How Successful Hackathons Increase Belonging, Reduce Anxiety, and Create New Self-Concepts for Future Skill Growth:

Research Insights from Hacking the Pluralsight Hackathon

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Executive Summary & Key Takeaways

This research brief summarizes a case study on the impact of hackathons on 64 employees participating in a corporate hackathon at Pluralsight.

- ★ **Hackathons decrease anxiety and increase belonging.** Using empirical measures of anxiety and perceptions of belonging, we found that simply participating in a hackathon can decrease participants' skill-related anxiety and significantly increase their sense of belonging in their workplace communities.

- ★ **Many people come to hackathons with existing anxieties that can impact their success.** Greater pre-event anxiety decreases the likelihood of achieving success on both tangible and intangible outcomes. Mitigating pre-event anxiety is an important concern for organizational leaders, especially because it disproportionately impacts minoritized and early career developers.

- ★ **Teams can change the likelihood of success.** Even if you come to a hackathon with a high level of anxiety, a hackathon team with a strong sense of belonging and learning culture can mitigate the negative impacts of that anxiety, and enable *both* high and low-anxiety individuals to achieve success.

- ★ **Hackathons as social interventions.** Our findings suggest that internal hackathons can serve as a compelling lightweight-but-effective *social intervention* to motivate employees' positive skill-related beliefs and learning at work. To run successful hackathons, organizers should focus on creating team practices of learning and belonging. Leaders and managers should take advantage of the power of exploratory and novel learning experiences like hackathons, and create time and resources for teams to invest in them.

{ **Hackathon:** a collaborative and social coding event }

Introduction

Although hackathons are a beloved tech industry tradition, the bulk of research conducted on hackathons focuses on one of two things: 1) How to run a hackathon and 2) How to achieve success in a hackathon. If you take a deeper dive into the research on just how you can achieve hackathon success, it also becomes evident that "success" is typically defined in terms of **tangible outcomes**, over **intangible outcomes** (Medina Angarita & Nolte, 2020; Nandi & Mandernach, 2016; Nolte et al., 2018).

Tangible vs. Intangible Outcomes

Tangible outcomes refer to outcomes that you can see, hear, or touch. For example, in the context of hackathons, this may refer to a new product, a new feature, or a new business outcome. In contrast, **intangible outcomes** refer to processes that you can't necessarily touch or see - for example, things like creative problem solving and learning, building community, or increasing engagement. Generally speaking, we tend to define success in terms of tangible outcomes - both in software research and at work (Medina Angarita & Nolte, 2020). For example, when your company decides to put on a hackathon, they likely position it as a way to get a new product feature (tangible outcome), rather than as a way to spend time learning (intangible outcome).

However, decades of psychological and behavioral science consistently show that **it's the intangible outcomes that not only drive the tangible outcomes, but also key long-term sociocognitive processes for employees such as motivation, performance, and productivity.** As such, it's not only important to intentionally foster the intangible outcomes, but it's also important to build in mechanisms of success to achieve them (Hackman & Oldman, 1976; Porter & Lawler, 1968).

Table 1. Tangible vs. intangible hackathon outcomes.

Tangible Outcomes	Intangible Outcomes
• Products • Features • Business Outcome	• Creative problem solving • Learning new skills • Building community

Key Research Question: Mechanisms of Success

Given the lack of research on the intangible outcomes of a hackathon, when Pluralsight held its annual virtual hackathon, we at the Developer Success Lab at Flow decided to hack into the hackathon. We wanted to understand what mechanisms impact hackathon success on both tangible and intangible outcomes. Using previous research on success and performance in the clinical and learning sciences as a guide (Anderson-Butcher & Conroy, 2002; Hofmann, 2007; Hicks, 2022; Kim et al., 2023; Luxton-Reilly et al., 2018; Pardede, Gausel, & Høie, 2021; Rattan et al., 2018; Robinson et al., 2019; Scott & Ghinea, 2013; Sherer et al., 1982; Wilson et al., 2010), we decided to test three potential mechanisms impacting success:

1. **Pre-Event Anxiety:** anxiety about an event prior to that event
2. **Belonging:** the extent to which individuals felt supported by and like they could be themselves with their team
3. **Learning Culture:** the extent to which individuals felt like the learning process, including mistakes, was celebrated

Our **key research question** was whether participation in hackathons would reduce participants' anxiety and increase a sense of belonging. If so, one potential pattern would be any hackathon participation *at all* reducing participants' anxiety. However, we also wanted to test whether differences in these three *mechanisms* change the impact of the hackathon on participants.

