Introduction

A young woman stands before at a 9 foot-high portrait of a woman engineer, who smiles back, larger than life. The undergraduate reads the professor's description of her research, which is printed across the portrait, and admires the tangle of colorful wires and computer servers that surround the engineer. The portrait stands among a series of other huge photographs printed on cloth panels, dissecting the usually open space of the Chemistry Building's lobby and disrupting students' and faculty's typical journeys among classrooms and offices. Passersby wind around the panels, glancing at them with surprise and pausing for closer looks. They search for professors they know among the portraits, and get distracted by the vivid portrayals of women engineers, scientists, and social scientists. Women who are too often underrepresented and marginalized in their disciplines are suddenly, unavoidably visible in this scientific space.

The goal of ADVANCE, "to develop systemic approaches to increase the participation and advancement of women in academic STEM careers" (ADVANCE), calls for changing institutional culture to promote gender equity among STEM faculty. Institutional and cultural change offers the most robust and enduring form of change; however, it is notoriously difficult to achieve (Rosser, 2004; Meyerson and Tompkins, 2007; Van den Brink 2013, Furst-Holloway et al., 2018).

To challenge the embedded narratives of masculinity in STEM at the University of Virginia (UVa), we approached the goal of changing institutions as a larger-scale outcome of first changing minds. One powerful way to change minds by exploring diverse perspectives and rethinking an assumed reality is through art. The arts and humanities ask viewers to see the world differently, often through appeals to personal experience and emotion. Our goal was to design an exhibit that encouraged audiences to critically reflect on the curated images and texts

of female scientists. Standing face-to-face with a portrait of a woman scientist or engineer makes it impossible, we hope, for people to believe that science and engineering are careers only for men. Reading women's narratives of oppression, discrimination, and unfair treatment can jar people out of complacent assumptions that there are few women in STEM because they choose not to pursue STEM careers, that they are not intelligent or competent enough to succeed in STEM, or that we have already solved the problem of gender inequity in STEM. In this paper, we describe our vision and design process for two photo exhibits, and then discuss how we evaluated the impact the exhibits had on the UVA community.

Critical Reflection and Transformative Learning Theory

Mezirow's foundational theory of critical reflection and transformative learning influenced the exhibit design. We designed the exhibit to encourage critical reflection based on Mezirow's three main types of reflective practice, often expressed as a series of questions (Kitchenham, 2008). Content reflection is based on the perceiver's exploration of the problem posed and the issues contained within the exhibit's images and texts. Content reflection questions based on the exhibit content might include, 'What is happening in this space?' or 'what problem is being addressed by the timeline of the history of women at the university?' Process reflection would encourage queries about how the exhibit came to be in the space: 'why is it here and who finds it important?' It could also lead a viewer to ask, 'how did these women become engineers or scientists?' Content and process-oriented questions together might interest the viewer in learning more about the subject from different perspectives. A final reflective practice is premise reflection, which, according to Mezirow, is the most emancipatory and transformative kind of learning. Premise reflection encourages the learner to view their beliefs and knowledge in a broader perspective and leads to questions about the nature of, context, and motivation for

inquiry: 'Am I really influenced by the view that women are too emotional to be scientists?' 'What would it take to reframe my thinking? Why does this exhibit matter to me?' (Kitchenham, 2008, Mezirow, 2000).

This paper describes our work to communicate women faculty's experiences at UVa through public art, in the form of two exhibits we built on campus. Women in STEM often describe feeling invisible, underrepresented, undervalued, and ignored (Alcoff 2005, Faulkner 2009, Gholson 2016). We hoped to reverse that experience through our public exhibits by making women faculty *visible*, both literally in the form of photographic portraits and figuratively by sharing their stories and the history of women at UVa. We thereby hoped to illustrate the struggles and contributions of women in STEM more generally through the local experiences of UVa faculty. In this sense, the key purpose of the photo exhibit in support of STEM women faculty was to increase the collective knowledge of their experiences, contributions and stories. Telling previously unacknowledged histories brings them to public attention and opposes the social and institutional structures that work to suppress those lived experiences. Visibility and having one's stories acknowledged in the form of recognition and respect is a crucial form of power (Alcoff, 2005). The work of feminist philosophers underscores the significance of the power of representation and representation as legitimacy. Fricker (2007) is especially consequential in making the claim that bearing testimony to the stories of marginalized women in STEM is a direct form of social justice and a means of ethically repairing the damage caused by discrediting women's presence and knowledge in STEM fields and institutions (Alcoff 2005, Fricker 2007, 2008, Rolin 2002, Wanderer 2012). Cultivating habits of "attributing credibility," is central to the production and flow of knowledge and to addressing gender and racial inequality. According to Fricker (2008),

…it matters whether our habits of attributing credibility are in good order. Clearly it matters from a purely epistemic point of view: if, for instance, a hearer's prejudice wrongly deflates her judgement of credibility, then the flow of knowledge is blocked, truths fail to flow from knower to inquirer. …The dysfunction of unduly deflated credibility may be not only an epistemic dysfunction, it may also be an ethical dysfunction. For the speaker who receives a prejudicially deflated degree of credibility from a hearer is thereby wronged —… wronged specifically… as a knower. This idea of being wronged in one's capacity as a knower constitutes [the] generic characterization of epistemic injustice (p. 61).

When an institution or individual listens to and legitimizes STEM women's stories, the possibilities for redressing inequalities and sustaining positive change are significantly enhanced. The available interpretive resources for "inclusive and responsive dialogue," are enriched structurally and individually (Rolin 2002, p.96).

