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Community Engaged Researchers Share Insights into Successes and Cautions [Traditional Research Paper]

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Abstract

This paper shares the experiences of community engaged research (CER) among women holding doctoral degrees in STEM fields. The research included interviews with 12 women who conducted CER during their time as doctoral students, post-doctoral researchers, various positions in academia (assistant, associate, and full professors; research faculty; lecturers and adjuncts), and/or while working for government agencies and non-profits. Most of the women held various minoritized racial / ethnic identities. The narratives represent a range of successes in terms of personal value, professional value, and community outcomes. There were also situations where individuals' CER was devalued and community outcomes were less optimal. The results draw attention to important issues in the hopes of inspiring interest, attention to best practices, and cautions.

Introduction

As the interest and application of community engaged research (CER) is increasing in engineering, it is becoming clear that there is a lack of consensus on best practices and a general underappreciation of ethical challenges. This research aims to help address these shortcomings, by amplifying the voices of academic women of color who have engaged in CER in STEM fields. This paper begins by providing background information on CER, then moves to the research methods, and concludes with the findings.

At its most basic, CER brings together two ideas: research and community engagement. Academics are familiar with research – systematically studying a subject to discover new information and gain new insights. Community engagement is less clearly understood, with more fluid boundaries. There are nuances of both a "community" and "engagement" that are salient. While communities are often thought of in terms of geographic boundaries, communities can also be social groups with common ties that are relevant to a particular research question (e.g., Black women faculty in engineering). Engagement can take a variety of forms, with elements of power, respect, privilege, and trust that are influential even if they are not acknowledged. Engagement is critical to avoid treating communities (people) as merely subjects of our research, rather ensuring that they are active participants and partners with scientists. Recent discussions of CER are explicit in recognizing a continuum of engagement [1],[2]. CER is an umbrella idea under which more defined sub-types are found including community-based participatory research (CBPR) [3]. A rough conceptual idea of forms of academic engagement with communities is shown in Figure 1, where areas within the gray box represent different forms and intensity of engagement. The activities located closer to the right side of the box represent more leadership and agency by communities and therefore may be more likely to meet their goals.

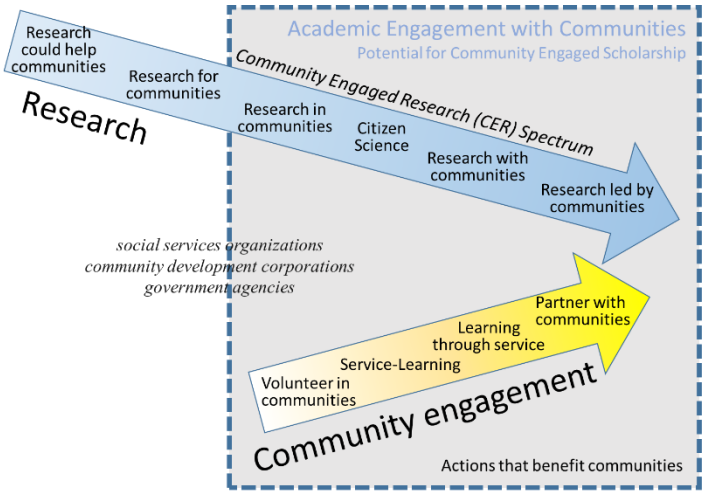

Figure 1. Examples of different types of academic engagement with communities

At its heart, CER (also called Community Based Research [4]) strives to achieve the dual goals of helping a community while contributing to the scholarly body of knowledge. This is a tricky and delicate balance. Just as different fields have their own traditions and expectations of research (including theories and methods), different fields have their own practices of CER. Public health has a long history of CER and recommended practices (e.g., [5],[6]). STEM fields are relative newcomers to embracing CER. Researchers may be adopting CER without sufficient expertise in community engagement. We argue that there is a need to advance the science of community engaged research within STEM (e.g., [7]).

CER is often conducted to aid marginalized communities. There are significant public health and public education disparities among minoritized communities that could perhaps be partially addressed through research partnerships with academia. Federal funding has been directed to help address these issues from the National Institutes of Health (NIH) [8],[9], US Environmental Protection Agency [10], and the National Science Foundation [11]. Funding opportunities may be drawing in researchers new to conducting and/or evaluating high quality CER. This is particularly concerning as these communities are the least able to endure the additional burdens of research participation without realizing optimal benefits. Thus, it is important that funding agencies and academic institutions have genuine ways to evaluate the quality of CER. Guidelines and rubrics to assess CER have been proposed [12],[13].[14],[15].

