domains. For example, participants articulated how their approach to supporting patrons had evolved or described traits they wished to embody, such as patience or adaptability. This introspection underscores the value of the CoP structure in fostering self-awareness and encouraging participants to envision their roles as more confident, capable, and community-oriented makerspace staff.

PS facilitators' reflections

The pre- and post-surveys, along with the project artifact photos, provide insight into the PA participant experience throughout the newly redesigned CoP program. However, it was also critical to collect input from the PS facilitators who updated the CoP curricula and implemented

it as they facilitated CoP cohorts during the Fall 2024 semester. During the Spring 2025 semester, the authors scheduled a focus group with as many PS facilitators as were available (5 out of 11). The remaining 6 PSs were sent the same questions used with the focus group and asked to submit a written response (see Appendix H). The focus group was recorded with a transcription app and reviewed for clarity prior to qualitative coding. The authors employed both deductive (codes drawn from program outcomes and CoP framework) and inductive (emergent themes) coding to investigate PS perceptions of their experience in implementing the revised CoP curriculum.

Community-oriented codes included any language that described the interpersonal relationships related to planning and leading the CoP program, with sub-codes organized around **Co-learning, Collective Identity, Dual Identity**, **Mentorship – Advice,** and **Mentorship – Shadowing.** Program Specialists described grappling with their dual identities as a mentor to new staff ('facilitator') while still developing their own professional skills in different areas ('learner'). They adapted their style of mentorship based on their familiarity of a task, providing advice (e.g. tips from manuals, observations from the floor, etc.) when lacking direct experience with a tool while being more familiar with a tool encouraged them to demonstrate multiple options (e.g. you could do this, this, or this) for new staff to shadow.

Domain-oriented codes included any language that described the knowledge base and professional skillset required to plan and lead the CoP program. Sub-codes were arranged according to program outcomes: **Teaching, Maintenance, Operation,** and **Contribution.** A major theme that appeared throughout PSs' reflections was trying to navigate when to depend more heavily on the written CoP guides, and when to draw from their own experience. One PS felt that the guides ensured that "all the participants (myself included) had a baseline for the skills we need…to assist patrons in learning how to use the tools." Another PS described augmenting the structured activities based on their own high level of expertise – in their words, "when I taught 3D Printer CoP, they learned the secret sh*t." There was a consensus that the written guides were a helpful starting point, but no agreement on how closely they should be followed, which indicates a strong preference for instructor freedom when leading a CoP.

Practice-oriented codes included any language that described the active engagement in tasks related to actively planning and/or leading the CoP program. Sub-codes included **Iterative Learning** and **Confidence.** PSs emphasized the evolving nature of professional development for both participants and facilitators throughout the CoP program. PA participants worked iteratively on hands-on projects, and they demonstrated the most growth when they needed to troubleshoot problems during the process. Similarly, PS facilitators made continuous changes to their teaching and plans for CoP based on what they observed during the sessions they led. One PS emphasized that for both groups, "part of the confidence is knowing that there are so many ways to…solve this problem."

Discussion:

Student staff at BeAM develop their professional identity through ongoing collaboration with one another. Whether a PA or a PS views themselves as a competent professional in a makerspace setting depends on their confidence with performing specific roles. These roles include safely operating makerspace tools, teaching others how to make things, maintaining tool functionality, and contributing a positive impact as a member of the staff community. The staff CoP at BeAM launched in 2022 and helped participants build confidence in these areas.

However, critical feedback from PAs, PSs, and full-time staff prompted a review and revision of the program model during Summer 2024 to avoid stagnation, provide consistent training opportunities across cohorts, and ensure that the staff CoP program would continue to be effective in building staff confidence.

The revised CoP program launched in Fall 2024, and data was collected before, during, and after the program. By analyzing and interpreting this data, we can make several recommendations for the next iteration of the CoP program in Fall 2025. First, quantitative analysis confirmed significant confidence gains across all tool areas despite shortening the program from 24 weeks to 12 weeks. PS reflections confirm that this made CoP more manageable in regard to scheduling, but they recommended redesigning the final project prompts to be more meaningful and achievable within the shorter timeline (which seems to be confirmed by the artifact photo scores.)