Art is a powerful way to disrupt the assumption that universities and the STEM fields are spaces for men, which they formally were in the long history of UVa. Some educators call for morphing "STEM" into "STEAM" by incorporating the arts and humanities in K-12 science education (Daughterty 2013; Land 2013). Art also inspires reflection and discussion about difficult social issues, such as at Holocaust memorials around the world and at the newly opened National Memorial for Peace and Justice in Alabama, which uses art and historical exhibitions to memorialize victims of white supremacy and raise questions about ongoing systemic racism.

We built the exhibits in two non-traditional gallery spaces with masculine significance: the lobby of the Science and Engineering Library and the lobby of the Chemistry Building. These spaces primarily serve STEM students and faculty, who are predominantly men. By

appropriating that space, we were calling attention to our exhibits in a way that got the attention

of people who might not otherwise have gone out of their way to browse or reflect on our

exhibit. In addition, the science library lobby features a Greek Revival mural of nude men and

women, which immediately encodes gender and sexuality into the space.

In response, we installed enormous panels in the middle of walkways, featuring:

- larger-than-life portraits of UVa women STEM faculty,

- excerpts from oral histories about their careers,

- a timeline of co-education at UVa, and

- the ongoing movements of women demanding equity in STEM careers, such as the
  social media campaigns #distractinglysexy and #ilooklikeanengineer.

By portraying women scientists and engineers in these masculine locations and in attention-

grabbing ways that passersby could not avoid, the exhibits proclaimed that women belong in

these spaces and these fields, which, in turn, also belong to women.

Project Description and Methods

The voices and visibility project can be divided into two main parts: (1) the collection of

professional portraits and de-identified personal narratives from women STEM faculty about

their experiences and accomplishments, and (2) the visual representation of these narratives

through an online exhibition, a two-month-long pair of gallery exhibits, and a series of lectures

and discussions. For the first component, a professional photographer took portraits of faculty

volunteers, and the Principal Investigator led a team of student researchers in the collection and

coding of oral histories from another group of volunteers (anonymized to protect their privacy).

For the second part, we worked with a curator as well as a web designer and an exhibit

construction company to build a website and a pair of gallery exhibits featuring faculty portraits

and oral histories, placed in the context of both the history of the institution and current

discussions on social media and in the public sphere. The physical exhibits consisted of a pair of

multifaceted galleries, one focusing on publicizing the accomplishments and contributions of

current women faculty, and the other visualizing and interpreting the oral histories collected from

de-identified subjects. Figures 2, 3, and 4 in Appendix B present the gallery spaces. This was a

particularly appropriate time to explore these topics and their impact on the growth and retention

of women faculty in STEM and SBE fields, as the university's strategic plan prominently

features assembling and supporting a dedicated and distinguishing faculty. This timing also

opened the door for funding from the IDEA fund, a partnership with the university's Office for

Diversity and Equity. The online exhibit, launched in advance of the construction of the physical

galleries, also emphasized both the publicity and narrative aspects, with additional detail and

visuals provided as appropriate for a medium not constrained by the limits of physical space.

Figure 5 in Appendix B displays a screenshot of the online exhibit site. Both the online and

physical exhibits and programming were evaluated for the degree to which they contributed to

individuals' perceptions of women in STEM, and how these conversations may lead to

institutional transformation.

　　　　Our hybrid research and arts-initiative to transform STEM women's representation used a

methodological approach based on the tenets of Feminist Participatory Action Research (FPAR).

FPAR explicitly blurs the epistemological boundaries between research and action so that the

gendered features of social hierarchies and oppression are rendered more transparent and so that

the researcher involves participants in creating the questions, processes and desired outcomes of

gender justice research and interventions. Being guided by FPAR principles, we wanted to first

do no harm by ensuring that our democratizing initiative did not unintentionally reproduce

patterns of gendered or racialized oppression and privilege, second, to share project decision-making with faculty participants even if this slowed down the timeline and surfaced disagreements and finally throughout the exhibit planning process to critically reflect on the spatial and visual dimensions of how diverse women experience and are represented in the university's built environment and public spaces (Coleman and Rippin 2000, Gatenby and Humphries 2000, Maguire 2000, Nowotny 2003, Reid and Frisby, 2007, Chevalier and Buckles 2013).

Our Approach

Constructing both the online and physical exhibits proved a challenging endeavor, requiring expertise beyond the immediate circle of social scientists and faculty originally engaged in the project. Our success was closely tied to forming relationships with experts in a wide variety of areas, including photography, curation, web design, space management, planning and construction, and marketing and advertising. Many of these resources came from the local community and larger region, beyond the university. For instance, our curator Kimberly Jacobs was recruited from Virginia Commonwealth University's curatorial art history doctoral program. Devoting adequate time and attention to forming a team early on in the planning phase, and including outside experts, is essential to avoid having the project stall later on due to unforeseen personnel needs.

Bringing together individuals with very different professional backgrounds or expertise introduces its own set of challenges. First, effective coordination and leadership is needed to manage each member's role in the larger project. We found that involving our ADVANCE grant's project manager helped greatly in this regard, as they held us accountable for each task and ensured we had the necessary resources to be successful. Effective project management

helped us meet the deadlines set by the exhibit construction company and resulted in the physical

gallery exhibits both opening on schedule.

A retrospective email review of the most intensive team commentary period during the

exhibit planning indicates that our greatest disagreements occurred about issues related to the

format, color, contrast and relationship of text to image on the large photographs. Should images

be green, blue, or grey and what tones and scales of gray in relation to text? Such aesthetic

questions could generate many rounds of input. As many members of our team have different

domains of expertise, communicating about exhibit curation or design was complicated by

differences in terminology or jargon. Patience with circumlocution of difficult-to-articulate ideas

was key to making progress. The following email from the curator captures consensus after

about two weeks of team input. It also points to our emerging agreement that the virtual and two

physical exhibits should be planned as connected, interactive modalities, though the latter were

spatially located in separate buildings, while the former appeared in an online format.