Previous research has found that community engaged research compared to more traditional research activity is not awarded funding at the same rate [16] or valued equally in academic reappointment, promotion, and tenure [17],[18],[19],[20],[21]. In particular, CER conducted by URM faculty has been found to be undervalued during promotion and tenure [22],[23]. However, these studies were largely conducted outside of engineering and STEM fields. More insights into how CER is valued in academic careers in STEM fields, and particularly for individuals underrepresented in STEM (i.e., women, people of color), would be useful.

The experiences of individuals from intersectional minority groups (e.g., women faculty of color) are often difficult to characterize using quantitative methods, due to the low number of individuals and their unique circumstances. Thus, qualitative research methods are the most appropriate to answer research questions about this group.

Research Questions

The research questions explored in this paper are:

- What successes and best practices associated with CER are described by women and women of color holding doctoral degrees in STEM fields?
- What cautions associated with CER are described by women and women of color holding doctoral degrees in STEM fields?

The perspectives of women of color might be particularly relevant given their experiences of marginalization and minoritization which may mirror those of many of the communities where CER is most critically needed.

Methods

This work is being conducted within the context of a larger, on-going study that is part of an NSF ADVANCE Grant (Award 2204099). The work within the grant is grounded in Critical Race Theory (CRT). This portion of the study focused on gathering counterstories from women faculty of color in STEM, and others who (had) aspired to faculty roles. Counterstories and narrative research is aligned with CRT, with goals of amplifying the experiences of those with less privilege, rejecting deficit perspectives (of both the academic women and partner communities), while seeking solutions and catalyzing actions [24],[25]. The research was conducted under an approved human subjects research protocol that was reviewed by the Institutional Review Board at the University of Colorado Boulder (Protocol #23-0344).

A series of narrative interviews were conducted with 13 women from August 2023 to March 2024. Interviewees were recruited to participate in the interviews via email. The individuals contacted were identified based on: published STEM papers that used CER, web searches using keywords (e.g, professor, “community engaged research”, engineering or science), personal contacts of members of the ADVANCE grant team (PIs, coPIs, senior personnel, advisory board), outreach via presentations and workshops associated with the grant, and snowball sampling (referrals). Interviews were conducted over Zoom, recorded, and typically were about 60 to 90 minutes in duration. Aligned with the counterstories methodology, it is important to share the participant experiences in their own words. Thus, this paper contains lightly edited clean verbatim quotes where hesitations and repeats have been removed to improve readability.

To fully protect the identity of the individual participants in the study, only composite demographics are reported. The ranks of the women while conducting CER included masters and doctoral students, post-doctoral researchers, research faculty, teaching faculty, and tenured/tenure track professors. These experiences spanned a wide variety of institution types: R1, R2, and Master’s; public and private; predominantly white institutions (PWIs), Historically Black Colleges & Universities (HBCUs), and Hispanic Serving Institutions (HSIs). Some women were currently or had previously served in leadership and administrative roles including Dean, Associate Dean, Department Chair / Head, and Associate Chair. The STEM fields represented included civil, environmental, and industrial engineering, biology, environmental science, and public health. The majority of the women were working in academia, but some had career pathways that included time in other settings (e.g., government, non-profits). Racial/ethnic

identities among the interview participants included: Asian, Black, Chicana, Latina, Indigenous, Jewish, White. Other identities included: first-generation college students, low income / working class upbringing, international students, and parents.

Limitations and Positionality. The research shares the stories of the lived experiences of our participants. There were only 12 individuals with CER experience included in this research. (One of the women professors interviewed conducted community outreach but not CER.) All of the interviews were conducted by the first author. This author has limited personal experience conducting CER, comes from a particular STEM field, and is a white woman full professor. These attributes may have influenced who opted to participate in the research and the extent to which they shared their candid opinions during the interviews.

Results and Discussion

The broad themes within the experiences of the 12 women who were interviewed which map to the two research questions are summarized in Figure 2. The largely personal positives and negatives for the women are shown at the left of the figure, while the community perspectives are provided on the right. The shared culture (or not) between the women in their roles as researchers and the community partners bridged the personal and community elements, as shown. The ideas found were not unexpected based on the literature. But the nuance and richness of these areas are unique. The stories shared by the STEM researchers were almost all a mixture of positives and negatives. The following sections provide some of the stories behind these themes, largely in the words of the interviewees.