The most salient takeaway from this investigation is the role of community building and its positive impact on outcomes for CoP participants. Multiple PS facilitators cited Cohort 5 as a model for successful professional identity development, where strong collaboration and camaraderie among participants fostered an environment of mutual support and motivation. This dynamic encouraged participants to take initiative, share knowledge, and approach challenges with confidence, leading to higher scores in both technical skill and creativity. The sense of community not only enhanced individual learning but also reinforced the collective identity of the cohort as capable, adaptable makerspace staff. Facilitators noted that the peer-driven support and engagement in Cohort 5 exemplified the core values of the CoP model, highlighting the importance of fostering interpersonal connections alongside technical and professional skill development. Based on observing this cohort's success, the PS facilitators recommended incorporating measures to increase community between participants and facilitators: keeping the facilitator consistent for each cohort to build trust, redesigning the final project to leverage participants' individual expertise, and providing more opportunities for collaborative problem solving.

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Appendix A: Example of Pre-Cohort Survey Instrument (Wood Shop)

Wood Shop: Pre-Cohort Survey

Instructions:
Before you attend your first meeting, **you must fill out the Wood Shop pre-cohort survey.** There are no "grades" in the Communities of Practice, and your answers to this survey do not negatively impact your participation in any way. We want your honest answers, so that fulltime staff and Specialists can support you while you're participating in the Wood Shop CoP.

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

Scale:

- Very Confident
- Somewhat Confident
- Neutral
- Somewhat Unsure
- Very Unsure

Safely operating wood shop tools. [select]

Training others on how to operate wood shop tools. [select]

Performing basic maintenance on wood shop tools. [select]

Using wood shop tools for BeAM-related projects. [select]

Question 2:

What are you hoping to accomplish during your participation in the Wood Shop CoP? What do you want to get from the experience?

[free response]

Question 3:

Picture yourself working at BeAM in 1-2 years. What's different (either about yourself and/or about BeAM?)

[free response]

Appendix B: Example of Post-Cohort Survey Instrument (Wood Shop)

Wood Shop: Post-Cohort Survey

Instructions:
During your final meeting, your Community lead will give everyone time to fill out both the Wood Shop post-cohort survey and the File Uploads assignment. Again, there are no "'grades" in the Communities of Practice, and your answers to this survey do not negatively impact you in any way. We collect this information so that we can measure the general impact of the CoPs across all BeAM staff, and so that we can better support your work at BeAM in the future.

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

Scale:
- Very Confident
- Somewhat Confident
- Neutral
- Somewhat Unsure
- Very Unsure

Safely operating wood shop tools. [select]

Training others on how to operate wood shop tools. [select]

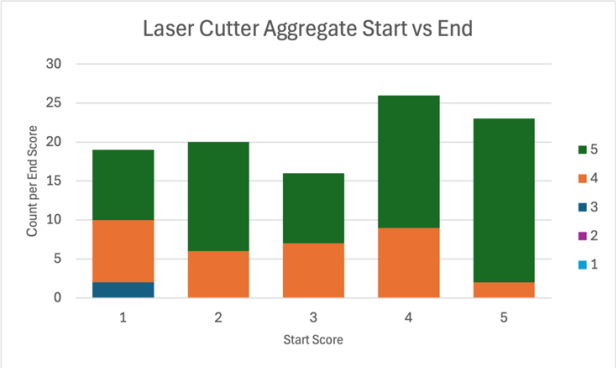
Performing basic maintenance on wood shop tools. [select]

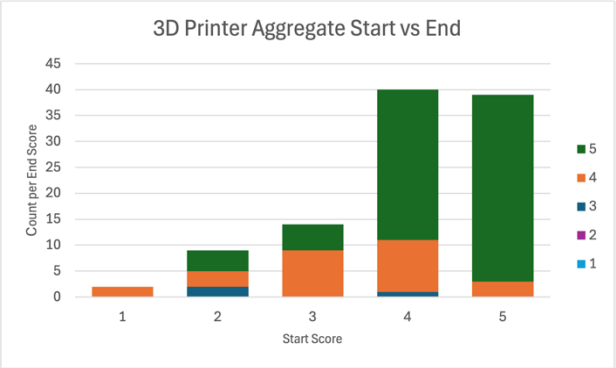
Using wood shop tools for BeAM-related projects. [select]

