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PERCEPTIONS OF THE VALUE OF COMMUNITY-ENGAGED RESEARCH IN THE PROMOTION AND TENURE PROCESS FOR ENVIRONMENTAL ENGINEERING AND SCIENCE FACULTY

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Community-engaged research (CER) is increasingly considered a conduit to social and environmental justice by actively engaging communities in knowledge creation. Understanding if engaging in CER is detrimental to faculty promotion and tenure may help explain the lack of racial diversity among faculty in fields like environmental engineering and science (EnvES). This study, grounded in critical race theory, investigated the extent to which EnvES faculty perceive that CER is valued in annual review, promotion, and tenure (RPT) processes. Among EnvES faculty who responded to an anonymous online survey, 43% agreed that CER scholarship is recognized and rewarded during RPT. More female than male faculty (36% vs. 13%, respectively) and more underrepresented minoritized (URM) than White faculty (50% vs. 21%, respectively) disagreed that CER scholarship was recognized and rewarded in RPT. High percentages of URM and female faculty also disagreed that RPT committees understand CER (83% and 68%, respectively; vs. 58% White and 45% male faculty). These discrepancies might be due to systemic conditions whereby CER is differently evaluated for faculty from historically majority and URM groups. Open-ended responses revealed that many faculty believed that the valuation of CER differs among disciplines, institutions, and within institutional levels. Many comments indicated that CER would be judged by the standard metrics of journal publications and funding; others felt that CER was undervalued and lacked support. The results raise concerns that warrant further research to better understand the role of CER in the persistent lack of racial diversity among environmental engineering and science faculty.

KEY WORDS: *community-engaged scholarship, promotion and tenure, underrepresented minority faculty, women of color, critical race theory, STEM faculty, female faculty*

1. INTRODUCTION

Community-engaged research (CER), which centers collaboration with communities, community-based organizations, and other stakeholder groups, aligns with the core mission of higher education, as articulated in a recent National Academies report (NASEM, 2020):

> Central to institutions are faculty who conduct research to push the boundaries of their fields… and engage in activities with **broad impacts on their** institution, **community, and society**…. However, there is a growing concern that the evaluation of those accomplishments and traditional incentive systems are misaligned (p. 1).

As individuals from underrepresented minoritized (URM) groups (e.g., Black, Latina/o/x, American Indian, Native Hawaiian, Alaskan Native) continue to be severely underrepresented in STEM (science, technology, engineering, and math), CER has great potential to diversify these fields. Prior research has found that URM students are more likely to pursue scientific careers for prosocial cultural values—to help society or give back to their communities (Jackson et al., 2016; Thoman et al., 2015). Thoman et al. (2015) suggested URM students experience a cultural mismatch between their prosocial cultural values and the content they learn in their science classes, negatively impacting their science interests. CER can help bridge this gap by connecting URM STEM students to community-based learning opportunities (Estrada et al., 2017). Research has also documented higher prosocial motivation for female compared to male faculty (Atta-Owusu and Fitjar, 2022) and strong community motivations among URM faculty (Blake, 2018).

Despite its importance for attracting and retaining URM STEM students and faculty, CER is inconsistently valued in the academy (Bloodworth et al., 2014; Castleden et al., 2015; Elliott, 2017; Marrero et al., 2013; Vuong et al., 2017). Research has found that CER conducted by URM faculty is undervalued and not rewarded during tenure and promotion (Croom, 2017; Urrieta et al., 2015). For example, Montoya et al. (2021) found that URM environmental engineering and science (EnvES) faculty utilizing CER methods had the rigor of their scholarly activities questioned or discounted as service to the community, which can have deleterious consequences for promotion and tenure. Of concern is the potential that *the undervaluation of CER results in the loss of faculty in EnvES, particularly female and URM faculty.* This study is a first step in understanding and addressing this concern by exploring the attitudes and experiences of EnvES faculty concerning the valuation of CER.

2. BACKGROUND

2.1 CER and Its Use in Environmental Justice Research

CER are research approaches that center collaboration with communities (London et al., 2020; Stanton, 2008), including community-based participatory research (CBPR), participatory action research (PAR), equity-oriented collaborative community-based re-

search (EOCCBR), and community-engaged scholarship (Gelmon et al., 2013; Newman and Glass, 2014; Wallerstein, 2021). Ortiz et al. (2020) presented a conceptual framework for CER based on a meta review of 100 review articles on health-related CER. Their CER conceptual model included contexts, partnership processes, intervention and research, and outcomes. According to daCruz (2018), CER generates knowledge that addresses public issues, is **collaboratively** developed by universities and community stakeholders, and produces relevant scholarship. It is important that academics engaging in research with communities avoid holding a deficit model of the community or a savior complex that perpetuates the marginalization and disempowerment of these groups (Castleden et al., 2015; daCruz, 2018; Montoya et al., 2021; Nkhoma, 2020; Warren et al., 2018).

Growing interest in environmental justice and funding from the U.S. Environmental Protection Agency (EPA) will likely increase CER activity (Owen and Parker, 2018; US EPA, 2023). Park et al. (2014) identified definitions and metrics to evaluate CER components in requests for proposals (RFPs), and Yuen et al. (2015) found that 16% of 211 RFPs from the U.S. EPA incorporated elements of CER. Increases in CER aligns with two 2021 executive orders through the U.S. Federal Government (White House, 2021a,b).

2.2 Undervaluing vs. Explicitly Including CER in RPT Criteria

Publications across various disciplines have argued that CER is undervalued in academia, particularly for faculty promotion and tenure (Marrero et al., 2013; Stanton, 2008). Among faculty in academic medicine, Nokes et al. (2013) found "moderate support for [community-engaged scholarship] in tenure, promotion, and retention decisions" (p. 265). Moreover, proposed topics of research "at the community and population level, as opposed to more fundamental and mechanistic investigations," were funded at lower rates by the U.S. National Institutes of Health (NIH) (Hoppe et al., 2019, p. 1). Weerts and Sandmann (2010) suggested that traditional perspectives of what constitutes "scholarship" are less likely to include CER in the RPT process. Alperin et al. (2019) advocated that public dimensions of faculty work should be rewarded in RPT.

