# Do I Belong in a Makerspace?: Investigating Student Belonging and Non-verbal Cues in a University Makerspace

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# Do I Belong in a Makerspace?: Investigating Student Belonging and Non-verbal Cues in a University Makerspace

**INTRODUCTION:** There have been dramatic trends displaying the problem of under-representation and lack of retention of females and minorities in STEM majors [1, 2]. With the long-standing stigma that predominantly men succeed and compose these fields, the sense of belonging for females and minorities in these fields is minimal, and entrance is unattractive [3, 4, 1]. The idea of "belonging" is the sense of fit or acceptance that people experience in response to physical objects, layout, and member representation that make up an environment [4]. Sense of belonging, therefore, is crucial to manifesting interest in a subject or domain [4, 2] and, as research shows, contributes significantly to self-efficacy [4]. By capitalizing on methods to increase students' sense of belonging and confidence in STEM majors, more students could be attracted to pursue STEM degrees [4]. Recent trends in welcoming makerspaces into educational environments suggests that makerspaces provide a domain in which interest and creativity is propagated. This work-in-progress study hypothesizes that by implementing a university makerspace that welcomes a representative population through non-verbal, physical cues, increased feelings of belonging and self-efficacy can be achieved. However, a tool is needed to evaluate stereotypes and ambient belonging in makerspaces. This study is in the preliminary stages of developing such a tool.

A university makerspace is where students may create personal projects, prototype ideas, or work on class assigned projects by utilizing resources such as 3D printers, laser etchers, CNC machines, sewing machines, embroiderers, vinyl heat-press, and other tools/crafting machinery. While these kinds of machines are not inherently gender/racially biased, the use of facilities nationally is not equally demographically balanced and supports data depicting a user dominance of "affluent males" [5]. One hypothesis is that the gender imbalance could be due to ambient identity cues that do not accurately portray a fully representative population [4]. With the unveiling of a new makerspace in the recently constructed Ingram Hall for Engineering and Science, this project will capitalize on the opportunity to implement targeted studies following a similar study on the effect of modified environments on interest in computer science by Dr. Sapna Cheryan [4]. This early stage portion of the study requires data collection with surveys to first identify stereotypes that students currently hold in regard to makers and makerspaces. Understanding the associated stereotypes will lead to secondary studies on the association of certain physical objects/cues with makerspaces. Finally, with these data, a makerspace that fosters ambient belonging and self-efficacy through non-verbal cues can be produced.

**BACKGROUND:** Historically, STEM fields have been demographically dominated by male participants [3, 1, 6]. Even now, where women make up the larger proportion of college students, men outnumber women in STEM degrees pursued/earned [3, 6]. A large factor to these statistics is that students' *environments* shape their interest in math and science. When environments are designed to propagate spatial skills and technical ability, not only are students' skills developed, but their confidence is, too [3, 4, 2]. This finding is echoed by several researchers including Dr. Cheryan from University of Washington. In her study, *Ambient Belonging: How Stereotypical Cues Impact Gender Participation in Computer Science,* she explores the idea that a person's sense of belonging and contribution in a space is affected strongly by the space's environment through physical "ambient identity cues, or socially symbolic objects that embody and communicate group member stereotypes" [4]. An example of such physical cues would be

crosses on the wall at church or spider posters in the office of an arachnologist. Essentially, environments act as the gatekeeper deciding whether or not people will fit into a group/domain. If the environment, ambient identity cues, and people already representing the domain is incompatible to a person's social identities such as gender, race, etc., not only will they be uninterested, but they will be deterred from entering [4]. She resolves that by creating spaces with more inclusive and compatible ambient identity cues, future participation in that domain is encouraged and sense of belonging is instilled [4, 3, 2]. Dr. Cheryan specifically studied the effect of modifying group environments with differing ambient identity cues on participants' interest in computer science. After staging two environments, one with stereotypical masculine objects/cues such as Star Trek and video game posters, and the other without such cues, it was found that "in the stereotypical environment, women were less interested in computer science than were men" while in the non-stereotypical environment, "there was no gender difference in interest of computer science" [4]. From her conclusions, it is evident that environments could be a contributing factor to the problem of underrepresentation of females and minorities in STEM fields.

