Learning in Academic Makerspaces: Preliminary Case Studies of How Academic Makerspaces Afford Learning for Female Students

Ms. Megan Tomko, Georgia Institute of Technology

Megan E. Tomko is a Ph.D. graduate student in the George W. Woodruff School of Mechanical Engineering at the Georgia Institute of Technology under the guidance of Dr. Julie Linsey. She completed one semester in her graduate studies at James Madison University with Dr. Robert Nagel as her advisor. Her B.S. degree in Mechanical Engineering is from the University of Pittsburgh where she also worked as a Field Telecommunications Intern for three consecutive summers at EQT, a natural gas company headquartered in downtown Pittsburgh, PA. Megan's research interests correspond to identifying ways to teach students how to become better designers and learners through creative and non-traditional means.

Dr. Robert L. Nagel, James Madison University

Dr. Robert Nagel is an Assistant Professor in the Department of Engineering at James Madison University. Dr. Nagel joined the James Madison University after completing his Ph.D. in mechanical engineering at Oregon State University. He has a B.S. from Trine University and a M.S. from the Missouri University of Science and Technology, both in mechanical engineering. Since joining James Madison University, Nagel has helped to develop and teach the six course engineering design sequence which represents the spine of the curriculum for the Department of Engineering. The research and teaching interests of Dr. Nagel tend to revolve around engineering design and engineering design education, and in particular, the design conceptualization phase of the design process. He has performed research with the US Army Chemical Corps, General Motors Research and Development Center, and the US Air Force Academy, and he has received grants from the NSF, the EPA, and General Motors Corporation.

Dr. Melissa Wood Aleman, James Madison University

Dr. Melissa Aleman (Ph.D. University of Iowa) is Professor of Communication Studies at James Madison University and has published research using qualitative interviewing, ethnographic and rhetorical methods to examine communication in diverse contexts ranging from aging families to university campus cultures. She has advised undergraduate and graduate students in ethnographic and qualitative interview projects on a wide-range of topics, has taught research methods at the introductory, advanced, and graduate levels, and has trained research assistants in diverse forms of data collection and analysis.

Dr. Wendy C. Newstetter, Georgia Institute of Technology

Dr Wendy C. Newstetter isAssistant Dean for Educational Research and Innovation in the College of Engineering at Georgia Tech.

Dr. Julie S. Linsey, Georgia Institute of Technology

Dr. Julie S. Linsey is an Assistant Professor in the George W. Woodruff School of Mechanical Engineering at the Georgia Institute of Technological. Dr. Linsey received her Ph.D. in Mechanical Engineering at The University of Texas. Her research area is design cognition including systematic methods and tools for innovative design with a particular focus on concept generation and design-by-analogy. Her research seeks to understand designers' cognitive processes with the goal of creating better tools and approaches to enhance engineering design. She has authored over 100 technical publications including twenty-three journal papers, five book chapters, and she holds two patents.

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Abstract

Recognizing the value of engagement in learning, recent engineering education initiatives have worked to encourage all types of students to pursue engineering while also facilitating the construction of makerspaces on university campuses. Makerspaces have the potential to engage a broader range of students by providing unique and personalized pathways into engineering. While this aims to improve the quality of an engineer's education, the reality settles in when we begin to question whether these makerspaces are, in fact, encouraging learning in engineering for all types of students.

In this work, we focus on investigating how a university makerspace affords learning for female students. We implemented an in-depth phenomenologically based interviewing approach which involved a series of three 90-minute semi-structured interviews with six highly engaged female undergraduate students involved in different makerspaces at a single university. The purpose of these interviews was to engage the students in their experiences with the makerspaces and the projects that they work on in this space, so as to inform how these spaces afford learning, specifically the impact on female student learning. All interviews were conducted by the same female graduate student. This work focuses on the second interviews of two females who had student worker roles in their respective makerspaces on campus. All of the interviews for these two females were transcribed resulting in 180 pages of single-spaced transcriptions, and the second interviews were analyzed through two phases of qualitative data analysis. Types of learning emerged in multiple forms and are presented via case studies of each female participant. For case one, these types of learning include machines learning, social learning, design learning, and self-learning. In the second case, the types of learning are tool learning, resourceful learning, space learning, and management learning. These types of learning are then further discussed according to engineering education pedagogy and implications. Makerspaces are often labeled as "open, learning environments," and this work demonstrates how these spaces facilitate unique forms of learning that engage these women in the makerspace.