Potential reasons for devaluing CER include a perceived lack of objectivity (de la Luz Reyes and Halcón, 1988) and classification as service rather than scholarship (LaFave et al., 2016; Ward, 2005). CER may sometimes focus on areas of typically "'undone science,' where certain—read, nonprofitable—research and development areas are overlooked and underfunded, like engineering and science to address environmental injustice" (Boucher et al., 2020, p. 5). Further, since CER commonly involves interdisciplinary collaboration, it faces barriers in RPT when it is judged by restrictive (and perhaps outdated) discipline-based standards and its contributions to collaborative research are undervalued (Klein and Falk-Krzesinski, 2017).

Many studies have suggested that explicitly including CER in RPT criteria is important (Calleson et al., 2005; Stanton, 2008). Janke et al. (2023) found notable differences in how RPT policies defined and counted community-engaged scholarship. For exam-

ple, Worcester Polytechnic Institute uses an inclusive definition of scholarship in promotion from associate to full professor, promoting equal valuation of the "scholarships of discovery, integration, application and practice, teaching and learning, and engagement" (Demetry et al., 2020, p. 6). Furthermore, this policy lessens the importance of the number of refereed publications, number of citations, and level of external funding as indicators of scholarship quality (Demetry et al., 2020). Similarly, Purdue University values CER in RPT, what they refer to as "Scholarship of Engagement," where faculty have collaborated in "a reciprocal partnership with the community, involving mutually beneficial exchanges of knowledge" (Abel and Williams, 2019, p. 6). The report notes that 72 individuals were promoted and/or tenured fully or partially at Purdue on the basis of CER between 2015 and 2019. Explicit inclusion of CER in promotion and tenure evaluation criteria is one element (among many) that can contribute to an institution earning the elective Community Engagement Classification from the Carnegie Foundation (Carnegie, 2020). However, Vuong et al. (2017) reported that while 47% of the 38 faculty they surveyed indicated that their institution had written policies regarding the value of community-engaged research, 11% indicated that those policies were not taken seriously in faculty promotion; 3% indicated that strong policies existed. This study illustrates why written policies cannot be naively assumed to overcome deep-seated (and perhaps unrecognized) cultural norms that contribute to undervaluing CER.

2.3 Diversity of EnvES Faculty and How Undervaluing of CER Disproportionately Affects URM Faculty

Studies have found that female and URM faculty are more likely to engage in CER than male and White faculty (daCruz, 2018; Demetry et al., 2020; Janke et al., 2023; O'Meara, 2002; Stanley, 2006). For example, among over 20,000 U.S. faculty members who responded to the Higher Education Research Institute (HERI) survey in 2016–17, more female (51.3%) than male faculty (44%) during the previous three years had "collaborated with the local community on research/teaching to address their needs" (Stolzenberg et al., 2019). Latinx tenure-track faculty in education described partnering with the local community and a desire to use their scholarship and expertise to give back, but this was not expected to be rewarded in promotion and tenure (Urrieta et al., 2015). Hoppe et al. (2019) found that African American/Black (AA/B) scientists were funded at lower rates for their NIH R01 applications relative to Whites. A key reason for this gap was that AA/B scholars were more likely to propose research that focused at the community and population levels rather than more traditional research that is viewed as "fundamental and mechanistic" (p. 1). Further, Croom (2017) suggested that Black womyn scholars' work is devalued because they research issues in minoritized communities using nontraditional methodologies. Thus, there is evidence that issues of faculty diversity may intersect with CER.

CER is particularly well suited for environmental engineering and science (EnvES), a field that includes water quality, air quality, and the treatment of solid and industrial wastes. There are well-documented disparities regarding the environmental exposures

of low income and marginalized populations. Ornelas et al. (2022) advocated for incorporating environmental justice principles in exposure science, specifically because they empower communities. CER in EnvES can contribute to addressing these environmental justice issues (Cohen, 2020; Davis and Ramirez-Andreotta, 2021; Wilson et al., 2017). Publications about and using CER have been increasing in many fields (Bloodworth et al., 2014; Ortiz et al., 2020). However, very few CER studies have been published in prominent EnvES journals; examples include Champion et al. (2017), Ivey et al. (2022), Lamplugh et al. (2019), and Velez-Torres et al. (2021). Some evidence of the undervaluing of CER in EnvES has been published (Montoya et al., 2021), but it is unclear if this is widespread or similarly experienced by both the majority and URM faculty.

CER approaches are critical for solving many environmental problems, such as those that disparately affect specific communities and require community-level solutions. Thus, understanding the intersection of faculty diversity in EnvES and CER is important. While environmental engineering (EnvE) has the highest percentage of female tenured/tenure-track (T/TT) faculty among engineering disciplines, 29% is still well below parity and low compared with the pipeline of 53% of bachelor's degrees, 46.1% of MS degrees, and 42.8% of PhDs awarded to females in EnvE in 2020 (ASEE, 2021). There is a severe underrepresentation of African American, Hispanic, and Indigenous faculty (see Fig. 1), and particularly female faculty in EnvE from those groups (see Table 1) (ASEE, 2021). The lack of racial/ethnic diversity in EnvE has not improved appreciably since 2016 (Blaney et al., 2018), and URM faculty representation is also low in environmental science (Taylor et al., 2022).

3. THEORETICAL GROUNDING: CRT

Critical race theory (CRT) provides a lens through which to view the issues outlined above surrounding CER. CRT scholars have put forth a variety of central tenets. This study is aligned with the framing CRT principles from Solórzano and Yosso (2002) and

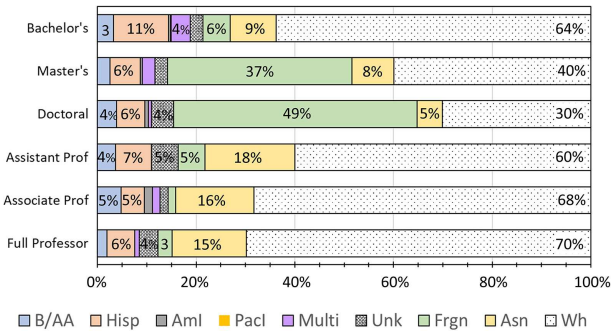

FIG. 1: 2020 Race & Ethnicity for Degree Recipients and Tenured/Tenure Track Faculty in Environmental Engineering (ASEE, 2021). B/AA, Black/African American; Hisp, Hispanic; AmI, American Indian; PacI, Pacific Islander/Native Hawaiian; Multi, Multiracial; Unk, unknown; Frgn, Foreign; Asn, Asian; Wh, White.