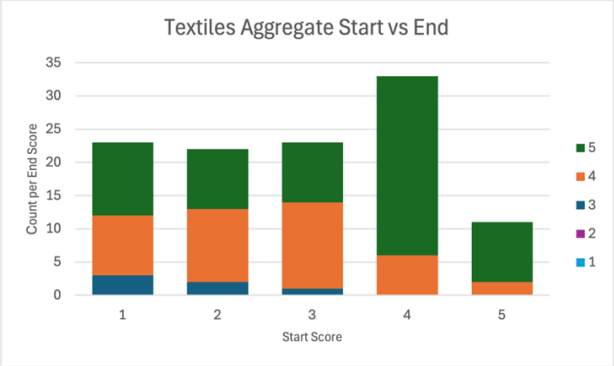
Question 2:

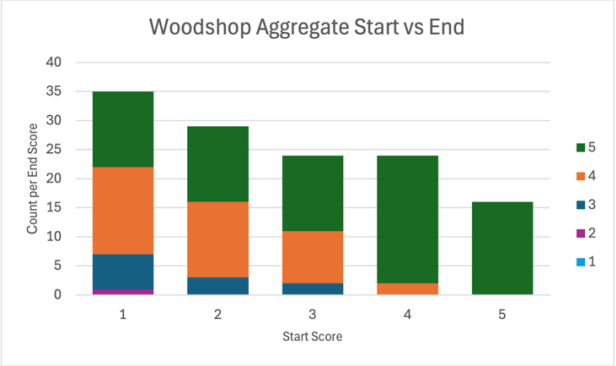
How would you describe your experience in the Wood Shop Community of Practice?
- What did you find most useful? What would you change?
- What's next in your wood shop journey? What do you want to learn?