> "I'm gathering as a general consensus here, and I agree, that the emphasis should be on
>
> the image/portrait and we should lessen the text. As C. pointed out, we have the
>
> opportunity now to direct viewers to website to read further information about each
>
> faculty member's work; where we can include hyperlinks, videos, etc... keeping up the
>
> interactive dynamic of the exhibit. Enlarging the photos will certainly give a much more
>
> dramatic effect... Also, conceptually I really love the idea of making their images much
>
> larger, which will automatically cause viewers to pause and ask 'who is this
>
> person?' Lets' please keep sharing thoughts and suggestions... all of this is very helpful!"

The organization and layout of the exhibit is particularly important when curating or

designing multiple exhibit spaces, and when using both physical and online media. Furthermore,

the subject of the exhibits is very sensitive, as we are representing the voices, experiences, and accomplishments of our colleagues, and colleagues of those viewing the exhibits. Ivan Karp (1991) reminds us that even the most well-intentioned exhibits operate through a process of narrating others' realities and as exhibit makers we take on the task of "mediation among parties who will likely "not come into face-to-face contact (p. 15)." We selected a curator whose experience extended to exhibits involving marginalized groups. Kimberly Jacobs' background curating exhibits with a social focus helped us develop a coherent exhibit plan that incorporated stories that were both personal and powerful. This experience reinforces the importance of preparing and realizing the needs of the project when assembling a team with the right expertise. With their guidance, we used larger-than-life portraits of women faculty positioned next to a brief caption describing their work. We intended the immense scale of the portraits to cause visitors to focus on the people doing the research, as well as to dominate the Chemistry Building lobby in which those walls were placed. In the Mural Room, we placed two rows of serpentine walls to form a pathway through the center of that room and placed content on both sides of the walls. The serpentine structure added a creative, visual dimension to the text-heavy elements describing the oral narratives and historical context of women at UVa. Figures 3 and 4 in Appendix B present the walls used for the narrative portraits. We learned that details like size and shape play important roles in exhibit design, right alongside the content and visuals.

In conjunction with the physical exhibit design, we also produced an online exhibit and organized programming including a speaker series to engage the community further. It was important that the online exhibit would complement the physical exhibits, not just repeat the content in another format. Thus, while we expanded upon the content to add detail, we also used the website to connect the community with related events and collect feedback. We used a

Wordpress-based template, since that platform was familiar to the exhibit team, to take advantage of its robust content management system (CMS), responsive design that readily extends to phones and tablets, and existing institutional support for the platform. While we hosted the online exhibit on our own domain, resources such as Google Arts & Culture, featuring the National Women's Hall of Fame and many other collections, can also host exhibits like this one. We learned that considering these decision points early ensured we had the resources available to prepare our online exhibit rapidly and efficiently.

On the programming side, we aimed to add a living, interactive dimension to our exhibition. Several highly regarded speakers accepted our invitations to come to UVa and share their experiences with students and the university community. These women complemented the gallery and online exhibits sharing the stories and accomplishments of women at UVa with live, in-person lectures and discussion with those who have succeeded and broken barriers around the country. These speakers have held leadership positions at national laboratories, international businesses, and major women's organizations. The range of speakers is clear evidence of the widespread interest in challenging stereotypes, removing barriers, and recognizing women's contributions to science and technology, and that these issues are not specific to UVa or to academia.

Project History: Action and Research Integrated

In order to understand the exhibit project in a broader conceptual framework, we must place it within earlier pre-proposal conversations with women faculty in STEM. Our initial ADVANCE proposal writing and research plan emerged from early and ongoing conversations with STEM women colleagues about the issues that mattered most to them and what highest priorities would make the most significant difference in their lives in their departments and at the

university. This conversational approach with an invitation to consider the ways things were and what they could be was influenced by FPAR and by work in organizational and communications theory. Intentional change is a "process that is created, produced and maintained by and within communication" (Ford and Ford, 1995, p. 542). Conversation is in this view the "generative mechanism of change," as insiders define current conditions and communicate about how a future state could be intentionally different. These initiating conversations are sometimes called the "call," or "proposal," phase of a change process when existing conditions and opportunities are established and discussed (Ford and Ford, 1995, p.542). We especially want to emphasize the importance of understanding conversations as change work because these have often been stigmatized or devalued in institutional contexts, derided as 'complaining,' 'whining,' or worse yet as 'nagging,' or the sour grapes of the disaffected. We find that especially for women in STEM who may have a practical preference for action, gathering together to talk about experience may be perceived as a waste of time better spent on research. For these reasons, we assert the credibility of making time for conversations and listening as a precursor to initiating or integrating an exhibit project into an ADVANCE proposal or initiative.

Facilitated conversations occurred about eighteen months before we wrote our ADVANCE-IT proposal. An email sent to tenured and non-tenured women faculty in STEM (including the social and behavioral sciences) provided an overview of the NSF ADVANCE-IT program goals and objectives and invited ideas and perspectives about what should be included in a proposal. Thirty colleagues accepted the invitation. We divided participants into three groups of ten for facilitated conversations and then reconvened to share and debrief. Most importantly, we wanted to better understand the kinds of challenges our colleagues experienced as they worked in institutional spaces and how, if at all, an ADVANCE grant could make a

difference; that is, how could an NSF ADVANCE-IT grant potentially contribute to changing the circumstances that inhibited their capacity to do their work and thrive? Small groups met for an hour and then reconvened for a report-out and collective conversation. A complex range of issues emerged. Challenges categorized as structural and policy-related were identified and discussed. These included the need for increased research funding, the decline in administrative and support staff, few mentorship or leadership opportunities, salary inequities, gaps in work-life benefits, and the need for increased transparency in promotion and tenure criteria. Other challenges groups observed were related to institutional culture-departmental life, such as the over-reliance on women faculty to advise and teach, male colleagues who dominated faculty meetings, or a generally chilly climate for women.

