Board 282: Finding Meaning in Makerspaces: Exploring How Gender Influences Makerspace Definitions Among First-Year Engineering Students

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Abstract: Makerspaces, intended for open and collaborative learning, often struggle to attract a diverse group of users, particularly concerning gender diversity. These issues include makerspaces becoming associated primarily with white male students, gendered connotations of machines and materials, and women's perceived lack of self-efficacy in using makerspace tools. As a result, women may view makerspaces as unwelcoming, and societal stereotypes can affect their engagement in these spaces. Efforts to create more inclusive makerspaces are essential to fully realize the potential of makerspaces, encourage and boost confidence in marginalized groups to pursue careers in different engineering areas, and promote a diverse and collaborative maker culture. Moreover, defining makerspaces is challenging due to conflicting perceptions, the uniqueness of spaces, and the abstract elements in these environments, revealing a gap between academic definitions and the diverse voices of people interested in utilizing makerspaces. Our goal is to see if there are differences in the fundamental academic makerspace definition and makerspace definition by different genders, providing insights into how inclusive our makerspace is. We focus on gender because our interviewees focused more on gender than other identity markers in our conversations, but we also report additional demographic data that likely impacted participants' experiences, namely, their racial and ethnic identities.

Our corpus is drawn from semi-structured interviews with students enrolled in an introductory first-year engineering course. Out of 28 students interviewed, 10 identified as women, 16 as men, one as both women and questioning or unsure, and one as women and nonbinary and transgender. In terms of racial/ethnic identifications, nine participants identified as White or Caucasian; six identified as Latinx or Hispanic; five identified as Latinx or Hispanic, White or Caucasian; three identified as Black or African American; two identified as Asian, Desi, or Asian American; one identified as Latinx or Hispanic, Native American or Alaska Native; one identified as Southwest Asian, Middle Eastern, or North African, White or Caucasian; and one identified as Native African. In this ongoing study, from interview transcripts, we extracted participant responses to questions regarding their definitions of and impressions of makerspaces to identify commonalities and differences. Specifically, we use natural language processing techniques to extract word frequency and centrality and synthesize commonalities into a shared definition of a makerspace. We also separated responses from participants by gender identities to evaluate how definitions varied with gender. These emergent definitions are compared with commonly accepted definitions derived from research papers. Additionally, we conduct a complementary discourse analysis of students' definitions and impressions of makerspaces, qualitatively examining how diverse students characterize ways of being and doing in the makerspace.

Keywords: Makerspaces; makerspace definition; gender

Introduction

Makerspaces have the potential for bringing together diverse creative minds, fostering collaborative knowledge development, facilitating the learning and application of new technologies, understanding technical terminology, addressing challenges encountered during the

making process, gaining insights from others' ideas, and enhancing individuals' efficacy and confidence in making. But makerspaces often find it hard to include diverse groups, particularly women, due to persistent gender disparities in makerspace participation, the perceived deficiency of skills among women-identifying students, unwelcoming environments for women, and the association of machines and materials with specific genders, hindering their full participation within such spaces [1], [2]. As a result, it is a challenge for most makerspaces to ensure the full utilization and participation of diverse students in the makerspaces.

To overcome those challenges and make the makerspaces more inclusive, learning directly from students about their involvement and experiences in makerspaces is needed. Digital badges, promoting personalized learning and skill recognition, are expected to encourage more inclusive participation, fostering engineering identity and a sense of belonging among diverse student groups. In this study, we describe some results derived from a two-year project which involves implementing a digital badging system through students' participation in makerspaces and collecting both qualitative and quantitative data to assess its impact on students' participation in making and makerspace activities and thus their engineering identity development and sense of belonging in engineering, acknowledging that gender, race, and ethnicity affect their engineering identity [3].

Makerspaces are community-focused spaces that derive their purpose and meaning from the people utilizing the space. Definitions of makerspaces and related spaces (i.e., hackerspaces, fab labs) vary, but often include a focus on design, creativity, and access to fabrication tools [4]. Van Holm defined these spaces as "characterized as a community workshop where members share access to tools in order to produce physical goods" [5]. In a recent literature review, Mersand defined a makerspace as "an area that provides materials and tools to encourage individuals or groups to make things, to create new knowledge, or to solve problems" [6]. In educational contexts, makerspaces should provide access to defining elements of the Maker movement, including digital tools, community infrastructure, and "the maker mindset," involving a positive view of failure and focus on collaboration [7].