Figure 2. Summary of key themes from the 12 interviews

Successes for Academics

The women found community engaged research **personally rewarding**, with many describing this as their motivation for pursuing STEM in college, advanced degrees, and persisting into

academia. An example quote that illustrates this: “I always feel a personal responsibility to help vulnerable communities. I just think it's part of what I should do. I guess it's about a core value of mine, and I do think it's shared with at least a lot of the minority women faculty that I talk to.”

When the women were conducting CER in their local communities or in communities that shared similar characteristics to their upbringing, they had a number of advantages. One woman explained,

> My [demographic] profile has been an advantage when I was working with communities along the Mexico border because they rarely see a researcher that looks like them, that speaks like them, that has lived the same experiences as them… mixed immigration status, bilingual, …. So that has been an advantage. Looking young has been an advantage because I come as like, ‘hey, … I just want to learn, teach me….’ I feel like they embraced more the [graduate] students…. Because they were from there, and also they wanted to support the growth of their students, of their community members.

A few of the women discussed how the relocation processes common in academia (for academic degrees from different institutions, moving for the first job after a doctoral degree) is often disruptive for CER. Despite these challenges, the women had successfully moved institutions and created solid local partnerships. One woman had considered moving away from CER to lab studies after her postdoctoral research but stayed with CER stating, “My natural talents were with community engaged research. Why should I move away from that? Naturally, I just started doing what I do best. You know, connecting with local organizations, introducing [myself to] other researchers. Try to brainstorm together on projects. And I have been funded successfully on small and big projects.”

Some of the women described the way that CER **contributed to their promotion and tenure**. Many were highly successful attracting grant funding to initiate, continue, and expand CER. This often expanded from initial funding related to their technical research focus to funding to support adjacent education activities, including National Science Foundation funding (e.g., REU, K12). The women had published outcomes from their CER. They were meeting standard metrics used to judge research quality in their field via CER. Some had been promoted to full professor and held leadership roles in their department and college.

Successes and Best Practices for Communities

A crucial step in CER that may be unfamiliar to many STEM faculty is to have the research reviewed and approved by an institutional review board for human subjects research. Going through the IRB process allows the research team to carefully consider how to respect the time, interests, and privacy of community members.

The CER described by the participants also provided real benefits to communities. There were a number of examples shared of very successful partnerships and collaborations by the women in our study.

A faculty member described how her institution decided to pursue the optional Community Engagement classification from Carnegie, which led to support for CER by the university

president and at the highest levels of campus. This brought together a minoritized neighborhood somewhat near campus with multiple faculty members and their students from the university and the support of the mayor to create a thriving ecosystem for multiple community engaged research projects and other collaborations. The CER was used to engage with K12 students and also work to broaden participation in STEM, and STEM curriculum was integrated into local schools. Thus, the community engagement encompassed the research, teaching, and service missions of higher education. This thriving partnership grew to yield a number of grants for the interviewee, and the collaborations expanded beyond the initial core technical engineering expertise of the faculty member into other topics, which then led to bringing in other collaborators from the university. The community partnership led to improved quality of life in the community and policy changes in the local government. However, after a decade with a thriving partnership, the CER with that particular community came to an end due to leadership changes in the city (i.e., the election of a new mayor) and neighborhood association.

Another woman noted "I worked with some tribal water systems which was very humbling and inspiring. I had a student who was a Native American and so we worked on [a project for her community]. It's kind of heartbreaking when you look at some of the water systems that are on some of those reservations. So, it's really super humbling but inspiring. When I think back at [the community engaged research that] I've done, that one sort of stands out."

Many interviewees described how they were well-positioned for the work due to their commitment, sensitivity, and racial insight. Interviewees noted that people have historically not been the focus of STEM research. They also discussed that in CER, relationship building through respect and sensitivity is critically important. Some noted that graduate students may have more relationship building skills than many PIs. In addition, individuals from minoritized backgrounds that are more similar to community members may have better success building relationships compared to individuals who come from more privilege (e.g., wealth, majority race/ethnicity). One woman of color noted that she was looking for community during her doctoral degree and connected via a community outreach program into the local schools that was being conducted by her PWI. When she started a faculty position in a new location, she was once again seeking out a community and was able to connect with a neighborhood through community engagement activities that were already underway by faculty from African Studies and public health. This eventually led to her own community engaged research.