Appendix C: Aggregate Scores (Pre vs Post) by Tool Area

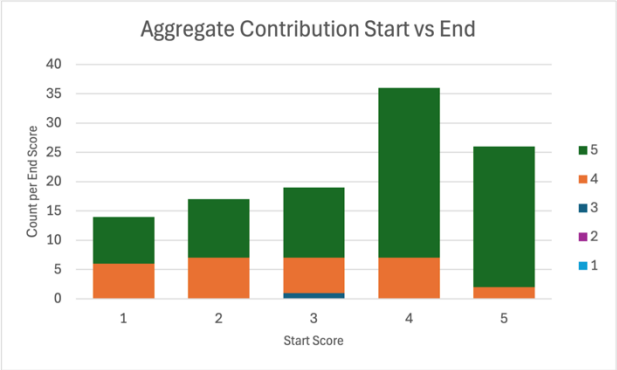


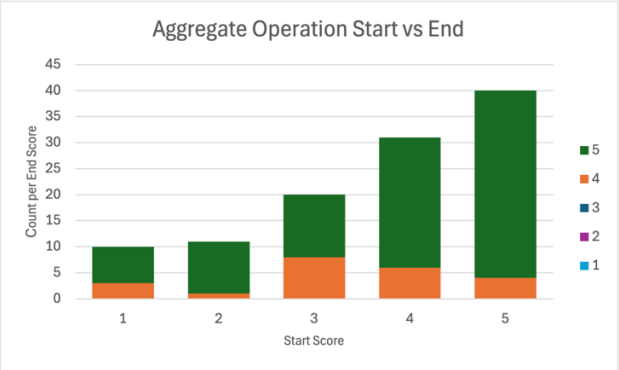


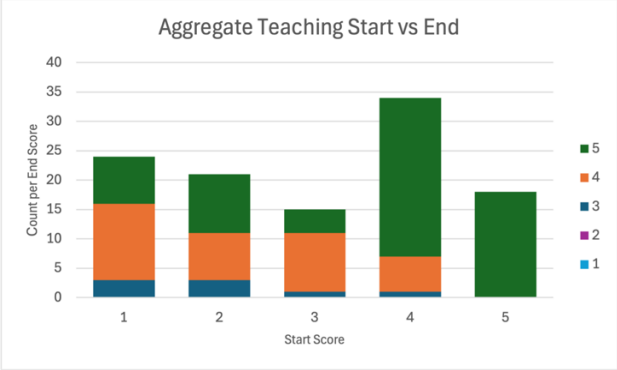


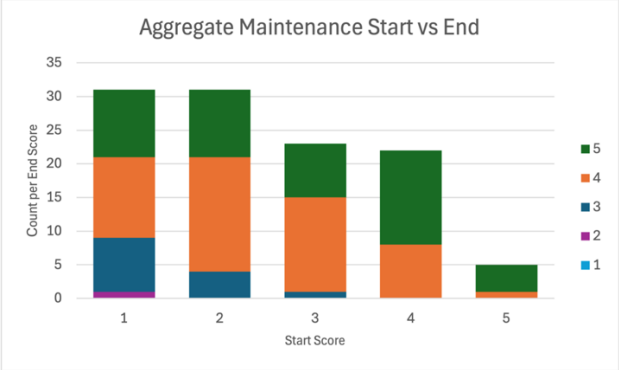


Appendix D: Aggregate Scores (Pre vs Post) by Program Outcome









Appendix E: Scoring Rubric for Project Artifact Photos

Operation						
	N/A	**1**	**2**	**3**	**4**	**5**
Wood Shop (WS)	Did not provide picture	Project is incomplete (e.g. not enclosed, missing sides, etc.)	Project is complete, but there are major issues. I.e. corners do not fit together. Screws sticking out etc.	All corners of box fit together cleanly with no gaps. Simple execution, four sides and a lid.	Attempted to make a more complicated box structure (dividers, a sliding lid, etc), but not all pieces fit together cleanly.	Made a more complex design (dividers, a sliding lid, etc). All corners fit together cleanly.
Textiles (TX)	Did not provide picture	Project is incomplete (e.g. straps are unfinished)	Project is complete, but there are major issues. I.e. shape is irregular. Stitches are not straight or the same length.	Project is complete. Only sewing machine used, but used well. Rectangular shaped bag (not irregular).	Not quite flawless execution, minor errors. Used multiple machines, went above minimum requirements, but product unpolished and/or misshapen.	Flawless execution. Multiple machines used. Actually rectangular shaped, no odd shapes.
3D Printer/ Laser Cutter (3DP / LC)	Did not provide picture	Project is incomplete (e.g. stand is missing, lithophane not functional)	Both pieces of project are complete, but there are major issues. I.e. stand is way too big or small for the lithophane. Simple stand connection. Lithophane seems too chunky to get light through.	Both pieces of the project are complete. Lithophane can sit on the stand nicely. Lithophane seems reasonably thin.	Not quite flawless execution, minor errors. Lithophane is reasonably thin and stand is customized, but pieces not proportional to each other / do not cohesively combine.	Both pieces of project are complete. Stand and lithophane proportionally sized. Lithophane thin enough for light to pass through. Execution is consistent and high-quality throughout.

