AC 2010-1754: MODELING THE CAREER PATHWAYS OF WOMEN ENGINEERING FACULTY THROUGH ORAL HISTORIES AND PARTICIPATORY RESEARCH METHODS

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Modeling the career pathways of women STEM faculty through oral histories and participatory research methods

Abstract

Women increasingly earn advanced degrees in science, technology, and mathematics (STEM), yet remain underrepresented among STEM faculty. Much of the existing research on this underrepresentation relies on "chilly climate" and "pipeline" theoretical models to explain this phenomenon. However, the extent to which these models follow women's actual career pathways has been undertheorized. Further, alternative metaphors may more aptly describe the career pathways of women STEM faculty. In our broader research project, we examine the ways women's career pathways into STEM faculty positions are similar to and/or different from chilly climate and pipeline models, and if they vary based on race and/or ethnicity. At present, we focus on the ways oral histories and participatory research methods allow us to model the career pathways of women STEM faculty.

Our goal is to illustrate how oral history and participatory research are effective methods to:

1) identify women's career pathways into STEM faculty;
2) compare and contrast career pathways to climate and pipeline metaphors as well as discover new metaphors;
3) identify critical points in women's career pathways; and
4) discover new information about women's paths into STEM faculty.

We describe early results from a set of semi-structured interviews of women faculty in STEM disciplines collected as part of research done through an ADVANCE grant, a NSF- funded project intended to achieve improved career success for women faculty in STEM disciplines. Interviews begin with oral histories that give context, depth, and structure to women's pathways into STEM faculty careers. Through participatory research methods, we tell participants the goals of the research and ask them to discuss, challenge, and suggest ways institutions may improve career success for women STEM faculty. Taken together, career pathways are modeled and compared with chilly climate and pipeline models. This innovative methodological approach will inform policy, recruitment procedures, and ways to retain women faculty.

Introduction

We describe the potential of two social science research methods to model women's pathways into STEM faculty careers and develop new theoretical models to understand women's underrepresentation as STEM faculty, with a particular focus on women faculty of color. We use data from a set of semi-structured interviews of women STEM faculty early in their careers to illustrate how these social science research methods may increase our understanding of women's career paths and shed light on the ways university policies and department culture affect the career experiences of women STEM faculty.

This purpose of the overall study is to examine the academic career pathways of women faculty in STEM disciplines at a large research university, with particular focus on women of color. The study investigates the extent to which their career pathways into and through academic faculty levels in STEM disciplines are modeled by pipeline or chilly climate models that metaphorically

explain women's underrepresentation among STEM faculty. At present, we focus on the ways oral histories and participatory research methods allow us to model the career pathways of women STEM faculty.

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The two prevailing metaphors to explain women's underrepresentation among STEM faculty are chilly climate and leaky pipeline. Chilly climate contends the working environment is so unfriendly, or chilly, to some that they decide to leave[1]. Leaky pipeline is a metaphor describing STEM faculty career paths as a pipeline with a pool of potential STEM faculty at the beginning and completed STEM faculty at the end[2]. Women "leak" from the pipeline before entering STEM faculty positions at the end of the pipeline.

These theories insufficiently explain women's underrepresentation among STEM faculty because of gaps in their rationale. For instance, leaks in the pipes are random in terms of what "bits" of water drip out, and leaks imply water only flowing "out" of the pipe. But women's experiences of choosing to leave (if temporarily) their scientific careers are rarely random in this way, and the outward leaking does not model many women's choices to re-enter a faculty career later in life.

Our goal with this overall research project is to develop new, more accurate models to understand women's career experiences. In this paper, we demonstrate the methodological power of oral histories and participatory research to better understand women's pathways into STEM faculty careers and examine the extent to which they follow chilly climate and leaky pipeline theoretical models.