Our **key outcome** of hackathon success included participants' perceptions of their success in both tangible and intangible outcomes, *and* their likelihood of participating in future hackathons (a measure of behavioral action; Lee & Hayes-Skelton, 2018).

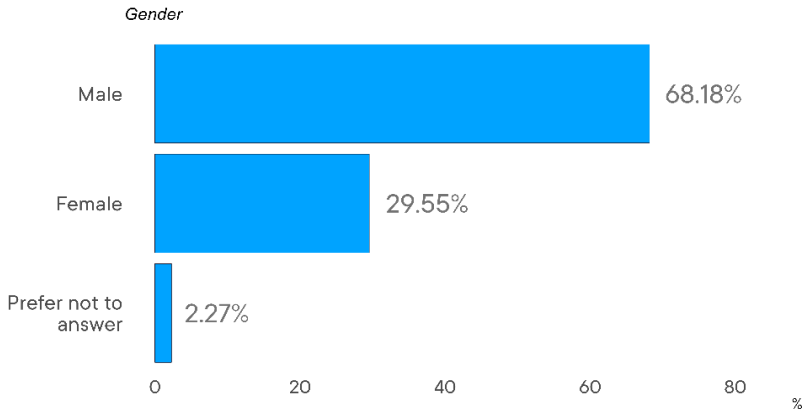
Hacking into the Hackathon

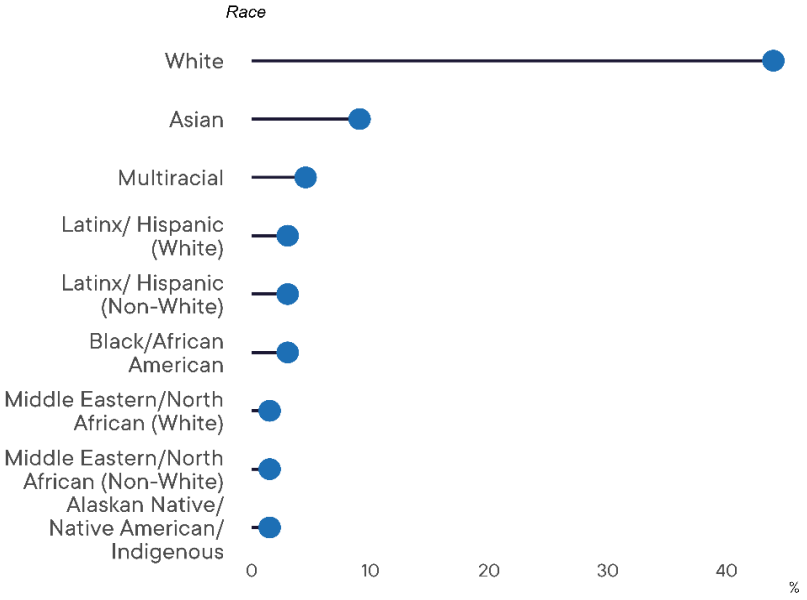
Participants & Recruitment

We recruited participants by working with the hackathon organizers, Pluralsight's Technology Center of Excellence, to announce the study at pre-hackathon meetings, in hackathon slack channels, and at the post-hackathon presentations. We recruited a total of 64 individuals. A summary of their demographic and firmographic characteristics can be seen in Figure 1. While this is a case study and not a representative sample of a large number of hackathon participants, it is still notable that many employees take on roles that are *different* from their existing job roles (e.g., for our participants, increases in "research", "engineering" and "design" roles). This pattern is an interesting affirmation that employees explore new or under-utilized skills as a part of participating in a hackathon.