While these definitions do not mention gender or race, they may reflect a bias of the predominant users of makerspaces [8], as makerspaces have, at times, struggled to adequately serve a broad community [9]. Rather than adopting a "branded, culturally normative" definition of making [10], which could be exclusionary, we seek here to organically define makerspaces based on our diverse student population's insights and ideas. To explore how definitions and conceptions of makerspaces vary, we explore variations amongst a group of engineering students. In this paper, we conducted a preliminary natural language processing (NLP) analysis of interviews conducted with first-year engineering students. This preliminary study explores gender-based differences in makerspace definitions and impressions from engineering students to assess makerspace inclusivity, aiming to guide makerspace planners and instructors in enhancing the making experience for engineering students of diverse backgrounds and promoting inclusiveness in makerspaces. We focus here on the words used and their frequency and centrality as a first step to identifying commonalities, and will follow in future work with more detailed qualitative analysis.

Background and Methods

Over three semesters, we interviewed 28 first-year engineering students enrolled in an Introduction to Engineering Design class. Our interview contents include questions on participants' making experience, their feedback on the badges and the badging process, their experiences in makerspaces, their feeling of inclusion in the engineering community, and how their peers and instructor see them as engineers. As part of this class, students were assigned to visit our campus makerspaces, learn more about some of the technology in the spaces, and take some basic training in the technology. The participants are from diverse races, genders, ethnicities, and engineering disciplines. In terms of racial or ethnic identifications, nine participants identified as White or Caucasian; six identified as Latinx or Hispanic; five identified as Latinx or Hispanic, White or Caucasian; three identified as Black or African American; two identified as Asian, Desi, or Asian American; one identified as Latinx or Hispanic, Native American or Alaska Native; one identified as Southwest Asian, Middle Eastern, or North African, White or Caucasian; and one identified as Native African.

In this study, we are focusing on the interview questions where the participants were asked about their makerspace experiences both from the campus makerspaces and any other makerspaces outside of campus, or they participated in before joining college. We extracted the responses of participants for the interview questions, including the definitions of makerspaces, their first impressions and memories about the physical makerspaces and its atmosphere or vibe, description of the people using or working there, helpful and least helpful interactions with peers and staff, and factors affecting their visit to makerspace. To help students understand the terms we used in the interview, we gave them definitions at the beginning of the interview. For "makerspaces," we gave the students the definition as "physical locations where people can use different technologies to explore ideas, learn technical skills, and create new products," which was derived from Brahms's definition [11].

In this study, we focus on response differences between genders. The responses of participants who did not have any familiarity with the makerspace by the time of the first interview and, therefore, did not provide any relevant answers were excluded from the analysis (n=2, one man and one woman). Participants who identified as "Woman" as one of their gender identities were included in womxn in this study. This category includes two participants identified as "Woman, Nonbinary, Transgender" and "Woman, Questioning or unsure." Our final sample had 15 men-identifying and 11 womxn participants. The corpus extracted from the men's interview contains 11,216 words, and the womxn's corpus has 8,652 words.

For this first preliminary study, we performed text network analysis and analyzed the most frequently used words. The frequently used words were extracted using MATLAB's Text Analytics Toolbox, with data pre-processing, including tokenization and identifying part of speech for each token. For network analysis, we used a text-network analysis pipeline from GitHub [12] to identify central words and connections between words. In both processes, common filler words (e.g., "um," "uh," "like") were removed.

We paired the text network analysis and word frequency analysis with a discourse analysis of the same corpus to contextualize the emerging patterns. Specifically, we applied Gee's figured

worlds tool, which seeks to identify how a person's words and phrases reveal assumptions and beliefs about who can participate and what kinds of activities and interactions can take place in a social and/or physical space [13]. The tool is useful for examining differences in how people orient to engineering spaces: for example, engineering education researchers have applied the figured worlds tool to examine engineering students' relationships to gendered norms in construction engineering [14].