Oral history

We use oral histories to understand women's career paths into STEM faculty positions and discover significant career pathway points. The data we wish to capture with oral histories are women's perceptions of their experiences into STEM faculty careers. Participants discuss what is important to them allowing chilly climate and leaky pipeline themes to emerge *from them* rather than imposed by the researchers, if they emerge at all.

Oral histories capture the totality of one's life experiences where participant talk about personal experiences demarking significant points throughout the life course[3]. Interviewers guide oral histories by asking the participant about points of interest particular to the study purpose[4]. Interviewers are active listeners and offer probes only as necessary. Traditionally, oral histories begin with the participant's childhood experiences and continue chronologically through other significant personal and socio-cultural life events[4]. These interviews are semi-structured and include broad, open-ended questions that allow participants to choose life events that hold personal significance or carry broad social significance. Because participants control what

information they divulge, themes emerge more naturally, reducing researcher bias that is more problematic in other research methods such as surveys or structured interviews[4].

Oral history methods uniquely allow researchers to examine personal decision-making processes[4]. As participants detail critical points in their life paths, they often describe why they chose one path over another. If participants do not disclose the rationale for their choices, the interviewer may probe for additional explanations. Given the conversational nature of oral histories, researchers easily tap into the dynamics of decision-making thought processes[4].

In effective oral histories, interviewers build good rapport, establish non-threatening interview environments, and offer sufficient protection of participants' identities[4]. Through the interactional nature of the interview, participants are encouraged to discuss information they might not disclose on a survey.

A common critique of oral history methods is reliance on memory to recount past events[4]. The faults of human memory may be problematic for data collected in historical studies focusing on factual accounts of past events. In social science studies, however, individuals' interpretations of past events are more important than the factuality of events. These interpretations are participants' psychological realities and increase our understanding of individual thought and decision-making processes.

To understand particular individual's experiences in the context and situation of their lives, we use oral histories to:

1) uncover career path information not revealed by written documents, such as curriculum vitae;
2) understand decision-making processes at critical career path junctures and elsewhere; and
3) give context for the entire career path.

Our oral history protocol begins with participants' biographical information, including family life while growing up, parents' occupations, and marital and parental statuses. This provides context and frames participants' career paths. Next, we talk about first memories of being interested in science, technology, engineering, or mathematics, followed by career beginnings in STEM disciplines, and people influential in encouraging an STEM career. We discuss in-depth participants'' educational and employment histories as well as participants' rationales for choosing an academic career over other STEM careers.

Participants discuss their respective departments' working atmospheres and feelings of "fit" within them. The interviewer asks participants to choose a metaphor to depict what working in their respective departments is like. Finally, participants are asked how their gender, race, and ethnicity affects the ways they are treated by others in their departments and how their own gender, race, and ethnicity affect their feelings of fit in their departments. We analyze the collection of oral histories for common patterns or differences among participants' career paths. Such patterns are used to evaluate existing career path models, such as chilly climate and leaky pipeline, and to develop new career path models.

Participatory research

The goal of participatory research is to work with those affected by a particular phenomenon to change and improve conditions[5]. Together researchers and participants critically evaluate historical, cultural, political, and other contexts to identify areas that need improving[5]. Participatory research is a collaborative effort where participants know the research goals, are part of the research process, and suggest avenues to implement change.

Using participatory research to study people of color helps establish trust by defusing the often-unequal relationship between researcher and the researched[6]. Tensions from the past often persist because historically, white researchers used unethical research practices to target people of color for research[7]. Additionally, people of color are often the "researched" but are infrequently asked for their stories[7]. Overcoming some of these barriers, subjects of color in participatory research are more likely to trust researchers when they know the goals of the study. Further, continued participation throughout the research decreases the likelihood that researchers will marginalize or misrepresent the views and experiences of people of color[6].

By using participatory research, women STEM faculty may articulate gendered ideologies and experiences affecting women's career paths. Discussing the effects of gender openly and in the context of the research goals encourages participants to discuss, challenge, and suggest ways to improve inequities in the career paths of women STEM faculty.

