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Navigating Deficit Narratives: Marginalized Student Experiences in Humanitarian Engineering Graduate Programs

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Abstract

Humanitarian Engineering (HE) graduate programs aim to address global infrastructure inequalities while creating inclusive engineering spaces. However, these programs often struggle with recruiting and retaining students from marginalized backgrounds, particularly those from Low- and Middle-Income Countries (LMICs) and communities of color. We conducted and analyzed 67 in-depth longitudinal interviews with 19 students across six US graduate programs in humanitarian engineering between 2021-2023 to examine how deficit mindsets—viewing marginalized communities through perceived shortcomings rather than recognizing their strengths—manifests in HE education. Our findings reveal how institutional practices, programmatic approaches, and field assumptions can reinforce deficit-based thinking even as programs strive to address global inequities. Specifically, we found that: (1) a lack of diversity in HE programs undermines students' sense of belonging and cultural worth, (2) an emphasis on hardships diminishes recognition of students' assets, and (3) savior narratives perpetuate deficit views of partner communities. However, our research also identifies transformative moments where programs recognized and built upon students' cultural wealth, suggesting pathways for institutional change. This research illuminates specific ways that deficit mindsets persist in educational settings, while highlighting concrete opportunities for creating more inclusive and equitable engineering spaces for marginalized students.

Introduction

Humanitarian Engineering (HE) graduate programs aim to train students in addressing global infrastructure inequalities. Critical to these programs' success is the recruitment and retention of students from diverse racial and national backgrounds, particularly those with lived experiences of infrastructure instability. However, these educational spaces can perpetuate a deficit mindset - a perspective that views marginalized communities through their perceived shortcomings rather than recognizing their strengths and the systemic barriers they face [1], [2]. This mindset is particularly problematic as students from marginalized communities carry valuable social, navigational, technical, linguistic, and cultural capital that enriches HE learning environments for all students and advances the field's mission of addressing global inequities.

As humanitarian field stakeholders have sought to decolonize and reform [3], understanding if and how deficit mindsets manifest in HE education is needed and timely. Growing calls for change emphasize that LMIC practitioners bring vital indigenous knowledge and deep understanding of local contexts [4], [5], yet their perspectives may be unheard or undervalued in educational settings. While HE programs show potential for creating inclusive engineering spaces - with humanitarian design components demonstrating higher retention rates for underrepresented students [6] - significant challenges persist. Programs continue to struggle with recruiting and retaining students from LMICs [7], and those who do enroll report encountering embedded structural racism within both educational and professional contexts [3].

Despite growing recognition of these challenges, little research has examined how a deficit mindset manifests within humanitarian engineering education, particularly given these programs' explicit commitments to diversity and social justice. Drawing from interviews with students across US graduate programs in humanitarian engineering, this study examines how institutional practices, programmatic approaches, and field assumptions can perpetuate deficit-based thinking, even as programs strive to address global inequities. Through this analysis, we aim to identify pathways for transforming HE education to better recognize and build upon the assets, knowledge, and experiences that marginalized students bring to the field.

Diversifying Humanitarian Engineering Education

Humanitarian Engineering (HE) graduate programs represent an emerging discipline within engineering education, training engineers to address infrastructure and service disparities in marginalized communities both domestically and globally. These programs distinguish themselves through explicit commitments to diversity, sustainability, and community partnerships, emphasizing user-centered design approaches and alignment with contemporary frameworks like the United Nations Sustainable Development Goals [8], [9]. However, the field's colonial legacy has historically privileged Eurocentric approaches to development, resulting in projects that often misalign with local contexts and needs [10].

Growing calls for decolonization have emphasized that transforming HE education requires fundamentally changing who shapes and leads the field. Both practitioners from Low- and Middle-Income Countries (LMICs) and racial minorities bring vital assets to the field - from indigenous knowledge and context-specific communication skills to deep understanding of diverse communities' needs, solutions, and socio-technical contexts [4], [5]. HE programs show potential for fostering this transformation - research indicates that students from marginalized communities are often motivated to pursue engineering by desires to help their communities and create social impact [11], [12]. This alignment between student motivations and program goals has shown promise in some areas, with humanitarian design components demonstrating higher retention rates for underrepresented students [6] and organizations like Engineers Without Borders reporting increased gender diversity [13].