For this preliminary study, we focused specifically on if-conditionals. The specific parameters for syntactic and semantic features, as well as the delineations of different function types, of if-conditionals are the subject of debate among linguists [15], [16], but for the purposes of our qualitative approach, we identified if-conditionals broadly as sentences with a subordinate (or conditional) clause that begins with "if," and a main clause that contains a "then" statement. The "then" may be implied, the "if" clause may come at the beginning or end, and both clauses can include a range of verb tenses and modal constructions. We focus on if-conditionals for two reasons: first, in an initial analysis pass of the corpus, we noticed a recurrence of if-conditionals across the definitions in the corpus, and, in fact, 18 of the 26 students represented in the corpus used at least one if-conditional. Additionally, the premise-conclusion structure common in if-conditionals, often accompanied by hedging or emphatics, reveals a person's orientation to the information they are communicating, and if-conditionals have been used to examine figured worlds in educational contexts [17].

Preliminary Results and Ongoing Efforts

The text network graph shows the most important words for interpretation based on how much they connect to other words and clusters the words about the same topics. The size of the nodes indicates how important and central the words are. In both graphs, we observe one single cluster, and two of the most prominent nodes in that cluster are "know" and "people," suggesting the knowledge aspect of a makerspace; for example, they know things, know stuff, people know things, people think.

In the men's text network (Fig. 1), the node "cool" suggests that men are going more to do cool stuff, cool things, and know cool people. The node "make" suggests that making things, knowing how to make, and wanting to make is important for men. This indicates that the men in our study are going to makerspace to make things, get things, get knowledge, and to have people who know things.

An interesting observation in the text network for womxn (Fig. 2) is the node "us," suggesting more of a sense of social and community elements; for example, it's us working on things, it's us going. The node "projects" in womxn's text network suggests that visits of womxn to the makerspace are more course-driven; they're going to work on engineering projects. In comparison, in the men's text network, we observe a focus only on people going to the makerspace. Another difference is that "Catalyst," the name of our library makerspace, is more central in the womxn's network, suggesting that this space is more attractive or familiar to them than the Engineering Design Center (EDC), a second, more engineering-focused makerspace.