Interweaved in conversations about the structural and cultural challenges, the cross-cutting themes of invisibility and story as a means of documenting and affirming presence began to emerge in the collective conversation. We did not define 'belonging,' but participants reflected on moments when they felt fully engaged and supported as STEM women faculty and times when they experienced a sense of being on the outside, devalued or simply made invisible, whether as individuals or as a community of women. As the organizers attempted to steer the conversation to summary synthesis of the small group conversations, individuals would take control of the process to assert the importance of telling their stories in contextually rich detail and to have those stories heard in the immediacy of the group.

Somewhat surprisingly, given the preponderance of the initial focus on structural and cultural barriers, when directly asked what top three issues an ADVANCE program should address, themes of meaning and legitimating women's presence through story began to emerge among the group as the most important areas of intentional transformative change. The following

excerpts point to the importance given to telling women's stories, though with somewhat

different emphasis. One participant noted that, "we don't tend to tell or hear the stories of women

and people on the margins," a deficit that an ADVANCE proposal could address. Another saw

the proposed grant as a catalyst to "bring women out of silence [to] tell their stories" (Facilitated

Conversation with STEM Faculty).

Referencing efforts in the School of Engineering that could be adapted more broadly, a

participant shared that "we have a luncheon for women students to hear women faculty share

their stories." They noted that "men faculty are coming to these luncheons—they want to hear

the stories of their female colleagues." This open view of an existing process that encouraged

men to reach across the gender boundary to hear women tell their lives was met by the opposing

view of another participant who asserted that "male colleagues spend a lot of time trying to

disconfirm the stories I tell them about women's experiences, they don't believe … the stories I

tell them about women's experiences." Yet other framings pointed to the need to document

through actively shared stories women's agency, what change strategies had previously worked,

and story as a way of connecting people to one another: "We need to hear stories of social

agency--how people made change;" "We need to address the lack of continuity of stories--there

is no institutional memory," "people need to connect so we don't keep reinventing the wheel"

(Faculty participants in pre-proposal facilitated conversation). As we wrote the ADVANCE

proposal, we began to integrate matters of story and voice and issues of visibility into our

conceptualization of the logic of change framework. The decision to include an oral history

component served these objectives.

The visual aspect of invisibility became apparent when participants reflected on the built

spaces in which they had their offices and labs, the public hallways linking private spaces, and

the conference rooms where they congregated for colloquia, committee meetings, receptions and

other key institution events. In multiple STEM spaces, there was a preponderance of male

portraiture, often the formal portraits of male STEM ancestors. Hallway photographs of men and

their machines reinforced the narrative. That was the present condition and though there had

been some efforts by individual women to have the portraits removed, there had also been strong

resistance and a counter call for the importance of preserving rather than erasing history.

The physical environment thus was a distorting mirror, experienced as intimidating as in

one story of a candidate who was offered the storied formal conference room to breast feed her

infant as the august men stared solemnly on. Many, if not all, of the women in the facilitated

conversation identified these images as alienating—a barrier to recruiting female candidates and

that the implicit, if not explicit, symbolic claim was that STEM work was male work and the

men were seminal progenitors of STEM disciplines. These photographs signaled that women did

not belong. By convening participants and encouraging conversations, we learned how our

STEM colleagues experienced and interpreted the visual environment in their work and

institutional spaces and why it was so important to integrate visual counter-narratives into the

ADVANCE work. We understood that beyond the work of taking down the male-centered

iconography, we should create new ways of seeing and inserting images of STEM women, how

they wanted to be depicted and made visible, into the built environment of the university's

STEM buildings.

For the exhibit, it was important to take into account, for example, the significant

challenges and risks of an exhibit focused on STEM women faculty. On the one side, we aimed

to respect the individual value and identity that faculty place on their likenesses and their stories.

However, we wanted to balance that individual interest with the community's interest in learning

about their stories and how it reflects society's attitudes about women in science and technology at large. Thus, we learned the importance of maintaining contact with the faculty participants throughout the exhibit planning and construction process. Making sure individuals are comfortable with how their stories and photos are used minimizes the chance of any unintended consequences that could compromise the project's message of visibility and inclusion. When dealing with de-identified oral narratives, for example, balancing ownership of individual experiences with the lessons learned from sharing those experiences becomes even more important. Researcher and participants are co-constructing gender representations for organizational change "at the edges between public knowledge and private lives" (Gatenby and Humphries, 2000, p.100). The exhibit maker and researcher needs to be aware of the power imbalance inherent in the work of exhibiting others' stories and in shaping the audience's reactions. One must also appreciate that an exhibit focusing on women's contributions may appear to single out particular members of the community and reduce inclusiveness through highlighting differences and perhaps even elevating some individuals over others. By placing the portraits and narratives in the context of the institution's environment and history, by consulting with faculty participants, and by being explicit about our goals for audience learning, we aimed to promote critical reflection, inclusion, as well as visibility.