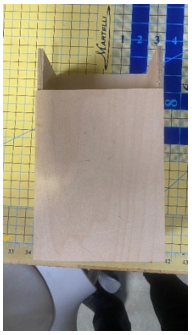
Contribution						
	N/A	**1**	**2**	**3**	**4**	**5**
Wood Shop (WS)	Did not provide picture	Has taken no steps to "finish" the project (e.g. sanding, painting, and/or staining.)	Partial finishing, but needs more work (e.g. sanded but not stained/painted; painted but messily done, etc.)	Basic effort required to finish project (e.g. sanded, painted a solid color, or stained.)	Clear effort beyond basic requirements, but lacking polish (e.g. box has a window or other bonus design piece, but not fully implemented)	Clear time and effort put into customizing final project. Sanded, stained or multiple color design. Bonus design piece present.
Textiles (TX)	Did not provide picture	Has taken no steps to "finish" the project (e.g. removing loose threads, haphazard choice of fabrics, etc.)	Partial finishing, but needs more work (e.g. no additional custom vinyl/embroidery elements, seams are irregular, etc.)	Basic effort required to finish project (e.g. heat press vinyl or embroidery details, simple designs)	Clear effort beyond basic requirements, but lacking polish (e.g. custom designs, but fabric doesn't match / isn't coordinated with embroidery or vinyl designs).	Clear time and effort put into customizing final project. Custom made design that is complex. Possibly multiple designs in either vinyl or embroidery. Effort has gone into picking fabrics that will match and look good together.
3D Printer/ Laser Cutter (3DP / LC)	Did not provide picture	Has taken no steps to "finish the project" (e.g. missing one of the pieces, neither stand or lithophane customized, etc.)	Partial finishing, but needs more work (e.g. lithophane and stand are made, but only one is customized; both are made out of cardboard, etc.)	Basic effort required to finish project (e.g. both pieces finished; stand is customized with simple design and made out of cardboard OR stand is not customized but made out of sturdier material)	Clear effort beyond basic requirements, but lacking polish (e.g. highly customized stand but still made out of cardboard; intricate lithophane design that is not quite functional, etc.)	Clear time and effort put into customizing final project. Used materials other than cardboard, lithophane is demonstrably functional and cohesive with stand design.

Appendix F: Aggregate Data for Project Artifact Photos and Example Photos

	TX-Operation	TX-Contribution	TX-Overall
Cohort 1	3	3.25	6.25
Cohort 2	3.08	2.5	5.58
Cohort 3	3.6	1.9	5.5
Cohort 4	2.75	1.38	4.13
Cohort 5	3.4	3.4	6.8
Cohort 6	3.17	2.25	5.42
OVERALL	**3.17**	**2.45**	**5.61**
	WS-Operation	**WS-Contribution**	**WS-Overall**
Cohort 1	3.75	1.33	5.08
Cohort 2	3.83	1.67	5.5
Cohort 3	2.92	1	3.92
Cohort 4	3.2	1.2	4.4
Cohort 5	3.6	1.7	5.3
Cohort 6	4	2.37	6.37
OVERALL	**3.55**	**1.55**	**5.1**
	3DP/LC-Operation	**3DP/LC-Contribution**	**3DP/LC-Overall**
Cohort 1	3.63	4	7.63
Cohort 2	2.75	1.88	4.63
Cohort 3	3.2	2.2	5.4
Cohort 4	3.08	2.5	5.58
Cohort 5	4	2.6	6.6
Cohort 6	2.92	1.58	4.5
OVERALL	**3.26**	**2.46**	**5.72**

Textiles


Wood Shop




3DP/LC


Appendix G: Snapshot of Qualitative Codebook for Participant Survey Free Responses

