Using a Social Ecological Model Framework for Advancing the Careers of Women in Science in Academic Medical Centers

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Abstract

Social Ecological Models (SEMs) offer a multilevel framework highlighting the dynamic, interdependent relationships between individuals, behaviors, and their social context. While this approach has been developed within the fields of public health and community psychology, in this paper we explore the applications of the SEM framework to gender equity initiatives. This case study is based on our experiences with the NSF-funded Center for ARROWS (Advancement, Recruitment, and Retention of Women in Science) at the Medical University of South Carolina (MUSC). ARROWS was designed to cast a broad net of change to support faculty gender equity and increase the number of women in leadership positions. In addition to utilizing a SEM framework to design ARROWS, a SEM Mapping Exercise was conducted as part of the evaluation, which revealed indirect impacts and some unanticipated gaps. The multilevel framework offered by SEM guides practitioners and evaluators to create institutional transformation. This case study is meant to serve as an example of the application of the SEM framework to a project designed to advance gender equity within one institution.

Keywords: Social Ecological Model, Gender Equity, Institutional Transformation, Systemic Change

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Despite the increasing number of women within academic medicine, women continue to be underrepresented in positions of leadership. In 2019, according to the Association of American Medical Colleges (AAMC), women made up 48% of Assistant Professors in U.S. medical schools, but only 36% of Associate Professors and 26% of Full Professors (AAMC, 2019). The underrepresentation of women faculty within academic medicine is even more stark when looking specifically at women belonging to underrepresented minority (URM) groups. Women faculty belonging to URM groups (i.e., American Indian, Alaskan Native, Black, Hispanic, Native Hawaiian, Pacific Islander, and Multiple Races) made up only 7% of Assistant Professors, 5% of Associate Professors, and 2% of Full Professors in U.S. medical schools in 2019 (AAMC, 2019).

Broadening representation among leadership within academic medicine is not only the right thing to do, it is the intelligent thing to do. Research has demonstrated that diversity within organizations leads to superior productivity and innovation, improved problem-solving, and a broader impact of research findings, relative to homogenous organizations (Fan, 2011; Freeman & Huang, 2014; Page, 2008). Further, when institutions lose women faculty to other institutions, they are also losing the time and money they have invested in these individuals' careers.

Reasons for the persistent underrepresentation of women faculty within academic medicine are complex. Prior research has identified a host of barriers including a lack of role models and mentors (Bickel et al., 2002; Vasil, 1996), lack of self-efficacy (Stout, Staiger, & Jennings, 2007), work/life balance (Ash, Carr, Goldstein, & Friedman, 2004; Carr et al., 1998; López, Margherio, Abraham-Hilaire, & Feghali-Bostwick, 2018), gender schemas (Valian,

2004), institutional bias (National Academies of Sciences, 2007), and stereotype threat (Burgess, Joseph, Van Ryn, & Carnes, 2012). Given that these factors occur at various contextual levels, including individual, departmental, institutional, and national, interventions to increase women faculty's representation would do well to utilize a social ecological model (SEM) framework. In this case study, we describe how a SEM framework was used in both the design and evaluation of a project designed to advance gender equity within one institution. This case study is intended to serve as a useful example for both practitioners and evaluators interested in applying SEM frameworks to institutional transformation projects.

Social Ecological Model Framework

Social ecological models offer a multilevel intervention framework highlighting the interdependence of individuals, their behaviors, and their social context. Recognizing the dynamic relationship between individuals and their environments, the SEM framework grew out of Psychology and Public Health fields working to address the needs of individuals within their various settings (Bronfenbrenner, 1979; Stokols, 1996; Visser, 2007). SEMs have been utilized to address a variety of health-related concerns, which include tobacco use (Corbett, 2001; Sorensen, Barbeau, Hunt, & Emmons, 2004), obesity (Li & Rukavina, 2012), HIV infection (Baral, Logie, Grosso, Wirtz, & Beyrer, 2013; Larios, et al., 2009), and intimate partner violence (Oetzel & Duran, 2004).