64

Participants





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Average # of Previous Hackathons Attended

41%

% of Participants on a Cross-functional Hackathon Team

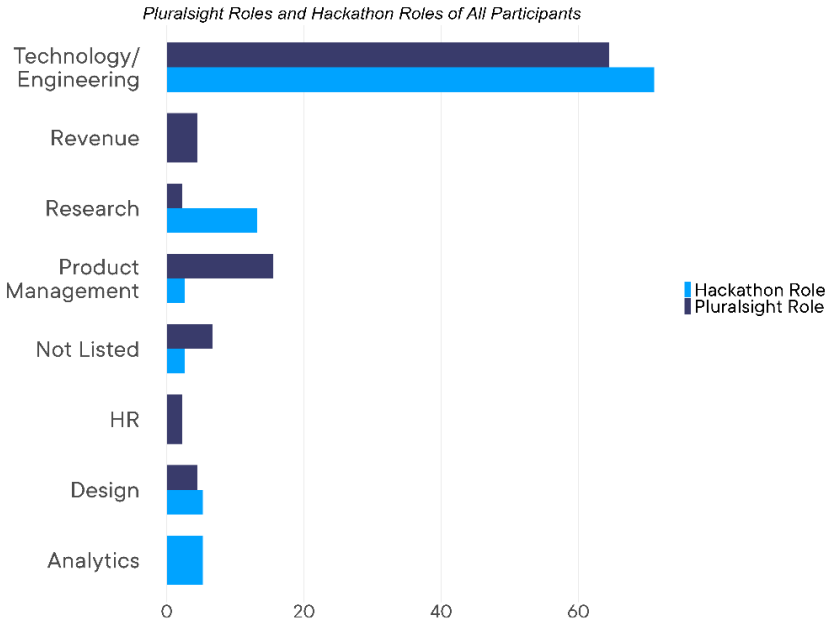

Fig 1. Participant Characteristics

Participant Consent & Privacy

In our research, we strive to follow best practices for social science research and human behavior data collection. Two key values for the Developer Success Lab are to provide informed consent to all participants prior to their participation, and to take precautionary measures to protect participants' privacy.

For example, we 1) restrict access to all raw participant data to Developer Success Lab researchers 2) anonymize across findings so that specific names, teams, and contexts aren't identifiable 3) only share quantitative data insights in aggregate 4) emphasize in multiple points during data collection that participants should only share what they feel comfortable sharing, 5) maintain a "continual consent" practice with participants, meaning that participants can opt-out of research at any time during their participation, and 6) do not treat opt-out of identity disclosures as an exclusion criteria, meaning that we analyze data in a way that ensures participants who opt-out of sharing personal information such as demographics are still able to participate in other research questions, where possible.

This information was communicated to our participants through a consent form shared at the beginning of each survey. In addition, our methods were developed in partnership with internal Hackathon organizers.

Methodology

Since we were interested in asking a *predictive* question by examining change over time, we utilized a **pre-post methodology**. This means that we gathered data from the same participants both one week before (pre) and one week after (post) the hackathon. While our case study still necessarily reflects observational data, this methodology allows us to examine changes occurring **as a result of the hackathon over time** (see Figure 2 for participant flow).