However, HE programs continue to struggle with recruiting and retaining students from LMICs and communities of color [7], [14]. One key barrier is the persistence of colonial mindsets in humanitarian engineering education. For instance, many HE graduate programs have experiential learning components, where students work with marginalized communities in LMICs on technology or infrastructure projects. This approach can reinforce existing inequalities and colonial mindsets by perpetuating power dynamics between socially dominant students and marginalized communities [15]. These educational dynamics mirror challenges in professional practice, where marginalized practitioners are burdened with navigating institutionalized practices rooted in colonial practices. Specifically, local practitioners and racial minorities report that structural racism is deeply embedded in the international development sector's culture and practices, affecting how they perceive their communities and engage with international NGOs [3]. This dynamic is further compounded by a prevailing color-blind understanding of global inequality that may reinforce colonial "white savior" mentalities [16].

Deficit Thinking: A Persistent Barrier in Higher Education

These challenges reflect deeper historical patterns in U.S. higher education's approach to diversity and inclusion. A deficit-based mindset - viewing marginalized students through the lens of their perceived shortcomings rather than their strengths - has persistently shaped educational institutions' responses to calls for increased representation [1], [17]. This perspective manifests in three key ways: attributing educational challenges to individual or cultural deficiencies rather than structural barriers; perpetuating stereotypes about marginalized communities' capabilities; and focusing on "fixing″ students rather than transforming inequitable institutional structures [18].

The deficit mindset in higher education stems from colonial foundations that continue to shape institutional structures today. Higher education systems were designed to support and privilege the cultural and social capital of white students from high-income countries while devaluing the assets of marginalized students [19]. This manifests explicitly, through barriers to enrollment and advancement, and implicitly, through institutional cultures that fail to recognize or build upon the diverse forms of knowledge and experience that marginalized students bring to their education [17]. Rather than acknowledging these structural barriers, institutions historically justified educational disparities by attributing them to perceived personal or cultural deficiencies of marginalized communities [1], [18].

These historical patterns evolved but persisted through civil rights era reforms and into contemporary higher education. Following Brown v. Board of Education in 1954, schools responded to integration mandates by placing the burden of diversity on marginalized students while maintaining structures that privileged white students. This included tracking practices that channeled white students into college preparatory programs while disproportionately placing students of color in vocational tracks [20]. Studies show the harmful impacts of these approaches continue today, with marginalized students experiencing lower academic achievement and graduation rates in predominantly white institutions due to hostile campus climates and increased discrimination as their growing numbers are perceived as threats to existing power dynamics [21], [22], [23]. Modern diversity initiatives often reproduce these patterns by focusing on increasing numerical representation without transforming the institutional structures and cultures that create barriers for marginalized students [24], [25].

While scholarship has documented both the potential of HE programs to create inclusive engineering spaces, and the persistence of deficit mindset in higher education, little research has examined how deficit thinking specifically manifests within humanitarian engineering education. This gap is particularly relevant given HE programs' explicit commitments to diversity and social justice, and their unique position working with marginalized communities both as students and project partners. This study examines how institutional practices, programmatic approaches, and field assumptions can perpetuate deficit-based thinking, even as programs strive to address global inequities. Understanding these manifestations is crucial for transforming HE education to better recognize and build upon the assets, knowledge, and experiences that marginalized students bring to the field.

Methods

Data Collection

We selected six US graduate programs offering master's or doctoral degrees in humanitarian engineering (HE) for this study. These programs were chosen based on their explicit mission statements focused on educating engineers to address the needs of marginalized communities, particularly those in low- and middle-income countries (LMICs). From a larger study on HE graduate education, we focused specifically on students who self-identified as either BIPOC (Black, Indigenous, and People of Color) in the US context and/or were born or raised in LMICs. Participants were recruited through email advertisements distributed by program directors and professors. Our final study sample consisted of 19 participants distributed across the six programs. Of these, 14 participants were born or raised in LMICs . Noting that racial identity and minority status can shift across national boundaries, 17 identified as racial minorities either in their home country or the US context. The complexity of participants' racial and national identities provided unique insights into how deficit mindset manifests in HE education.

