Unintended Positive Consequences of an NSF-funded System-wide Collaboration

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Abstract

Four campuses from the California State University (CSU) system received an NSF ADVANCE Partnership grant to increase the participation and advancement of historically underrepresented women in engineering and foster gender equity, focusing on identifying and eliminating organizational barriers. The grant encompasses four components: i) development of a faculty success dashboard, ii) research alliance, iii) mentoring, and iv) engagement with the NSF Eddie Bernice Johnson INCLUDES Aspire Alliance. These initiatives have led to increased inter-university connections and collaborations, particularly through periodic speed mentoring sessions that provide a platform for discussing topics such as academic leadership, navigating tenure, proposal writing, overcoming biases and microaggressions, and balancing career and family. The collaborative effort has led to deep explorations of equity and transparency concerns facilitated by the shared institutional context and governance. The paper aims to provide a comprehensive account of these activities and the positive outcomes facilitated by these connections, presenting data from an external evaluator from the perspective of mentors.

Introduction

Although more than half of all PhDs are obtained by women, representing a large pool in academia, this women's talent pool has yet to transform into a sustained representation in engineering faculty and leadership positions in academia. Research shows [1], [2] that women and URM faculty encounter various obstacles that set them back from promotion at all stages of their careers and/or remove them from academia. In these regards, the cross-disciplinary collaborations and strong diverse network connections offer a powerful pathway for individuals from traditionally under-represented groups to make their voices heard, contribute to knowledge creation, and drive positive change in the world [3], [4]. By recognizing the unique value these collaborations and connections bring, we can achieve gender equity and foster more inclusive and equitable academic and research environments that benefit academia and society. This paper aims to provide a comprehensive account of such fostering activities implemented in the engineering faculty advancement project, which was funded by an NSF ADVANCE Partnership grant to four CSU campuses, and how the participating institutions have fostered connections. Periodic speed mentoring sessions, held three times a year, bring faculty members together virtually for two-hour discussions on topics such as academic leadership, navigating tenure, building research networks, proposal writing, dealing with biases and microaggressions, and balancing career and family. Additionally, it will present data from an external evaluator from the perspective of mentors, shedding light on the positive outcomes facilitated by these connections.

Value of cross-disciplinary collaborations for under-represented minority (URM) member faculty. The cross-disciplinary collaborations offer immense value for members of traditionally under-represented groups, amplifying their voices, fostering innovation, contributing to knowledge creation, and driving positive change in their careers. By recognizing these unique values that cross-disciplinary collaborations can bring, we can cultivate more diverse, inclusive, and equitable academic and research environments that benefit everyone by building networks and communities, providing mentorship, finding allies and funding opportunities, and amplifying

underrepresented perspectives. Through such cross-disciplinary collaborations, URM faculty, specifically foreign-born/foreign-trained (FB/FT) female-identified faculty, can find support and guidance from colleagues in other disciplines who share their commitment to equity and justice and create new insights and solutions. This can create a valuable network of allies and mentors who can champion their work and provide career advancement opportunities.

Finding ways of interacting and working together across various disciplines, professions, ideologies, communities, and subject areas across the university curriculum have been studied in a variety of fields [5], bringing together a wide range of perspectives from scholars across various disciplines to examine the challenges and opportunities for diversifying STEM fields [6], [7]. In particular, Shivers-McNair et al. [8] implemented a community-driven framework for supporting technology innovation with marginalized communities and explored how a community-based mentorship can guide innovative technology design through intersectional technofeminist perspectives. It is increasingly noted that diverse and inclusive scientific teams can amplify innovation, productivity, and impact [3], [4]. Despite these increases, STEM women faculty are still underrepresented [1], [2], and they often advance slower than male faculty into senior leadership due to numerous barriers related to the workplace environment and support provided. Studies [2], [9] [10] have reported the slow progress of women and women of color faculty due to biased hiring and promotion processes. It is reported in NSF 2023 CEOSE Report [11] that intersectional identities in STEM are needed to broaden participation in STEM.

