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Space invaders: First-time users feel like intruders in the makerspace☆

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ABSTRACT

Makerspaces have proven to be mainstays within library ecosystems. However, alongside the continued popularization of library makerspaces, there remains a seemingly immovable issue endemic to these environments; makerspaces continue to attract a narrow demographic of patrons. The threshold of the makerspace serves as a critical site for inquiry, specifically, for insight around students' everyday life information seeking (ELIS) behaviors. This study responds to the research question, "Why do students from underrepresented communities turn away at the threshold of a makerspace?" The research design is methodologically informed by participatory action research (PAR) and grounded theory and uses a virtual reality (VR) makerspace to provide a consistent "threshold" experience to capture students' fleeting first impressions. The research findings offer novel insight into the information seeking behaviors of students by capturing and analyzing critical data that haven't been collected before: the real-time thoughts and feelings of students from underrepresented communities entering a makerspace for the first time.

1. Introduction

More than a durable trend, makerspaces have proven to be mainstays within library ecosystems (Melo, Hirsh, & March, 2022). However, alongside the continued popularization of library makerspaces, there remains a seemingly immovable issue endemic to these environments: makerspaces continue to attract a narrow demographic of patrons. The issue of the underrepresentation of diverse user communities has been researched since the inception of the maker movement in the mid-2000s. Existing scholarship on inclusion in makerspaces has provided generative research angles for application. This research seeks to add to the conversation by focusing on a critical yet admittedly mundane feature of the makerspace: the threshold. The threshold of the makerspace serves as a critical site for inquiry; specifically, for insight around students' everyday life information seeking (ELIS) behaviors when it comes to using a makerspace (Chen & Hernon, 1982; Huotari & Chatman, 2001). In this research study, the threshold is seen as a clear juncture for students to either enter or turn away, making this a generative site for investigation because a clear decision is being made: to enter or to turn away. The research findings offer novel insight into the information seeking behaviors of students by capturing and analyzing critical data that have not been collected before: the real-time thoughts and feelings of students from underrepresented communities entering a makerspace for the first time. The research design is methodologically informed by participatory action research (PAR) and grounded theory and uses a virtual reality makerspace to capture students' fleeting first impressions.

This study poses the following research questions:

- What first impressions, gut reactions, and feelings do students experience?
- How do students who've never been to makerspace experience it?
- Why do students from underrepresented communities turn away at the threshold of a makerspace?

There is persistent dissonance between the user communities that makerspaces attract and the touted values of the Maker Movement – a movement that promotes creativity and hands on making for any and all who are interested (Hynes & Hynes, 2018). This research scrutinizes the entanglement between the design and spatial arrangement of a makerspace with the decisions that participants make when deciding to enter or not.

2. Literature review

The Maker Movement is a global phenomenon that sparked interest around collaborative making with DIY technologies around the mid-

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2000s. Although making and design spaces have long existed before the social movement (what Costanza-Chock, 2020 calls "subaltern sites"), this brand of making celebrated creation of all types but more specifically DIY tinkering with technologies such as 3D printing and microcomputing (Costanza-Chock, 2020). Making as a form of innovation and information seeking is a constructivist learning method that has been promoted in university makerspaces. Through the process of 'making,' students are constructing their knowledge on how to problem solve and engineer solutions (Lombardi, 2007; Melo & March, 2021). However, there is an overwhelmingly narrow demographic who utilizes makerspaces (Holbert, 2016; Hynes & Hynes, 2018; Lam, Cruz, Kellam, & Coley, 2019). The Principal Investigator (PI) of this research program spent eight years either working in or collaborating with makerspaces. During this time, the PI became intrigued by a recurring behavior that occurred when individuals reached a certain point. It became evident that this behavior was not unique to the makerspaces the PI was personally involved in, but rather a common phenomenon observed by colleagues and collaborators across various makerspace environments. The patterned behavior ultimately inspired this research.