Using processes outlined in IRB 21-0207, we conducted 67 interviews with these 19 participants between winter 2021 and spring 2023. Interviews were incentivized with a $20 gift certificate and conducted via online video conferencing or in-person meetings. The interview questionnaire was collaboratively developed by the research team, including experts in HE education and theoretical frameworks on race and deficit mindsets. To explore students' educational experiences, particularly how deficit mindsets manifested in students' HE education, we asked broad questions about their feelings regarding their semester, coursework, and experiential learning opportunities. To gain insight into students' perceptions of their educational development, we also inquired about how these experiences were or were not helping them achieve their career aspirations and overall experiences as marginalized students in the program. We invited them to share instances where they felt their backgrounds and experiences were valued within their education or extracurricular activities, as well as times when they encountered deficit-based assumptions, burdens, or hostile experiences, focusing on experiences they felt were influenced by their identities.

Data Analysis

We employed a hybrid deductive-inductive approach to analyze the interview data [26]. Interview responses were segmented into meaningful units of analysis, each representing a distinct educational experience or perspective. We first coded for instances when a deficit mindset or experience was mentioned in our , and subsequently employed inductive subcoding for emergent themes [27]. Following Valencia's [1] work, we defined deficit-based experiences as instances where students encountered perspectives that attributed marginalized community challenges to perceived cultural, linguistic, or cognitive shortcomings rather than systemic barriers - viewing marginalized communities through the lens of their perceived shortcomings and hardships rather than their strengths.

For example, consider Serena, a student of color from an LMIC, who described her internship experience stating, *"As someone who is a non-native English speaker is incredibly daunting. And*

if anything, you'd think that in this industry people would be more forgiving of that. And oftentimes it isn't always like that."

This excerpt exemplifies deficit mindset as defined by Valencia (1997) - the environment positioned Serena's multilingual abilities as a deficit rather than recognizing her language skills as valuable for humanitarian engineering work in global contexts.

Through iterative coding cycles, we inductively identified three key themes regarding how deficit mindsets manifested in humanitarian engineering education, including through: (1) a lack of diversity in the program undermining students' sense of belonging and cultural worth, (2) an emphasis on student hardships, which diminishing recognition of student assets, and (3) savior narratives perpetuating deficit views of partner communities. These themes emerged consistently across multiple participants' experiences and different programs. To ensure the validity of our findings, we conducted member checking sessions with participating students, sharing our thematic analysis and incorporating their feedback into our final interpretations.

Findings

Our analysis revealed how deficit mindsets manifested in humanitarian engineering education through three distinct yet interconnected themes that emerged consistently across programs and participant experiences. These manifestations illuminate how institutional practices, programmatic approaches, and broader field assumptions can perpetuate deficit-based thinking, even as programs strive to address global inequities. Each theme reveals specific ways that deficit mindset shapes student experiences while also highlighting opportunities for institutional transformation

Lack of Diversity Undermines Students' Sense of Belonging and Cultural Worth

The interviews revealed a pervasive concern about the striking lack of diversity within humanitarian engineering (HE) education and related programs, particularly regarding racial and geographical representation. Students consistently reported being one of very few, or often the only, person of color or student from a Low- and Middle-Income Country (LMIC) in their classes. Grace, a Hispanic female student from the United States, emphasized her stark awareness of being "*polar opposite from everybody*" in an engineering department that was "*very male or white*," noting how remarkable it felt to be selected given these demographics. Similarly, Caitlin, a biracial South Asian-American student who was born and spent her early childhood in South Asia, poignantly observed that even in well-regarded programs at top institutions, this underrepresentation was stark: "*I'm just like tired of walking to a class... and seeing another person of color and like being excited*." She highlighted the irony of such homogeneity in global development courses, noting that even at "*one of the best programs for this in the country*," the lack of diversity was concerning. Caitlin worried that this current lack of representation could perpetuate itself, becoming "*a barrier to entry for a lot of people*" who might not feel comfortable joining programs where they "*don't have people who understand them or who look like them*."