1 Introduction

Makerspaces, places dedicated to making things, are labeled as open, accessible spaces where one is free to create. These spaces gave makers a place where they could design, build, test, and create. While more and more makerspaces surfaced, the maker movement crept into academia, and before researchers could even make sense of this new phenomenon, makerspaces were starting to take root on college campuses and in K-12 educational settings. From repurposing supply rooms to building bright and shiny new facilities, these spaces have been filled with 3D printers, laser cutters, woodworking machinery, and metalworking equipment with the hope of embracing making, the maker movement, and design thinking in education.

Empirically, educators and researchers realized that there was something about these spaces that was uncharacteristic and impacting the learning environments at their respective educational settings. In order to understand the impact, both quantitative and qualitative researchers began to explore the complexities of these spaces looking at questions such as "what is going on in these spaces?" and "how are students becoming engaged in these spaces?" The questions of "what are students learning?" and "what does learning look like in a makerspace?" became of particular interest. College campuses are spending billions of dollars on these spaces so as to encourage the non-traditional learning at their campus. Yet, the value and learning of these university makerspaces are not fully understood and not well-researched.

In this work, we have aimed to understand learning in makerspaces by expanding on the qualitative research that explores makerspaces. In our direct effort to understand the learning unfolding in these spaces, we have incorporated in-depth phenomenologically based interviewing techniques and open coding analysis in order to generate themes of learning in these makerspaces. This particular work follows two of six female narratives at the different makerspaces within a single university. The two females were invited to participate in a three-series semi-structured interview process. Types of learning were coded within the second interview, which focused on what they do in the makerspace. The findings are presented as case studies for each female participant. We further discuss the implications for these types of learning in comparison to traditional learning approaches.

2 Background

Understanding a makerspace necessitates examining how these spaces are defined and then how these definitions inform the research that has evolved through the widespread interest in makerspaces.

2.1 Defining a Makerspace

In the maker community, the activity of 'making' was formed so as to not have a clear definition [1]. Ultimately, this was to not discriminate and confine the experiences of those who are making. While there is not a clearly articulated definition of making, this has resulted in an ambiguous definition to a makerspace. Yet, there are numerous ways a makerspace has been characterized. Makerspaces are:

- Unique learning environments that are motivated by advancing technology, sharing about projects, and remaining centered on making, in all its' form [2];
- Spaces that utilize a variety of tools, equipment, and methods focused on resourcefulness, as inspired and attributed to the Maker Movement [3];
- A bridge between universities and industry, most notably in Science, Technology, Engineering and Math (STEM) fields [4];
- Hackerspaces, hack labs and fab labs, which are open and accessible to a community of people who share tools, machines, and knowledge [4];
- Neutral spaces where discovery, innovation, and collaboration become daily occurrences [5]; and
- The next generation classroom [6].

Apparent in these definitions, makerspaces are defined by learning and engagement. They are open, accessible, and project-oriented spaces. In makerspaces, one will have access to tools, technology, machinery, community, and a shared culture focused on open ideas, knowledge, and a passion for making.

2.2 Interest in Makerspaces

Over ten thousand documents resulted from a Google Scholar search for “makerspace”, “maker movement” and “maker culture” with the largest of the knowledge clusters focusing on the maker movement, the Do-It-Yourself culture, and the craftsman hero [7]. Evidently, interest in these spaces has significantly risen in the past decade and continues to rise [8]. How is it that unpacking this unexpected rise in the popularity of makerspaces has left many persons immensely intrigued, so much so that there are over ten thousand documents dedicated to broadcasting findings about these spaces?

The makerspace setting is unique, innovative, and flexible. For example, a library can be makerspace as can a mobile cart [6, 9-11]. Yet, these spaces seem to have a way of engaging students that differs from the traditional classroom setting. According to Heath [12], traditional and formal educational settings have difficulty promoting opportunities, while makerspaces allow for more project longevity and students can take on more meaningful roles. Makerspaces offer project longevity and meaningful roles to students through 1) the tools, specifically digital tools and tools that work for various making activities, 2) the community, pertaining to infrastructure, resources, and events, and 3) the maker mindset, for that to be encouraged and implemented in the community [13]. Recognizing the opportunity but not understanding how to go about creating a university makerspace, a study performed by the University of La Rioja noted that at the top engineering universities in the world have engineering makerspaces that are open to the entire university community [4], thus providing an opportunity for campus-wide student engagement. Evidently, these spaces offer a unique opportunity for students.