Building Networks: Difficulty of being included in networks. Being part of a strong network can provide women engineering faculty with various benefits, including a sense of belonging, mentorship and guidance, collaboration opportunities, and professional development, to name a few. However, building networks for women engineering faculty can be very challenging and may vary depending on the resources available and training obtained. Some of the difficulties they often face include feelings of isolation [12], uniformity and lack of diversity among senior faculty members [13], hidden barriers, navigating different cultures [14], discrimination, shortage of professional development opportunities, time constraints, scarcity of legal support and leadership training, and isolation of, specifically, FB or FT women [15], [16]. More women faculty than men faculty report difficulty in finding collaboration opportunities, mentorship, and guidance. The literature review of research on mentoring [13], [15] shows that persistent mentoring and supporting women faculty to build strong diverse connections can create a more inclusive and equitable environment and foster economic, societal, and cultural growth for academia. Horbach et al. [17] analyzed researchers' self-identification with diverse communities, i.e. within a department or center, organization, scholarly community, country, and affiliated professional societies, and showed that the identification with scholarly communities tended to be the strongest.

Foreign-born/Foreign-Trained (FB/FT) Faculty. Although a burgeoning literature, propelled partially by NSF programs such as ADVANCE (e.g., [18], [19], [20]) has focused on gender in STEM faculty, most studies do not consider the FB status of the faculty, while those that study trajectories of FB faculty do not focus on gendered experience; this results in FB women STEM faculty being overlooked and understudied. In this project, we have considered using the word "foreign" when talking about individuals who are living and working in the United States and may very well be US citizens. Although often used interchangeably with immigrant faculty or international faculty or even diaspora faculty, the preferred term, according to Akulli [21], now most commonly used in the literature is FB/FT faculty. We urge a rethinking of referring to

individuals in this group as foreign but will continue to use this reference throughout this paper. While data on international students are publicly available (e.g., [22], [23]), collecting data for faculty becomes very difficult because of privacy issues and rapid changes in residency status; most university employers only track the FB status of the faculty for visa purposes, without linking it to any internal assessments as they do with gender and URM status. A small number of researchers (e.g., [21], [24], [25], [26]) have studied the issues related to FB faculty in STEM.

While overall trends in recruiting and retaining more faculty identifying as women in STEM departments are promising, demographic markers such as URM status need to be carefully studied, especially FB status. NSB-NSF [23] documents that the number of foreign students with doctoral degrees in STEM has been consistently increasing for almost two decades, and hiring FB/FT women in academia has also increased simultaneously. Most of these foreign nationals are eventually naturalized and become citizens. While the immigration status of these faculty is transitional, their specific cultural and racial identity carries forward. Unfortunately, the classification of these individuals in URM/Non-URM status is complicated [25], as 1) the URM definition used by NSF is based on underrepresentation in STEM fields relative to the overall U.S. population, but FB faculty are drawn from the world population where the ethnic groups adversely affected by systemic inequities may or may not align with the U.S. definitions; 2) FB faculty of Black and Hispanic backgrounds are included in URM, which raises the number of URM faculty but does not reflect an improvement in the including of historically underrepresented African American and Hispanic populations in the U.S.; 3) FB faculty of White and Asian backgrounds are not included in URM because they are not underrepresented in STEM relative to their proportion in the U.S. (although white and Asian women are underrepresented in some STEM fields), but many are still minorities in the education system and thus experience cultural isolation. Also, their experiences with bias are obscured when combined with USB non-URM experiences; Asian is an overly broad category that as a whole is overrepresented in STEM fields, but considering it as an aggregate masks pockets of under-represented minorities (e.g., Hmong, Vietnamese); and White aggregates European, North African, and Middle Eastern, making it difficult to distinguish the biases individuals from these different regions face. Furthermore, the definitions of whether Asians, who form the largest pool of PhD awardees in some STEM areas (e.g., engineering), are considered a racial minority vary between the NSF and U.S. Census Bureau, creating major gaps in understanding the demographic data on faculty in the professoriate.

The CSU is the nation's largest and most diverse public university, with over 450,000 students enrolled from a wide range of backgrounds and more than 56,000 faculty and staff employed. The CSU provides opportunities for upward mobility to students and empowers them to become leaders in the changing workforce. The CSU system, which has 23 campuses across the state, serves each of California's regions from Humboldt to San Diego. The CSU campuses offer 4,100 degree programs that align with workforce demands and have conferred degrees on more than 4 million alumni. The CSU provides more than half of all undergraduate degrees earned by California's Latinx, African American, and Native American students combined. Twenty-one CSU campuses are currently recognized by the Department of Education as Hispanic-Serving Institutions (HSIs), colleges and universities with a Latinx student enrollment of at least 25 percent. The CSU academic programs are known for their strong focus on career preparation, with many programs offering hands-on experience and internships. The CSU system plays a vital role in the state's and nation's economy, producing a highly skilled workforce that is ready to meet employers' needs. The CSU system boasts a large and diverse faculty population, including many talented women

researchers, educators, and leaders with a wide range of expertise and diverse backgrounds representing a variety of academic backgrounds, nationalities, and cultural groups. The composition of women faculty in the CSU system varies by campus and discipline.