The lack of diversity in HE programs had profound impacts on how students viewed their own place and value within these spaces. As programs attempt to diversify, multilingual students and students of color are often among the first in their programs, leaving them to navigate unwelcoming environments shaped by neocolonial and racist standards. Serena, an Afro-Latinx student from South America, articulated how this lack of representation led to deep self-doubt and imposter syndrome, particularly when her unique skills and perspectives were met with criticism rather than appreciation: "*As someone who is a non-native English speaker is incredibly daunting. And if anything, you'd think that in this industry people would be more forgiving of that. And oftentimes it isn't always like that*." Despite expecting to find peers with similar international experiences in her program, she instead encountered "*unforeseen resistance*" and environments that weren't "*the most welcoming*." Rather than recognizing her multilingual abilities and international experience as assets, she found herself questioning "*why am I subjecting myself to all this criticism when I'm not receiving a lot of empathy*?"

The lack of diversity created an environment where certain types of multicultural experiences were privileged over others, leading some students to question the value of their own lived experiences. Will, a Mexican-American student who grew up in the United States, described grappling with imposter syndrome despite having deep cultural connections through his family: "*I always struggle to think I can, like, connect with communities, even my own communities back home.*" Despite being only *"one family member removed"* from East L.A. where his mother grew up, Will found himself comparing his experiences to those of his peers who had international volunteering experiences - opportunities he hadn't had access to because *"my family just didn't have, like, the economic means."* The prevailing culture in HE programs, which often prioritizes international travel experiences, led Will to minimize his own valuable multicultural knowledge gained from growing up in a transnational family.

The transformative power of representation in countering deficit mindset emerged clearly when students encountered peers and mentors from marginalized communities. Talia, who identifies as white in her home country in South America but is perceived as a woman of color in the US, described how being in spaces with other minoritized engineers fundamentally shifted the environment: *"being in a room with 30 majority women, black and Hispanic women or men* [...] *it's easier to talk about the challenges that people face as minorities more casually* [...] *it felt natural and didn't need explanation."* This comfort extended beyond just cultural connection to a deeper validation of their technical expertise and belongingness in the field. Seeing *"three black women... all working at the fusion reactor... finishing their PhDs, doing incredible work"* challenged internalized assumptions about who belongs in technical spaces. Similarly powerful was witnessing the challenging of linguistic norms, as Talia described the *"earth shattering"* experience of seeing a Central American woman presenting in Spanish at an English-language conference, with translation support - an experience she saw as *"pushing the boundaries of what's considered the standard."*

Emphasis on Hardships Diminishes Recognition of Student Assets

A critical manifestation of deficit mindset in HE programs was the tendency to view students from LMICs or minoritized backgrounds primarily through the lens of presumed hardships rather

than recognizing their unique assets - assumptions that could ironically lead to lowered educational standards. Talia's experience pointedly illustrated this problem when her program waived a credit requirement solely based on her nationality from a LMIC. She challenged this decision, noting the problematic assumptions underlying it: *"Just because I'm from* [a low-income country] *It doesn't feel right. I am white* [in my country]. *I was raised in a private British school in* [...] *a very modernized city. And I've grown up, you know, upper middle class."* While Talia acknowledged her work experiences might justify waiving the requirement, she found the blanket policy based on nationality *"very insensitive"* and potentially harmful to her education. Her concern extended beyond personal offense to how such policies might actually diminish educational quality: *"What if I did need this experience? What if I needed very much* [this credit requirement] *to get out of my privileged mindset?"*

The emphasis on hardship over assets became particularly pronounced as HE programs attempted to incorporate discussions of racism and neocolonialism into their curricula, creating pressure for students to share experiences of oppression rather than their diverse perspectives and cultural knowledge. Chad, a Black student from Eastern Africa, found himself expected to contribute to discussions about racism based on assumptions about his experiences, rather than his actual lived reality. *"I'm a Black person* [...] *people might expect me to talk a lot* [in these discussions]...[and racism] *probably affects me in some way, but* [...] *I haven't experienced it that much,"* he explained. While these classroom discussions were well-intentioned, they created an environment where Chad felt uncomfortable expressing perspectives that differed from his predominantly White classmates' expectations. More troublingly, he worried that the intense focus on racial oppression could reinforce deficit thinking he had observed in his home country: *"Some people in* [my country] *feel like Whites are much better than Blacks* […] *which is a big* [mindset] *that disturbs me."* Rather than creating space for Chad to share his unique insights and perspectives about his nationality and culture - assets he was passionate about contributing - the classroom environment pressured him to conform to preconceived narratives about racial struggle.