Examining processes within the university as a workplace using participatory research methods is unique. Participatory research is a multi-disciplinary method to create processes or implement improved processes. Employers, educators, and humanitarian organizations commonly use participatory research to improve learning processes or community resource processes[8]. In this study, we use participatory research to evaluate hiring and retention processes within the university as an employer. Examining the university as an employer is a groundbreaking approach to improve the recruitment and retention of women STEM faculty. Using participatory research in this way will expound knowledge about the university as an employer and its ability to implement change.

Participatory research has some limits. The success of participatory research depends on the strength of the relationships between the interviewers and participants[6]. The data quality and accuracy are compromised if the relationship is not strong. Because personal and professional information about each participant are discussed, interviewers must create safe, comfortable, and private environments during (and after) the interviews[8]. Additionally, interviewers must offer and execute sufficient identity protection and confidentiality to participants to secure their trust and cooperation.

Protecting participants' identities is particularly challenging when participatory research is used in the context of a NSF-sponsored ADVANCE grant because our population is often underrepresented at the department-level. To address this, we disclose to participants all aspects of our procedures for protecting participants' identities. We assure participants that we aggregate the data across disciplines, college, and departments in addition to changing any potentially personally identifiable information in the final transcripts. Participants are asked to

review their respective identity-neutral transcribed interviews. We do not release transcripts for data analysis until participants are satisfied their identities are sufficiently protected.

After the oral history portion of the interview is complete, the participatory research portion of the interview begins and focuses on participants' opinions about: 1) their career paths; 2) chilly climate and leaky pipeline models; and 3) metaphors to describe their career paths.

We begin interviews by explaining our specific participatory research methods. Next, we explain the goals of the research and give high-level information about women's underrepresentation among STEM faculty. Chilly climate and leaky pipeline theoretical models are described. We explain that we are for their experiences and opinions rather than inferring about them to create institutional change.

Next, we ask participants how they feel chilly climate and leaky pipeline metaphors fit or do not fit their career experiences. We ask new faculty to reflect on their interviewing and hiring experiences, look ahead to their third-year reviews, discuss their departments' working atmosphere, and reflect on their interviewing and hiring processes. We ask third-year faculty to reflect on their interviewing and hiring experiences, their experiences as faculty at their current university, and satisfaction with their productivity and accomplishments in their careers so far. Additionally, we ask third-year faculty to discuss what they feel their next professional accomplishments will be. All interviews conclude with general career path reflections.

Data collection

Data are collected for research conducted for an ADVANCE grant, a National Science Foundation-funded project focused on improving the career success of women faculty and faculty of color in STEM disciplines. Data collection is in progress and not yet complete. We conduct in-person semi-structured interviews of women faculty and faculty of color in STEM disciplines at a large research university who have been newly hired or are approaching their third-year reviews. Interviews are audio-recorded.

We invite by email faculty newly hired or near their third-year review to participate in an interview to discuss the paths that lead them to their current positions as STEM faculty. We conduct interviews in two parts. The Part 1 interview is an oral history that includes biographical, educational, and employment information. Participants discuss the working atmosphere in their current departments and their feelings of fit within them. At the conclusion of the interview, the Part 2 interview is scheduled.

At the beginning of the Part 2 interview, participants discuss the working atmosphere in their respective departments. The oral history ends and the participatory research methods begin with an introductory explanation of the research method and goals of the study. Chilly climate and leaky pipeline ideas are explained to participants as well. We ask participants to share their thoughts about the metaphors and the extent they feel the metaphors do or do not fit their experiences. Finally, participants' discuss their experiences with interviewing, hiring, and utilization of career support services.

Data analysis
We are in the early stages of data collection and describe our process for analyzing preliminary data. When data collection is complete, we may revise these procedures for final data analysis.