TABLE 1: Number of T/TT Faculty in EnvE Departments and Closely Related Disciplines in 2020, based on data from ASEE (2021)

Discipline	% Female	% URM	Number					
			Total	Females	Hispanic females	African-American females	Native American females	Multiracial females
EnvE	28.6	9.4	224	64	5	3	0	1
Civil/EnvE	22.6	9.2	1656	375	22	10	2	2
CivilE	21.1	8.2	1832	386	25	7	2	2

Urrieta et al. (2015), including intersectionality, challenging the ideologies of objectivity, meritocracy, and colorblindness, commitment to social justice, the centrality of experiential knowledge (lived experiences), and inter/transdisciplinary perspectives. CER, viewed through this lens, promotes social justice, embraces inter/transdisciplinary perspectives, and values the lived experiences of community members, working in partnership with academics to achieve their goals. EnvES is embedded in a culture that views the field as objective, with RPT in academia based on purported meritocracy; this is not the lived reality for people of color and other/additionally marginalized identities within academia (Thoman et al., 2015).

Intersectionality is critical in this research. The faculty demographics in EnvES illustrate the importance of intersectional perspectives, given that many female URMs are likely the "only" in their department or college. The relatively high representation of females in EnvES cannot be assumed to translate into gains for female URMs (Daniel, 2019; Hall, 2006). Multiple marginalities are of particular concern for female URM faculty (Turner, 2002). Further, some EnvES faculty may be marginalized in their departments due to their disciplinary focus or untraditional background. For example, a higher percentage of EnvES faculty in civil engineering departments have nonengineering degrees than colleagues in the other sub-disciplines within the department (Bielefeldt, 2019). The undervaluation of CER could bring additional marginalization for faculty conducting this work.

4. RESEARCH GOALS

The literature raises concerns regarding how faculty involvement in CER is valued in RPT processes. This may be particularly detrimental for female and URM faculty, who are frequently disadvantaged in RPT (Corneille et al., 2019; NASEM, 2020). This study examined:

1. The extent to which EnvES faculty believe CER is valued in annual merit review, promotion, and tenure within their current institution, and
2. Whether the opinions about CER valuation in RPT vary among groups with different personal demographics and employed at different institution types.

5. METHODS

This research was reviewed and approved by the Institutional Review Board for Human Subjects Research at the University of Colorado Boulder; the study was deemed exempt category 2 with minimal risk level (Protocol #21-0422). A short survey instrument was developed based on published studies of CER. To address issues of equity and accessibility and to ensure that the survey was aligned with CRT principles, it was reviewed by about 10 EnvES faculty and scientists (inclusive of females and males; female URMs; race/ethnicity groups of White, Black, Latinx, Asian; different academic ranks; different types of institutions; a variety of subdiscipline focus areas in EnvES) and pilot tested with a smaller group. The survey was administered anonymously online using Qualtrics to protect marginalized respondents.

5.1 Survey

The online survey began by obtaining informed consent among participants and providing the definition of CER from Harvard Catalyst (2021). This was followed by three Likert-scaled questions regarding perceptions of CER in RPT at their institution (modified from Marrero et al., 2013). The survey also included eight items to characterize personal engagement with CER, two open-ended items, and personal demographic items (race/ethnicity select all that apply, gender with which they self-identify*) and the Carnegie classification(s) of their current institution (see Supplemental Materials for survey instrument). Respondents could elect to skip any of the survey items.

5.2 Recruitment Methods

Participants were recruited from among the members of three EnvES professional societies: the Association of Environmental Engineering & Science Professors (AEESP), the Environmental Engineering Division of the American Society for Engineering Education (ASEE), and the American Association for Aerosol Research (AAAR). E-mail invitations indicated that a team of environmental engineering faculty were exploring CER and invited academicians working at educational institutions to participate in the study. These recruitment emails were sent to the societies' members in September and October 2021. There is potential membership overlap among these groups. For example, the first author is a member of and has held leadership positions with both AEESP and ASEE; the second and fourth authors are both members of and have held leadership positions with AEESP and AAAR. Cookie tracking was enabled to impede respondents from completing the survey more than once.

* The survey asked about gender, but the terms provided for the choice options included the sex categories of female instead of woman and male instead of man. We recognize that this conflated gender with terms that denote sex. To be consistent with the choices provided in the survey, the results section uses the sex terms female and male.

5.3 Respondents

A total of 122 participants completed the survey, with an additional 23 partially completed responses without demographic information (Supplemental Materials, Table S1); this represents a response rate of 8–18% (given the extent of overlap among the membership of the three organizations and the number of student members who did not meet the inclusion criteria). Respondent demographics are provided in Table 2 and reflect the options provided on the survey. Female faculty were over-represented among survey respondents (43%) compared to EnvE T/TT faculty (29%, ASEE, 2021). These demographics agree with those of previous studies that found females are more likely to participate in surveys than males (Smith, 2008). The numbers of URM faculty who completed the survey (3% African American, 6% Hispanic) were in proportion to their representation among EnvE T/TT faculty (3% African American, 6% Hispanic; ASEE, 2021). Most of the respondents were tenured professors (69%), with degrees in environmental engineering (74%), rostered in environmental engineering departments (64%), and at institutions with very high research activity (70%). Thirteen (13) respondents had no degrees in engineering or were not rostered in an engineering department.

Sixty percent of the survey respondents indicated that they conducted CER. Among the EnvES faculty who indicated that they conduct CER, 46% were female and 9.5% were from URM groups. A recent general survey among 294 AEESP respondents found that 24% conduct CER (Blaney et al., 2023). The high percentage of CER-active EnvES faculty among our survey respondents is likely explained by the leverage salience theory (Groves et al., 2000) whereby faculty engaged in CER were more likely to participate in the survey.

5.4 Quantitative Data Analysis

T-tests and Mann-Whitney U-tests (nonparametric tests often used with ordinal data) of the quantitative Likert-type responses were used to explore potential differences based on respondent demographics (IBM SPSS v. 26). Fisher's exact tests were used to compare yes/no response rates between two demographic groups. Statistically significant differences were inferred when p values were below an alpha of 0.10 to balance Type-I and Type-II errors at this sample size (Kim, 2015); in survey research, alpha 0.1 is considered marginally significant (Lavrakas, 2008). Results significant at an alpha of 0.05 are also indicated. Effect sizes were calculated using Hedges' g; the rules of thumb for small, medium, and large effects are 0.2, 0.5, and 0.8, respectively. Spearman's rho nonparametric correlations were calculated among the RPT Likert-type responses.