2.3 Learning in Makerspaces

More specifically, makerspaces offer students an opportunity to learn through constructivism [14], constructionism [15], and situated learning [16]. Through constructivism, the students can learn within the context of social interaction, gaining insights and understanding meaning from engaging in the social community. Further, with constructionism, the learning manifests in the act of building a physical object [17], which allows the student to construct meaning from actively building [18]. Then, via situated learning, learning occurs through engaging in experiences in real-world, authentic environments [16]. For example, in a children’s museum, children and families learned through interactions, tools, and materials [19]. In the academic setting, K-12 students learned computer programming, engineering, electronics, design, and art when introduced to making activities in the classroom [17, 20].

3 Research Questions

While learning is occurring in children’s museums and in the K-12 classroom, we believed there to be similar learning instances taking place for STEM female students on college campuses. In makerspaces, there are women who are highly engaged, identify as makers, spend hours in the space, and know how to use a variety of machines. Intrigued by these women and what they are learning through their engagement in the space, two main research questions are developed.

> *RQ1: How does an academic makerspace afford learning for female students and what are they learning about?*
>
> *RQ2: What are the implications for this learning compared to traditional learning approaches?*

In this paper, we discuss the method for answering these questions; we investigate the learning that we see occurring in the space; and we discuss how the implications for this learning in comparison to traditional learning.

4 Methodology

To answer the research questions, an in-depth, phenomenologically-based, interview approach is used. Through interviews, the pieces of a person's story are brought together. For every story, there is a beginning, a middle, and an end. To really capture the story, the in-depth phenomenologically-based interview approach uses the theoretical stances for life-history interviewing [21] combined with focused, in-depth, interviewing rooted in phenomenology [22]. This approach includes the participants engaging in three separate 90-minute interviews. In these interviews, the participants describe and reflect on their past and current experiences. This allows participant experiences, in the specified domain (e.g., makerspaces, making activities), to be understood through the context of their lives and allows meaning to be distilled from experience [23]. Through the three-interview series, developed by Schuman [24], participants describe the context, articulate the details, and mull over the meaning of their experiences. A 90-minute interview structure is suggested to prevent participants from looking at the clock for an hour interview or from losing interest from a two-hour long interview (i.e., a 90-minute interview is considered "just right").

Our decision to use the in-depth phenomenologically interviewing approach was due to the need to capture the narratives of female students. Their interest, engagement, and learning in the space, we speculated, was in part due to their past experiences and also from what they were participating in and doing currently. We also needed them to be able to reflect on their experiences, not just tell us about them. And even more so, we needed the time because a one-time interview would not produce the comfort level between the participants and interviewer that we needed in order to really understand the female's experiences and learning in the makerspace. We framed the interviews to focus on their involvement in the makerspace and their participation in making activities.

Because of the nature of the research questions, we decided to focus on only the second interview. The first interview focuses on prior experience of the participant in a certain domain, which in the case of this research, is making. The second interview corresponds to the present experiences that the participant is currently going through in regards to making. The final interview asks about the meaning of these experiences. In the second interview, the participants talk about what they are *currently making and doing in relation to the makerspace*. It is in the participants' responses to this interview where we would be able to examine their learning *in the space*.

4.1 Participants and Recruitment Strategy

Six female undergraduate students have participated in this study. In qualitative research, low sample sizes are not uncommon due to the in-depth nature of qualitative methods and the purpose being transferability, as opposed to generalizability. In this paper, we discuss two of the six participants. The two students selected for this paper were contacted directly by the interviewer via purposive sampling, which is a process where participants are selected based on desired characteristics; in this case, we were interested in students who were highly engaged and involved in the makerspace. The interviewer was introduced to each female undergraduate student as per their involvement in makerspaces on campus, and the interviewer further contacted them to see if they would be interested and able to talk about their making experiences. Both students agreed to meet for further interviews and then also provided names of other students who would be interested in participating (resulting in six female participants). This is known as snowball sampling where participants in the study provide names of other individuals who would be relevant to the interviewer's study.