Multiple faculty members described differences in CER compared to more traditional STEM research. A best practice of CER related to the timeline. One researcher noted:

> You have to be patient. And you also have to invest in those relationships. The time to meet them, the time to understand them, the time to report back. Sometimes I feel like some researchers do the investment at the beginning to get the data, but then they don't do the same thing for communicating the data, and I don't like that. I think you should do the same time you took to get the data you should invest to report back the data.

A faculty member described some of the best practices she conducted which truly worked in respectful partnership that shared power with communities. It required her to engage with academics with a diversity of skills and appropriate background. The right way to engage in CER was intentionally incorporated into her proposals and she had been very successful winning

funding. Unfortunately, this work was often slower than “traditional” engineering research conducted by her colleagues and was misunderstood.

> I came here to do research …. [on issues] influencing disproportionately vulnerable communities. And I feel like I was [from] one of those [communities] back home. So I do identify. I know that I have a background and an understanding of how the system works that allows me to communicate and inform these communities to increase awareness. But I'm not that arrogant to think that I have all the knowledge, right? There's a lot of things that I don't know. So I do rely a lot on community knowledge to even design my sampling. And I feel like they feel comfortable talking to me. I work with them a lot. So in every project that I have, I involve communities and train them to collect samples. And then I share the data. … We do annual community conferences where we share this information, but the plan is to have a follow up with stakeholders to see how we can strategize and **implement** either changes in policy or in management practices that can increase resilience and [reduce] this vulnerable community’s exposure to these pollutants. So I just think the community is really happy that it's not just data [going] to [academic] publications, that there's actually some follow up…. And every time I submit new grants they're happy to provide letters of support because they've been happy with the work.
>
> The funding agencies love it. I've had really good feedback from the funding agencies. At the University it's kind of mixed. **I don't think they understand** that it **takes time** to create trust and connections with the community before you can actually start producing things with that. So there's this rush. You need to get stuff out. But it's not that easy. There's some things that might be going out faster. But there's others that [don’t]. Like our sampling plan was designed with [the community]. They were collecting for us. So this is how it's going. And they're trusting the data because they collected the samples, because they were part of it. ….
>
> I feel like the head of the school doesn't care too much about the type of research I do, as long as it's bringing funding, and I'm getting the funding but [ ] my colleagues … don't understand. …. I collaborate with environmental sociologists to do the work, …because I'm not an expert [on that]. So **I collaborate with other fields**. But yeah, so the community is really happy. I feel like funding agencies really like it too, but it's not always understood by my colleagues what I do. …. I think I even work more with people outside of my department and other disciplines [including] public health, environmental sociologists, and microbiology. It’s like they understand the work. …. The way that I’m engaging is **very participatory and bi-directional**. ….
>
> And I think the funding agencies see the value in it and the amount of information that I'm getting. And the things that I'm learning from the community are so [significant]. … I’m even writing grants differently now, because I have specific things that I propose. But I'm also allocating funding in a space for the community to decide what they want to do, and what they want to prioritize. … I’m restructuring my proposals in a way that I’m giving space for the community to decide some of the research questions.

This story illustrates that one can have a well-funded research lab that is highly productive and provides real benefits to communities, but educating our colleagues can pose a challenge. These challenges and “cautions” are elaborated on with examples from other interviewees in the next section.

Cautions for Academics

A theme within the overlapping context of academic pathways and CER relates to the challenges of conducting CER when the researcher does not have a shared cultural background with the community. For example, one professor stated,

> I feel that it's hard to connect. There are some times I have an accent when I speak, and so some times that comes through…. I'm the real minority here. And so I can't really relate culturally to the communities that we are serving. So I rely a lot on one of my students who [shares the culture with the community]. Sometimes there's even slangs or languages, I'm like, what does that mean?

There were multiple examples in the interviews where student researchers seemed to be serving as cultural informants [26] to assist the CER.

Nearly all of the interviewees shared some reservations that their CER was understood and respected by colleagues. For some this was true in a limited number of settings, and they had examples of other places they had worked that were highly supportive. In many cases, the women's stories described a journey to educate their colleagues on the nuances and value of their CER which was ultimately successful. Others recommended that conducting a mixture of more "traditional" research for their STEM field with CER was the safest path, at least for women in tenure-track positions prior to tenure. Some example quotes are shared below.