2.1. Everyday life information seeking practices

Common university environments such as a library or dining hall are chock-full of informational cues that students consider when making a decision: Should I leave a collaborative learning area in the library for a quieter one? The dining hall is unusually busy, should I go off campus to eat? These everyday information seeking practices are made almost unintentionally by students in real-time as they base their decisions on actively scanning an environment for information (McKenzie, 2003). An analysis of the mundane information seeking processes reveal norms, behaviors, and values of a specific community (Huotari & Chatman, 2001). Specifically, this research is informed by a seemingly inconsequential behavior that occurs at the thresholds of makerspaces: students approach the threshold, look inside, and walk away. This moment of decisioning could provide important insights into the ELIS practices of students from underrepresented communities (Chen & Hernon, 1982; Huotari & Chatman, 2001; Warner et al., 1973). ELIS is characterized as the ordinary information seeking behaviors that occur in daily life contexts (Huotari & Chatman, 2001). While ELIS provides a helpful framework to recognize the potential impact of the spatial configuration of a makerspace, the student's personal values, beliefs, and lived experiences all play a role in their information seeking behavior (Ahmed, 2010; Soja, 2010). The engagement of ELIS theories has shaped the first two years of this research program (i.e., the scope of the current study) where a focus on the baseline defining features of a makerspace is first investigated. ELIS played a significant role during the second year of the program where experiences and reactions of students experiencing a makerspace for the first time was examined.

2.2. The maker movement and diverse user populations

One core value of the Maker Movement is accessibility in terms of technologies, materials, and community expertise. Accessibility was seen as a democratic incentive to invite and welcome a diverse population of makers. The Maker Movement received local community support, but also generated interest on a national level. For example, the Obama Administration held a "Week of Making" event to support and motivate a generation of makers, specifically underrepresented and diverse students (Greene, Kellam, & Coley, 2019; Melo, 2020). Despite widespread adoption of makerspaces and interest in making, the inclusion of underrepresented students - namely, students with disabilities and students from marginalized gender and racial communities - continues to be a persistent problem (Andrews, Borrego, & Boklage, 2021).

Underrepresentation in university makerspaces is a complex issue, and one contributing factor relates to how students are treated and perceived within these spaces. To delve into this matter, researchers conducted interviews with women who had utilized the makerspace at Arizona State University. The findings revealed that female engineering students frequently faced doubts about their abilities while in the makerspace (Lam et al., 2019). This skepticism can make it challenging for women and individuals from historically excluded communities, such as BIPOC, LGBTQIA+, and people with disabilities, to return to and engage with such spaces, as their knowledge and skills are constantly questioned. Consequently, this contributes to creating an unwelcoming atmosphere within the makerspace environment (Lam et al., 2019).

This study contributes to the broader discourse on makerspaces and inclusion by considering various research perspectives and approaches, including the "prove-it again" bias. It focuses specifically on the physical layout and design of makerspaces and the messages they convey to potential users. Although makerspaces are often associated with STEM (Science, Technology, Engineering, and Mathematics) disciplines, it's important to note that these spaces are not exclusive to STEM students. Instead, they promote interdisciplinary collaboration. As highlighted by Hynes and Hynes (2018), bringing together students from diverse academic disciplines in makerspaces offers numerous benefits, including the opportunity for students to gain fresh perspectives from their peers, develop innovative solutions that may not have arisen within their own disciplines, and foster valuable collaborations within the university community.

2.3. PAR in LIS for community-centered research

PAR is a collaborative research method where researchers and impacted community members are co-informants regarding a specific topic or challenge, decentering the researcher as sole expert and instead recognizing expertise amid researcher and community members (Singh, 2020; Somerville & Brown-Sica, 2011). PAR and ELIS are a generative pairing to capture this fleeting dataset while also honoring the importance of centering the makerspace user communities. Having an egalitarian relationship is important for this research program because the participants are community members and potential users of the university's makerspace. By including participants in the research via a PAR framework, the research upholds the value to promote a democratic community-based approach for redesigning inclusive makerspaces (Mehra, Peterson Bishop, Bazzell, & Smith, 2002).