4.2 Interviewer and Interviewing Process

Because the interviewer's background influences the interview and the information provided by the participants, it is important to express information about the interviewer. The interviewer is female graduate student in her mid-twenties. She had a mechanical engineering degree from a public university in the Northeast and is working to receive her PhD in mechanical engineering at a public university in the Southeast. She has been trained by two qualitative researchers and has worked on both quantitative and qualitative design research. She utilizes an interpretive paradigm for her qualitative lens.

The interviews were conducted at a large university in the Southeast. The timing between interviews is dependent on student schedules where availability fluctuates amidst waves of exam and project deadlines. This resulted in the interviews being conducted roughly 1-2 weeks apart.

After each interview, the audio file was sent to be transcribed by a third-party company. Once the text transcriptions were received, the interviewer listened to each interview while following the transcription, so as to edit for any errors on the received file. For the two participants being discussed in this paper, there were 180 pages of single spaced transcriptions total. The interviewer analyzed the transcripts through a first phase of open coding followed by a second phase of building out broader categories and finding relationships between the codes.

5 Findings

The findings of this paper are constructed to follow each individual participant in the form of individual case studies. Each participant has been evaluated for the types of learning that have emerged in their narrative. This is not to say that the type of learning in one case study does not occur in the other case study. This is to showcase each narrative as is and to maintain the open coding process throughout each narrative. Further work will be to coalesce the codes and themes developed by each individual case study in order to create a consolidated list of the types of learning occurring in makerspaces.

For the sake of keeping confidentiality to the makerspaces and the participants, names have been changed and certain details, such as major and year, have been omitted. Additionally, if the student volunteers in the space or is paid to work in the space for a few hours each week, they are called a "student worker" in the space. The different makerspaces use different terminology for this role and also have different rules regarding the responsibilities for these student workers. Overall though, these student workers have the responsibility to help students, or any persons who come into the space, with projects or questions when considered "on duty" in the space.

5.1 Henry: Learning in the Makerspace

Henry is a female student worker in one of the makerspaces. The makerspace that she works in, is a single room with 3D printers, a laser cutter, a mill, a lathe, two workbenches, and additional machines that are geared for major-specific research endeavors. She is required to spend three hours each week according to her student worker responsibilities and is also compensated for her time.

In the second interview, Henry talks about different projects that she has worked on and what working in the space is like. Throughout her detailed description of her experiences, four major types of learning emerged: machines learning, design learning, social learning, and self-learning. The machines learning and social learning inform her design learning, and all three aforementioned learnings inform her self-learning (Figure 1).