EMIC CODE	KEYWORD CODE	Definition	Examples (Documentation)
"I want to be able to do more"	Operation	Any language directly related to the experience or usage of tools, machines, or any related software in any capacity, or reference to using tools, machines, or software for specific reasons.	"I want to learn in depth understanding of the laser cutting"
"get to know the equipment and use it"	Operation--Domain	Any language directly related to knowledge or skill domain - e.g. drill bits, bandsaw, fabric, sewing machines, thread, pattern, Adobe Illustrator,etc.	" I really enjoyed working with the kreg jig and practicing staining."
"I am really hoping to create some things"	Operation--Application	Any language directly related to the application of domain resources, knowledge, or skill--e.g. sew pillow cases, print lithophanes, etc.	"My next laser cutting journey is a DnD tracker."
	Operation--Intimidation	Any language about feeling intimidation, fear, or a lack of proficiency towards a BeAM-related domain--e.g. using technology, no experience, scared, etc.)	"I want to get more confident with the textiles tools because it is one my largest deficiencies."
" be able to answer questions people have when using them"	Teaching	Any language describing educating others in some form, such as demonstrating, explaining, or assisting, someone on tools, machines, or software.	"I do not have much experience with 3DP or lasers but I hope to gain experience and learn how to properly use them, then be able to teach others."
"Then I try my best to fix it"	Teaching--Approach	Any language describing educator strategies--e.g. trial by error, hands-on, demonstration, etc.	"If it doesn't look like they have the Canvas guide open, I have them pull that up on their laptop. I'll then walk around occasionally to see if their struggling on a step."
"I want to be a helpful BeAM Program Assistant"	Teaching--Disposition	Any language describing educator styles--e.g. being fun while teaching, confident, effective, etc.	"I try to be approachable and be friendly, and try to check in often to see how its going."
	Teaching--Dual Identity	Any language describing the dual identity that BeAM staff have as both CoP participants/inexperienced staff (students) and makerspace staff (helping others)	"I usually check out what is not working, then I either fix it or ask the other floor staff member. If we both can't figure it out, I usually ask Joel/Kristen or I Google it if they're not available.
	Maintenance	Any language describing the act of keeping tools and machines functional, or the process of mediating issues with tools, machines, and software.	" I would change how much time was allotted for making the frog and put that towards sewing machine maintenance training."
	Maintenance--Routine	Any language describing upkeep of tools with the intention of ensuring normal operation or in regular scheduled intervals--e.g. basic procedures, maintenance system, etc.	"I hope to learn more about the basic functions, the complex features, and the maintenance needed to keep these machines operating properly."
	Maintenance--Circumstance	Any langauge describing probleming-solving during the operation of tools or as problems occur--e.g. troubleshooting software, cleaning clogged 3D printer heads, massive fixes, etc.	"I would have rathered spend more time taking apart the laser carriage and 3D printers and learning how to do maintenance when things break."
	Contribution	Any language that describes the ways PAs add value to BeAM beyond their baseline responsibilities--e.g. building community, training new staff and patrons, working on challenging projects, etc.	"I want to be as knowledgeable as possible as a floor staff assistant, I want to be able to help with anything."
" I'd like to be known for having a lot of experience with one tool."	Contribution--Domain	Any language associating added value to BeAM through specific tool domains--e.g. metal shop, vinyl master, etc.	"I want to be the program assistant everyone comes to about embroidery questions."
"I want to be know know for making the coolest things."	Contribution--Artifact	Any language associating added value to BeAM through physical objects or projects.	"One who has a really cool apron and is helpful and nice."
" I want students to feel comfort"	Contribution--Experience	Any language that associates added value to BeAM resulting from staff character--e.g. kindness, effective, confident	" I want my excitement to radiate in the space and be able to explain and guide patrons through an effectively."
"I enjoyed the woodshop COP"	Contribution--Reciprocation	Any language that demonstrates what BeAM can offer to staff	"I see myself coming in frequently to use the equipment and meet people in the spaces. "

Appendix H: Questions Used for Program Specialist Debrief and Reflection

We're here to debrief from the Fall 2024 CoPs. We have two goals: reflect on what happened, and gather information for planning Fall 2025 CoPs.

We'll dig into more specific questions later, but let's start at a high level.

- If you had to pick one thing to keep from the way we did CoP this semester, what would it be?
- Other side: If you had to pick one thing to toss from the way we did CoP, what would it be?

COMMUNITY:

- What connections (if any) did your participants make between their CoP work and their experiences on the floor?
- When did you feel most confident in your role as a CoP facilitator? When did you feel the least confident?
- How did this CoP session compare to the other CoPs sessions you participated in (either as a participant or facilitator)?

DOMAIN:

- What skills or concepts were the most challenging for your cohort?
- What skills or concepts were the easiest for your cohort to grasp?
- Are there skills or concepts that you wish were emphasized more in CoP?

PRACTICE:

- Which types of activities or projects were the most helpful to your cohort?
- Which types of activities or projects were the least helpful to your cohort?