Of all the interviewees, only one noted that CER was fairly common among colleagues in her department, noting that about a quarter did CER. But as a pre-tenured assistant professor even she noted:

> I feel that community engaged work is not as valued as the other types of research [such] as your bench top research. And I felt that also from our Dean. He's really pushing for projects that are very scientifically, he calls it, rigorous. And [with] community engaged work it is hard to be that rigorous. You can be systematic in your approaches and your methods but it's not very rigorous in terms of the outcomes. And so he favors more of the mathematical models and [other types of non-CER research]. Slowly but surely I think I've demonstrated value to [CER] with the metrics of success that they like: bringing the funding, growing my lab, how many students I have under my lab, publications. But I feel that the time that I dedicated to build those relationships and go out in the field and collect the samples gets **undervalued**. It took me almost two years… to build those relationships here, especially being a transplant to the Midwest. … I'm still not sure how it's going to be valued at my evaluations….

An assistant professor was the only person in her department doing CER. She noted:

> Sometimes I will get comments from … my colleagues. I have to be careful of the wording that I use when I talk about community engagement, because they think that I just merely do social work ….. They don't think that this [counts as] engineering [research]…. I would also be told 'she's in engineering education'. And I was like no. It's a very different research. I don't do engineering education [research]. I do outreach as part of my work [in addition to my CER]. ….
>
> …it's not always understood by my colleagues what I do. …. They kind of dismiss you. It's like, **she's not a real engineer**. She's just doing some social work or something like that. …

> In [my] department I'm probably the only one that is actively doing community engagement, the way that I do….
>
> I'm really looking forward to starting more projects back [near my home community]… I don't think I care if [my department] doesn't like it because I really want to do this. And I think it's important. And I think the funding agencies see the value in it. …. I wanna get my tenure. But I think I'm gonna get it. I think they'll see it **eventually** that the value is in there.

Across the interview pool, the women had experienced varying levels of support for their work within **different institutions**, with some intentionally changing jobs to find a position and a culture that more closely matched their interests, including working for the government, non-profits, and other settings outside academia.

One interviewee stated: "at DEIDENTIFIED University it was all this B.S. bureaucracy, and virtue signaling and stopping me from doing my [CER] work and being told multiple times by my colleagues I don't do real research." Multiple interviewees noted that support of CER was given lip-service by their institutions but then devalued in tangible ways.

In another interview a professor contrasted her experience at a Historically Black College & University (HBCU) with other institutions when asked, "how is CER valued in reappointment, promotion, and tenure?" Her answer was:

> I think it depends on the institution. I really do not think some institutions value that community-based approach and they frown upon it. Because they want that pure stellar researcher that's only disciplinary focused. And how dare you go into the community and engage your research? Especially in engineering. But when you think about it, why not have that community-based research?
>
> And I know a lot of our faculty here, because we're a HBCU, we do that community-based research, which is why we're here. Because if you have experiences that you've lived or experiences that your family, or that you know of others, have lived, you want to try to address those concerns. And as a faculty member, that community-based is the way that you might address it from a scholarship standpoint, but then also address it from your own fundamental passion. And I don't think it's valued in as many places as it should be.

Another highly successful interviewee described her challenges with how CER was valued in her own promotion process, including perceptions that it is valued differently across various engineering disciplines. The transcript segment below shares this story including her recommendations for untenured faculty:

> Interviewer: So, have you done any community engaged research yourself?
>
> Participant: All the time. And I went against the recommendation to not do it. But I knew that's what I needed to do, just for my passion, right?
>
> Interviewer: Were you balancing some traditional research to check the boxes and then doing CER because it was your passion?
>
> Participant: Exactly. And when I went up for full professor the **community based hurt me**, because they said, Oh, you don't have enough disciplinary. So then I had go back and do a

little bit more disciplinary so I could make it to full. But then what I'm recognized the most for, probably, is my community work more so then my traditional work.

Interviewer: Do you think it's just a numbers game? Like frequently it takes more time to build relationships communities. Maybe the money isn't the same color of money, or the same amount of money as something that's more traditional. Is it those things? Or on a one-to-one basis, like this one publication that was traditional and then here's this one publication that was community-based, are people disregarding [CER] even at that level?

Participant: I think they are.

Interviewer: …. Why is it that it's getting discounted?

Participant: Yeah, I think they wanted pure number crunching, pure the scientific aspect. And why are you thinking about the community? Why engage them? Because we're environmentals I think we just naturally do it. But I think for the other disciplines like mechanical engineers they're like, why.

Interviewer: What ideas do you have to help folks be successful if [CER] is their passion?