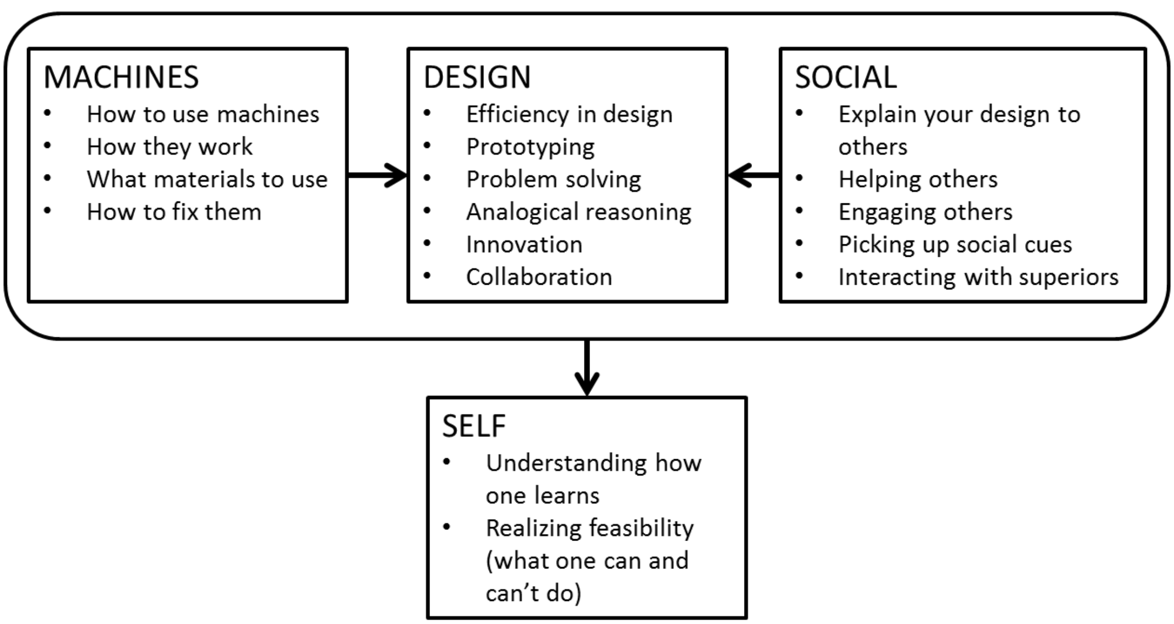

Figure 1: Types of learning that Henry encounters

5.1.1 Machines Learning

Machines learning is the code that was adopted to encompass the learning that Henry goes through when she learns about the machines in the makerspace. She learns how to use the machines, how the machines work, what materials to use, and how to fix the machines. More specifically, Henry has become acquainted with multiple tools, whereas other students have only a few tools that they know how to use. Through her involvement in the space, she has learned more on all the machines. In describing a class project, Henry emphasizes the importance of using a 3D printer appropriately to make a design.

> *When you 3D print whatever surface it's on, like wherever it starts to print, it'll have a marking right. So then it was also orientation on 3D printing because this one we 3D printed as well. So this part will have a – you can see the seam, but because what we cared about in this part was having not the seam, because we want this roll to be like a smooth circle.*

Henry wants to have a smooth circle, and she knows how to orient her part when using the 3D printer in order to create that smooth circle. From learning these techniques and learning more about the machines, Henry has made these machines more accessible to use when going through the design process and when wanting to make something.

5.1.2 Design Learning

In design learning, Henry learns about design through efficiency, prototyping, problem solving, analogical reasoning, innovation, and collaboration. First of all, she learns how to be efficient when designing something. If time is limited, she would look at the product that she wants to make and determine if subtractive or additive manufacturing would be beneficial for her use of time. Because she has the understanding about the machines, this allows her to have a greater sense of what machines to use in order to be more efficient. In prototyping, Henry strategically uses multiple iterations before finalizing her product. From concept to product, she is constantly thinking through the designs and trying to solve each problem that confronts her. Even in her attempt to solve the problems, she will look to products or analogies that are outside of the domain that she is solving the problem in. *"And these are like Velcro, but then Velcro won't stick enough. But we wanted to demonstrate the, like, idea concept of having pieces that would come apart."* Here, Henry wants something in her design that comes together and apart like Velcro, but that also holds stronger than Velcro. Later in her narrative, she is inspired by Lego's and produces a lock and key type of design.

Further, Henry is learning to innovate and build upon existing products for both the classroom and personal projects while also thinking up new designs and ideas that she had not heard of before. Finally, she learns how to collaborate on a team and in an informal setting, where she learns to build off of other's ideas rather than deny an unrealistic idea, and to expand and explore ways to make that person's idea realistic. Her ability to collaborate with others is advanced through the social learning that takes place in the makerspace.

5.1.3 Social Learning

While makerspaces can provide for more interaction among individuals, we see Henry developing social skills since she is required to talk to others about design in ways that they can understand what she is saying. In these spaces, she is learning how to explain her own designs and work with others. This is evident throughout the interview process where she is able to explain her designs to the interviewer. Additionally, Henry learns how to effectively help others and also engage other students in their projects. When students come into the space seeking help on their projects, she has learned how to help them, despite her not having a complete background on their projects. She has also learned how to engage them in their projects. Students may not always be excited and may feel pigeon-holed, so Henry talks with the students about their projects, which thereby engages the students in their work, even when they are frustrated.