5.5 Qualitative Analyses

This study used qualitative methods to examine participants' perception of the value of CER at their institution and in the field of EnvES. Inductive analysis was conducted in two phases. First, valence categories were developed to allow the researchers to identify

TABLE 2: Demographics of survey respondents and among those conducting CER

Group	All *n*	Survey reported demographics, % of n = 122	Respondents who conduct CER, % of n = 73
Gender (self-identified)[1]			
Male	*68*	56	53
Female	*53*	43	46
Nonbinary	*1*	1	1
Self-describe	*0*	0	0
Race/ethnicity (check all that apply)			
Checked 1 or more	*122*		
Caucasian/White only	*90*	74	71
Asian	*16*	13	15
African American or Black	*4*	3	4
Hispanic/Latinx	*7*	6	4
Native Hawaiian or other Pacific Islander	*2*	2	3
Native American/Alaskan Native	*0*	0	0
International	*2*	2	3
Other	*2*	2	1
Career stage			
Tenured professor	*67*	55	63
Tenured associate professor	*17*	14	11
Tenure-track assistant professor	*24*	20	18
Research professor (any rank)	*3*	2	3
Instructional faculty (any rank)	*4*	3	3
Postdoctoral researcher	*0*	0	0
Graduate student	*1*	1	0
Nonacademic	*0*	0	0
Other	*5*	4	3
Current institution (check all that apply)	[a]	[a]	[a]
Community engaged	*17*	*14*	*18*
Very high research activity (R1)	*85*	70	72
High research activity (R2)	*17*	14	14
Doctoral (D)	*3*	2	1
Master's college or university	*5*	4	6
Baccalaureate college	*12*	10	7
Other	*0*	0	0
Department affiliation (most representative)			
Environmental engineering	*78*	64	65
Other engineering (e.g., civil, mechanical)	*20*	21	24
Public health	*3*	2	4
Environmental science	*5*	4	3
Other (write-in)	*16*	8	4

Note: 23 respondents did not answer any demographic items.

[a]Intended to be Carnegie Classification, so data cleaned to retain only highest category (R1 to Bac) that was indicated.

the respondents' sentiment of the valuation (Leu et al., 2010; Miyaoka et al., 2023). Second, the authors conducted a content analysis of the responses.

5.5.1 Open-Ended Responses

The first open-ended question, "Explain if and how you perceive that CER is appropriately valued at your institution and more broadly in EnvES," received 86 write-in responses ranging in length from 3 to 117 words (median 31 words). The open-ended question, "Share any feedback on your CER experience and/or opinions," received 37 write-in responses ranging in length from 4 to 60 words (median 26 words; 34 responses from among those who also wrote in responses to the first open-ended question). Because themes relevant to our research questions were found in the responses to both questions, the unit of analysis selected was the combined open-ended responses per individual. Both open-ended responses were analyzed together. This process avoided double-counting individuals and yielded 89 responses.

5.5.2 Value Valence Coding

First, responses were coded for respondent valence with respect to how they described whether CER was valued at their institution and in EnvES. The valence categories (Leu et al., 2010) used were Positive, Negative, Positive/Negative, and Neutral. Note that the personal feelings (e.g., their own value of CER) or actions (e.g., they conduct CER) of the respondent were not considered in the valence coding. Two authors independently assigned valence codes to 87 respondents. Initially, 80% of the valence categories agreed. The discrepancy was mostly due to the coders including the respondents' personal values, as opposed to whether their institution or the field of EnvES valued CER. The two authors then discussed each response where their evaluations differed. After this negotiated process, they achieved 99% agreement. A few responses were difficult to code and therefore not coded for valence; e.g., "My involvement is now reduced because I am emeritus." Chi-squared tests were performed to evaluate if there were differences among valences for responses from different demographic groups.

5.5.3 Emerging Analysis

Next, the authors used an open coding process to code all the data in every possible way to generate an emergent set of concepts and their properties relevant to the topic of the open-ended questions (Glaser, 2016). This process resulted in 15 open codes. Finally, thematic codes were applied to integrate the emerging theory. As such, the 15 open codes were used to develop thematic coding categories (with eight main themes, each having 0–5 subthemes). To determine reliability, two authors independently coded the responses; if there were any discrepancies, the authors met to discuss and negotiate the final code application. There were 86 responses assigned to one or more codes, with a

maximum of eight codes assigned to a single respondent. Three responses were unrelated to the question of CER valuation and were not coded.

5.6 Author Positionalities

All four authors are female faculty in academia. Three are full professors. Three have doctoral degrees in environmental engineering or closely related fields and have conducted CER or community-engaged scholarship; one has a doctoral degree in developmental psychology and has conducted extensive research using CRT. Two identify as White and two as Chicanas. One author experienced regular marginalization as the only tenure-track female URM in the EnvE program and College of Engineering at her institution. As the first female URM to undergo tenure review in the College of Engineering she experienced further marginalization and devaluing of her CER. Two authors served on the university-wide tenure committees and tenure appeals committees at their institutions; one witnessed unequal valuation of scholarship based on gender and race. One also served on the annual merit review committee in her department and chaired the reappointment, tenure, and promotion committee for the College of Engineering. These collective experiences spurred the interest of the author team in evaluating intersectional issues between CER, faculty demographics, and RPT processes in EnvES.

5.7 Protection of Vulnerable Populations

The survey solicitation was distributed through professional societies to all their members, with respondents using a generic link tagged with the professional society. No personally identifying information (name or institution) was collected. Individuals could elect to skip any survey item, including demographic questions. The responses shared in this paper are not linked to the full suite of provided demographics for a single individual (e.g., institution type, department, rank, gender, race/ethnicity) in order to protect the anonymity of the participants.