Participant: I think we just have to recommend to them that they have to look at the landscape that they're part of. And they need to have those traditional pathways, collaborations, partnerships and lead in those research areas. But at the same time still be authentic and true to themselves. But just know one can't outweigh the other until they get their promotion, their tenure, that ultimate rank that they're going for. They may not want to be a professor. They may not want to be an administrator. So they have to kind of balance that out if they see that one side is too heavy and they know that's not gonna help them progress. Then they need to go ahead and also get that disciplinary pure research that would be respected in their environment. But at the same time, for your own mental health, if you need to do community based, you need to sprinkle that in there and be kind of creative with how you do it. But just know how to, and I always say, **play the game**. You just have to know your environment.

Interviewer: …. even if you feel like you're on a good path in your local context, is there still gonna be a risk in the external peer review letter realm?

Participant: …. I think it depends on the letters that they're seeking and your reputation. And hence why you have to get off your campus so that you meet the right people that can really be those spokespeople and advocates outside. And you know, if that's community based people that are going to be high powered then you're okay if your university or your department values it, or your college values it. If they don't, then you need to understand that early [pause] and make a decision.

Interviewer: …. [Does] the department chair … looking at the portfolio of a particular candidate, and seeing they are doing some community engaged research, specifically find letter writers who can speak to that type of work in addition to others that might speak to their more traditional work?

Participant: I think it depends on your chairs. Chairs have a lot of power, and probably if they value you, they'll go that extra step. If they don't value you, then they're just gonna be generic. And then it's a gamble. …. Cause I could think of some civil engineering former

> chairs that would have been rigid. … if you're in a department like mechanical, you have to be cautious. It's all about that reflection to say, Okay, here's my path. Am I in the right place? And get out early, if you can get out early and shift instead of being stuck, and then your mental health suffers, your research suffers, your engagement suffers, your family life suffers.

The interviewee continued to discuss that individuals who are committed to conducting CER should be extra aware while they are interviewing for a position. The institution might appear to value CER, such as giving awards, but this might not translate into value during reappointment, promotion, and tenure. It is important to "find the right fit."

Another interviewee stated,

> I do think there's a perception both in our engineering community and then in other disciplines that issues around environmental justice or environmental equity are not for engineers. Engineers should stick to just the technical piece. … I think it's a risk honestly, because as much as we talk about changing our tenure and promotion criteria and including things like innovation, community engaged research, or things that may not be as traditional… it's very difficult to change minds. And even when someone says, 'Yeah, you know, we should include those things,' the tenure and promotion [process] is very subjective, no matter what. And I do believe things have improved but I don't think they've improved to the point where I would advise an early career faculty member whose portfolio is primarily community engaged research. I would be nervous for that faculty member. To be honest, I'd advise them to try to be safe, to make sure they had enough traditional research to get through the promotion and tenure committee, because I just don't know if we're there yet. So I do think it's a risk.

Overall, the recommendations to faculty are to be strategic selecting a job and institution. Some faculty might 'fit' into different department homes, and there are also potential disciplinary differences in the extent that they support CER. Alternatively, faculty should carefully evaluate their current environment and strategically invest their time and energy.

Cautions for Communities

Not all researchers collaborate with community partners in ways that share power and yield true benefits to the community. One of the interviewees recounted a story of what pushed her toward academia and community engaged research:

> when I was in high school and I realized that **scientists were studying us**…. In my home town… there were a lot of environmental justice activists that were coming out and shouting that we were dying. … that the government was not helping us. I started seeing what they were doing. And then [a University] came to my high school to recruit for a study of health impacts of these chemicals. And I remember helping recruit them. **But they never came back** and told us what the results were at all. That fueled me when I realized. Because … I grew up with different values and different ethics that a lot of my colleagues… And so when I saw that I didn't like it at all. So I made it my life goal to become a scientist. And then I would one day face those researchers that did that study in my hometown and they were going to have to answer to me.

> [But] I realize that … we will never solve environmental justice issues through academia, never. Never! We will never solve poverty through academia. Never. …. we, as academicians, are spinning our wheels in a system that is not going to solve our issues. And people need to realize that. … That is not their business model.

This quote represents the concern that some grant programs may be drawing individuals more focused on securing funding than solving challenging issues in partnership with impacted communities. This illustrates the problem of interest convergence that is a key tenet in CRT [27], [28]. Some academic researchers participate in CER to the point where interests converge (e.g., get grant money, get data from the community), but then stop short of executing the project to actually benefit the community. And the speaker believes that academia more broadly is playing this game of interest convergence.