While many researchers have considered influences of human behavior from only a dichotomy of perspectives, either micro (e.g., individual behavior) or macro (e.g., structural influences), the SEM framework focuses on the person, the environment, and the continuous interaction of the two. A SEM contains nested levels of influence: intrapersonal/microsystem

(e.g., attitudes, knowledge, and behavior); interpersonal/mesosystem (social networks, social support); organizational/exosystem (policies, structures); and national/macrosystem (laws, social norms) (Baral, Logie, Grosso, Wirtz, & Beyrer, 2013; Bronfenbrenner, 1979). The SEM framework compels researchers, practitioners, and evaluators to think of interventions as situated within complex systems and to incorporate aspects of systems thinking, such as feedback loops and reverberating effects (Golden, McLeroy, Green, Earp, & Lieberman, 2015) and to investigate how contextual factors may moderate intervention efforts aimed at the individual-level (Farrell, Henry, & Bettencourt, 2013). While the SEM framework accurately captures the complexity of systems thinking, it can be difficult to understand the relationships among the different levels and to analyze the web of causation (Gregson et.al., 2001; Wold & Mittelmark, 2018). Research and evaluation through a SEM framework require measures that are appropriate at multiple levels (Farrell, Henry, & Bettencourt, 2013).

In this case study, we present an intervention designed to support women faculty within an academic medical center through a SEM framework. While efforts to improve gender equity within academic medicine have been increasing, interventions and research that take a multilevel approach are still lacking (Carr, Gunn, Raj, Kaplan, & Freund, 2017; Edmunds et.al., 2016). In a nationwide study of 23 academic medical schools, it was found that the most common strategies to support women faculty targeted the individual and interpersonal levels simultaneously *or* the institutional (i.e., organizational) level (Carr, Gunn, Raj, Kaplan, & Freund, 2017). Interventions targeting the national level were much less common, and eight of the 23 institutions had no programs to support gender equity among faculty (Carr, Gunn, Raj, Kaplan, & Freund, 2017). In a systemic review focusing on women's career choices within academic medicine, Edmunds et. al. (2016) found that prior research on gender equity within academic medicine has been focused

on the individual-level, and identified research on the organizational, professional, and societal structures to be a significant gap within the literature. Thus, this case study serves as an example of a gender equity intervention that was both designed and evaluated using a SEM framework to address multiple levels of change.

The Center for ARROWS

Through a National Science Foundation-funded ADVANCE PAID (Partnerships for Adaptation, Implementation, and Dissemination) grant, the College of Medicine at the Medical University of South Carolina (MUSC) developed the Center for ARROWS (Advancement, Recruitment, and Retention of Women in Science). The primary goals of the Center are to (1) increase the number of women scientists recruited into the College of Medicine by changing the applicant pool and hiring practices; and (2) improve the retention and advancement of women scientists in the College of Medicine by achieving critical mass, changing promotion practices, and providing key supports.

To meet the first goal of improving the recruitment of women faculty, the Center for ARROWS designed and implemented the following activities (and associated outcomes):

- A. Change the applicant pool by reformatting job postings to attract women, and women belonging to URM groups in particular;
- B. Change the applicant pool by targeted publicizing of openings, including via professional societies for URM women scientists;
- C. Change the applicant pool by increasing the external visibility and awareness of MUSC women scientists' accomplishments;
- D. Change the applicant pool by requiring justification of the applicant pool if minimal diversity criterion related to gender and race/ethnicity has not been met;

- E. Include faculty delegates on search committees to ensure the reduction of implicit bias;
- F. Provide implicit bias training for all search committee members and chairs; and
- G. Establish annual reporting of gender equity data in hiring scientist faculty, including numbers, salary, and start-up packages.

To meet the second goal of improving the retention and advancement of women faculty, the Center for ARROWS designed and implemented the following activities (and associated outcomes):

- H. Achieve critical mass by increasing the ratio of women to men hires;
- I. Achieve critical mass by increasing the internal visibility and awareness of MUSC women scientists' accomplishments;
- J. Require annual reporting of gender equity data in retention and advancement of scientist faculty including numbers, salary, and leadership;
- K. Include faculty delegates on promotion and tenure committees to ensure the reduction of implicit bias;
- L. Provide implicit bias training for all promotion and tenure committee members;
- M. Ensure at least one woman scientist is regularly selected for an academic medicine leadership development program;
- N. Salary equity modeling; and
- O. –S. Provide key supports to women faculty via: grant writing training, external grant review, mentoring opportunities, teleconferencing kits, and promotion of awareness of bridge funding.

These activities and expected outcomes were based on prior research and theory, with each of the strategies used in other environments and adapted to the medical school arena.

From the beginning, the Center for ARROWS has been guided by a SEM intervention framework and an intersectional approach. In applying this framework to a college of medicine, the Center for ARROWS recognizes the mutual influences between individual scientists, department/division, institution, and national network of medical schools (see Figure 1). The host of activities (listed above) deployed through the Center for ARROWS have targeted each of these levels, with some strategies targeting multiple levels at once. By providing interventions at multiple levels, the Center for ARROWS was designed to cast a broad net of change, with the continuous interaction of the multiple levels leading to systemic change in order to support faculty diversity and increase the number of women in leadership positions.