5.8 Limitations

The key limitation of the study relates to the small number of survey responses, particularly from underrepresented groups, and the extent to which these responses represent the opinions and experiences of EnvES faculty at large. Using majority groups (i.e., White and males) as the reference groups further centers them, which is inconsistent with CRT. However, the demographics of the participants in the current study are proportionate to their representation in university faculty positions. Leverage salience theory posits that those with more interest in a topic are more likely to participate in the survey (Groves et al., 2000). Thus, individuals who are active in CER or have opinions about the importance of CER would be more likely to be represented in these data. Small numbers participating in the survey limit the ability to identify differences among the experiences and opinions of individuals from various personal intersectional demographic groups and institution

types. There were not enough female URMs among the respondents to properly address intersectionality in these results. It is also unclear what level of experience survey respondents have with CER and the promotion and tenure (P&T) process. Further, in their overview of CRT, Brown and Jackson (2021) indicate that there are severe limitations in the ability of traditional research methods to reveal the nature of racial oppression. Thus, the extent that racial oppression plays a role in the experiences and perceptions of the research participants is unlikely to be illuminated in this study. Mixed methods, including counterstories, can help address some of these challenges. Given these limitations, the study findings should be viewed as preliminary and are intended to stimulate discussion and further research. The potential benefits of further research may be significant in addressing the persistent absence of URM female tenured faculty in EnvE and their missing contributions to solving important issues like environmental injustice and climate change.

6. RESULTS AND DISCUSSION

6.1 CER in Relation to RPT: Overall Quantitative Results

The results from the Likert-type items related to faculty perceptions of CER with respect to RPT are summarized in Fig. 2. A plurality of EnvES faculty (43%) strongly agreed/agreed that CER scholarship was recognized and rewarded during RPT processes at their current institution; 32% neither agreed nor disagreed, and 25% disagreed/strongly disagreed. These findings are slightly more positive than those in the study by Marrero et al. (2013), whereby fewer (35.1%) agreed/strongly agreed that CER scholarship was recognized and rewarded during RPT among 675 faculty across three institutions. One participant noted that they were unable to answer the question because there was a significant difference between "annual review" and "tenure and promotion." The Marrero et al. (2013) study also combined review, promotion, and tenure into a single item.

A small percentage of the respondents (19%) agreed that CER scholarship was explicitly included in the annual review, tenure, and promotion policies and procedures at their institution, similar to the Marrero et al. (2013) study with 20.6% agreement.

The majority (54%) of the respondents disagreed that members of RPT committees have a broad understanding of the definition, nature, documentation, and assessment of CER scholarship. It is unclear to what extent respondents have accurate perceptions of this understanding among RPT committees. In the Marrero et al. (2013) study, 47.6% disagreed and 18.2% indicated that they "had no basis to respond."

There were moderate correlations among the responses to the three survey items on RPT, with Spearman's rho values between the items ranging from 0.53 to 0.59 ($p < 0.001$); the correlation matrix is provided in the Supplemental Materials (Table S3).

6.2 Differing Perceptions of CER Value in RPT: Quantitative Results

More female than male respondents disagreed that CER scholarship was recognized and rewarded in RPT (36% vs. 13%, respectively) and disagreed that CER scholar-

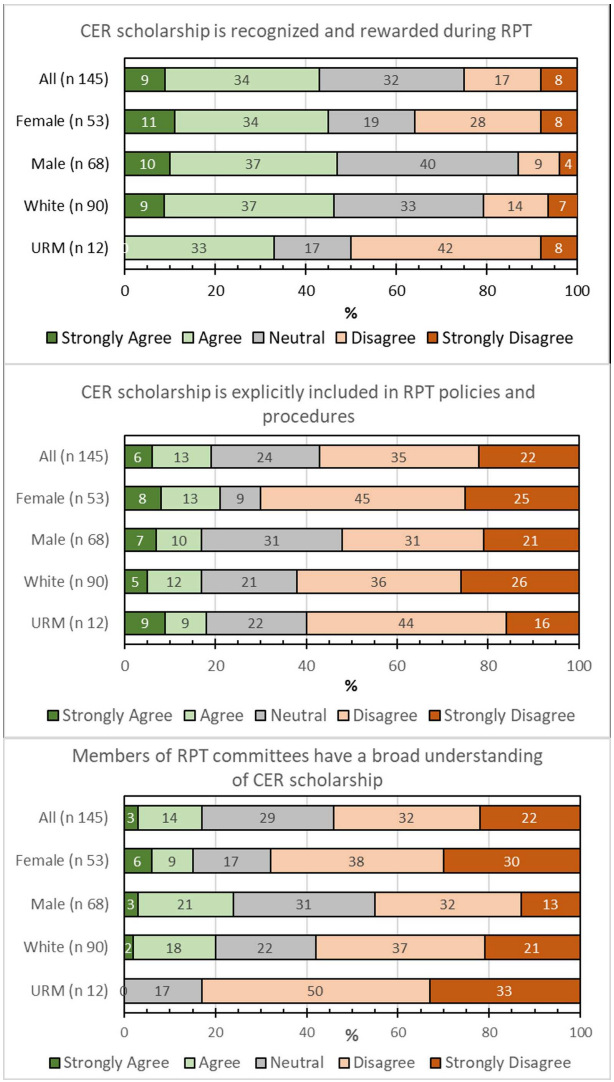

FIG. 2: Opinions of EnvES faculty on CER and RPT

ship was explicitly included in RPT criteria (70% vs. 52%, respectively) (Fig. 2); these differences were marginally statistically significant (Table 3). Females disagreed more strongly that members of RPT committees understood CER scholarship (68% vs. 45%, respectively). While the differences in responses between females and males might be due to actual differences between their institutions, using a CRT perspective, intersecting identities may reveal differences in how CER is valued when conducted by male versus female faculty. A tenant in CRT notes the centrality of racism and other forms of discrimination (e.g., gender) within institutions. Females comprise about 29% of tenure-track faculty in EnvE. As minoritized faculty in the field, fewer faculty share their demo-

TABLE 3: Statistical test results for differences in faculty opinions regarding CER and RPT

Survey statement	Statistical parameter	Female vs. Male	URM vs. White only
CER scholarship is recognized and rewarded during the annual review, tenure, and promotion processes	Mann-Whitney p *t*-test p Hedges' g	0.040* 0.061* 0.324[g]	0.063* 0.051* 0.507[G]
CER scholarship is explicitly included in the annual review, tenure, and promotion policies and procedures	Mann-Whitney p *t*-test p Hedges' g	0.097* 0.064* 0.243[g]	0.181 0.073* 0.325[g]
Members of review and P&T committees have a broad understanding of the definition, nature, documentation, and assessment of CER scholarship	Mann-Whitney p *t*-test p Hedges' g	0.005* 0.006* 0.472[g]	0.044* 0.033* 0.573[G]

*p values < 0.1 inferred as statistically significant.
[G]Hedges' g > 0.5 medium effect; [g]Hedges' g 0.2–0.5 small effect.

graphics and can serve as reviewers in the RPT process. This issue is exacerbated when the scholar is a female URM faculty—the same type of research (e.g., CER) is devalued when conducted by URM faculty compared to majority faculty.