The default narrative to focus on hardship rather than assets extended beyond classroom discussions to public forums, where students could feel pressured to perpetuate deficit narratives instead of highlighting their unique strengths and contributions. Alexandra, a woman of color from the US, encountered this when her professor asked her to participate in a panel discussion about her Peace Corps experience. Rather than focusing on her valuable insights and accomplishments, the request centered on assumed hardships: *"We need a woman's point of view and maybe a person of color because* [...] *you probably get harassed when you go to other developing countries and communities, and you just have different problems than men."* Alexandra recognized how this framing would not only constrain her ability to share the nuances of her experience but could also reinforce harmful stereotypes about the communities she worked with. Her discomfort with the request was clear: *"I'm sorry, you want us to volunteer to be on this panel to talk about harassment?* [...] *he was assuming it was a safe space to share those things."*

The transformative power of moving beyond deficit-focused narratives emerged clearly when programs created intentional spaces for students to share their full range of cultural wealth and experiences. Caitlin's experience demonstrated how this shift could profoundly impact student engagement and sense of belonging. When her professor created structured opportunities for international students to share their perspectives, Caitlin enthusiastically embraced the chance to present a complete picture of her background: *"I didn't walk. I ran to this professor and said, 'Let me talk about my life in* [South Asia] *and help people understand my community. I want to tell everybody about my upbringing and my beautiful home country.'"* The impact of this asset-based approach extended beyond the classroom into her professional development. During her internship, Caitlin found that embracing her cultural background - rather than downplaying it - enhanced her ability to connect with community partners.

Savior Narratives Perpetuate Deficit Views of Partner Communities

Finally, the deficit mindset was perpetuated in HE education through vocabulary and terminology that systematically positioned partner communities as lacking or deficient while implicitly elevating HE practitioners as solution-providers. Talia highlighted how this manifested in the persistent use of problematic terminology, even when students voiced their concerns. She described her frustration with a professor who continued using the term "developing country" despite being informed of its offensive implications: *"she has shared with the class before that a student told her once that they didn't like her using the word 'developing country' because coming from a developing country, they felt offended and I really relate to that. It's a term I really don't like. Yet she still uses it."* This resistance to changing problematic language was especially troubling given the program's purported focus on critical analysis of global issues.

This positioning of communities as deficit-holders extended into broader program philosophies that assumed HE practitioners possessed superior knowledge that needed to be transferred to marginalized communities. Serena challenged this presumption, questioning the common trajectory of students with limited global experience believing they could effectively intervene in other cultures: *"how would someone who grew up in like middle of nowhere, Oklahoma, now end up studying this and flock into a country and say, now I'm going to teach the kids in this country a specific subject* [...] *because the way I've been taught how to teach is the best way."* She identified this as a *"dominant narrative in the space"* where programs emphasize *"take what you learn and what's worked here and maybe go do it there,"* leading to failed interventions when practitioners *"coming in with their own biases, their own perceptions"* lack genuine engagement with community perspectives.

The framing of partner communities through their deficits rather than their assets manifested directly in how HE programs communicated with these communities, often undermining students' efforts to build meaningful partnerships. Grace described how her program's communication inadvertently perpetuated deficit narratives despite her attempts to build respectful partnerships. She recounted her dismay at being carboned-copied on an email where her program wrote to her partner community: *"thank you for accepting* [our student to work with you]. *We really like working with underserved communities."* Grace identified this as *"a horrible insult,"* recognizing how the language reduced the community to their perceived deficits while

positioning the program as saviors: *"aren't we wonderful that we have this* [humanitarian] *engineering program because we're out here to save the world."*

However, some programs demonstrated how moving beyond deficit-based approaches to genuinely value community knowledge could transform both research and practice in humanitarian engineering. Jay, a Mexican-American student from the United States, discovered concerning approaches in some programs' research, such as using *"shame"* as an intervention strategy for changing community practices - an approach he found *"problematic."* In contrast, he was drawn to a program that documented their commitment to mutual learning and exchange rather than positioning themselves as solution-providers. He described being impressed by a documentary showing *"professors talking with* [people at] *that* [mineral] *processing plant, and like, you know, kind of iterating how they can improve the* [mineral] *recovery* [process] *and things like that. And the students learning from the people there and interacting and exchanging."* For Jay, this evidence of *"exchange of ideas"* and *"working directly with communities"* stood in stark contrast to approaches focused on *"applying a* […] *technology or a really intricated or elaborated engineering project in an area."*

Discussion

Our findings reveal how deficit mindsets persist in humanitarian engineering education through interconnected institutional practices, programmatic approaches, and field assumptions, even as programs strive to address global inequities. These manifestations of deficit thinking create barriers for marginalized students while simultaneously undermining HE programs' stated goals of fostering inclusive engineering spaces and addressing infrastructure inequalities.