Figure 1. Social Ecological Model Framework for Advancing Gender Equity in Academic Medical Centers

The programmatic offerings that targeted the individual level included the following: implicit bias trainings for search committees, department chairs, and promotion and tenure committees; improved external visibility of women scientists at MUSC; a guarantee that at least one woman scientist is regularly selected for an academic medicine leadership development

program; and the provision of key supports for women faculty such as grant writing training, external grant review, mentoring opportunities, teleconferencing kits, and promotion of awareness of bridge funding. Programmatic offerings designed to create change at the department/division level included requiring justification of applicant pools in regard to gender and race/ethnicity; annual reporting of gender equity data; and salary equity modeling. Programmatic offerings implemented to create change at the institutional level involved changing college-level policies to require use of the reformatted job posting language to attract women, and URM women in particular, and targeted publication of job openings, including via professional societies for URM women scientists. Finally, the Center for ARROWS was designed to create change at the national network of medical schools by serving as a model of institutional transformation for gender equity and as the first academic medical center to receive NSF ADVANCE funding.

Social Ecological Model Mapping as an Evaluation Tool

In the third year of the grant, the external evaluators worked with the Center for ARROWS' leadership to conduct a SEM Mapping Exercise to gain insight on how the programmatic offerings were impacting each level of the SEM framework and to identify areas in which adjustments to programmatic activities needed to be made to increase the impact on gender equity. Figure 2 shows the SEM Mapping Exercise Tool as developed by the external evaluators. In the SEM Mapping Exercise, the Center for ARROWS' leadership team sorted each of their activities into the SEM level that best aligned with the expected outcomes of that respective intervention (i.e., the level that the intervention was designed to directly impact). At the time of the SEM Mapping Exercise, the Center for ARROWS had implemented, or was in

the process of implementing, eleven activities: reformatting job posting language; increasing visibility of women's accomplishments to change the applicant pool and to achieve the perception of critical mass; justification of application pools; implicit bias trainings; having department chairs provide annual reports to the dean on gender equity hiring; career development workshops and roundtables; external grant reviews; grant writing training; selecting women faculty to attend leadership programs; formation of a SACNAS chapter; and salary equity modeling. The Center for ARROWS' leadership team then identified how each of these activities might also create indirect impacts at additional levels via expected outcomes. The external evaluators facilitated discussions with the leadership team around expected outcomes and assisted in completing this table.

SEM Mapping Exercise

Individual Level

Activity	Expected Outcomes	
	Direct impacts at this level:	Indirect impacts at other levels:

Department/Division Level

Activity	Expected Outcomes	
	Direct impacts at this level:	Indirect impacts at other levels:

Institutional Level

Activity	Expected Outcomes	
	Direct impacts at this level:	Indirect impacts at other levels:

National Level

Activity	Expected Outcomes	
	Direct impacts at this level:	Indirect impacts at other levels:

Figure 2. SEM Mapping Exercise Tool

Figure 3 presents a sample of how two of the activities, Implicit Bias Training and the Formation of a Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) Chapter, were placed within this evaluation tool. The Center for ARROWS implemented each of these activities with the direct impacts in mind; it was only after implementation that the indirect impacts were evaluated via this SEM Mapping Exercise. For example, the Implicit Bias Trainings were designed to have direct impacts on the individuals serving on search committees and promotion and tenure committees; through the SEM Mapping Exercise, indirect impacts at the Department level were also identified, as shown in Figure 3.

Individual Level

Activity	Expected Outcomes	
	Direct impacts at this level:	Indirect impacts at this level:
Implicit Bias Training	This intervention is designed to educate and raise awareness at the individual level so that search committees and tenure and promotion committees will be more conscious of implicit bias and take action to counter it when making personnel decisions.	This intervention has indirect impacts at the Department level through changing the demographics of the department via hiring, promotion, and tenure, as well as potentially impacting interpersonal interactions within the department.

Institutional Level

Activity	Expected Outcomes	
	Direct impacts at this level:	Indirect impacts at this level:
Formation of a SACNAS Chapter	This is an institution-wide chapter that is designed to create a community that meets regularly with each other as well as with institutional leadership. The SACNAS chapter is also part of events open to the entire institution, such as regular coffee hours.	<p>This intervention has indirect impacts at the Individual level by improving individuals' sense of belonging, facilitating sharing information about resources, and providing social and emotional support.</p> <p>This intervention has indirect impacts at the National level via the connection to the national SACNAS organization.</p>

Figure 3. Sample of Two Activities in the SEM Mapping Exercise

Once all of eleven of the activities (listed above) were placed in the SEM Mapping Exercise, the external evaluators created a tool to assess the extent to which each level of the SEM framework was being impacted. As shown in Table 1, the results of this exercise revealed that while the majority of the Center for ARROWS activities have a direct impact at the Individual level, they also have indirect impacts at both the Department and Institutional levels. Without a SEM-approach, these indirect impacts may have been overlooked by both the leadership team and the evaluators. Further, this exercise brought to light that the national impact

was limited to indirect impacts. Plans to increase impact at the National level were then made through activities such as collaborative research and increased dissemination efforts.