Comparisons were also made between the responses of White and URM faculty. URM faculty had poorer perceptions of the institutional culture around CER. A higher percentage of URM compared to White faculty disagreed that CER scholarship is recognized and rewarded during RPT (50% vs. 21%), a result that was marginally statistically significant (Fig. 2 and Table 3). In addition, more URM than White faculty disagreed that RPT committees understand CER (83% vs. 58%). There was not a significant difference in the perception that CER was explicitly included in RPT criteria. In alignment with CRT and previous research, these perceptions are likely grounded in the reality that CER conducted by URM faculty would be devalued. Since CRT contends that racism is real, racists will use any excuse to exclude racial/ethnic minorities. Because CER is not mainstream, it is easier to devalue without question and acts as cover for racism. Settles et al. (2021), for example, found, "Epistemic exclusion occurs through formal hierarchies that determine how scholarship is valued and the metrics used to assess quality, and through informal processes that further convey to faculty of color that they and their scholarship are devalued" (p. 493).

There was more agreement that CER scholarship was recognized and rewarded, explicitly included in policies/procedures for RPT, and understood by RPT committees at Community-Engaged (CE) institutions (the optional Carnegie classification) as compared to institutions that were not designated CE (Supplemental Materials, Tables S2 and S4). More faculty in nonengineering departments agreed that CER scholarship is explicitly included in RPT and that members of RPT committees understand CER, as compared to faculty in engineering departments. There were not significant differences among faculty who did or did not conduct CER (Supplemental Materials, Tables S2 and S4) or faculty of different ranks (data not shown).

6.3 Perceptions of CER: Qualitative Results

The valence of the respondent toward how CER is valued at their institution and/or environmental engineering and science is summarized in Table 4. The most common categorization was Positive/Negative, indicating that the response from a single individual included both positive statements about the value of CER and negative statements, typically associated with different entities at the institutions, e.g., "CER is extremely valued in _some_ colleges and schools at my university, but not meaningfully in engineering" (White female, tenured associate professor, environmental engineering, R1 institution).

TABLE 4: Valence of opinions on valuation of CER at institution and in EnvES

Valence	Description and/or example	All, %	Male, %	Female, %	URM, %
		n = 87	n = 41	n = 42	n = 8
Positive	Response is positive. "It is considered positively in our annual review process and advancement portfolios."	26	32	21	38
Positive/ Negative	Response includes both positive and negative elements.	40	37	45	25
Negative	Response is negative. "It is not valued. At my institution it's been referred to as 'the NGO-ization' of the university."	16	10	21	38
Neutral	Unclear if positive or negative. "Department leadership solicits such information from faculty and includes it in evaluations for promotion, tenure, and salary."	17	22	12	0

The categories reflect a spectrum of the strength of the valence. For example, the "extremely valued" positivity in the previous example versus qualified positivity: "CER is valued if it is integrated with other performance metrics related to teaching and research" (nonbinary, R1 institution). Some statements were general and others personal, e.g., "Doing CER was used against me in my tenure review. It was an absolute negative" (URM female, R1 institution).

The extent of negativity among the responses varied from comparing CER to "commie/collectivist BS" (White male, Baccalaureate institution), to indicating it is "really applied consulting or social work," lacking "strength of academic quality" ("human" male, tenured professor, environmental engineering, R1 institution), "less publication-worthy compared to pure science research" (Asian female, tenured associate professor, R1 institution), and concern that CER not become "advocacy work" (White male, tenured professor, environmental engineering, R1 institution). This fourth comment is evocative of the argument against crossing the "imaginary line that separates the dispassionate researcher from the environmental activist" put forth in an editorial by Sedlak (2016, p. 9803). In response, many others responded with counterpoints in letters to the editor: "I… do not see a line, just good science making the world a better place" (Mihelcic, 2017, p. 1055); "There is not a line that one crosses, there is a continuum of engagement with society…." (Swackhamer, 2017, p. 1056).

Statistically significant differences in the response valences among different demographic groups were not found. For example, the higher percentage of negative valence responses among females compared to males was not statistically significant (chi-square p 0.235 across the four categories). Responses among faculty at R1 institutions (27% positive, 45% positive/negative, 10% negative, 18% neutral; n = 62) did not differ significantly compared to faculty at non-R1 institutions (24% positive, 28% positive/negative, 32% negative, 16% neutral; n = 25). The low number of respondents limits the power of statistical comparisons.

The results from thematic coding are provided in Table 5. The counts for the main theme categories (*in italics*) include responses that coded to any of the subthemes and/or the root theme itself (not double counting if the same response was coded to multiple subthemes). Example quotes in Table 5 that are from URM respondents are indicated with a superscript u.

The *clarity of CER for promotion and tenure* emerged as a theme, with 31 comments classified under this umbrella. The subtheme that *CER is not clearly defined or measured* was the most common across all the coded qualitative responses (n = 27, 31%) and was the most common subtheme among female respondents. Four individuals indicated that *CER had a clear definition and measurement at their institution* (n = 4).

About half of the responses commented on how the *valuation of CER differs* by specific campus levels or departments and/or at different institutions (44 comments). Subthemes related to valuation at the university level or department level, while others noted that some disciplines and/or institutions value CER more than others. One example: "My university has stated in new strategic plans that it does value community-engaged research; however, in practice not many academics in engineering (my field)