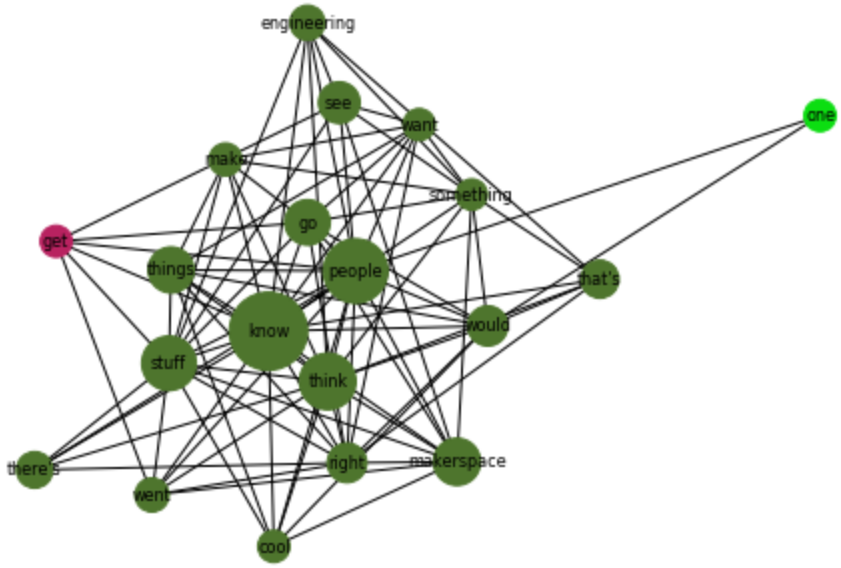

Figure 1: Men text network analysis

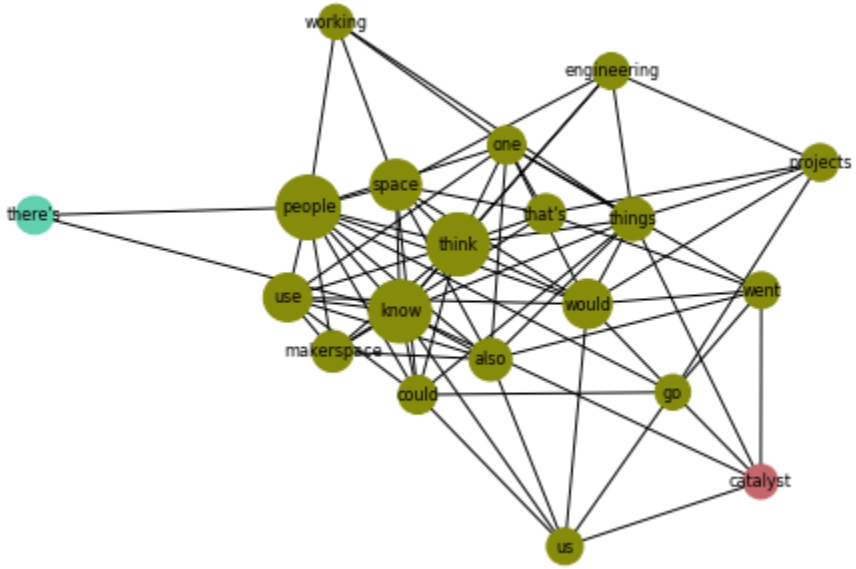

Figure 2: Womxn text network analysis

Looking at the words people use most frequently (Table 1), we find that both men and womxn share words like “people,” “go,” “know,” “things,” “stuff,” and “engineering.” But there are some differences in how they talk; men’s descriptions are more technology-driven, and then, womxn’s descriptions are community and social-driven. Men often use “makerspace,” while womxn prefer words like “space,” “makerspace,” “Catalyst,” and “EDC.” For womxn, the vibe and community feeling seem more important, as seen in words like “projects,” “working,” and “space.” Men, on the other hand, focus more on tools, mentioning words like “printers,”

"printing," and "laser." Furthermore, a disparity in the usage ratio of the words "make" and "help" is evident between men and womxn. While men use "make" and "help" with similar frequency, womxn use "help" more often than "make." Additionally, men commonly include the term "cool" in their descriptions, a term absent from the womxn's descriptions.

Table 1: Most frequently used verbs, nouns, and adjectives for men and womxn

For men (n=15)		**For womxn (n=11)**	
Token	**Frequency**	**Token**	**Frequency**
know	117	people	55
people	104	know	53
go	86	help	48
things	75	working	48
stuff	62	things	45
make	59	projects	39
help	50	space	39
engineering	45	engineering	35
printing	42	makerspace	35
something	42	go	34
time	41	catalyst	27
makerspace	39	make	27
work	38	machines	26
get	37	need	26
cool	33	different	21
printers	32	idea	21

Comparing these central and frequently used words to the academic definitions from the literature mentioned in the introduction, we find some commonalities and differences. For example, Van Holm's definition in [5] ("a community workshop where members share access to tools in order to produce physical goods") has a similar focus on tools and making, as seen in the men's descriptions. In the definition used in Mersand's work [6] ("an area that provides materials and tools to encourage individuals or groups to make things, to create new knowledge, or to solve problems"), we again see a focus on tools, materials, and making. In this definition, we also see the word "area," which reflects the focus on space and location of womxn's definition. There is little focus on the key aspects we referred to in the definition we provided students at the start of the interview ("physical locations where people can use different technologies to explore ideas, learn technical skills, and create new products."), with "skills" and "products" not appearing in the list of commonly used words.

It is interesting to note that none of these definitions focus on the ideas of "help" and "know" that we see in both the men's and womxn's descriptions. Additionally, existing definitions focus on technology and tools, which is in line with frequently used words of men, but somewhat at odds with the frequently used words of womxn, which emphasized people, space, and projects. Examining the differences between the academic definitions of makerspace and the

focus/interests of both men (e.g., cool, help, make) and womxn (e.g., people, space, help) in makerspaces from our findings, we identified additions for a more inclusive makerspace definition. A definition that merges the academic definitions with elements from our diverse novice population could be "a space with people who can help you and your friends make cool stuff for projects." While this definition is perhaps less sophisticated than the academic definition, it may be more relatable and approachable to a diverse set of first-year students because it is derived from their own words and ideas.

Our proposed merged definition also reflects patterns from the discourse analysis of figured worlds via if-conditionals in the corpus. In particular, the two verbs in the merged definition, "help" and "make" reflect the two key figured world characteristics that emerged in 48 total sentences (uttered by a total of 18 speakers, 11 men and 7 womxn) that included at least one if-conditional. "Help" is typical of figured world characteristics we categorized in our analysis as "interactions," or if-conditionals that emphasized the kinds and conditions of interactions, relationships, and identifications with other people in the makerspace. "Make" is typical of figured world characteristics we categorized in our analysis as "actions," or if-conditionals that emphasized the kinds of conditions of object-oriented actions, including project work and skill learning, in the makerspace. The patterns in men's and womxn's respective uses of interaction-focused if-conditionals and action-focused if-conditionals (presented below in Table 2) echo the patterns described in the frequency analysis above.