> *…because you could be frustrated, not knowing how to do something. And be like, "Hey, you can totally make that on the lathe in like five minutes." And like get them trained on it -- train someone on the lathe. And they'll be like oh, like seeing the, "Oh, [man]. Like this is awesome," is like pretty fun part of my job.*

Not only is Henry able to engage these students, but she is even helping the students to build their own machines and design learning. Furthermore, another interesting finding is that Henry was able to pick up on social cues of the students in the space. She could read their facial expressions and hear in their voices whether they were in need of help or if they did not want to be bothered. *"But I'll be like, 'Hey, like what are you doing?' And if they're like, 'Oh, I'm just doing this,' and they like don't seem receptive to talking I won't like bug them."* While it is a part of her student worker job to check in on people and she also enjoys hearing about their projects, she is able to understand when a student does not want to be bothered.

A final social learning code that emerged is Henry's ability to interact with superiors, both professors and supervisors to the space. She felt comfortable talking with them about the space, the machines, and her designs. She knows what her own limits are and when she needs to seek out the professors or supervisors for advice.

5.1.4 Self-Learning

The machines, design, and social learning all help Henry to understand herself better through being a part of the makerspace. Through her different experiences, she has better been able to understand how she learns and what she needs to do in order to learn something better. On top of that, she begins to realize what she is capable of and what she likes and does not like, as a student and a student worker in the space.

> *Whereas, like the mill and the lathe, I am more partial to them because two different people who both know how -- the skill of how to use a lathe, and if I gave them the same like list of creating something out of it, it could come out looking beautiful versus horrible, but you're like how does that happen if it's just subtractive? ... And it's just because it's like -- I think there's like an art to machining. Like I'll watch YouTube videos of people making stuff because it's like soothing to watch.*

From knowing about the tools that she enjoys using, Henry learns more about the spaces that help her to work and inspire her in her work. She has realized that she is more attracted to the subtractive machines, such as the mill and the lathe. In fact, she even goes so far as to watch

YouTube videos of other people using these machines, simply because the nature of the subtractive machines, to her, is soothing.

5.2 Glen

Involved in another makerspace at the same university is a female undergraduate student worker named Glen. The space where Glen works has multiple rooms for different making activities. For Glen, being a student worker requires three hours a week of volunteered time. She also volunteers extra time by being part of the student oversight board.

During her second interview, Glen discusses some projects that she has made, her experiences being a student worker, user, and board member for the space, and what it looks like when she trains someone on one of the machines. From her experiences, four main types of learning emerged: tool learning, resourceful learning, space learning, and management learning. Tool learning and space learning inform resourceful learning, and management learning is informed by space and resourceful learning, as shown in Figure 2.

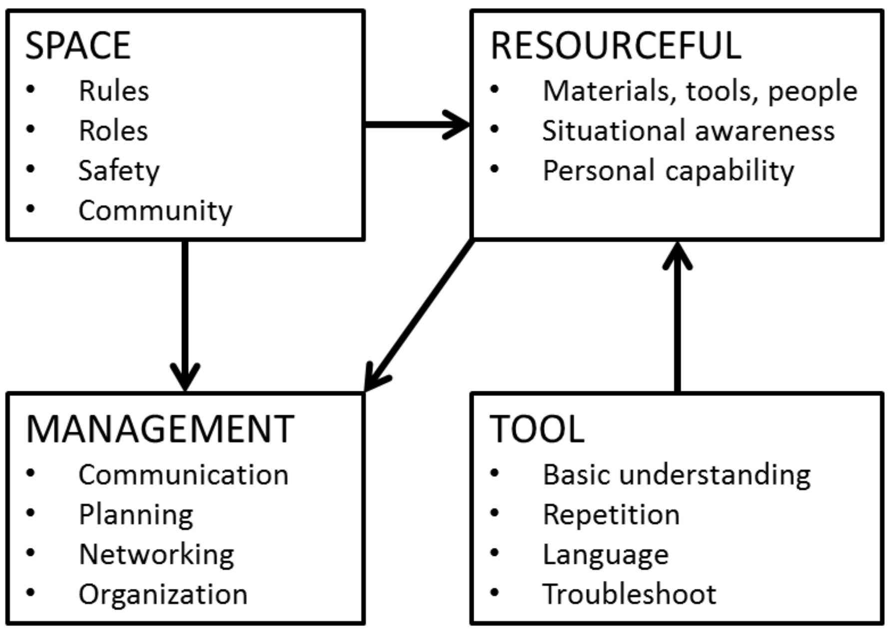

Figure 2: Types of learning that Glen encounters

5.2.1 Tool Learning

In developing competence in the space, Glen learns more about tools through learning how to develop a basic understanding of the tools, how to get accustomed to the tools through repetition, what language to use to talk about the tools, and how to troubleshoot the tools. Tool learning focuses on physical tools and computational tools. Glen develops her competence through gathering a basic understanding about the tool and how it works. She then builds her competence in tools by thinking of simple projects that use a tool and repeatedly using the machine throughout her iterations of her prototypes.