We transcribe the audio-recorded interviews and print the transcript. As we read individual transcripts, we identify: 1) critical junctures, defined as decision-making points; 2) milestone markers, such as educational achievements or changes in employment; and 3) information pertinent to career path movement not found on a curriculum vitae, such as career paths considered but not pursued[9]. For each participant, we map this information onto a chronological timeline. Finally, in each transcript, we write notes to identify specific language participants use to describe their careers.

We compare timelines across interviews looking for differences and similarities among participants' career paths9. We compare participants' career timelines with chilly climate ideas looking for experiences of micro-inequities building up over time. Participants' career timelines are reviewed for evidence of departures from the traditional career path that support leaky pipeline theories. Language participants use to describe their careers is examined for new metaphorical ideas or variations on the pipeline and chilly climate metaphors[3, 10].

To test chilly climate and leaky pipeline metaphors, and discover new metaphors, we analyze data from the oral history interviews that focus on the working atmosphere in participants' departments. We look for language that either supports or refutes chilly climate or leaky pipeline models[10]. Data from the participatory research methods section describing participants' views on chilly climate and leaky pipeline models are also analyzed. Finally, we identify emergent metaphorical language4.

We analyze participants' career timelines for critical junctures, which are decision-making points where participants may have taken another career path but instead continued to STEM faculty careers. Finally, we examine career path trajectories from interviews for new or emergent themes that inform us about women's career paths into STEM faculty.

Results
Oral history and participatory research are effective methods to identify women's pathways into STEM faculty careers, compare career pathways to chilly climate and pipeline theoretical models, develop new metaphors, and identify critical junctures along women's career pathways to STEM faculty.

New ideas about women's career paths into STEM faculty emerged through the language women used when telling their educational and career stories. When reflecting upon her career into STEM faculty, one participant said, "I had doors opened for me." The "door" is a new metaphor that emerged and may lead to the development of new theoretical models about women's career paths to STEM faculty. The passive voice in the participant's phrase may have significance. It depicts her as a passive actor whose fate is determined by an outsider with the power to open or not open doors at junctures along the career path. These "doors" also represent critical junctures

along women's career pathways. A shut or open door changes the direction or course of one's career path.
Another participant explained that while in graduate school she had one mentor who "facilitated" her career goals and mentor who "obstructed" her career goals. The student is a passive actor controlled by faculty who influence and direct her through graduate school. Unlike the randomness of doors opening or closing for the student, this metaphor identifies graduate school mentors as highly influential to her graduate school success and her career path direction. Notions of careers being facilitated or obstructed by mentors also mark critical junctures in women's career pathways. Facilitation and obstruction indicate directional movement, or the potential of it, in one's career path.

Some women feel pipeline and chilly climate models fit their experiences. One participant's career fit the pipeline metaphor as she explains, "I kind of got into the pipeline as an undergraduate and have just kind of stayed through it… and so, I flowed through the pipeline pretty smoothly." Another participant described an experience during her postdoctoral position that fit the chilly climate model. As a postdoctoral fellow, her male mentor did not view or believe her data in the same ways as her male colleagues' similarly derived data. This mentor publically criticized her research and excluded her from the camaraderie he shared with the rest of his all male research team. She called it an "emotionally draining" experience that made her doubt her abilities and career choice.

Personal satisfaction and altruistic thinking emerged as important themes in women's career paths. In the oral histories, participants talk about how they became interested in STEM faculty careers. One participant knew she wanted to continue to graduate school but was unsure about pursuing a high school teaching career or a STEM career. The participant explained, "I wanted to do something where I felt that I could make a bigger impact, you know, help people, so high school teaching [...] seemed like a good place for that." After being accepted into a graduate program for high school teaching, she delayed admission and explained she felt she did not have enough information about high school teaching careers and was not sure it would be a good career fit for her. This participant took a few years to choose a career that would offer the most personal satisfaction, utilize her best skills, and positively affect other people. She explained, "It wasn't just about a good job. It was about applying my skills."