Including participants as co-designers provides deeper insight into historically marginalized student communities and the way makerspace culture intersects with their lived experiences (Baum, MacDougall, & Smith, 2006). In terms of PAR specifically, participants can be included in any part of the research process from forming questions to data analysis. PAR can include methods such as surveys, focus groups, charrettes, and interviews (Barniskis, 2013; Mehra et al., 2002; Singh, 2020). Including participants in research will look different depending on the context of research. An advantage of PAR is the incorporation of participants' lived experience, which shifts the power from the researcher to the community that have or will be impacted (Barniskis, 2013; Baum et al., 2006). PAR in LIS research will be beneficial in creating more inclusive spaces (Somerville & Brown-Sica, 2011).

As a qualitative research method, PAR findings are not evaluated based on generalizability but instead on their ability to produce valid inferences (Morse, 2006). PAR practiced in LIS, and within the scope of this research program, aims to encourage action within libraries and information seeking communities. Existing scholarship shows the use of PAR to design library spaces, in addition to an improved understanding of the information seeking behaviors of underrepresented community members (Mehra et al., 2002; Siew, Yeo, & Zaman, 2013; Somerville et al., 2011). The strength of using PAR to research experience and produce action contributes to this research program's goal of identifying what makes underrepresented students turn away from the makerspace threshold, and apply their insight (i.e., the research findings) as design interventions to create a more inclusive makerspace. Moreover, this research program's implementation of PAR will be expanded on in the

Methods section.

3. Methods and methodology

At a high level, this research program consists of three parts: (1) identifying the defining features of a university makerspace, (2) collecting and analyzing the everyday information seeking practices of first-time makerspace users (the scope of this study), and (3) and the implementation of the findings from phase two into an operational makerspace. The current study for phase two of this research draws from a constructivist grounded theory foundation, which supports the findings based on the knowledge of the participants (Charmaz, 2014).

The intention to pair PAR with grounded theory was to collect deeper, real-time data regarding students' first impressions of a makerspace (Afzal, 2012). Additionally, "embedded participatory techniques, when paired with grounded theory methods, build testable theories from the ground up, based on the real experiences of those involved" (Barniskis, 2013). In the current phase of this research study, the researchers relied heavily on the participatory piece of PAR, with the action piece being applied in phase 3 of the research program.

3.1. Participants

Purposive sampling was used to recruit students (undergraduate, graduate, and Ph.D.). To be included in the study, the participant needed to be a University of North Carolina (UNC) at Chapel Hill student and identify as one or more of the following: LGBTQIA+, Black, Indigenous, person of color, disabled, marginalized gender identity (cis-gender woman, non-binary, transgender man, transgender woman), first-generation college student, or lower to middle socio-economic status. Participants were recruited through email and social media. The sample population focused on UNC Chapel Hill students since the researchers are a part of this community. The goal is to deepen an understanding of this community through research and the application of findings in existing makerspaces therein. Researchers invited students who had not been to a makerspace before. The intention behind this rationale was to collect a fleeting, short lived dataset: students' first impressions and reactions to an environment they haven't experienced. Had the participants been to a makerspace before, the context of their previous experience would have biased their experience within the VR makerspace. In total, there were 16 participants in this study.

3.2. Data collection

The following PAR methods were chosen for this research study: think-aloud observation, follow-up survey, and a semi-structured interview. Each session lasted 45 minutes and was structured as follows: 20 minutes for the think-aloud observation, 10 minutes for the follow-up survey, and 15 minutes for the post-observation interview. During the think-aloud portion of the study, participants explored the virtual makerspace for the first time while discussing their thoughts and impressions as they walked through the environment. The follow-up survey shows how participants felt about specific metrics, such as if they felt empowered, intimidated, or welcomed. At the end of the think-aloud portion, researchers conducted an interview where participants were asked to elaborate on their makerspace experience in conjunction with their responses to the post-observation survey. Specifically, these three methods were chosen to triangulate the data analysis, while also allowing participants opportunities for reactive (think-aloud reporting) and reflective (survey and interview) responses.