Translating Research to Public Art

Qualitative research may seem like an easy medium to put on public display; after all, qualitative data are basically stories. They are individuals' explanations of their own experiences. However, social scientists typically approach these data in search of more general trends, such as how social systems and structures shape the lived experience of individuals and groups. This

approach is more complicated and creates distance between the stories and the individuals, through generalization as well as the ethical requirements of confidentiality. The challenge was that our team of social scientists wanted to do both: analyze a set of 17 in-depth interviews with women faculty as 1) the 'narrative portrait' section of our online and physical exhibits and 2) the foundation of the lead researcher's anthropological research. These dual purposes for the data both involve sharing personal stories while keeping participants' identities confidential. Because participants' confidentiality was an IRB requirement for conducting the interviews, we had to present the stories without the storytellers. This is normal practice for social science research, but we worried this clinical abstraction would not appeal to the broad audience we envisioned for our exhibits.

Our curator advised us that the exhibits should be "outward-facing," meaning attention-grabbing and meaningful for a wide range of people. Therefore, we should select and explain the oral history data in ways that would appeal to the audience's knowledge and interests to powerfully illustrate the experiences of women in STEM. In a nutshell, our challenge was to apply our research-focused analytical techniques and skills to bring these data to life for the public. So we thought of the data as stories, personal lived experiences, and examples of themes that are shared among the interviewees and are relatable to the public. Here we explain our approach, including our struggles and successes, to making public art from data. In particular, we altered our data analysis to focus on themes across the interviews and we thought carefully about how to share the stories in an engaging, accessible way.

We first approached the interview transcripts as we would for a research project: with careful, repeated reading. We marked passages that struck us as interesting, common, or unusual, as a form of open coding, i.e., undirected, without preconceptions of what we wanted to find. For

example, this story revealed the male-dominated cultures of research spaces based on a

workshop that built laboratory equipment for faculty:

> There was one particular workshop … plastered with pin-ups … I thought it was horrible
>
> to walk through that thing … It kind of sucks the energy out of you when you constantly
>
> have to block this kind of stuff … So you walked through there and you had the feeling
>
> everybody was just undressing you with their eyes mentally (Oral history participant).

This was one woman's experience, but it captures a feeling that many women in STEM have

encountered: feeling disrespected and out of place because of their gender. Next, we met to

discuss the trends we were noticing. One of the interview questions asked participants to imagine

their life story as a book and then tell the story in chapters. So we thought of the exhibit as

sharing women faculty's experiences in the format of a life story. Accordingly, we organized our

excerpts and themes into a chronology, such as by starting with women's stories of their

childhood. For example, several women felt encouraged not to study science, as in this woman's

case:

> I finished a high school level of math and science and I decided I wasn't interested
>
> anymore ... I used to like physics. I was good at math. There wasn't really any reason for
>
> me to decide I didn't like it, but nobody even discussed that with me… It for some reason
>
> wasn't attractive to me; it was full of machinery. That's what it felt like. It wasn't very
>
> feminine [laughs](Oral history participant).

We learn gender roles and norms at young ages, so it made sense to include women's early

memories about science. However, our list of chronological themes was enormous, detailed, and

complicated. We decided that we could write a journal paper from it, but we could not build it as

an exhibit, so we ditched the chronology idea and tried again.

We re-coded the excerpts and themes into three broad themes that captured most of our specific themes. This structure seemed more manageable as an exhibit, but how could we address those long lists of sub-themes? It was painful for us to zoom out and thereby lose the intricate details of the data. But we kept returning to our goal, which was to capture the attention of someone strolling by an exhibit panel or scrolling through a website. Those viewers, we assumed, would prefer broad themes illustrated by a few short, easy-to-understand quotes, so we forced ourselves to be very selective and broad-minded, and produced four themes to represent the interviews. We wrote a brief text about each theme to explain how we understood that theme and what it represents about the interviewees' stories, and then listed a few quotes that demonstrated that theme. For example, for the theme we titled Gendered Expectations, this quote illustrated the social norms and systemic biases that women perceive and experience:

> I was **getting papers rejected** and I honestly thought that it was **because I was a female,** so I **started using just my initials** and I **started getting my papers accepted** (Text format from exhibit).

We used bold font and red lettering to highlight striking phrases, to attract viewers' attention and guide their skimming. Our explanation was the broad, generalized approach, while the quotes added the crucial elements of narrative and personal experience. Thus, we could still do the interviewees' stories justice without social scientists' beloved nuance, detail, and complexity.

Finally, to broaden the exhibits' themes and message about women's experiences, we wrote about the use of social media to promote and unify women in STEM. These trends were important precedents to the ongoing #metoo movement that aims to reveal sexist discrimination in U.S. workplaces. By connecting our faculty's experiences with current events, we hoped to show the audience that their stories are not unique, but rather reflect our society's assumptions

about gender roles, women's intelligence, and what kinds of people should do science and

engineering. Thus, the wonderfully individualized and detailed interview data shared by our local

colleagues, professors, leaders, and friends are powerful reflections of broader social realities.

To contextualize our faculty's narratives, we wrote a women-centered history of UVa.

This is a shorter story than at most universities: UVa did not fully admit women undergraduates

until 1972, but women have been a part of UVA for far longer, as 'special,' non-degree-earning

students in the 1890s and as graduate and professional students, such as in nursing, since 1901.

Kelly Feltault combed the UVA archives for snippets of women's voices and for policies about

coeducation. They found many shocking stories, such as that the Board of Visitors, UVA's

governing body, voted against coeducation in 1894 because, they explained, higher education

would 'physically unsex' and thus weaken women and women's presence would ruin UVA's

revered honor code, because only men can live honorably. The message that women did not

belong at UVA continued even after women enrolled as graduate and professional students in the

20th century. For example, women students were not allowed to live on campus until 1952 and

were called "Mr." by faculty and men students, to match Thomas Jefferson's insistence on "Mr."

as a democratic title. Feltault selected these powerful examples of our institution's history from a

mountain of documents and photographs spanning the university's (almost) two-century

existence and organized them as a timeline. On the physical exhibit, the timeline ended with the

faculty's oral histories. We thereby framed women's struggle for equality at UVA as long and

ongoing, and with considerable success in the late 20th and early 21st centuries.