Encouragement to pursue STEM careers early in life was also an important theme in the course of women's career paths to STEM faculty. For some women, encouragement came primarily from influences at home and school. Participants whose parents were in STEM careers received the most influence at home. For example, one participant's father was a scientist and taught her experiments at home when she was a child. Other participants were encouraged to pursue STEM career as early as eighth grade by teachers and fellow classmates. One participant first considered a physics career after the results of a high school aptitude test indicated a physics career was the best fit for her.

These early influences are examples of critical junctures in women's career paths. Critical junctures are decision-making points where a chosen path alters the career path direction. Understanding decision-making processes at critical junctures will enhance the recruitment and retention of women to STEM faculty careers. One participant exemplifies the importance of

understanding critical junctures. When finishing her graduate education, one woman described a mentor who suggested she consider non-academic career options. Doubting her abilities, she considered leaving graduate school to pursue a non-academic career. A different mentor reassured her in her abilities and swayed her to continue toward research and teaching at the university level.

During the oral histories, new metaphors and climate descriptions emerged as participants described the working atmosphere in their departments and their feelings of fit within it. One woman described her mostly male department as "a bunch of people who get along relatively well." She also noted that the people in her department have, "a sort of common camaraderie, sense of humor, and people seem pretty comfortable with each other. There's not a lot of arguing, and people are pretty diplomatic when they have issues." When talking about her fit within that atmosphere, she said, "I've never felt uncomfortable about speaking up…" Overall, she portrayed a supportive working atmosphere that is not representative of a chilly climate.

When talking about being a woman in a primarily male department, this participant explained that she felt more comfortable working in her mostly male department than in other departments she worked in with a higher female faculty representation. She explained, "I feel more comfortable with these guys, this group of men, than I probably would have as a faculty member in some of the other departments I've been at." Her comments address the relationship between gender and chilly climate and do not support the chilly climate theoretical model. Rather, this participant describes her mostly male department as a warm climate.

Later in the oral history, when this participant was asked to choose a metaphor to describe what working in their department feels like, she explained, "Well, to be honest even in such a good environment, I still feel like such a token representative." After casually laughing, she continued, "I'm kind of the outlier, but it's not uncomfortable." Despite the warm climate in her department, she feels she is not entirely included in the group.

This participant demonstrates the ways separate discussions in the oral history are pulled together to understand the combined effects of separate discussions. In one part of the interview, she described a warm climate in her department yet in another part of the interview she described feeling like an "outlier" and "token representative, " which support chilly climate. Taken together, we understand that although her department's climate is warm, she perceives herself within that warm climate as the token woman representing her department's efforts to include women. In this case, her perception of herself within the climate may be more important than the climate itself.

The paradox of this participant's feeling like a token representative at the same time she feeling comfortable in her department's climate is an important preliminary finding that may have implications for the chilly climate model and its representation of women's experiences as STEM faculty. This participant's self-perception takes on "chilly" characteristics while her department's climate takes on "warm" and inclusive climate characteristics. Self-perceptions uncovered by the oral history methodology add depth to our understanding of women's experiences as STEM faculty and shed light on the ways self-perceptions of fit may be different from, and even paradoxical, to a group's dynamics.

The oral history methodology was also conducive to discovering the ways race and/or ethnicity affects group dynamics and feelings of fit. One participant demonstrated this by discussing the effects of her racial and ethnic status in her department. She explains of her department's working atmosphere, "my ethnicity…probably makes me feel like I fit in more, just because there is a pretty white atmosphere (laugh)." She recognizes she benefits from increased feelings of fit from her majority white status. When asked if she felt she was treated different from others in her department because of her ethnicity, she at first said, "probably not." After pausing and reflecting, she realizes she is treated, "a little bit better" because of her white status. If she perceives she is treated better because she is white, then she likewise perceives non-white faculty are treated less favorably than white faculty in her department. The interactional and conversational nature of oral history interviews encouraged this participant to consider and reconsider the effects and benefits of being white her department.