Another interviewee also shared concerns that align with interest convergence:

> Working with people involves a whole set of tools that are not engineering tools. And there are people in engineering who claim that they can do this without the tools. Without knowing the community, without valuing them, without ever being disadvantaged, always being privileged. … unable, literally unable to produce anything. …. I'm no longer ignorant that these entities outside are doing it wrong, whether it's on purpose or whether it's because they're in competition, or whether they refuse to get more training, or they don't value it enough to wanna do something that is useful. ….
>
> …. they did not ask the right questions. …. They didn't know what the problems are, and they are arrogant enough to think that their incompetence is as good as it gets. See? So that's what I mean about the bad side. There is a lot of that. And so they come up with studies that produce no outcomes [that help communities]. … they don't need to know how to ask the question. They don't know what questions to ask, and sometimes they ask questions, and the people will not give them the right answer. They won't give the truth, because they don't trust them. So what kind of science do they produce? But they don't care, **because at the end of the day it was never about the communities**. [They] just wanted to get another paper out, because that's the beans that my institution wants. Whatever tragedy it is, it doesn't matter. And so that's the awakening that I had in my experience, especially at [DEID] University. It's not really the science, it's the beans.
>
> … the community suffers. That's very clear to me, and many people talk about this. And you talk to people of color because those of us who come from this community, we see that harm. The people who come from outside, they come, do the little project, or the little whatever song and dance, and they leave, never to look back. They don't see them at church. They don't see them in social events. They never have to worry about them. They're not part of that world.

Multiple women described seeing CER where the researchers did not follow-up with communities to ensure that their goals were met. Thus, CER sometimes continues to perpetuate the first example where researchers extract value from communities and 'study them' without engaging in respectful partnerships.

It is also important to acknowledge that sometimes the results of the science will not match the goals of the community partner. A number of the women conducted research related to chemicals in the environment, with concerns about health impacts to community members. Some stakeholders may be sure that the data will show unacceptable health risks or violations of regulatory limits, which they can then leverage for changes in the community (e.g., shut down an industry that is emitting pollution, get the state to allocate funds to clean up the water or air, school closure effects). However, the research will not always find results that support the goals of the community, as described by one of the interviewees. She first gave a specific example from one the projects that she worked on (related to elementary school closure decisions in the community) and followed with more overarching sentiments.

> In total, there were three elementaries in that community. And this community nonprofit organization … has been organized in that concept of we advocate for ourselves and for our well-being. And they've been also trying to improve their environment and protect themselves from any environmental exposure. And so they came to the university asking for help, saying we would inform the decision of this local school district in terms of not to close the elementary schools. And if they do really have to close the elementary schools, we want them to close the one that has the least risk of environmental exposures. So out of those three elementaries, two were nearby possibly major environmental concerns. The other one was a little bit farther away from those industries, but it was very small and on a lot that didn't allow for building or expanding. And the school district at that point was facing financial challenges so they couldn't justify operating the schools based on the student population that they were serving. It was strictly because of financial reasons, and they were doing citywide school closures or consolidations. So, … we did a community soil assessment. …. What we found is there were no areas that exceeded the EPA maximum contamination level for children play areas in any of the soil samples that we collected. …. We did find some levels that we considered moderate risk and those areas were very localized. …. And we communicated this with the school district and the school district decided to remove that soil and put new soil and keep monitoring, so that removed that risk. And the school then used that as a way to say, Well, look, … we're eliminating the immediate risk…. And with that they decided to close the school that was farther away from any industry. ….
>
> This didn't go very well with the community organization. The community organization was really upset. In fact, they thought that the science was used against them. They really wanted to keep the school that was closed open. …. And so this group felt very, I guess, not betrayed, but I guess frustrated by the outcome. …. That community decided to even put a lawsuit against the school district. …. And it was really disappointing, because we did what we thought was right. We did the community engagement part. We got the input from all the different stakeholders. We conducted an assessment that was hopefully unbiased. And of course it had limitations. …. I think it did its job, right? It did assess where the risk was and eliminated the risk. But it probably didn't assess comprehensively the risk…. So it's a very hard topic to navigate. And I felt so bad doing that work because I thought I was doing good, and probably I did do good in some aspect, but … I didn't solve the whole problem.
>
> And this community organization is a bit radical. They like to protest a lot. They're very visual. They bring in the news. They like to do headlines. And so it was hard to communicate