3.2.1. Virtual reality

Virtual reality (VR) is an immersive technology that has the ability to simulate real life experiences digitally. There are various uses for VR: recreational to professional, as well as for conducting research (Bruno et al., 2010; Davies, 2004). The application extends to participatory research in meaningful ways, as VR can immerse participants into digitally created environments or situations for various uses. VR environments allow for co-designing of spaces and gaining better insight around interface usability (Bruno et al., 2010, Davies, 2004). For example, in a study exploring the effectiveness and efficacy of VR for participatory methods, Bruno et al., found that VR is a generative method for usability testing as well as gaining feedback to improve the usability of interfaces (Bruno et al., 2010). VR served a critical role in the research program: it provided an observational setting where the variables in a makerspace remained consistent (this wouldn't be possible in a physical, operational makerspace). For example, variables such as the weather, available technologies in the space, and the staff working in the makerspace could spur remarkably different experiences for each participant. Creating a VR makerspace also afforded participants with an accessible way for students to participate in the study. Considering COVID-19 restrictions, participants had the opportunity to participate remotely, using the desktop version of the makerspace instead of the VR headset which would necessitate an in-person meeting. To ensure data fidelity between data gathered on the desktop or VR headset, the study compared the data gathered from the think-aloud portion of the study from both interfaces. The main objective was to determine if participants' responses would've differed depending on the interface; all participants responded in the negative – the interface (either a VR headset or desktop) did not impact how or the content of their responses.

3.2.2. Virtual makerspace

The think-aloud observations were held in a virtual makerspace, created by a local VR development company. Students accessed this makerspace using a Virtual Reality headset or their desktop computer. The virtual makerspace was crafted using input gathered through interviews with makerspace leaders from the UNC system of universities. These leaders were asked, "What are the key characteristics that define a makerspace?" The responses provided by these makerspace leaders informed the development of the VR makerspace. Additionally, items were strategically placed within the virtual makerspace, like backpacks in the communal work area and a drink tumbler in the sewing section, to indicate that other students were utilizing the space. This was done to convey the sense that the space was being actively used. However, it's worth noting that virtual staff members or makerspace users were not incorporated into this representation, as their inclusion could have created a distracting and unrealistic depiction of people within the space. Consequently, the data collection efforts did not prioritize gathering information related to the physical characteristics of individuals in the makerspace.

3.2.3. Usability and comfortability of VR technology

To ensure data fidelity, the researchers measured participants' comfort using the VR interfaces. Given the target population, desktop computers were known to be a familiar technology whereas VR headsets were not as familiar. To determine whether participants' responses and overall experience were impacted by the different interfaces, the researchers created a survey to quantify usability and comfortability of using the VR technology. The survey was composed of multiple statements regarding either usability or comfortability, which participants rated in a Likert Scale from "Strongly Disagree" to "Strongly Agree." The data from this survey is used to show data fidelity as well as acceptance of the technology.

3.3. Data analysis

Data collection and analysis were co-acted together: as the researchers conducted observations for data collection, they also began the analysis process. ELIS provided a critical framework to guide the analysis. Applying ELIS as a framework helped uncover the underlying factors that contribute to students deciding to turn away from makerspaces. This framework allows for a more holistic examination of the

Table 1
Study findings and prevalence.

Finding	Definition	Prevalence (Out of 16)
An open space isn't an inherently welcoming space	Despite the visual openness of the space, participants didn't feel welcome	15
Familiar feels welcoming	Seeing familiar tools (e.g. sewing machine) and/or areas within the makerspace inspired feelings of being welcomed in the environment	14
I am an intruder	Participants felt like they did not belong in the space and/or they were not the intended audience	13

social and cultural contexts shaping students' information-seeking behaviors and reveals insights to address this issue of demographic narrowness in makerspaces. ELIS practices serve as a revealing lens into the dynamics at play within a student's social and cultural context. The findings from this study extend a striking illustration of how the spatial organization of makerspaces can trigger a sense of alienation among first-time users. Specifically, ELIS highlights the profound impact of norms, values, and trust networks within one's small world. Librarians, educators, and information professionals seeking to provide support to diverse communities can gain valuable insights by understanding how these practices shape information-seeking behaviors.