To further frame the oral histories in contemporary American culture and help the

audience identify connections to their own lives, we followed social media campaigns that strove

to unite women in STEM and give them a stronger public image. Hashtags, such as

#distractinglysexy and #ilooklikeanengineer, spread quickly as women posted photos of themselves doing science. We saw this form of grassroots publicity as a strategy that women in STEM were employing to re-image themselves. Their work matched the goals of our exhibits and showed that our work was part of a larger movement to recognize and celebrate women in STEM. We hoped that the sight of Twitter posts in the exhibits would catch viewers' eyes. The information powerfully reminded the audience that women are still sometimes treated like outsiders in STEM and that they—and we—are actively working to create a new, inclusive public perception of science.

<center>**Evaluation Process**</center>

Evaluation Design

As the exhibit design was informed by Mezirow's theory of reflective practice, the exhibit evaluation sought to measure visitors' learning experience, while also assessing outcomes to report to NSF. As previously stated in the introduction of this paper, Mezirow identifies three types of reflective practice involved in the transformative learning process: content reflection, in which the viewer reflects on what is happening in the space or what is presented in the content; process reflection, in which a viewer wonders how the exhibit and its media came to be; and premise reflection, in which the viewer sees their knowledge in a broader context or new perspective and asks, "why does this material matter to me?" and "Am I, too, influenced by these beliefs and assumptions about women in science?" (Kitchenham, 2008; Mezirow 2000). In designing the evaluation, evaluators balanced the dual goals of measuring visitors' levels of transformative learning and collecting data on the extent to which the exhibit achieved its intended outcomes.

To navigate the complex process of designing an evaluation plan for an arts project, we consulted experts in museum evaluation at the National Endowment of the Arts and literature on exhibit evaluation practices. Patricia Shaffer, Deputy Director of Research and Analysis at the NEA, suggested several data

collection strategies. Dr. Shaffer advised first visiting the space to observe the flow of people throughout the room. How do people move through the space, and how will they interact with the exhibit? When the exhibit opened, Dr. Shaffer suggested that evaluators collect data through "intercept surveys" (P. Shaffer, personal communication, October 24, 2016). With this method, a roaming researcher would approach visitors and ask them to respond to three to five questions in brief, two to three-minute conversations. The researcher would then record the data in a digital questionnaire form on a tablet or take notes on a clipboard. Based on our observations of the flow of people throughout the space and knowledge of the exhibit layout, we decided that collecting evaluation data through intercept surveys was an ideal evaluation strategy.

Diamond, Horn, and Uttal's research on evaluation in informal learning spaces also informed the design of our interview protocol. According to Diamond, Horn, and Uttal, a visitor's interaction with an informal learning environment can both "result in the acquisition of implicit knowledge," and "in conceptual change," and an exhibit can ignite a visitor's interest in learning about a topic and a continued desire to learn about the topic in the future (p. 15). Our goal for the evaluation was to understand how the exhibit influenced visitors' learning about the issues with gender discrimination in STEM disciplines. Specifically, the exhibit aimed to "spark discussion and raise awareness of the diversity of scientists and their experiences, expanding the current conversation on Grounds regarding diversity, departmental climate and culture, and adding to the vision of an even more inclusive future at UVa" (curatorial statement). We designed an interview protocol with these evaluation outcomes in mind, to assess the degree to which the exhibit raised visitors' awareness, sparked discussion, expanded the conversation about diversity on Grounds, and added to the vision of a more inclusive future at UVa.

Challenges and Limitations

Collecting and analyzing data that achieved our dual goals proved challenging; how could our research team both assess critical learning and determine whether the project was effective in short, three to five-minute interviews? We first looked to technology to aid us in the data collection process,

considering a QR code that visitors could scan to complete an online survey, however, the physical layout

of the space and flow of people through the room suggested that visitors would be unlikely to use it.

Further, we considered setting up a notebook or tablet station to allow visitors to leave comments, but

facilities and building security staff cited fire and safety concerns given the space's primary function as an

academic building.

Using a cognitive assessment that provides quantitative data may have helped us to more reliably

measure visitors' levels of learning and critical reflection. But the exhibit's physical location limited

participant evaluation strategies. For instance, the academic setting meant that the amount of time visitors

would likely spend on an evaluation was minimal—most visitors were students passing through on their

way to class, rather than visiting the site for the express purpose of viewing the material, as they would in

a museum setting. We determined that the best solution would be to collect data by asking people directly

about their responses to the exhibit. This approach yielded rich qualitative evidence that demonstrated the

project's success.

Results

From March to May 2017, the evaluation team conducted intercept surveys with 57 visitors at the

two exhibit sites. Interview questions and their alignment with evaluation outcomes can be found in

Appendix Table A. Most visitors (88 percent) were undergraduate students, seven percent were UVa

employees, and five percent were graduate students. Sixty-five percent of visitors who participated in

interviews identified as female, compared to 35 percent who identified as male. Most of the

undergraduate students who participated in interviews were STEM majors. Evaluators recorded data from

intercept surveys in notebooks, and then entered data from each interview in a Microsoft Excel

worksheet.

Coding the data.