TABLE 5: Frequency of themes and subthemes among the write-in responses

Theme	Example quote	n	n F	n M	n URM
Clarity of CER for promotion and tenure	*[N/A = all responses logged to subtheme].*	*31*	*16*	*15*	*0*
CER is not clearly defined or measured (or included)	I see it is valued and evaluated very differently at different schools, with perhaps a growing understanding from researchers and evaluators how to conduct and define success of CER activities.	27	15	12	0
CER has clear definition and measurement	My department provides value to CER and it noted in our scholarship guidelines.	4	1	3	0
Valuation of CER differs	How CER is valued will vary tremendously across the institution.	*44*	*22*	*18*	*2*
Department values CER	Valued at department level, but that does not translate up during evaluation/promotion process.	10	4	6	0
Provost/institution values CER	Our university is a Carnegie community-engaged university, and CER is valued at the provost level.	19	10	8	1
Valued on a case-by-case level (including some types of positions)	In the many decades at my institution including being on P&T at all levels, I would say CER and many of its other names has been valued on a case-by-case basis and often depends on how well the P&T package is assembled.	8	2	6	0
Some disciplines value CER more	CER is more appropriately valued in the social sciences and public health disciplines. Engineering and science also consider CER as valued but less when it does not produce quantitative metrics like papers, h-index, etc.[u]	18	10	8	1
Variable at different institutions	University is classified as community engaged…. There have been a few years when this was not prioritized, but things are shifting back again to the importance of community-engaged research…. As more top-ranked programs embrace the importance of CER, I think we will see more mainstreaming in EES.[u]	9	4	3	1
CER scholarship positively valued	If CER can be explained in context of institutionally defined "extension," "outreach," and/or "applied research" then it is valued. The key to CER at my institution is to have outputs that can be explained as having merit under these other terms.	*35*	*14*	*20*	*3*

TABLE 5: (*continued*)

Theme	Example quote	n	n F	n M	n URM
Peer reviewed publications	I think CER is valued as long as the results are published like other research topics.	24	9	14	3
Publication quality (top tier, cited)	At this juncture I would be looking at where the work is published as a metric of quality.	6	3	3	1
Extramural funding	CER is valued to the extent it increases your other research metrics (proposals, funding, ….).[u]	18	5	12	1
Strong scientific/engineering methods	All research is valued if it is scholarly, which means that it is published in peer-reviewed journals and recognized by peers as following sound scientific methods.	3	2	1	0
Extramural funders value broader impacts	These days NSF and others require some form of impact, and this makes proposals stronger anyhow.	3	1	2	0
Undervaluing of CER	Doing CER was used against me in my tenure review. It was an absolute negative.[u]	*34*	*17*	*15*	*4*
Considered service-learning only	My institution has programs supporting service-learning…. The conventional wisdom on campus is that service-learning, even award-wining programs, is not enough for T&P.	4	1	2	0
Counted as service or outreach	Community-based research largely defined and treated as service rather than true research.	11	5	6	0
Less scholarly (harder to publish)	CER-based research is less publication-worthy compared to pure science research. It remains of local interest and reputed journals are less interested in issues of local interest.	9	5	4	0
No value/demeaning CER	It is not valued. At my institution it's been referred to as "the NGO-ization" of the university.[u]	3	2	1	1
Lack of support for CER	*[N/A = all responses logged to subtheme].*	*7*	*5*	*2*	*0*
No resources for CER	CER researchers can tend to receive fewer resources, which is an equity issue.	3	2	1	0

TABLE 5: (*continued*)

No/little financial support	There is not much funding available.	5	3	2	0
Teaching and mentoring valued	*[N/A = all responses logged to subtheme].*	*13*	*4*	*7*	*0*
Teaching as metric	Community-engaged teaching is valued at the university level, and this spills over into research especially if undergrads are involved with the research.	7	3	2	0
Tie to student outcomes (e.g., # students mentored, advised, graduated, dissertations)	CER is valued if it is integrated with other performance metrics related to teaching…. So it needs to be integrated with undergraduate and graduate student advising and their progress.	8	2	5	0
Community relationships/ outcomes	*[N/A = all responses logged to subtheme].*	*15*	*7*	*8*	*1*
Community impacts are not considered	CER activity is highly valued at chancellor/provost level when it can be marketed as the university being engaged in the common good.... At the P&T level… papers only count if they generate citation counts rather than positive outcomes for communities.	5	2	3	1
Community relationships are valued	At my institution, there are close ties with the local community, and those ties are generally valued.	4	2	2	0
Challenges with doing it right to achieve beneficial outcomes for communities	The amount of time required to build meaningful partnerships, before there is any research "product" or even a clear design, is usually too much for funders to bear and makes a researcher seem unproductive. The fact that CER results in much higher quality research and more relevant results is not considered when thinking about "costs" and "benefits."[u]	8	5	3	1
Supported by CE office on campus	Our institution has a robust office supporting CER and civic engagement more broadly.	*9*	*7*	*2*	*1*

[u]means a quote from an individual who self-identified as a URM.

89 surveys included write-in responses, but only 86 had responses that received one or more codes, including 42 females (F), 41 males (M), 1 nonbinary, and 2 who chose not to answer any demographic items on the survey.

have ever told me it was valuable or would be helpful for merit/tenure considerations" (White female, tenure-track assistant professor, R1 institution). As another example, "CER is valued and promoted by various institutes on campus which exist separately from the promotion and tenure system. P&T is more conservatively defined in my field of engineering" (White female, professor, civil engineering, R1 institution). Some comments indicated that engineering/environmental engineering specifically was not supportive, while others indicated that it was (e.g., "In general, [EnvES] MUCH better in this type of research compared to other disciplines, especially other engrg disciplines" White female, professor, doctoral institution). Differential valuation among the string of entities involved in tenure and promotion are problematic, as multiple levels of assessment across an institution and the solicitation of evaluation letters from outside an institution are embedded in the tenure and promotion process. Even more problematic were individuals who implied that CER valuation in RPT varied on a case-by-case basis, a situation that seems more likely to be plagued by unconscious bias that differentially harms URM and female faculty.

The broad theme of *CER scholarship positively valued* was found in 35 responses. Some individuals believed that CER was equally valued when it resulted in traditional journal publications and grant funding. This equal value of CER in RPT was a common theme identified among male respondents. As one example, a faculty member stated: "CER is valued if, and only if, it fits the model of bringing external grant money and producing peer-reviewed papers. These are the only metrics that matter, with heavy emphasis on the grant money. Without grants, CER is a hobby" (White male, chemistry department, R2 institution). As a positive, some noted that extramural funders value the "broader impacts" of CER.

The responses mentioning scholarly metrics often included qualifiers, such as the publication quality being relevant or the use of strong scientific or engineering methods. Comments which indicated that CER might be valued differently than other EnvES research included, "I enjoy CER but it's rarely the sort of fundamental research that many academic review committees appreciate" (White male, professor, environmental engineering, R1 institution) and, "To be valued for promotion and advancement the CER research would need to have a strong engineering component" (White female, professor, environmental engineering, R1 institution). The literature supports the notion that different types of research have different levels of prestige, "theory over application, quantitative over qualitative, publishing over presenting, academic audiences over public audiences," and "The higher value placed on the scholarship of discovery compared to application, integration, and teaching seems persistent in both practice and culture" (Demetry et al., 2020, p. 3, p. 5). One survey respondent even noted, "At the P&T level for faculty, some money is colored better than other money…" (White male, professor, environmental engineering, R1 institution).