ADVANCE KIND project. The National Science Foundation's (NSF) ADVANCE program supports multi-year funding for projects addressing the issues of the under-representation of women faculty by discipline and across groups. The "ADVANCE: Kindling Inter-university Networks for Diverse (KIND) Engineering Faculty Advancement in the California State University System" grant is led by California State University, Fresno, in partnership with California State University, Los Angeles, California Polytechnic State University at San Luis Obispo, and San Jose State University. The ADVANCE KIND program uses a multi-pronged approach to address the issues related to equity for women. 1) The creation of hiring and faculty success dashboards is aimed at collecting institutional data on the demographics (gender, race, and FB/FT status) of faculty applicants and existing faculty and tracking their progress in the system. 2) The partner institutions will undergo the IChange Process.

Dashboard: The creation of dashboards to monitor equity in CSU engineering faculty hiring and career progression, primarily measured through retention, tenure, and promotion, is one of the primary goals of the ADVANCE KIND project. The proposed dashboards included a 1) Faculty Demographics Dashboard, 2) Faculty Hiring Dashboard, and 3) Faculty Retention and Advancement Dashboard. Before this grant, most campuses had dashboards that displayed engineering faculty demographics in terms of either gender or ethnicity. However, the tabulation of engineering faculty considering both gender and ethnicity did not exist, and manual tabulation of data was required in Faculty Affairs offices. Thus, the severity of the under-representation of women from backgrounds considered URM (i.e., Black, Hispanic, and Native American) was masked by the presence of URM men and White and Asian women. As a result of this grant, the Faculty Demographics dashboards at 3 of the partner campuses have been revised to allow for the display of intersectional gender and ethnicity tabulation of engineering faculty. The Faculty Hiring Dashboard has been developed at CSU, Fresno, and is fully functional for the 3 campuses. Generally speaking, this dashboard visualizes intersectional demographics of the pools for faculty searches and the demographics of first-round and second-round candidates, making comparison of demographic yield ratios possible. While the grant focused on engineering faculty, California State University, Fresno, built the dashboard to be fully functional for all disciplines on campus, thereby increasing the potential benefit of this dashboard. Adjustments to the dashboard are currently being made to incorporate data from the other CSU partner campuses into the dashboard. One such alteration is filtering data by Classification of Instructional Program (CIP) codes instead of department names, given that department names are not consistent across campuses. An unexpected impact of this project was that the Faculty Affairs offices across the CSU system were receptive to the idea of tracking data based on CIP code and worked together to have a data field added to the hiring software, PageUP, for tracking CIP codes of faculty job postings. This change makes future inter-campus analysis of hiring data by any discipline more feasible. The final dashboard for faculty retention and advancement is currently under development. A key feature of this dashboard will be the computing of tenure success, as the number of tenure track faculty who

receive tenure divided by the number of tenure track faculty who were *hired* instead of dividing by the number of tenure track faculty who *apply* for tenure. Current data tracking in the CSU system indicates tenure success ratios over 95%, but these do not consider faculty who leave the university before applying for tenure. The revised approach is analogous to the process used to evaluate student graduation rates and is a more appropriate measure of the ability of a university to foster faculty success. Table 1 below describes the activities under KIND project and their frequency.

Table-1. Four areas of grant activities, including frequency/number of events held annually and number of participating campuses each year.