The evaluation team decided to use multiple coding methods to analyze the data. First, researchers coded the data "openly," searching for broad themes that emerged from interview responses. Then, in a second review of data, the research team coded themes by evaluation outcome. Evaluators determined whether the themes identified in the interview responses aligned with the exhibit's goals of raising awareness, sparking discussion, expanding the conversation about diversity on Grounds, and contributing to the vision of an inclusive future at UVa. While aligning themes with evaluation outcomes allowed us to determine the degree to which the exhibit accomplished its goals, the "outcome coding" approach was limited in its ability to assess visitors' deeper levels of learning. A coding method based on Mezirow's schema of transformative learning could have better allowed us to measure visitors' levels of critical reflection.

Open coding.

Several interesting themes emerged in the initial "open coding" of response data. In response to an interview question about visitors' initial reactions to the exhibit, themes ranged from curiosity, interest, and excitement to confusion, oblivion, and even frustration. For instance, one undergraduate student found the material "relatable and powerful," and another felt "encouraged" that UVa was "taking initiative" to address discrimination experienced by women in STEM fields. Perhaps the most positive response to the exhibit came from a student in the sciences who felt inspired by the exhibit material: "it shows me that this could be me, and shows that we are advancing," they said. Other visitors did not notice the exhibit at all or felt the exhibit disrupted their routine treks to class or the library. Some commented on the large physical size, explaining that the "room was open and now the exhibit is in the middle…you can't help but notice it." Another visitor reported feeling "overwhelmed" when first encountering the exhibit; "it's huge…there's no sense of subtlety," they remarked. Overall, 14 different themes emerged in visitors' responses about their initial reactions to the exhibit. These themes were then coded again based on the extent to which they aligned with evaluation outcomes.

Interviewers asked visitors about their level of awareness of gender discrimination in the STEM fields and whether the exhibit changed their perception of women in the sciences. Visitors' levels of awareness varied greatly, though most were at least somewhat aware of the issues. For instance, some undergraduate students had personal experiences with gender disparities in STEM fields or had discussed the topic in class but were unaware of the issue's prevalence or relevance to UVa. Gesturing to the narrative portraits displayed at one exhibit site, a student observed, "we hear little murmurs and looks, but nothing compared to these examples."

Several visitors' comments suggested that the exhibit increased their awareness or broadened their knowledge of the material presented, intimating a level of learning that Mezirow would classify as "content reflection." Many commented that though they were generally aware of the topic, the exhibit provided more specific, detailed information about the problem at UVa. One student noted that though they were familiar with the exhibit from their mother who worked as a science teacher, the exhibit "broadened my base of knowledge." Seeing portraits of women scientists allowed one visitor to "see women that I didn't know were here." The heightened visibility of STEM women was "really encouraging" to one student who had "very few women" in their major. They remarked, seeing the portraits of "women at the master's and PhD level" was "encouraging because I may be interested in going for that one day." The levels of learning demonstrated by visitors' comments on their awareness of the material suggests that many visitors engaged in content and premise reflection, according to Mezirow's framework. They reflected on and learned from the content, and in some cases, connected it to their own circumstances and assumptions.

When asked whether the exhibit had sparked discussion among visitors' friends and family members, many indicated that it had. Some professors took groups of students to see the exhibit or discussed the exhibit in class. Other visitors discussed the content with friends while passing by or explained the reason behind the exhibit to other students. One student noted that they shared information from the exhibit with their parents. The student explained, "I told my parents [about the exhibit] and they

were surprised. My dad went to college in Pakistan and they were coeducational before UVa." Finally, some students indicated that they had shared information about the exhibit with friends on social media. While we did not monitor social media discussion about the gallery exhibit for the evaluation, visitors' responses suggest that there was dialogue about the exhibit on multiple social media platforms.

Outcome coding.

After coding the interview data for themes, evaluators then coded themes by evaluation outcome to determine how visitors' responses to the exhibit aligned with the exhibit's goals. Specifically, the research team sorted through themes to assess whether they supported the exhibit's intended outcomes of "sparking discussion," "raising awareness," "expanding the conversation about diversity on Grounds," and "adding to the vision of a more inclusive future at UVa." The results of outcome coding were mixed suggesting that for some participants the exhibit content did not seem to stimulate further conversation, while others actively reflected on and shared what they had learned with others. For instance, while 25 visitors remarked that the exhibit did not influence conversations with friends and family, 31 visitors remarked that the exhibit led to conversations with friends or peers (14 comments), with professors (2 comments), with parents or family members (2 comments), or that they had discussed the exhibit in class (4 comments), with friends while in the building (4 comments), or shared information about the exhibit on social media (3 comments).

Coding the themes for the "raising awareness" outcome suggested that visitors' responses may have depended on their initiating awareness level about exhibit topics. For example, a large number of themes clustered in the "did not increase awareness" or "were already aware of issues STEM women faced" categories. In the "raising awareness" category, a range of themes demonstrated *how* the exhibit raised visitors' awareness or what they learned from the exhibit. For instance, many comments suggested that visitors were somewhat aware that gender inequality in the sciences was an issue (20 comments) but were not aware of the history of gender inequality at UVa (15 comments) or that the issues persisted today (5 comments). Further, while some visitors were familiar with the material from their experience as

STEM students (10 comments), the exhibit still expanded many visitors' understanding of gender discrimination (5 comments).

Many themes that aligned with the "expand the conversation about diversity on Grounds" outcome indicated that reflective learning was occurring among visitors. Several visitors mentioned that they personally related to the material about gender discrimination (6 comments), and that they noticed a lack of minority women in the academic community. Multiple themes demonstrated a sense of surprise in response to the exhibit material, including surprise at the persistence of issues today (3 comments), surprise at the history of women at UVa (18), and surprise at the quotations and language used to describe women in historic university documents (4 comments). The sense of surprise expressed in visitors' comments demonstrates a questioning of assumptions and shift in understanding of the subject matter, consistent with Mezirow's "premise reflection." The theme of surprise suggests that though visitors were aware of issues, their interaction with the exhibit material incited a new type of understanding.