The stark lack of diversity in HE programs creates a self-perpetuating cycle that undermines students' sense of belonging and devalues their cultural assets. As demonstrated by participants like Grace and Caitlin, being *"polar opposite from everybody"* in predominantly white spaces creates isolation that can deter future students from entering these programs. This demographic homogeneity is particularly problematic given HE's focus on global development and cross-cultural engagement. The experiences of students like Serena highlight how unwelcoming environments can lead multilingual students and students of color to question their place in the field, despite possessing valuable skills and perspectives that could enhance humanitarian engineering practice.

More troublingly, our findings reveal how well-intentioned efforts to address diversity and inclusion can inadvertently reinforce deficit thinking. When programs focus primarily on students' presumed hardships rather than their assets, they risk creating environments where students feel pressure to share experiences of oppression rather than their diverse perspectives and cultural knowledge. Chad's experience demonstrates how discussions of racism and neocolonialism, while important, can become counterproductive when they constrain students to conform to preconceived narratives about racial struggle rather than creating space for their unique insights.

The persistence of savior narratives in HE education further compounds these challenges by systematically positioning partner communities as lacking or deficient while elevating

practitioners as solution-providers. As illustrated by Talia's frustration with problematic terminology and Grace's experience with program communications, this deficit framing can undermine students' efforts to build meaningful partnerships based on mutual respect and recognition of community assets. The contrast between approaches focused on *"applying really good technology"* versus those emphasizing *"exchange of ideas,"* as described by Jay, highlights how deeply ingrained deficit thinking can impact both research and practice in humanitarian engineering.

These findings have significant implications for transforming HE education. First, programs must move beyond simply increasing numerical representation to creating environments that genuinely value the diverse forms of cultural wealth that marginalized students bring. This includes reconsidering how discussions of racism and colonialism are facilitated to ensure they create space for students to share their full range of perspectives and experiences, not just stories of hardship.

Second, our research suggests that addressing deficit mindsets requires fundamental changes to how HE programs conceptualize and communicate their work. Rather than positioning themselves as providers of solutions to *"underserved communities,"* programs can instead emphasize mutual learning and exchange, recognizing the expertise and assets that both students and partner communities bring to humanitarian engineering practice.

Finally, these findings highlight the need for more comprehensive approaches to meet inclusive and equitable goals in HE education. While participants' experiences demonstrate how increased representation can help counter deficit mindset, they also reveal how institutional practices and field assumptions can undermine these efforts if not explicitly addressed. Programs must critically examine how their approaches to recruitment, curriculum design, and community engagement might perpetuate deficit-based thinking, even as they strive to create more inclusive engineering spaces.

Future research should explore how HE programs can effectively implement these transformations while navigating institutional constraints and field expectations. Additionally, longitudinal studies examining how changes in program practices impact student experiences and outcomes could provide valuable insights for advancing equity in humanitarian engineering education.

Conclusion

This study reveals how deficit mindsets continue to shape humanitarian engineering education in ways that may undermine student experiences and program effectiveness. By examining the lived experiences of marginalized students across multiple HE programs, we identify specific manifestations of deficit thinking that persist despite programs' explicit commitments to diversity and social justice. These findings demonstrate that creating inclusive engineering spaces requires more than increasing numerical representation or adding cultural competency components to existing curricula. Rather, it demands fundamental transformation of how programs conceptualize and value diverse forms of knowledge, experience, and cultural wealth that marginalized students bring to humanitarian engineering. As the field continues to evolve,

addressing these deep-seated patterns of deficit thinking will be crucial not only for supporting student success but also for developing more equitable and effective approaches to humanitarian engineering practice. The experiences and insights of marginalized students offer vital guidance for this transformation, pointing toward educational practices that can better recognize and build upon the assets of both students and partner communities.

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