Table 2: If-conditionals used by men and womxn.

If-conditional categories	**Men who used at least one if-conditional (n=11)**	**Womxn who used at least one if-conditional (n=7)**	**Totals**
Sentences with if-conditionals that reveal makerspace figured world "interactions"	14	9	23
Sentences with if-conditionals that reveal makerspace figured world "actions"	12	13	25
Total sentences with if-conditionals	26	22	48

And while the counts of if-conditional instances echo word frequency patterns across gender differences, the nuances of the if-conditionals are as diverse across gender differences as they are across race/ethnicity differences. Below are examples illustrating the diverse semantic and syntactic nuances of if-conditions categorized as interactions (note that participants are referred to by their self-selected pseudonyms and self-described gender and race/ethnicity identities):

- “I mean, if you ask for help, there’s definitely help available [in the makerspace].” - Maria, a Hispanic/Latinx woman
- “If I’m working on the 3D printer, I might interact with someone who’s using the sewing machine.” - Hermione, a Hispanic/Latinx woman
- “Like, if I went there [to the makerspace], it’s not like I would feel like I wasn’t welcomed.” - Natalie, a white/Caucasian woman
- “That kind of stuff [being the only brown person in the makerspace] doesn’t really bother me because I just grew up with white kids my whole life, so, it’s OK, that’s normal, but I could definitely see how somebody else, like, if you walk over there and you don’t see somebody looks like you, it’s like, shoot, are these people gonna judge me or they gonna look at me weird?” - Maverick, a Hispanic/Latinx man

As these examples illustrate, within the categories of interaction-focused and action-focused if-conditionals, we found a range of epistemic stances, from hedges with modal verbs and/or negative constructions, to emphatic declarations with adverbs like “definitely.” We also found a range of participant attitudes toward the interactions they describe, from unanimously positive characterizations of the help they received or believed they could receive in the makerspace (exemplified in Maria’s quote), to more ambivalent characterizations of the extent to which they felt connected to other people in the space that may reveal uncertainty rooted in limited experience (as we might interpret Natalie’s quote) or that reveal, in Maverick’s case, uncertainty about the extent to which students of color might feel represented and included in the space.

A comparably diverse range of semantic and syntactic nuance is present in the ways students characterized actions in the makerspace figured world through if-conditionals, evidenced in the following examples:

- “Definitely anywhere where I can, if I have an idea in mind or if I’m trying to just generate ideas, anywhere that really suits the purpose in the environment of what I’m trying to think of or where I’m trying, how I’m trying to develop my idea–that’s what a makerspace is for me.” - Wren, who identifies as white, nonbinary, and woman
- “If I have any intriguing idea, I know where to go.” - Luffy, a Black/African American man
- “[The makerspace] is like a place you can go to work on little projects that you have or like that, or learn a new technical skill or something if you have interest in that.” - John, a white man
- “If you want to learn how to sew and learn how to make your own clothes or anything like that, you have to do things [in] a very design[-focused] and creative way as well, a very artistic way [in the makerspace].” - Colgate, a Hispanic/Latinx man
- “I kind of just do things spontaneously, like, when maybe, if I think of something I need, and I will, now that I know that [the makerspace] is available to me, I could definitely see myself going there for some random project that pops into my head.” - Isabella, a white woman

These examples illustrate the range of epistemic stance present in action-focused figured world if-conditionals, from emphatic declarations punctuated with “definitely” (as in Wren and Isabella’s quotes) to a more muted stance, illustrated in John’s final-if construction, where the “if” subordinate clause appears after, rather than before, the main clause it modifies. The examples also illustrate the range of both intellectual and physical actions, from ideating,

thinking, and learning, to sewing and working on design projects. Taken together, the action-focused and interaction-focused if-conditionals characterizing students' makerspace figured worlds in this preliminary discourse analysis affirm the patterns emerging in the text network analysis and word frequency analysis, as well as the proposed merged definition, even as these if-conditionals also reveal a wide range of nuance that invites further exploration through both quantitative and qualitative methods.