Makerspaces are on the rise and may be an answer to creating more ambient environments for the attraction of STEM students. University makerspaces are spaces in which students have the ability to create and work on personal and class-assigned projects using provided equipment. It's a space which enables creative expression through hands-on works. The push for makerspaces started with the Make movement, which formed around the idea that when people create things, they feel a sense of satisfaction. People that create exercise self-discovery, ingenuity, and intrinsically motivation to learn that garner higher levels of self-satisfaction [7, 8, 2]. The creator of the Make movement, Dale Dougherty, has shown through involvement in younger education, that by giving children the opportunity to be involved in making, they could develop skills in problem-solving, design process, and optimizing that are integral to engineering and design [8]. Makerspaces are certainly an avenue for the increase of attraction and retention of students in STEM fields, but already demographically, makerspaces are proving to be white, male dominated.

Therefore, modeling Dr. Cheryan's study on ambient identity cues on interest in computer science, this study seeks to ascertain the preconceptions that college students have about what are in makerspaces, in makers' personal spaces, and what students believe they would like to see in a makerspace to be welcoming and compatible to themselves. This study gains to understand what are typical items associated with makerspaces, makers, and maker culture, and do they contribute positively to ambient belonging?

**PROCEDURE:** At the start of the Spring 2019 semester, students and faculty over the age of 18 in the engineering building were verbally asked to participate in a short, anonymous research survey asking for written list responses about makerspaces (i.e. objects they would find in a Maker student's dorm room, the office of a maker, a makerspace, and what they would like to have in a makerspace) and their major, in addition to "circle all that apply" questions for race/ethnicity and gender. In return for participating in the survey, they received a piece of candy. It was reiterated that participation was purely voluntary. The physical paper survey was predominantly hosted in the lobby of the engineering building so people could interact between classes, and most participants completed the survey at the time they chose to participate. Surveys are still being collected and this paper reports the preliminary findings from the first seventy (70)

participants. To graphically represent popular responses, word clouds were created from the written responses.

**RESULTS & DISCUSSION:** The summary of participant-reported demographics are presented in Figures 1-3. These charts show that the approximately one third of the respondents were women; that less than half of the respondents identified as White, non-Hispanic and nearly the same number of students identified as Hispanic and/or Black; and, as expected due to the location of the survey, most of the respondents were engineering majors of some sort.