Finally, several comments expressed optimism, hope, or encouragement that the exhibit signified an increase in gender equality at UVa. These themes aligned with the exhibit's goal of "adding to the vision of a more inclusive future at UVa." The theme of an increase in the visibility of STEM women was expressed in several comments (15 comments). Related themes suggested that visitors felt empowered (2 comments), encouraged (8 comments), or optimistic (7 comments) after viewing the exhibit and believed that the exhibit shows progress towards gender equality in the sciences (4 comments). Visitors' hope, optimism, and appreciation for the greater visibility of STEM women represented in the portraits suggests that the exhibit effectively created a vision for an inclusive future; by publicly presenting STEM women's portraits, the exhibit fostered a vision of inclusion in the STEM fields, in which female scientists and their diverse experiences are celebrated.

External evaluation

In addition to meeting its evaluation goals, the "ReImaging Women in STEM" exhibit supported the larger goals of the NSF ADVANCE program at UVa. A major goal of UVa's ADVANCE program

was to "increase the sense of belonging of STEM/SBE women faculty among their schools and

departments" (UVa. ADVANCE proposal, 2012). In a fifth-year report, external evaluators observed that

"the installation of the photo exhibit and the oral histories have brought visibility to women in the

university, and in combination with other changes in the environment, have translated to positive

sentiments among women" (Hill & Hammons, 2017). The report presented evidence from the 2015

Collaborative on Academic Careers in Higher Education (COACHE) survey of UVa faculty to show that

measures of belongingness, including fit with environment, recognition, and empowerment, have

improved.[1]

Results from the 2015 COACHE survey demonstrated greater levels of satisfaction among faculty

who participated in UVa CHARGE in 2015 than in 2012. Furthermore, the mean scores of UVa

CHARGE faculty on measures of Personal and Family Policies, Mentoring, and Divisional Leadership

were significantly higher in 2015 than the means for non-CHARGE faculty in 2012, in the first year of

the grant program. Though these data do not demonstrate the direct impact of the photo exhibit project,

they suggest that UVa CHARGE's efforts to increase STEM/SBE women faculty's visibility and improve

the environment for women in STEM at UVa had a significant positive impact.

Conclusion

The NSF ADVANCE program aims to transform institutional culture to advance women in the

academic science, technology, engineering, and mathematics fields and create a more diverse science and

engineering faculty. The "ReImaging Women in STEM" photo exhibit project at UVa demonstrates how

art can be used as an agent of institutional change. By presenting the lived experiences and stories of

STEM women through art, we invited the UVa community to join us in reflective practices about our

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[1]The Collaborative on Academic Careers in Higher Education (COACHE) is a survey sponsored by the Graduate
School of Education at Harvard University. The COACHE survey queries faculty on their work experiences and
perceptions of their institution in order to offer the institution's senior leadership the capacity to identify drivers of
faculty success and to implement informed changes. UVa administered the COACHE survey in 2012 and 2015, and
external evaluators used data for evaluation purposes.

history, culture, and the environment for women in STEM; guided by a vision of a more inclusive future,

we invited the community to join us in taking steps toward institutional transformation.

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Appendix A

Table 1

Interview Questions and Evaluation Outcomes

Outcome	Questions
Spark discussion	• How has viewing this exhibit influenced conversations you have with peers, mentors, or family members about gender stereotypes?
Raise awareness of the diversity off scientists and their experiences	• What was your initial reaction to the exhibit when you first saw it? How has that changed over time? • Before seeing this exhibit, how aware were you of gender discrimination in STEM fields? • How has the exhibit affected your perception of women in STEM fields or what a scientist or engineer looks like?
Expand the conversation on Grounds regarding diversity, departmental climate and culture	• What was your initial reaction to the exhibit when you first saw it? How has that changed over time? • What surprised you most about the history of women at UVa? • How has viewing this exhibit influenced conversations you have with peers, mentors, or family members about gender stereotypes?
Add to the vision of an even more inclusive future at UVa	• What was your initial reaction to the exhibit when you first saw it? How has that changed over time? • How has the exhibit affected your perception of women in STEM fields or what a scientist or engineer looks like?

Table 1

Appendix B

Figure 1. Introductory Panel to Chemistry Building Exhibit

Figure 1. Introductory panel to Chemistry Building exhibit featuring female scientists' portraits.
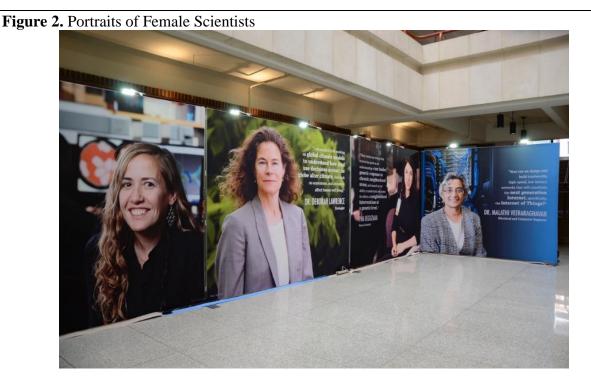
Figure 2. Portraits of Female Scientists

Figure 2. Portraits of female scientists in the Chemistry Building exhibit.

Figure 3. Panels of Narrative Portraits

Figure 3. Narrative portrait panels in the Science and Engineering Library.

Figure 4. Narrative Portraits and Social Media

Figure 4. Narrative portrait and social media panels in the Science and Engineering Library.

Figure 5. Online Exhibit

Figure 5. (Re)Imaging Women in STEM Online Exhibit.