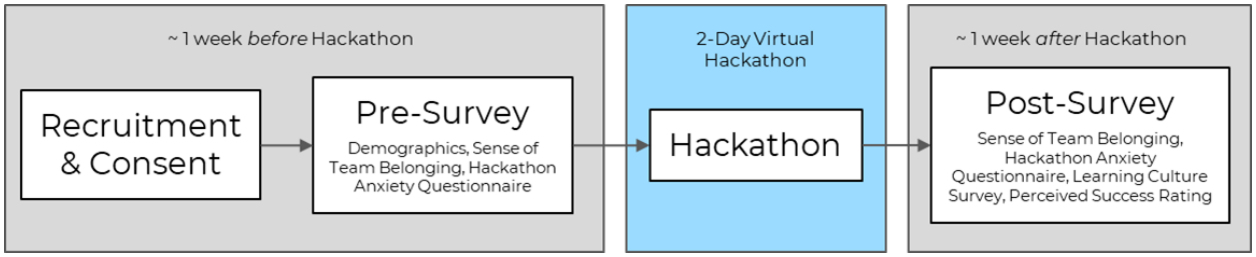

Fig 2. Participant Flow

Measurement

Given the time and logistical constraints of a virtual hackathon, we chose to operationalize anxiety, belonging, learning culture, and success using survey data. Our literature review failed to uncover empirically validated software and hackathon-team specific measures of these constructs, so we adapted existing empirically validated psychology measures of these constructs (e.g. the Spielberger State Trait Anxiety Inventory) to be more specific and relevant to hackathon teams for our study. For example, the item "I am accepted at this program" was adapted to read: "I am accepted by my hackathon team." See Table 2 for more details on these measures.

Hackathon Study Measures

Measure	*Description*	*Response Format*
Hackathon State Anxiety Inventory (H-SAI)	Measures symptoms of pre-hackathon anxiety. Items are adapted from the Spielberger State-Trait Inventory (Spielberger, Gorsuch, & Lushene, 1970)	Rating: 1-4 Likert scale. Scores averaged.
Hackathon Sense of Belonging Scale (H-SBS)	Measures the extent to which participants felt accepted and supported to grow on their teams. Items are adapted from the Sense of Belonging Scale (Anderson-Butcher & Conroy, 2002).	Rating: 1-5 Likert scale. Scores averaged.
Hackathon Learning Culture (H-LC)	Measures the extent to which participants felt like the learning process, including mistakes, was celebrated. Items are adapted from Hicks, 2022.	Rating: 1-5 Likert scale. Scores averaged.
Hackathon Behavioral Action (H-BA)	Measures the likelihood of participating in a future hackathon. Item is adapted from the General Behavioral Action Rating (Lee & Hayes-Skelton, 2018)	Rating: 1-5 Likert scale.
Perceived Hackathon Success	Original measure assessing perceived success on tangible (e.g. a specific product, feature, deliverable) and intangible (e.g. learning, networking, community building, continued engagement in hackathons) outcomes.	Rating: 1-5 Likert scale. Scores averaged.

Table 2. Hackathon Study Measures

What Happens During a Hackathon?

Even just participating in a hackathon can have positive outcomes

There is a common industry belief that participating in a hackathon is beneficial for employees, as it can increase a sense of belonging and decrease anxiety about future hackathons. To test this, we compared hackathon anxiety and team belonging scores from pre- to post-hackathon. **We found that even just participating in a hackathon can slightly lower hackathon anxiety and significantly increase a sense of team belonging.** This echoes both conjectures about the power of social hackathons, as well as research in the clinical and learning sciences indicating that shared experiences like team collaboration on meaningful activities can increase a sense of belonging while executing new skills and domains (Bauer et al., 2018; Costello et al., 2022)

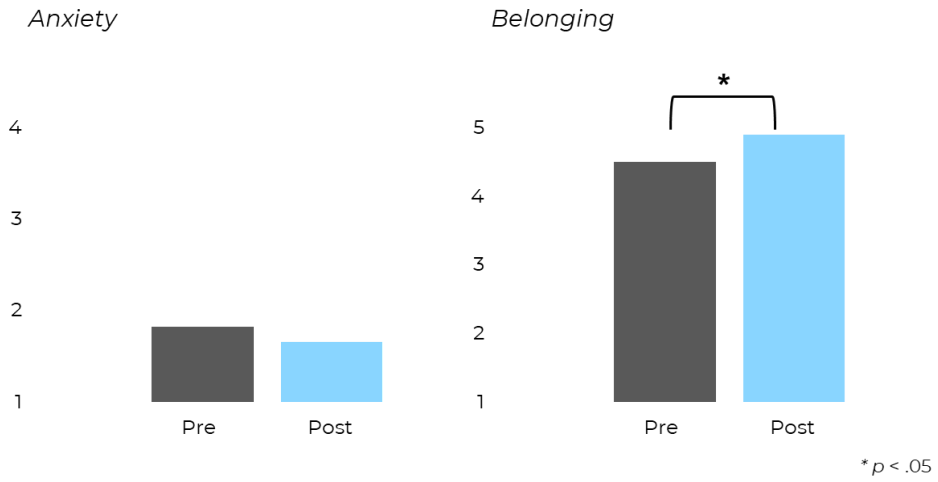

Fig 3. Average hackathon anxiety and team belonging scores from pre to post hackathon