Informed by an inductive analytical approach, the researchers performed line-by-line coding as outlined by Charmaz (2014). After coding the first three transcribed observations, the researchers discussed common themes. These themes were fully developed and compiled into a codebook that was used as a reference guide for the remaining transcripts. Across the 16 transcripts, 23 categories were identified. This data was analyzed by seeing how many participants referenced each code. The findings were organized into a saturation grid to determine the prevalence of each finding.

4. Findings and discussion

The researchers argue that the spatial arrangement of makerspaces invokes a sense of alienation in first-time users from underrepresented student communities. This ultimately spurs feelings of intrusion and the incessant need for users to seek permission to be in and to use the space. Specifically, this argument is evidenced by three categories that emerged from the data analysis. The spatial organization of makerspaces is an information source that first-time users use to determine whether the environment (and by extension persons therein) could be trusted and if their information needs will be met. A common thread that was surprising was how the information seeking thought processes were tied directly to the participant's gut feeling or overall feelings of the makerspace. This supports the idea that an information need of the makerspaces *needs* to communicate safety and trust both on physical and emotional levels. Table 1 outlines the findings and prevalence based on participant responses.

The following sections unpack the study's major categories and the accompanying codes that comprise them. Each category will be explained individually and collectively.

4.1. An open space isn't an inherently welcoming space

Upon entering the virtual makerspace, participants step into a spacious room with visible work benches, machines, and tools. Fig. 1 shows how directly in front of participants is a wall of windows that invites natural light into the environment.

One of the first sentiments that participants expressed was how open the space felt. However, while participants were impressed by the spaciousness of the environment, this feeling didn't necessarily inspire a feeling of welcomeness. This observation ran contrary to what the research team assumed to be a positive feature of the space. Specifically, one participant articulated the uneasiness of the vastness of the room upon entering:

> "It's a really big space. I think since I've never been in one, it's very intimidating. I see three computers that I don't want to touch because they're expensive. There's power tools over there. Power tools here. Computer solder. I think I would need training. I don't know, gives me anxiety since I don't know how to use any of this stuff."

To pinpoint this uneasiness further: 93% of participants noted that the openness of the environment was a source of intimidation. Typically, when a space feels open it is accompanied by the assumption that it is welcoming. However, this finding unlinks the assumption that an open environment is an inherently inviting environment (Bernstein & Waber, 2019). These responses support the idea that feelings of intimidation and discomfort arise and can influence first-time users to turn away. It became evident that the ELIS behaviors exhibited pinpointed a sense of embodiment – the body is an information source. The information that participants were processing indicated that they were not welcome. Moreover, in alignment with this finding, participants compared this discomfort with being in the spotlight or being put on the spot.

Compounding the negative reaction to the spaciousness of the makerspace, participants noted that the space seemed cold – not in terms

Fig. 1. View of the VR makerspace from the threshold of the entrance.

of temperature, but in regard to how inviting the space felt. Specifically, the term "sterile" or "cold" came up across four observations:

> "I think it was the fact that there [were big machines that] seemed very expensive that definitely made me feel like I needed permission more. So I think it was that, so even more sterile looking, I definitely would feel more stressed about messing it up or something."

The uneasiness stemming from the "sterileness" of the makerspace came up as participants tried to make sense of the rules of the makerspace. The lack of signage made it difficult to know what and how participants should behave in the environment. Moreover, the sterility of the space manifested in how "clean" the environment looked, and with a self-possessed fear: participants didn't want to burden the space with their presence. In other words, there was a fear that they would get in someone's way, break something, or make a mess.