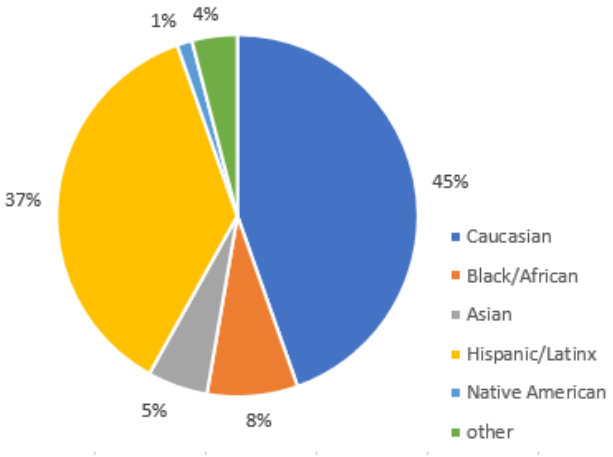


*Figure 1: Self-reported race/ethnicities of survey participants*

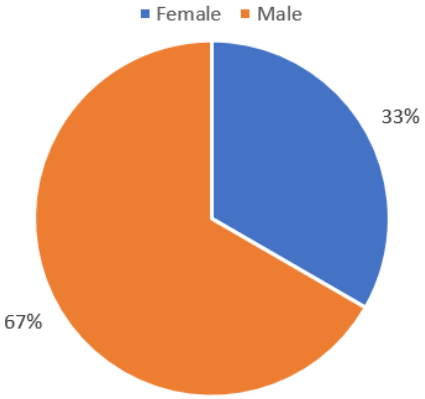


*Figure 2: Gender of survey participants*

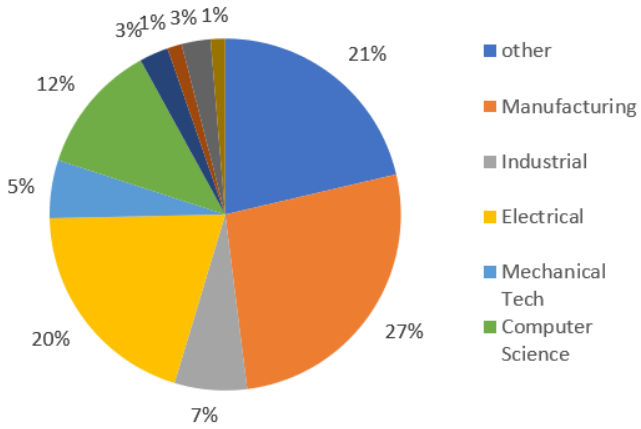


*Figure 3: Majors of survey participants*

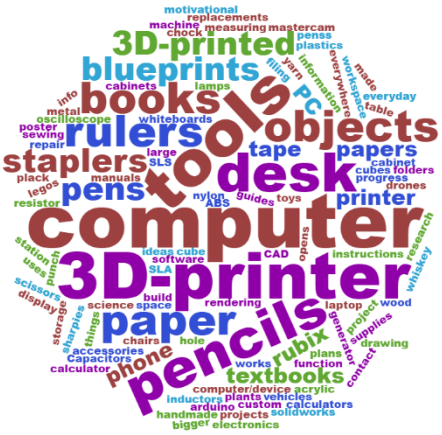


*Figure 4 displays responses to "list objects you would likely find in the office of a Maker"*

At this preliminary stage of the project, the open-ended responses were transcribed and used to generate a word cloud in order to observe initial trends. These word clouds are presented in Figures 4-7. Looking at the word bubbles generated from the individual survey questions, there are obvious trends showing participant association of makerspaces primarily with 3D- printing, tools, lasers, and computers, which are necessary artifacts in a makerspace. It has been roughly noted that participants whose major falls into the "other" category such as Nutrition or Nursing tend to have responses that are more focused on the environment rather than technical, STEM-related objects. Their listing of non-STEM related objects such as posters, bean bags, windows,

and good lighting might suggest non-stereotypical objects that could be used for creating a welcoming, inclusive space. Additionally, there were also varied mentions of craft and office supplies which suggest the desired versatility of a makerspace on-campus.

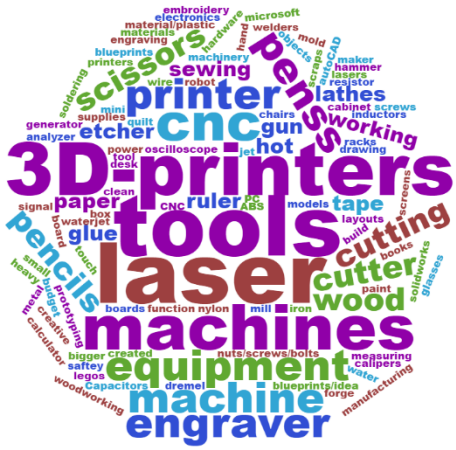


*Figure 5 displays survey responses to the question, "list objects you would likely find in a Maker student's dorm room"*


*Figure 6 displays responses to "list equipment you would expect to find in a Makerspace"*

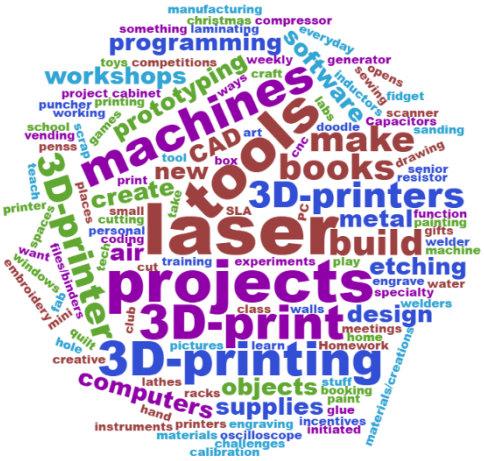


*Figure 7 displays responses to "list equipment you would like to find or activities you would like to do in a Makerspace"*

**FUTURE WORK:** This work-in-progress project is in the beginning stage; therefore, conclusions cannot yet be made. Through the preliminary surveys, we are developing an instrument for studying the stereotypes and forming hypotheses on sense of belonging. As surveys continue to be conducted and data continues to be analyzed, it will be most beneficial to associate demographic responses with the respective participants' written responses to more clearly understand the effects of a participant's background on their understanding or preconceptions of makerspaces. It might be interesting to study also if unfamiliarity with makerspaces translates to not feeling belonging. Considering the responses from non-STEM majors, environment-related responses may be used in the following surveys as a baseline of non-stereotypical objects. The written responses that were mentioned by three or more people, which are visible through the larger words in the word cloud, will be utilized in a new survey to further explore stereotypes about makerspaces, makers, and making. The goal is to conduct the new survey by asking participants to rank the survey-generated objects on a scale of 1-7 on their association to Makerspaces, 1 being not at all and 7 being very much.

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