> *Like with the lasers, I used to not be very good on the lasers, but I've done probably six or seven projects on them. And I've gotten better at, "Okay, here's a problem. Here's when it's happened before. Here's how I fixed it before. Let me just try those solutions."*

From here, Glen also acquaints herself with the language and terminology associated with using the machines. She learns from developing her basic understanding, from going through issues and resolving them, and from trying to use the appropriate language with the tools. This helps her to create a step-by-step process that allows her to troubleshoot issues with machines. Continuing with the above example:

> *And so I feel much more confident knowing that if someone comes to me with a question I can't answer, I kind of know the steps to walk through the problem solving. And if all those fail, I can find someone who knows more who can take their steps. ...being able to point out, "Here's the issue you probably have. Here's how to fix it. Here's why it happens, and here's how to prevent it." Like I can go through that for most of the common errors.*

5.2.2 Resourceful Learning

Through developing more of an understanding of tools, Glen is then able to build off of the resourceful learning that is occurring in the space. Glen learns how to be resourceful through understanding about the materials, tools, and people in the space along with extracting details and being aware of the current situation while knowing of what she is personally capable. Glen, more often, will buy materials *"just because."* She knows what materials are able to be used for multiple purposes and for potential future ideas. This is juxtaposed with her knowledge on tools (i.e., what tools she will use and what tools she can use quickly). She also has learned who the people are whom she can turn to and who will help her to finish a project. When Glen is making something, she thinks about the *"Let me see what resources I have and how I can look like that character with those resources."* This is particularly apparent when she comes into the space, and she wants to create something. She looks to the materials that she has, the machines that are available, and the potential customer or purpose for her project; then she makes something. All within the reason and understanding of what she is capable.

5.2.3 Space Learning

When becoming more involved in a space, a person learns what the implicit and explicit rules are of the space, who the people in the space are and what their roles are, what the safety indicators for the space are, and what the community is like. Learning about the space, or space learning, is about learning how the makerspace works. There are rules to the space. Sometimes these rules are explicit and well-known. Other times, they are implicit. Through her participation in the makerspace, Glen is learning how to follow the rules governing these unique spaces and how to gain insights into the implicit rules. This will help her in other situations and spaces where she may not have the knowledge about rules in the space. Additionally, Glen has learned who she can talk to in the space and what the roles are in the space.

> *I'm really in there as a maker and not as a [student worker]. It's hard -- once people start recognizing you, like you can -- usually when you go in -- as you go*

> *into the [makerspace], you can pretty easily tell who's a [student worker] and who's like a maker -- or who's just like a user of the space. Like I think when I went up to the structure last time it was like user, [student worker], and [experts], and [board member].*

Glen has defined clear roles of the people in the space, identifying that one can even fluctuate between roles. Moreover, Glen also learns how safety is enforced and identified in the space. She mentions that as a student worker, her first steps in entering a room involve looking at the safety of the space. *"And so I'll go in, and if there's people working, I'll make sure to do like a safety check."* By developing an understanding of safety indicators, she can quickly point out and make amends to any hazardous events in the space. Lastly, her involvement in the makerspace allows her to learn more about the community, and what it is like. Learning about the community helps her to understand the maker culture, how the community works, and how she can grow in this community.

5.2.4 Management Learning

In her role on the student board, Glen has learned more about management. She has become equipped with knowing how to communicate to board members and supervisors, how to plan events, how to reach out and network, and how to maintain organization in a makerspace. Now, Glen learns to build efficient and effective forms of communication to other board members, supervisors, and other student workers. She develops a voice that allows herself to be heard and clearly understood. This aids in her ability to plan events for the space where she must network and go beyond her current contacts so as to provide for the needs of the community.