Age was not a central focus of our study, but emerged through the oral histories as a factor influencing feelings of fit. Participants often mentioned age alongside gender as creating a double-negative affect for women STEM faculty. One participant demonstrated the confounding effects of age and gender when she explained that she is "the only woman under the age of about 60" and one of only a few women faculty in her department. Chilly climate focuses on the negative effects of unbalanced gender ratios but does not consider the effects of large gaps in age on feelings of fit.

A participant described how she felt outcast and demeaned by the ways "some of the older-school males" talked down to her. They talked about highly technical concepts to her in elementary ways even though those technical concepts are basic in her line of research. She also noted that other older male faculty act "fatherly" toward her and other younger male faculty indicating the effect of faculty age across genders.

The oral histories also uncovered positive discrimination of young women faculty in STEM departments. This participant suspects her department head makes extra efforts to accommodate her needs compared to the requests of other young male faculty. She explains, "I also can't tell if I'm getting some benefits to the way I get treated on the faculty level because I am a young woman. I know my department head listens to me, and I don't know if that's because he is trying to make sure he always listens to me, or because he always listens to everyone." Several young male faculty members of her department have told her that they are surprised at aspects of her research the department head agreed, and that they have not received similar support from the department head. She explained, "I don't feel like I'm being any more persuasive than they probably were in their arguments, but he just might be doing a really good job of paying attention to what I'm asking. I don't know."

Implications

These preliminary findings support the effectiveness of oral history and participatory methods in examining the ways chilly climate and leaky pipeline models fit or do not fit women's career pathways into STEM faculty careers. Although some women described chilly climates, self-perceptions of fit within the climate may be influential to women's retention in STEM faculty positions.

New metaphors may lead to new theoretical models of women's pathways to STEM faculty careers. Investigating the ways doors are opened by others and ways others facilitate or obstruct women in their career paths may inform educational and university policies that affect the recruitment, hiring, and retention of women in STEM faculty careers. Theoretical advancements may be made by examining the metaphors women use to discuss their career paths. Understanding women's decision-making processes at critical junctures in their career paths will likewise inform theory and policy aimed at increasing women's representation among STEM faculty.

Methodological advances may be made by establishing the groundwork for utilizing oral histories in conjunction with participatory research methods. This study uniquely fuses these methods allowing themes to emerge while seeking participants' views on particular themes. Further, patterns among career path timelines may shed new light on women's decision-making at critical junctures along their paths to STEM faculty. Insight gained by this study will inform educational processes to retain and encourage women into STEM faculty careers. Finally, this study may influence policy and climate changes to recruit, hire, and retain women in STEM faculty positions.

Limitations

This study reports preliminary data from a small number of case studies completed at the time of this writing. Results are not generalizable to the larger population of women STEM faculty. Data may not be disaggregated by race or ethnicity to protect participants' privacy.

Oral history methods rely on participants' retrospective accounts, which may not be factually accurate although this study is concerned with participants' perceptions rather than factual accounts[4].

Conclusion

We have illustrated how oral history and participatory methods may be used to shed light on women's career paths into STEM faculty, identify ways women's career experiences compare to chilly climate and leaky pipeline models, discover new metaphors, identify critical junctures along women's paths to STEM faculty careers, and discover new information about women's path into STEM faculty careers.

These innovative research methods may lead to new ways of thinking about the underrepresentation of women among STEM faculty by developing groundwork needed make theoretical advances. New metaphors will highlight the lived experiences of women STEM faculty. Women's career paths may be theorized about beyond chilly climate and leaky pipeline theoretical models, thereby contributing to the overall state of knowledge of women's persisting underrepresentation among STEM faculty.

Using oral histories in conjunction with participatory research methods will create advances in research methodology and in theoretical modeling in engineering education research. New theoretical models developed with these methodologies will inform recruiting, hiring, and retaining practices aimed at increasing women's representation among STEM faculty.

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