Grant Activity	**Number of events annually**	**Description/University Participation**
Dashboard	Annually	a) Leadership teams (2-3 individuals per campus). 4 campuses have confirmed participation meetings are held 1-2 times annually
IChange	Monthly	a) Leadership teams (2-3 members) from 8 campuses meet monthly.
Speed Mentoring	3 times a year + 1 Faculty Success Seminar	a) Speed mentoring sessions in Fall, Spring, and Summer, with summer sessions especially for future faculty and current lecturers b) Faculty from 18 CSU campuses participated c) Faculty success seminar
Research alliance	4-5 events (per year)	a) Seed grants (annual) - 4 -5 teams (8-10 faculty) from 4-6 CSU campuses. b) Panel discussions / Information seminars on proposal development -2 times/yr- 12-13 campuses c) Grant writing workshops in collaboration with ASEE (annual) d) Research faculty directory (continuous) - 15 campuses

IChange: The four CSU partner campuses and four additional CSU campuses (California State University - San Bernardino, California State University - San Francisco, California State Polytechnic University, Humboldt and California State Polytechnic University, Pomona) are participating in the NSF Eddie Bernice Johnson INCLUDES Aspire Alliance's Institutional Change (IChange) Program (Grant No. 1834518, 1834522, 1834510, 1834513, 1834526, 1834521). In this program, each campus has conducted a self-assessment of its policies and practices related to hiring, onboarding, retention, and advancement. Using these self-assessments, they have also developed or are in the process of developing action plans to make changes to their campus policies and practices that are expected to improve the potential for increasing the

representation of women from URM backgrounds in their engineering professoriates and improving equity for women faculty from URM backgrounds and FB/FT women faculty.

Mentoring Events: From Spring 2022 to Spring 2024, the mentoring program has organized seven two-hour speed mentoring events, one each semester, providing mentoring workshops and networking opportunities for women and URM engineering faculty of the CSU system. These events are virtual to enable cross-institutional mentoring. Moreover, to incorporate networking, a small group setting is adopted for the mentoring sessions. The fall and spring events are open to all tenure track/tenured engineering faculty in the CSU system. The summer event is open to all CSU tenure track/tenured engineering faculty and also lecturers, Ph.D. students, and postdoctoral fellows who are interested in a career as an engineering faculty in the CSU system. Note that since the main focus of the grant that funds this mentoring program is on the retention, promotion, and advancement of the tenure track/tenured faculty in the CSU system, the lecturers and Ph.D. students/postdocs were only included in the summer event. This event was selected because it precedes the typical job application process for tenure track positions. High-ranking women faculty from the CSU system and other faculty who are familiar with and understand the obstacles faced by women and URM faculty are recruited as mentors. Mentees rotate to breakout rooms on topics of their choice, such as navigating tenure, attaining full professorship, academic leadership, proposal writing, building a research network, dealing with biases, engineering education, and work-life balance. Each mentee can choose 2 to 3 topics per event. For the summer sessions, besides the above topics, there are two more topics: 1) transitioning from a lecturer position to a tenure-track position (for lecturers) and 2) getting a tenure-track job in the CSU System (for lecturers, postdocs, and Ph.D. students). There are usually 3 to 7 people in each breakout room, providing an opportunity to make meaningful connections and broaden faculty networks. Note that there was no such cross-institutional mentoring program available in the CSU system before this initiative. These events were advertised by sending information about the events to deans of colleges containing engineering programs throughout the CSU system. At most campuses, the dean forwarded this advertising to their faculty. The KIND program followed up by directly emailing women faculty about the event. Because the summer event was also open to individuals outside the CSU system, additional advertising was performed using LinkedIn.

Research Alliance*:* A typical expectation for new tenure track faculty is to establish their independent research. In the CSU system, collaborative research is more prevalent as a productive strategy to address the research limitations typically found at PUIs, compared to R1 institutions. Oka et al., 2019 [27] indicated that 78% (37 out of 47 respondents) of engineering faculty valued collaboration with others, with female faculty and tenure-track faculty most frequently valuing collaboration with others. Yet, engineering faculty from CSU expressed low levels of satisfaction with existing resources for expanding their professional network. Women, particularly URM women, often have smaller and less diverse instrumental networks [28]. Smaller and less diverse networks have been shown to have adverse effects on publication impact and citation count [29] and limit faculty access to research resources [28]. Collaborative research opportunities and grant writing for successful career advancement have been recently identified as three major concerns for female engineering faculty at predominantly undergraduate teaching institutions [27]. Additionally, the COVID-19 pandemic has reduced faculty networking opportunities and disrupted faculty collaborations, with early research showing women being disproportionately disadvantaged [30]. The virtual Research Alliances address the disparity in the size and diversity of the networks of female engineering faculty by connecting all faculty across institutions to form