> the science and advise them what to do and what not to do. Because they were ready for a fight, they just want to fight. ….
>
> When you do science, you want to minimize bias as much as you can and manage that bias. And so when you engage with community members, you are now including a valuable perspective into the design of your study and the outcome and the impact of your study. But then, at what point do you protect it from community bias as well? As in, if that doesn't go their way then what is in place to protect the researchers from that outcome? It's not like we could have just said we're gonna make up data and support the outcome they wanted.
>
> So that's been kind of my dilemma with community-engaged work. I love it. I think it's super valuable. And I really, I love connecting with communities, especially underserved and vulnerable populations. But at what point do you separate yourself as the researcher. And you follow the science, you know. And knowing that science has flaws in itself, as well, you know, there's limitations. Maybe there are no technologies yet developed to assess all those risks. And then how do you communicate that very well with the community partners? We attempted, and I thought we did communicate that with the community partners about the limitations and the possible outcomes even before the assessment, and they were okay with it. But at the end they were not okay with it.

This researcher understood the trade-offs between science and activism. And the dilemma when the science didn't provide the answer desired by certain stakeholders. In society, there are complex factors beyond a single issue (in this case soil contamination), including intersections with economics and a wider lens (such as a local community within a larger city). These are complex ethical spaces to navigate [29], and there is likely to be a lack of consensus on the right answer.

Conclusions

This paper shared a selection of the stories of women, women faculty of color, and women from low-income communities who had doctoral degrees in STEM fields and participated in CER. There were a number of positive outcomes from these partnerships. The women themselves were highly motivated by their CER, which was personally rewarding and aligned with their values. The women had garnered funding for their CER, published their research, and mentored graduate students in CER. These activities met the criteria for earning promotion and tenure at their institutions. Some of these women had advanced to full professor, department chair, and Deans.

These women were exemplars in their CER practices. They truly respected and valued the community. Many of these women were themselves raised in underserved, marginalized, and/or minoritized communities. Through this lived experience they were uniquely aware of the many assets that communities bring. They understood the critical importance of true engagement, partnership, and supportive relationship building. The power balances in these engagements were appropriate to the research activities. The women were committed to long-term relationships that truly benefitted their community partners. It is clear that the academic community should look to these women as exemplars of high-quality CER.

On the other side, most of the women conducting CER had experienced situations where their community-engaged research was misunderstood and undervalued by academic colleagues. This eroded the sense of respect and belonging that some of the women felt within their academic STEM departments. Their CER was in some cases perceived to have had negative impacts on their promotion and tenure. This provides cautions for any faculty engaging in CER in STEM fields to be aware of these issues in order to seek a supportive department, understand the culture of their department and institution around CER, and proactively educate colleagues. Supports for success might include collaborations at their institution outside of their home department (including with non-STEM disciplines) and building their professional network outside their institution. This is particularly critical for women of color who conduct CER. These women are likely to be facing systemic bias and barriers that might be exacerbated by CER.

As more research is conducted in and with communities, it is important that these collaborations are appropriately designed in order to yield both real benefits to communities and insights from the research. Academics should recognize the value of the embedded knowledge in communities, which is imperative to yield a successful project. Power should be shared with communities. Communities should be engaged from the initiation of the project, provided appropriate resources (including funding from the grant), and respected for their contributions. There must by carry-through and commitment whereby the communities are provided with useful information that meets their needs. The partnership should not end with a journal publication for faculty. Community engaged research generally requires an extended partnership and commitment. The blend of technical and social elements will often require interdisciplinary collaboration.

CER has outstanding potential to contribute to healthier, thriving communities, working toward social and environmental justice, and reducing inequities. Realizing this potential is challenging. Most STEM researchers are not formally trained in CER practices. Individuals who have experienced marginalization and minoritization or come from underserved communities may have funds of knowledge that make them ideally suited to CER. It is imperative that researchers from these backgrounds and communities are viewed from an asset rather than a deficit perspective. Take-aways from the research alludes to the benefits of creating a toolkit for faculty. This would integrate an academic perspective and a community perspective. Given disciplinary differences, it is likely that the toolkit should be customized for a particular STEM discipline, as norms and practices differ. The toolkit should draw on the expertise of women faculty of color, researchers from outside academia with relevant expertise (such as researchers working for governmental agencies and non-profits), and communities who have experienced CER. Additional work is needed to advance the science of community engaged research within STEM.

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