Table 1. Categorization of ARROWS Activities by SEM level and Type of Impact

Level	Direct Impact	Indirect Impact
Individual	Career Workshops & Roundtables External Grant Reviews Grant Writing Training Implicit Bias Training Publicity for women scientists Leadership Programs	Job posting language Chair reports to Dean on gender equity data SACNAS Chapter
Department/ Division	Applicant Pool Justification Chair reports to Dean on gender equity data Salary equity modeling	Career Workshops & Roundtables External Grant Reviews Grant Writing Training Implicit Bias Training Job posting language Leadership Programs
Institutional	Job posting language SACNAS Chapter	Applicant Pool Justification Career Workshops & Roundtables External Grant Reviews Grant Writing Training Publicity for women scientists Leadership Programs
National		Applicant Pool Justification Leadership Programs SACNAS Chapter

Evaluation data was then collected to assess the extent to which each of these activities was actually having direct and indirect impacts at these different levels. As part of an external evaluation site visit in May 2017, the first and second authors conducted six 60-minute focus group discussions with constituents involved in the Center for ARROWS programming, with groups ranging in size from four to eight participants. Each focus group was organized around one of the Center for ARROWS activities: Career Development Program participants, External Grant Review participants, Grant Workshop participants, members of the SACNAS chapter, Implicit Bias Best Practice Scholars, and the Women Scholars Initiative Steering Committee. Each focus group protocol was designed to gather information specific to each of the six activities. The first and second authors also conducted 30-minute interviews with eight MUSC and College of Medicine administrators. In addition to questions about the specific activities implemented by the Center for ARROWS, semi-structured interviews asked such questions as “How would you characterize the climate for diversity at MUSC?” and “How does MUSC ensure a diverse faculty?”. Using data from both the focus groups and interviews, we highlight here the utility of the SEM framework with two of the grant activities that showed multi-level impacts: the Implicit Bias Trainings and the formation of a local chapter of SACNAS.

The Implicit Bias Trainings are one of the interventions designed to create impacts directly at the individual level. These trainings were provided by four senior faculty to search committees, promotion and tenure committees, and faculty meetings, with the intended direct impact of changing the behavior of individuals serving on these committees both to be more aware of their own biases and also to take actions to counteract these biases. In both the interviews and focus group discussions, the Implicit Bias Trainings were widely perceived as

effective. One administrator explained, “I think it's much more on folks' consciousness than it was four or five years ago and a lot of that is due to the work of ARROWS.” In addition, focus group participants described reflecting on their implicit bias while serving on committees as a result of the Implicit Bias Trainings. However, some administrators noted that the Implicit Bias Trainings, on their own, would not be enough to improve faculty diversity. One administrator stated:

This is one of those things that needs to be a multi-pronged approach. I think that helps, and then if the Dean, or whoever it is that's calling the search, says, ‘I want to make sure there's a woman, or an African American, or whatever, in the list that you give me,’ that helps too. So yeah, I think we need to use multiple leverage points, but I think a little education is not a bad thing.

This same administrator went on to explain that MUSC would need a more diverse array of individuals in positions of leadership to truly improve the overall climate for diversity, equity, and inclusion.

Through the evaluator-guided SEM Mapping Exercise, the Implicit Bias Trainings were also identified as creating an indirect impact at the departmental level through changes in departmental culture, hiring, and the promotion process. The administrators that were interviewed agreed with these indirect impacts; as one administrator explained, “I think that that's really got people jazzed up and talking about the concept, which before wasn't really talked about as a concept.” In addition, the administrators linked the Implicit Bias Trainings to the adaptation of diversity and inclusion as one of the goals of the institutional strategic plan—i.e., a program aimed at changing individual behavior has also led to changes at the departmental and

institutional levels. Thus, the evaluation uncovered that the Implicit Bias Trainings were also having an indirect impact at the Institutional level.