Team culture is an important mechanism for success

Unsurprisingly, we also found that participants with higher levels of pre-hackathon anxiety experienced lower levels of success - a finding that is echoed throughout similar research in the clinical sciences (Hofmann, 2007). However, when we conducted moderation analyses (Hayes, 2022), **we also found that being on a team with a strong culture of belonging and learning could actually mitigate the negative impacts of anxiety on success.** That is, when participants felt like they belonged and/or that the learning process was celebrated, even participants *with a higher level of anxiety* were able to experience success (see Figure 4 for moderation results). This success was not achieved for participants with a high level of anxiety who did *not* experience a strong team culture of belonging and learning.

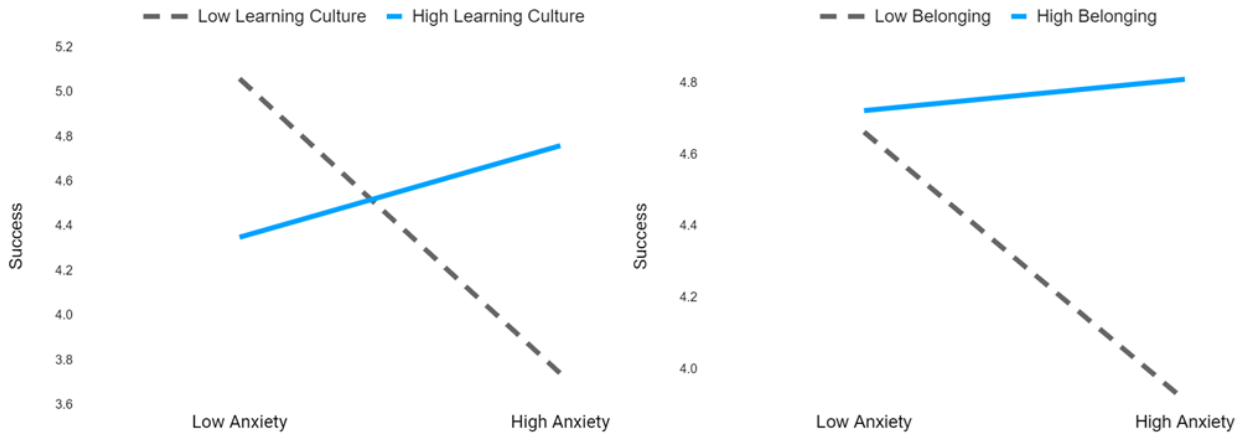

Fig 4. Learning culture moderates the relations between anxiety and success [$F(3,22) = 12.2$, $R^2 = .62$, $B = 6.55$, $p < .001$]. Belonging moderates the relations between anxiety and success [$F(3, 22) = 7.72$, $R^2 = .51$, $B = 6.97$, $p = .001$].

The Success Mechanism of Team culture also translates to greater behavioral action

Finally, when we examined participants' ratings of *how likely they would be to participate in a future hackathon,* we also found a significant benefit from a positive team belonging and learning culture (see Figure 5 for moderation results). **Importantly, this suggests that team culture can impact people's beliefs about new skills in the moment, *and* their plans to continue to invest in them.**