Appendix I: Snapshot of Qualitative Codebook for Program Specialist Reflections

Keyword Code	Definition	Examples (Focus Group)	Examples (Individual Surveys)
Community	Any language describing community in the makerspace	"So my 3d printer cohort. They actually were, like, they got along a lot. They had, like, little inside jokes and stuff like that." Taylor	"I try to make a connection with the staff while also making them confident in their skills so they can apply them to working with others." Michael
Community (Co-Learning)	Any language describing the learning from the experiences and skills another person	"they just didn't have the skills to be even comfortable to attempt to design anything for that. And they would come up to me and be like, how do I do this?" Daisy	"I felt the most confident in my role when I was able to draw off of my cohort for their skills." Jonah
Community (Collective Identity)	Any language describing a sense of unity or camaraderie among COP members and/or facilitators	"Yeah, I actually did know which COP you had when you said that." Maggie, referring to Taylor's 3Dp COP	"I definitely felt that the community bonding was similar to previous COP sessions. Everyone got along well and was super interested in learning every way that a machine could be used." Neev
Community (Dual Identity)	Any language in which staff describe their use of the makerspace outside of work	"What are you gonna do to your tote bag?" Taylor	"the aspect of finding something you want to make, and then planning and designing yourself really allowed me to better address patron's questions about design for projects I wasn't familiar with." Jonah
Community (Mentorship – Advice)	Any language in which PS's pass on their skills and knowledge to PA's verbally	"In the wood shop, I've been doing it for years. I know everything about it, like, not in like, that kind of way, but like, I do, right? Yeah, it's like, it's my area of expertise and comfort" Alec	"I was able to answer more questions about the tool and also direct participants to other resources to explore more because I had more knowledge about the non-traditional things that you could do with those tools." Neev
Community (Mentorship – Shadowing)	Any language in which PS's pass on their skills and knowledge to PA's through their actions	"This is very unlikely that you're gonna have to do it, but I'm gonna show you how to do it" Alec	
Domain	Any language in which PS's mention their personal or professional skills as a leader or mentor.	"I was comfortable using it on my own, but I was definitely not comfortable enough to teach people and lead people to learn about the more technical side." Daisy	"Going between my floor shifts and leading COP sessions, I could definitely see participants become more comfortable talking with patrons about their own projects." Neev
Domain (Teaching)	Any language describing the ability to teach the	"When I taught, when I taught 3d printer COP, they learned the secret shit."	"I appreciated the structured training guide as a tool to lead COP. I felt that it was important in making sure all the participants

	PA's the designated skills of COP.	Taylor	(myself included) had a baseline for the skills we need as specialists to assist patrons in learning how to use tools and thinking about ways that they can complete their own projects." Neev
Domain (Maintenance)	Any language describing the ability to maintain and repair makerspace related tools and machines	"I'm very glad that we covered a lot of maintenance in our COP" Daisy	"we had the occasional maintenance needed (like fixing a broken needle) and this was probably helpful to people on the floor. " Emily
Domain (Operation)	Any language describing the ability to use makerspace related tools and machines to create projects	"Also sometimes, especially on laser cutter #4, the materials database likes to spontaneously delete itself. And so I've had to teach a bunch of people manual controls because of that." Maggie	"I think the most challenging activities for both LC and textiles were troubleshooting the faulty files - but I also think those were some of the most rewarding activities." Zach
Domain (Contribution)	Any language describing the ability to use makerspace related tools and machines in a manner relevant to the overall makerspace community	"Regardless of what happens with the canvas module for patrons for that - staff absolutely need to know how to do that, because to help somebody." Alec	"After each session, at least one participant came back with a story of how they had to fix a machine to help a patron or how they used the machines for their own personal projects." Michael
Practice	Any language describing repeated use and increased confidence in makerspace tool areas	"here's like, the base of what you need to know. Now take that and just take this time and go find something interesting to do with it." Alec	"the ring making using the drill press in the woodshop. It was fun and allowed people to learn by experimenting on their own." Emily
Practice (Iterative Learning)	Any language describing improving makerspace skills through trial and error experiences	"maybe I'll change that around a little bit." Alec	"I think the most challenging activities for both LC and textiles were troubleshooting the faulty files - but I also think those were some of the most rewarding activities." Zach
Practice (Confidence)	Any language describing growing confidence in makerspace skills through practice	"part of the confidence is knowing that there are so many ways to sort of like, like, solve this problem" Daisy	"They felt more confident after completing the CoP." Lindsey