The formation of a local chapter, and the first professional chapter, of the Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) occurred via sponsorship through ARROWS. This activity was designed to build community for URM women scholars across the entire institution; thus, the new SACNAS chapter directly impacts the Institutional level by creating networks of scholars. One of the focus groups conducted by the external evaluators consisted of members of this SACNAS chapter. These participants discussed the community built through SACNAS as facilitating connections across the institution. As one participant explained:

I think that it's made it more of a community at MUSC in general. I now know this familiar face, that may be in this other area of campus or this other department that I never would have known, and I feel like that brings about the sense of community. So, because I know that familiar face, then I might feel comfortable going to an event there, or seeking out mentorship there, or something like that, so it's almost like through the small networking, it's broadened through spokes, and made it so that it seems more of a community.

These participants also spoke about the network-building goals of SACNAS as reaching out to other STEM folks in the tri-county area as a community multidisciplinary-based entity where they could network with other marginalized individuals in their neighborhoods and communities. SACNAS activities have strengthened connections between MUSC, the College of Charleston, and Boeing, as participants described utilizing their social connections to establish professional connections with their peers and build a cohesive multidisciplinary network.

The SEM Mapping Exercise identified SACNAS as creating secondary impacts at the Individual level through increasing participants' sense of belonging and access to resources. Indeed, focus group participants emphasized that through SACNAS they experienced the creation of spaces in which they are able to have conversations about social identity and cultural backgrounds, which reduced their sense of isolation and led to an increased sense of social support. One participant explained, "it's very nice to have... that safe space, to go in, to see people who look like you, or even people who don't look like you, but who have had similar experiences throughout life." Another participant described the social support received through the SACNAS chapter, noting that "it is a breath of fresh air to know that the microaggressions are not just happening to me, they're happening to other people." Thus, while the participants identified ongoing challenges to equity and inclusion within higher education, they also saw the SACNAS community as providing needed support and validation. Participants also shared that through this Institutional level intervention, their increased sense of community led to changes in individual-level behaviors, such as seeking mentorship.

Conclusion

This case study serves as an example of an application of the SEM framework to an institutional transformation project. While the SEM framework has been widely applied to health-related interventions, this case study explores the potential of this approach for a multilevel project designed to improve intersectional gender equity within an academic medical center. It is important for equity-focused transformation projects to apply systems thinking approaches, such as the SEM framework, in order to think holistically about change. This type of approach must not stop at simply applying interventions to multiple levels of a system, it must

also take into account indirect impacts, unintended consequences, and interactions between factors at different levels.

In a review of interventions addressing intimate partner violence, Oetzel and Duran (2004) find that the impact of any one intervention is relatively small to moderate, as singular interventions address factors at only one level. In one of the administrator interviews (quoted above), the participant noted that while the Implicit Bias Trainings were having an impact, they would not be enough on their own to create institutional transformation for equity and that a “multi-pronged approach” was needed. Further, in the focus group with SACNAS members, participants described the value of the SACNAS community while also noting intersectional challenges to equity and inclusion around gender and race/ethnicity. In noting the limitations of any one activity, both the interview and focus group participants were calling for a multilevel approach like that offered by the SEM framework.

As shown in this case study, the SEM framework has been useful for both intervention design and evaluation and is a worthwhile exercise to undergo even at later stages of a project. While the SEM framework was used to design the intervention, originally only the direct impacts of the expected outcomes were considered. That is, activities were designed to create direct impact at each level (individual, department/division, institutional, and national) of the model, but there was no articulation given at the outset in regard to indirect effects. The SEM Mapping Exercise, conducted in the third year of the grant-funded project and led by the external evaluation team, allowed the Center for ARROWS’ leadership to comprehensive assess their multi-level intervention. The SEM Mapping Exercise could be done in early planning stages of an intervention, so that indirect impacts are taken into account within the design of the intervention. However, as projects progress, plans change and unintended impacts arise, it would

still be useful for practitioners and evaluators to employ the SEM Mapping Exercise at the midpoint of projects as shown here.

While the SEM framework presupposes that effects interact across different levels, in both the SEM Mapping Exercise and the overall evaluation we found it difficult to assess interaction effects (e.g., how factors at one level might be moderating the impact of efforts at another level). Thus, while this case study provides one example of the application of an SEM framework to an institutional transformation project, more work is needed to explore how to best capture relationships among the various levels of the model.

Similarly, many interventions designed to increase the recruitment, retention, and advancement of women faculty have been aimed at a singular level which limits their impact. In order to increase the representation of women faculty in leadership within academic medicine, as well as throughout higher education, it is necessary for more interventions to utilize SEM-based frameworks and to assess the impact of their interventions at the individual, departmental, institutional, and national levels. SEM-based interventions can have a profound impact on transforming higher education to be more equitable through a multi-level and intersectional approach.

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