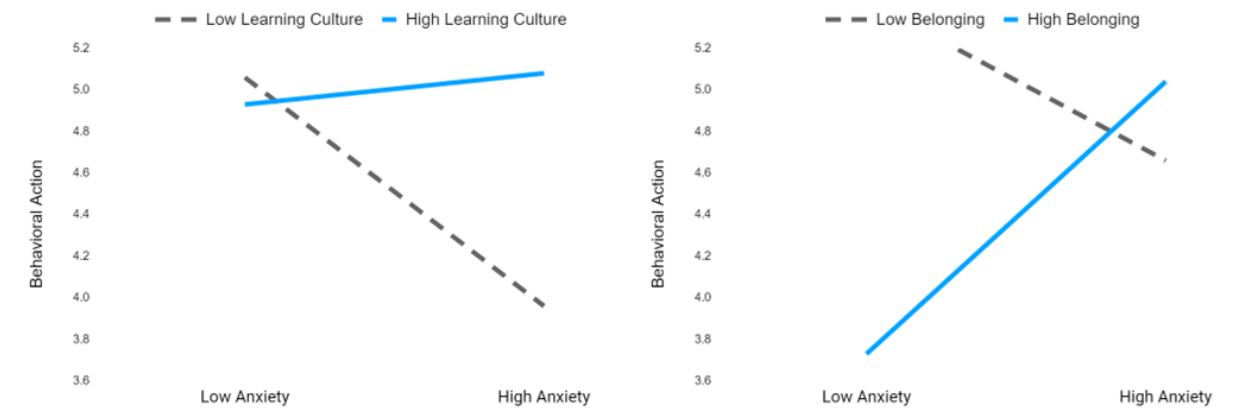

Fig 5. Learning culture moderates the relations between anxiety and success [$F(3,22) = 27.03$, $R^2 = .76$, $B = -3.92$, $p < .001$]. Belonging moderates the relations between anxiety and success [$F(3,22) = 11.35$, $R^2 = .61$, $B = 8.34$, $p = .001$].

Discussion

While hackathons are generally positively regarded, they are also frequently *discarded* as merely an outlet for employee socializing within a business. When hackathons *are* evaluated in terms of potential business impact, this impact is typically only measured in the tangible outputs such as discrete product ideas.

Our case study reveals a third, important view of successful internal hackathons: **a lightweight vehicle for transformative "new team" experiences that can change people's self-efficacy in future skill growth.** Beliefs about learning and belonging have a direct impact on employees' work, and have been shown to increase overall productivity. Particularly in technical work such as learning new coding languages, where many individuals struggle to maintain motivation and overcome internalized barriers (Hicks, 2022; Hicks, Lee, & Ramsey, 2023; Scott & Ghinea, 2013), a successful hackathon experience could be a powerful tool for change.

Our findings show suggestive evidence for hackathons as a social intervention that impacts new self-concepts about skills for employees, and their future behavioral action on those self-concepts. Future research on hackathons should explore how employees can use internal hackathons to experiment with new role types and new teams, and investigate long-term outcomes such as whether internal hackathons drive more beneficial patterns of employee engagement, such as decreased attrition and increased skill growth within an organization.

Our findings further show that **teams** are an important differentiator in a successful hackathon experience. Even when participants feel anxious and worried about participating in a hackathon, they can still experience success if their teams celebrate the learning process and make them feel like they belong. This finding is particularly relevant when considering that pre-event anxiety disproportionately impacts minoritized and early career developers (e.g. Cokley et al., 2013). As such, it's likely that a focus on team culture can help equitably distribute the benefits of success across team members.

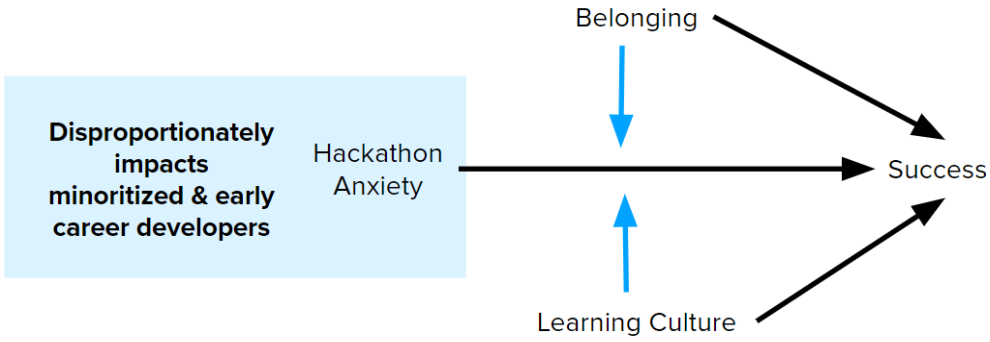

Fig 6. Conceptual diagram of learning culture and belonging as moderating anxiety's impact on success.