4.2. Intruder

The feeling of being in the spotlight is accompanied by a sense of alienation for first-time makerspace users who do not feel like they are the intended audience. Alienation in the sense that while they understood the environment to be open to them, the makerspace in itself signaled that they weren't the intended audience. Participants expressed feeling like they were an outsider, viewing the space as a place to view from a distance, but not to utilize. One participant shared that:

> "I think with students in particular, myself included, I think we're just worried that we're trespassing. I think this is just a universal feeling. You don't want to feel like you're trespassing at a place. I'm like, 'Well, maybe I shouldn't be here, because this feels like trespassing."

This sentiment was shared by 80% of participants, indicating that the environment invoked a sense of alienation. Participants conveyed a variety of unsettling emotions, particularly by characterizing their role within the environment using identifiers such as observer, visitor, rule breaker, intruder, and burden. One participant reflected that they felt like they were in a museum, where they could look at what was in the space, but not touch it. This presents an issue because the sense of exclusivity that participants felt contradicts the intended tone of a makerspace – to welcome diverse user communities. In a makerspace, the primary aim is to encourage people to interact, explore, and engage in creative problem-solving. Furthermore, the feeling of being an intruder was heightened by another discovery: participants expressed a desire to have a friend with them.

Nine participants specifically expressed a desire to have a friend to accompany them in the makerspace. A friend acts as a protective layer to an otherwise anxiety-inducing encounter with a new environment. The feeling of a makerspace generates feelings of alienation, and to counter this, a friend offsets this unsettling sensation. A friend extends affective protection against an environment that is perceived as threatening. While the threat of physical harm wasn't articulated, the threat of being judged is evident:

> "I feel like one of the main things is just this feeling of unsureness and feeling a little bit out of place just about not knowing what this space is. I know one of the other comments on it was talking about, oh, I would definitely go into a makerspace if I had a friend there with me. I feel like that statement is very true just because I do know someone who is always in there and I've always wanted to go, but I feel like I wouldn't go unless I'm there with her just because she knows the space better than me and she'd probably show me the ropes better instead of me just wandering in a little bit lost."

Friendship offers a microcosm of affective protection against the "sterile" environment and intimidation of a makerspace. Reinforcing the notion of feeling like an intruder is the overwhelming sensation among participants that they require permission to occupy the space, as reported by 81% of respondents. This highlights their sense of not truly belonging in the environment. Specifically, a participant mentioned that in order for someone to feel comfortable in the space: "they feel like they'd have to know everything or be extremely tech oriented to walk in and know what they're doing." Part of what contributed to the feeling of being an intruder and needing permission can be attributed to the exclusive feeling that the space is only for people making in the realm of science, technology, engineering, and math (STEM). 62.5% of participants expressed how high tech the various tools in the space looked, and that they would not be comfortable using that equipment:

> "With the power tools and the laser cutters and the soldiering and computers, or even the 3D printers was intimidating too because it's like I have no idea how to use those and made me feel like whatever I was working on was going to be less than the projects of those people who were into construction stuff we're going to be making to use these things."

Feeling like an intruder was further compounded by participants' assumptions of the demographics of *who* belongs in the space, which they associated with people who are represented in STEM fields.

> "It's a building and I could walk into it, but I do feel a little reserved about it, just from prior experiences of people I've seen working in technology and using spaces like that before."

> "[I feel] less comfortable. Probably, if I think it's mainly going to be used by guys, that definitely makes me feel less comfortable and definitely more intimidated seeing the power tools and the computers. And it makes it feel like whatever project I might be doing in here is not the right vibe."

These two participant quotes show that there is an established view of who belongs in a makerspace and who does not. For students who do not fit in with the assumed targeted demographic, it can be very exclusive and further contribute to the feeling of being an intruder.

4.3. Permission

A major theme that branches from the intrusion finding was participants' incessant need for permission. Participants wanted the assurance that they were allowed in the space: at a fundamental level, they just wanted to make sure their presence was permitted in the space. The idea of permission came up explicitly during the observations, and was coupled with the discussion of signage or, more specifically, the lack thereof.