In this study, we have highlighted interesting preliminary findings, but it is important to also acknowledge that this is a work in progress, and we are analyzing a small corpus. Some limitations inherent to our study include the limited familiarity of students with makerspaces, as most of them encountered such environments for the first time and had only made a few visits by the time of our interviews. Moreover, their understanding and definitions of makerspaces might evolve over the semester in response to the level of instruction received in related coursework and changes introduced to the resources, facilities, and policies within the makerspace. Additionally, our study is further constrained by the utilization of a modest corpus for NLP, with a specific focus on gender, thereby potentially overlooking the impact of other relevant factors like race or ethnicity.

In future work, we seek to overcome some of these limitations by exploring students' pre- and post-interviews comments about makerspaces to see how their responses change as they gain more familiarity with these spaces. We will also explore more detailed qualitative analysis to delve deeper into the sentiment of students' impressions and interactions in these spaces and see how these sentiments color students' perceptions and definitions of a makerspace.

We are also curious to explore if students are interested in any design or fabrication technologies currently unavailable within the makerspaces, which could serve as ways to enhance participation. Additionally, during certain interviews, participants associated specific makerspace technologies with particular engineering departments, thereby suggesting further analysis to identify additional makerspace technologies beneficial across all engineering disciplines.

Another avenue for future work is connecting our definitions to existing work. For example, Tomko et al.'s study (2021) identified key aspects of women's pathways into university makerspaces, which also identified important themes of community and relationships [18]. We will also explore how our makerspace definitions can intersect with existing work on defining more forms of participation in making to include more social practices (e.g., [9], [19]).

Conclusion

The knowledge and collaborative assistance aspect of makerspaces, as evidenced by the frequent use of terms like "people," "know," "go," "things," "stuff," "help," and "engineering" in both men's and womxn's text, suggests a common theme of individuals going to makerspaces, getting help, and understanding engineering concepts across genders. The men's text primarily focused on specific technologies in the makerspace, knowledge generation and sharing, and making. At the same time, space, community, and course projects have more influence on the womxn's text. While existing makerspace definitions emphasize more on resources (e.g., area, material, tools), skill development, and product creation, our expanded definition incorporates additional

elements such as human resources (e.g., people), community dynamics (e.g., friends), individual's specific interests (e.g., cool stuff, projects), additional functionality (e.g., getting and providing help) within makerspace. Ultimately, it is important to avoid over defining terms and to have an inclusive view of activities that qualify as Making and the spaces where Making is conducted [6], [20], while still considering clarity and specificity of definitions. As we move forward with the analysis of our corpus, we will continue to explore how students from different backgrounds define makerspaces.

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References

[1] M. Rahman and M. L. Best, "Why are Some Makerspaces not so Male-Dominated," in *Human-Computer Interaction: Thematic Area, HCI 2023, Held as Part of the 25th HCI International Conference, HCII 2023, Copenhagen, Denmark, July 23–28, 2023, Proceedings, Part IV*, Berlin, Heidelberg: Springer-Verlag, Jul. 2023, pp. 341–354. doi: 10.1007/978-3-031-35572-1_23.

[2] A. Tannebaum, S. T. Santillan, and R. Simmons, "Women in Engineering: 3D Printing Interests, Habits, and Persistence," presented at the 2021 ASEE Virtual Annual Conference Content Access, Jul. 2021. Accessed: Feb. 08, 2024. [Online]. Available: https://peer.asee.org/women-in-engineering-3d-printing-interests-habits-and-persistence

[3] J. Bushra, H. Budinoff, A. Shivers-McNair, and E. Berger, "Using badging to promote makerspace participation and engineering identity development: Emergent themes and lessons learned from a pilot," *Proc. ASEE Annu. Conf. Expo.*, Jan. 2023, Accessed: Feb. 01, 2024. [Online]. Available: https://par.nsf.gov/biblio/10415144-using-badging-promote-makerspace-participation-engineering-identity-development-emergent-themes-lessons-learned-from-pilot

[4] E. C. Hilton, K. G. Talley, S. F. Smith, R. L. Nagel, and J. S. Linsey, "Report on Engineering Design Self-Efficacy and Demographics of Makerspace Participants Across Three Universities," *J. Mech. Des.*, vol. 142, no. 102301, May 2020, doi: 10.1115/1.4046649.