> *So for me it's a lot of administrative stuff. It's -- okay, so someone wants to do a workshop, let me make sure that the resources for that – let me get them a room, and pick a time, let me put it on Facebook and email people. Or like say we had a bus maker fair this year. It was like, "Okay, let me organize the bus, and make sure the finances are in place, and we talked with the relevant people. Let me make sure that there is posters for that, and publicity for it, and everything."*

Ultimately, the amount of work that she does requires her to be significantly organized and able to showcase this organization to other student workers and board members.

6 Learning in the Makerspace

6.1 Types Learning

How does the academic makerspace afford learning for Henry and Glen and what are they learning about?

By engaging more in makerspaces, the female students are learning through their making experiences. For Henry, the focus is more on the ability to problem-solve. The more she learns in the space then the more that she can do in designing and problem solving. While for Glen, she desires to be more involved in the community of the space and developing an understanding of the machines in case she needs to use them. She emphasizes that if she does not know how to use a machine then she has the ability to ask someone if needed. For both, their effort to engage more in the space allows them to learn more about making and designing.

6.2 Implication for Learning

What are the implications for this learning compared to traditional learning approaches?
In the makerspace, Henry and Glen have the ability to place their work in the context of their lives. They are learning through their respective situated experiences. Henry asks question after question, and this method is acceptable in the makerspace, where she will ask questions about machines, projects, and designs. She is given opportunities to learn and talk to others more knowledgeable about the designs. Whereas, Glen is able to complete several iterations of a project so that she can learn more about the tools while using the resources available to her. On the contrary, traditional learning approaches do not inherently facilitate placing learning in context of one's life.

Further, through working with others and building off of each other's ideas, Henry and Glen are both able to learn more in the makerspace. From a social learning framework, Henry is engaging with others about what she is making, about what they are making, and about how what other people are doing can feed into her own designs. She is also interacting with superiors about the space and learns more about what she can do in the space. For Glen, she is connecting with others, asking for help, understanding the community, networking for events, among other activities. Glen is fully engaged with the people around her as she builds on their own expertise to create designs. Meanwhile, learning via building off of other people's ideas can remain a challenge in traditional approaches. Traditional approaches can incorporate collaboration, though a makerspace has the ability for multiple and diverse collaborations to contribute to a project.

Through engaging in these spaces, the female students interviewed harness the ability to understand and make something from their own and other's interests and struggles. Henry starts to develop a greater understanding of herself and how she learns. She starts to realize that the makerspace is a place not only for solving her own design problems but also helping others and working with others to solve greater problems. She brings what she learns in the makerspace into different contexts, such as class group work and research, where she collaborates and leverages the experiences of her peers. Moreover, through understanding more about the community, Glen recognizes what her role is, what she is capable of, and how working with others helps her to make innovative designs. From all her types of learning, she is more able to contribute to the community and the ideas of others. The awareness of one's own self and learning abilities is not fully engaged in traditional learning approaches. The traditional learning approaches can confine the opportunity to pursue alternative and unstructured learning approaches.

7 Conclusions

Makerspaces are considered open, learning environments. While college campuses are investing billions of dollars into adding makerspaces to their campus, the value of the impact of these spaces begins to be questioned; this further begins speculation as to whether these spaces are actually places where learning is occurring. Even so, while in the typical classroom setting, learning is evaluated through examinations, rubrics, and expert evaluators, the same cannot be said for the learning that could be occurring in the makerspace. For a makerspace does not warrant exam-based or rubric-based evaluations; this would negate the very foundation of the makerspace.

To study the learning that is going on in these spaces, we, therefore, utilized qualitative research methods. This paper presents the findings of a three-series in-depth phenomenologically based interview process with two female participants who were engaged in using different university makerspaces. Since understanding a makerspace is a large and broad endeavor, the scope was sharpened to look at the learning occurring in the makerspace for two female students. From the second interviews for each female, types of learning emerged from the data and were juxtaposed to implications compared to traditional learning approaches. The types of learning that emerged for one female participant were: machines learning, design learning, social learning, and self-learning. For the other female, the types of learning were: tool learning, resourceful learning, space learning, and management learning. These types of learning are placed into the context of these females' lives, into settings to work with and build off of others, and into expanding beyond one's own interests showcasing the heterogeneity of learning in makerspaces. By examining the phenomenological experiences of learning in these spaces, we are able to begin to identify how these spaces are impacting the female students' educational experience in higher education.

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