Recommendations for Changing Team Culture

Key Focus	*In a Hackathon*	*On Eng Teams*
Redefine Success. Shift your internal definition of success to include and center the intangible outcomes. Explicitly model the intangibles as success by positioning your team's ability to learn together, explore together, and build community as performance. Celebrate these achievements as much or more than you celebrate tangible outcomes.	Explicitly name the intangibles as a hackathon outcome. Discuss your team's progress on both tangibles and intangibles when presenting your final product.	Document the intangibles in your ticketing systems and assign story points to them.
Create a Culture of Learning. We create a culture of learning by valuing and celebrating the learning process, including mistakes. Honestly and nonjudgmentally reflect on what you've learned each day, and model sharing the seemingly "obvious" things you've learned and/or realized.	Hold a hackathon focused on learning by organizing teams around learning goals (e.g. Learning Python Team), rather than a product or feature.	Create time for learning, embrace and process mistakes with teammates during retrospectives, and share what you have learned with others.
Create Belonging. We experience belonging when there is a shared experience that we can honestly and non judgmentally process, discuss, give input on, and shape together.	Ask hackathon participants what *they* would like the hackathon focus and process to be. Allow participants to collaboratively create teams around shared interests.	Give teams agency and a voice in team processes. Continuously check in with one another on how different processes are hurting or helping individual and team health and wellbeing.

Table 3. Methods for changing team culture on hackathon and engineering teams

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Appendix A. Asking about Identity

We chose to ask about demographic information such as race and gender to better describe, represent, and contextualize our participants. Although these categories do not fully capture the complexities of each individual's experience, they were an attempt to reflect the diversity of people's identities. Participants were also reminded that they could skip items they did not feel comfortable answering.

Racial Identity

When asking about racial identity, we chose to utilize a "check all that apply" approach that included a free-text response option. This approach creates some structure for coding purposes, while providing participants greater freedom in how they identify. While a case could be made that simply providing the options of "multiracial/biracial" is sufficient, we wanted to reflect that the biracial and multiracial experiences are distinct and may not encompass how participants are racialized (Wadsworth et al., 2016). That is, people may identify as holding multiple racial identities, but not necessarily identify as "multiracial."

We also asked participants about their "racial/ethnic" identity. While racial identity is distinct from ethnicity, we chose to include ethnicity in order to capture ethnicities that have been racialized (e.g. Native Hawaiian).

Additionally, we split our racial categories of "Latinx/Hispanic" and "Middle Eastern/North African" into subcategories of "white" and "non-white." This was to allow space for individuals who may be racialized as white by others (and are typically forced to identify as white in national census data; Wang, 2023), but are systemically minoritized based on factors such as cultural practices, appearance of family members, and name.

Racial Identity Question
[OPTIONAL] Which group(s) below most accurately describes your racial/ethnic background? (check all that apply) ☐ Alaskan Native/Native American/Indigenous ☐ Black/African American ☐ East Asian ☐ Middle Eastern/North African (Non-White) ☐ Middle Eastern/North African (White) ☐ Latinx/Hispanic (Non-White) ☐ Latinx/Hispanic (White) ☐ Pacific Islander/Native Hawaiian ☐ White

- ☐ Multiracial
- ☐ I would like to self-identify: _____
- ☐ Prefer not to answer

Finally, throughout the report, we used the term “racially minoritized.” The use of this term is consistent with best practices in social science research and best reflects the systemic ways in which people are treated as inferior or deficit based on the way they are racialized by others, despite being the global majority. We chose not to use the term “marginalized,” as it can imply a deficit narrative and can be stigmatizing. We also chose not to use the term “under-represented,” because it ignores the experiences of those who may be well-represented in tech, yet be systemically and socially minoritized by others. Finally, we opted not to use the term “people of color,” as it has been historically viewed as inaccessible to Native/Indigenous, Asian, and Latinx-identifying individuals.