Signage was both a means to provide logistical information (e.g. open hours), but more as an extension of permission (i.e. there isn't a cost to use the 3D printer). During the think-aloud observation section of the study, participants asked several questions. Questions ranged from how to use specific technologies to what would happen if they, the user, were to accidentally break something in the space. Participants noted the importance of signage to help offset their questions and concerns about the makerspace. The lack of signage contributes to the uncertainty and intimidation that participants felt. The need for permission is further deepened as it is also extended through familiarity and competence: knowing how to use equipment begets an understanding (even if implicit) of the values of the space, who uses the space, and expectations (i.e., I know that acrylic could be expensive, hence it would be asking too much to use 4 sheets for a project).

4.4. Familiar feels welcoming

An environment that is unfamiliar can be unwelcoming, and these findings underscore the prevalent sense of exclusion experienced by underrepresented students. It suggests that they require permission and reassurance to access and utilize the makerspace. However, participants remarked a sense of delight, joy, and even inclusion when they

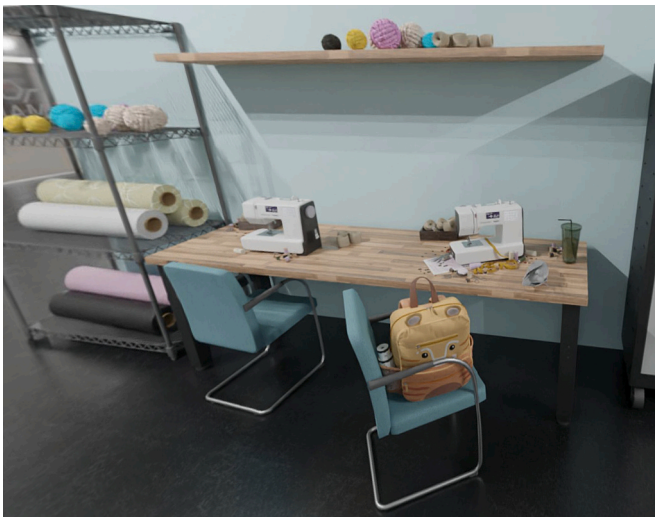

Fig. 2. View of a section of the sewing area in the VR makerspace.

encountered familiar technologies or materials. 14 participants or 88% mentioned positive associations when entering the sewing section of the makerspace as shown in Fig. 2. These positive associations were followed by participants' noting their willingness to try the sewing machine or saying that they would be comfortable using the sewing machine first out of the other tools in the makerspace.

Participants expressed a sense of invitation or encouragement to use tools or materials based on prior experience, such as familial memories (e.g., my grandma taught me) or their previous projects using sewing machines. One participant stated:

> "[A] sewing machine is something that I'm familiar seeing, so at first glance it's not very intimidating, but for something like the 3D printer, I've never seen that before so I'm definitely not going to know how to use it. I feel like with this, I'd be more comfortable just from experience and just knowing what it is."

Each participant arrives at the makerspace with their own experiences and understanding of technologies, and this research shows that it was evident that familiar technologies spurred a range of emotions in participants. Specifically, this finding erred on the side of positive reactions to familiar objects – namely the sewing machine area of the makerspace, which 10 participants responded to in a positive way. While familiar materials can be a shorthand for invitation, it also appeals to the users' previous experience and competence: you've used a sewing machine or grew up around one and can attest that it isn't an intimidating technology (and by extension not an alienating signifier). In an environment that is overwhelmingly unfamiliar, familiar features offer participants an anchor for their understanding of the space. Participants said that seeing a sewing machine signaled to them that they were welcome into that part of the space. Put another way, Ahmed (2010) notes that the "biography of a person is intimately bound up with objects" (2010). That is, participants expressed excitement, joy, nostalgia, and delight when seeing the sewing machine. However, there was an instance where a participant articulated a familiarity with the power tool space shown in Fig. 3 in a negative light:

> "This looks like a Home Depot. It's even Home Depot colors, like the orange and the black. That's not someplace I would feel comfortable going into… I guess subconsciously, the expectation for me would be like, you have to come in here and already know what you're using and how to use it. Yeah."