[5] V. Holm and E. Joseph, "What are Makerspaces, Hackerspaces, and Fab Labs?" Rochester, NY, Nov. 07, 2014. doi: 10.2139/ssrn.2548211.

[6] S. Mersand, "The State of Makerspace Research: a Review of the Literature," *TechTrends*, vol. 65, no. 2, pp. 174–186, Mar. 2021, doi: 10.1007/s11528-020-00566-5.

[7] L. Martin, "The Promise of the Maker Movement for Education," *J. Pre-Coll. Eng. Educ. Res. J-PEER*, vol. 5, no. 1, Apr. 2015, doi: 10.7771/2157-9288.1099.

[8] M. E. Andrews and A. Boklage, "Supporting inclusivity in STEM makerspaces through critical theory: A systematic review," *J. Eng. Educ.*, vol. n/a, no. n/a, doi: 10.1002/jee.20546.

[9] A. C. Barton, E. Tan, and D. Greenberg, "The Makerspace Movement: Sites of Possibilities for Equitable Opportunities to Engage Underrepresented Youth in STEM," *Teach. Coll. Rec.*, vol. 119, no. 6, pp. 1–44, Jun. 2017, doi: 10.1177/016146811711900608.

[10] S. Vossoughi, P. K. Hooper, and M. Escudé, “Making Through the Lens of Culture and Power: Toward Transformative Visions for Educational Equity,” *Harv. Educ. Rev.*, vol. 86, no. 2, pp. 206–232, Jun. 2016, doi: 10.17763/0017-8055.86.2.206.
[11] L. Brahms, “Making as a Learning Process: Identifying and Supporting Family Learning in Informal Settings.” Accessed: Feb. 08, 2024. [Online]. Available: http://d-scholarship.pitt.edu/21525/
[12] M. Gruszecka and M. Pikusa, “Using Text Network Analysis in Corpus Studies — A Comparative Study on the 2010 TU-154 Polish Air Force Presidential Plane Crash Newspaper Coverage,” *Int. J. Soc. Sci. Humanity*, vol. 5, no. 2, pp. 233–236, 2015, doi: 10.7763/IJSSH.2015.V5.459.
[13] J. P. Gee, *How to do Discourse Analysis: A Toolkit: A Toolkit*. London: Routledge, 2010. doi: 10.4324/9780203850992.
[14] A. J. Gonsalves, E. Silfver, A. Danielsson, and M. Berge, “‘It’s not my dream, actually’: students’ identity work across figured worlds of construction engineering in Sweden,” *Int. J. STEM Educ.*, vol. 6, no. 1, p. 13, Apr. 2019, doi: 10.1186/s40594-019-0165-4.
[15] E. Rowley-Jolivet and S. Carter-Thomas, “When practice belies ‘theory’: Form, function and frequency of if-conditionals in specialised discourse,” *ASp Rev. GERAS*, no. 53–54, Art. no. 53–54, Nov. 2008, doi: 10.4000/asp.343.
[16] K. Warchał, “Moulding interpersonal relations through conditional clauses: Consensus-building strategies in written academic discourse,” *J. Engl. Acad. Purp.*, vol. 9, no. 2, pp. 140–150, Jun. 2010, doi: 10.1016/j.jeap.2010.02.002.
[17] R. Brefeld, “Practitioner Inquiry: Teaching literacy with English language learners,” *Dissertations*, Aug. 2015, [Online]. Available: https://irl.umsl.edu/dissertation/150
[18] M. Tomko, M. W. Alemán, W. Newstetter, R. L. Nagel, and J. Linsey, “Participation pathways for women into university makerspaces,” *J. Eng. Educ.*, vol. 110, no. 3, pp. 700–717, 2021, doi: 10.1002/jee.20402.
[19] L. Martin, C. Dixon, and S. Betser, “Iterative Design toward Equity: Youth Repertoires of Practice in a High School Maker Space,” *Equity Excell. Educ.*, vol. 51, no. 1, pp. 36–47, Jan. 2018, doi: 10.1080/10665684.2018.1436997.
[20] S. Vossoughi and B. Bevan, “Making and Tinkering: A Review of the Literature,” *Natl. Res. Counc. Comm. Sch. Time STEM*, vol. 67, pp. 1–55.