The valuation of CER using only traditional metrics is problematic. CER strives to achieve real change that benefits communities—and academic publications contribute little to these aims. Further, there is likely to be resistance to publishing this nontraditional research in traditional venues with high impact factors. Stanley (2007) noted that

"research on marginalized groups by members of marginalized groups" (p. 14) may be "difficult to publish in mainstream journals" (p. 15), impeded from publication by the typical editorial-review process. It has also been shown that attracting funding for CER may be more challenging (Hoppe et al., 2019). Castleden et al. (2015) argue that traditional quantitative metrics for productivity are often incompatible with high-quality CER.

Another common root theme was the *undervaluing of CER* (34 responses). This was the most common root theme among URM faculty, with half of their write-in comments coded to this theme. In a few cases, the specific reason for undervaluing was unclear, e.g., "It is celebrated in highlights/speech/announcements by department head and dean, and there are university-level programs to support it. However, not valued in P&T" (White female, assistant professor, environmental engineering, R1 institution). Subthemes identified specific types of CER undervaluation, due to CER being counted only as service learning or service/outreach or being viewed as less scholarly (including being harder to publish). One example, "General interdisciplinary research valued. Community-based research largely defined and treated as service rather than true research" (White female, professor, doctoral institution). Some comments indicated that CER was viewed as having no value or were particularly demeaning of CER.

A small number of responses spoke to the *lack of support for CER* (n = 7). This included the subthemes of no resources for CER or less financial support for CER. But a higher number of respondents (n = 9) indicated that their university had an office or support for CER.

Finally, 15 respondents spoke directly to *community relationships or outcomes*. Five respondents explicitly indicated that community impacts or outcomes were not considered or valued (e.g., "For typical tenure track positions, I think that my institution values publications and grants that can come from CER **but not necessarily the act of CER in and of itself**" (White male, associate professor, R1 institution), versus four respondents whose comments indicated that community relationships were valued. An additional subtheme was comments that discussed the challenges associated with conducting high-quality CER that would result in positive outcomes for communities. A response that mapped to two of the community outcomes subthemes is: "There is grudging recognition if standard publication, grant, and citation metrics met, but no explicit valuation of CER, and little recognition of challenges of interdisciplinary nature, time required for building trust, and novel theories of CER" (White female, professor, R1 institution). This response speaks to the importance of conducting CER using well-established best practices and how these practices are often at tension with traditional metrics for research which may preference quantity of productivity over real-world impact (e.g., Edwards and Roy, 2017).

7. SUMMARY AND CONCLUSIONS

The results presented here indicate that many EnvES faculty, particularly female and URM faculty, believe that CER is not appropriately valued in the RPT process. Fewer

than half of the female and URM faculty (45% and 33%, respectively) agreed that CER scholarship is recognized and rewarded during RPT; 15% of the female and none of the URM faculty agreed that members of RPT committees have a broad understanding of CER scholarship. Faculty at institutions who had earned the Carnegie elective classification for Community Engagement had more positive perceptions of the valuation of CER. Qualitative results indicated that some faculty felt that CER was viewed differently across departments and levels at their institutions.

Using CRT as our theoretical framework helped clarify the relationship between the perceived valuation of CER among faculty from different demographic groups. The thematic codes illustrate that while some progress is being made in the valuation of CER at some levels of the university (e.g., department level), the progress is not uniform across the institution or in the RPT process. CRT also highlighted the limitations in the current study, such as few responses from URM faculty who use CER.

This points to the need for further research into whether female and URM participation in CER could exacerbate other documented barriers to their promotion and tenure in academia. This is of particular concern for individuals with multiple marginalized identities (such as URM female faculty); therefore, gathering counterstories, in alignment with qualitative methods congruent with CRT, is a logical next step. There appear to be unique institutional cultures that may be more supportive of CER, such as institutions that are recognized as Carnegie Engaged. Further work should also explore unique disciplinary cultures, exploring differences between the perceptions of faculty in engineering departments versus those in natural science and/or public health departments.

These results pertaining to EnvES are similar to those found in previous research on CER in other disciplines. It appears that across higher education, more work is needed to inform all faculty and administrators about CER methodology and to include CER explicitly in RPT criteria. Beyond the Academy's *Guidebook for the Engaged University* (Keeler and Locke, 2022) provides a framework for addressing not only language for tenure and promotion policy, but systemic change that will enable institutional readiness to value community-engaged research in line with other types of research for RPT. We support Beyond the Academy's recommendation for institutions to adopt the research continuum framework from basic to applied research, where CER is on the applied end of the continuum, as well as the development of criteria for assessing CER for RPT. Pathways toward enabling the necessary systemic change at the institutional level are to work toward a Community Engagement Classification from the Carnegie Foundation, embed CER in the department, school, or institution's mission, and identify criteria for assessing CER or public impact scholarship in annual merit and P&T processes.

One important concern is that the metrics used to assess traditional research may not be fully congruent with the outcomes of high-quality CER. Many departments and institutions recognize research impact using standard impact metrics such as publication in highly ranked academic journals and number of citations by other researchers but fail to account for the broader impacts that may be realized for the communities who partner with academics in CER. These metrics are not mutually exclusive. In addition, CER includes many types of engagement, and care must be taken to ensure that communities,

sometimes the most vulnerable and disadvantaged, are true partners with shared power in the research process. Thus, high-quality CER may possess characteristics that are not pertinent in traditional STEM research but should be used in authentic evaluation of CER.

STEM disciplines must evolve to incorporate approaches that produce more scientific advances with legitimate social impact. In addition to traditional research outcomes, empowering vulnerable populations and promoting environmental justice must be aligned with metrics for promotion and tenure of scholars who perform CER, especially URM scholars who are equipped to contribute the most to this type of research. The importance of addressing these challenges holistically cannot be understated. The undervaluing of CER and the persistent lack of racial diversity in EnvES should be viewed as an opportunity to evolve, as changes will enrich these fields. The urgency of threats like climate change and environmental injustice demand that we move away from exclusive, marginalizing, and deficit models towards more inclusive and transparent models of scholarship. This is of critical importance in STEM fields, as they are expected to play a key role in our common global future.

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