Participant sentiment aligns with the associated affective qualities that the participant assigns to certain objects, as Ahmed (2010) notes:

An object can be affected by virtue of its own location (object might be here, which is where I experienced this or that affect) and the timing of its appearance (the object might be now, which is when I experience this or that affect). To experience an object as may affect of her sensation all is to be directed not only toward an object but to what is around the object, which includes what is behind the object, the conditions of its arrival (25).

While it's clear that the familiarity of a space can invoke a range of reactions, this study shows that familiar objects spur more positive reactions than negative when it comes to an environment that participants are largely unfamiliar with.

5. Conclusion

Students from underrepresented communities arrive at the threshold of makerspaces with information needs, which are not only logistical in nature but are based on feelings of safety and assurance. For first-time users from underrepresented communities, a makerspace can be overwhelmingly unfamiliar and spur unsettling feelings, thoughts, and questions.

Specifically, the findings show that participants felt alienated from the space and excluded from the intended audience. In terms of the ELIS behaviors of participants, it was clear that their bodies were a driving information source to determine whether to enter the space and how to interact in the makerspace. To combat the feelings of intrusion, users noted the need for permission to be in the space and purpose for being in the space. Purpose in this context is an extension of permission – to have a purpose is a form of permission (e.g., I have a research project with findings I need to visualize with 3D modeling for a class project).

Participants turn away at the threshold because they don't believe

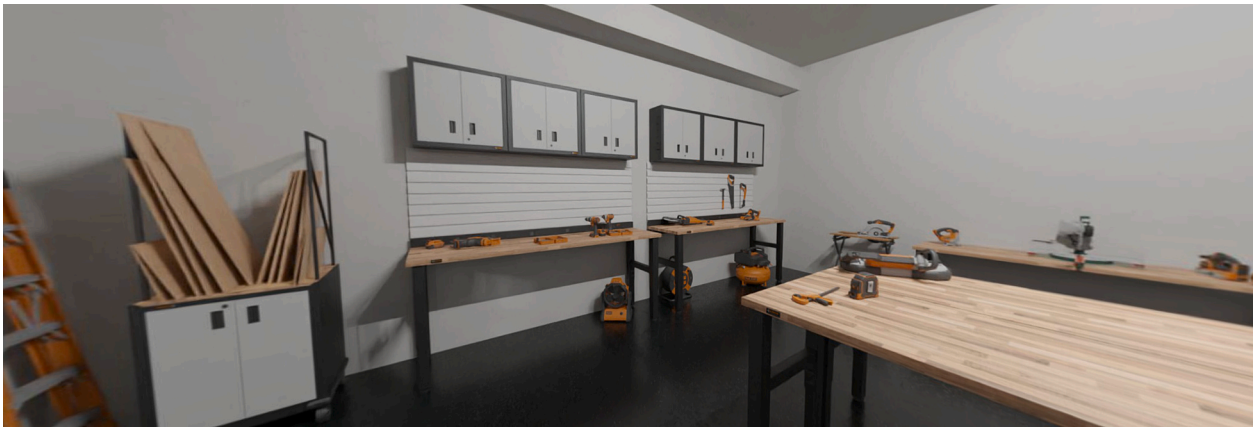

Fig. 3. A view into the power tool room in the VR makerspace.

that they are the intended audience for the environment, because the environment is too unfamiliar to them, because there is a fear of judgment. Despite the desire to create makerspaces that are inclusive and open, this desire doesn't translate into the design of the space. The two are at odds with another leaving a dissonance between the hoped for intended audience and the first impressions that the space conveys immediately. This research study presents an opportunity for continued exploration. The initial findings were based on participants' responses within a simulated makerspace in virtual reality. Subsequent research endeavors will enhance our comprehension of students' perceptions, as the Principal Investigator (PI) intends to apply these findings to a real-world operational makerspace.

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