instrumental networks. Therefore, the goal of the Research Alliance Program is to promote collaborative, cross-campus, interdisciplinary research. It is aimed at providing research networking opportunities for women and URM faculty. The program includes several system-wide initiatives aimed at supporting faculty research and grant writing: a) Research seed grants to foster initial research collaborations, b) Panel discussions focusing on grant opportunities and the grant writing process to enhance successful funding, c) Grant writing workshops in partnership with ASEE Learning to provide professional grant training, and d) Development of a system-wide research directory to facilitate information sharing. Thus far, the research alliance seed grant has funded 7 teams consisting of 17 faculty. ASEE's grant writing workshops have been attended by 15 faculty members, and the research directory has approximately 70 faculty researchers and is constantly updated. Similarly, panel discussions are also well attended. In total, the research alliance program has engaged 15 out of 19 campuses that have engineering programs.

ADVANCE KIND Project Impact on CSU

During the period December 2022 through January 2024, the external evaluator interviewed groups associated with the pillars of the CSU proposal to obtain their assessment of project progress and impact. All people were interviewed individually for approximately 30 to 45 minutes by the external evaluator by phone or Zoom to assess the impact in these areas:

Dashboard: During June 2023, the four leaders of the dashboard teams were interviewed. Most were excited about the project and felt the dashboard had great potential, and were pleased that the hiring dashboard had been completed, although not yet used. Obtaining the data has proved challenging on some of the partner campuses; confidentiality and the unique ways each campus uses PageUp also present issues. The long-term impact will be significant if all campuses maintain and use the dashboard; obtaining buy-in from the Chancellor's Office to maintain will be the long-term challenge. Institutionalization through the Chancellor's Office will be critical. Although the leaders have a moderate understanding of the overall ADVANCE KIND Project goals, they emphasize the importance of having all campuses of the system involved via the Chancellor's Office for the long-term success of the dashboard.

Aspire IChange: While the Aspire IChange process focuses on improving diversity and equity in engineering, many of the proposed changes will be implemented campus-wide, improving faculty working conditions across all disciplines. Some of the changes individual campuses have proposed include interviewing applicants who turn down offers of employment, more targeted outreach, providing increased transparency, implementing mentoring programs, and improving orientation programs. Teams from each campus and facilitators from APLU meet monthly via Zoom and annually in person to discuss their progress and exchange ideas. Through these meetings, common needs arose, such as the need for improved outreach to develop more diverse applicant pools and improved mentoring. While the program intended for each campus to work in parallel to make improvements at their campuses, the discovery of these common needs led to the desire for collaborative actions. Most notably, at the 2023 National SWE conference career fair, multiple campuses shared the expense of a CSU booth and sent engineering faculty to staff the booth. The purpose of the booth was to educate attendees about system-wide faculty opportunities, including the CSU Doctoral Incentive Program. The IChange teams developed an action plan to continue this type of collaborative outreach with a specific focus on reaching underrepresented populations.

Mentoring: During December 2022 and January 2024, eight leaders of mentoring sessions were interviewed. The analysis of the interviews revealed that an average of six people attended each session on proposal writing, leadership, getting a job in this system, early tenure and promotion, and diversity, equity, and inclusion. All leaders were enthusiastic about their sessions, which they perceived as going well; most had follow-up with at least one attendee. All felt that they understood ADVANCE KIND goals but that the sessions were somewhat stand-alone events, as the focus was mentoring. All believed that the sessions were invaluable in fostering cross-system collaborations as the conversations in the sessions permitted faculty from different campuses to discuss issues and meet colleagues from other campuses. All would continue voluntarily to lead a session without grant money. They perceived that the greatest challenge to sustaining the mentoring after the grant ends would be for someone to organize the sessions and participants.

Research Alliance: During March 2023, the three leaders of the research project teams awarded funding under the Research Alliance seed grants were interviewed. Each of the three teams had a different focus for their projects: 1) cameras to detect fires in the wilderness; 2) developing and locating additive manufacturing hubs for health care and manufacturing; 3) cross-campus collaboration on training robots for the future workforce. The teams consisted of 2-4 professors and 2-4 graduate students and met at least weekly; they all seemed to be functioning well and producing results. On the whole, Research Alliance Teams and leaders seem less connected to overall ADVANCE KIND goals and projects. They suggested that perhaps it would be useful to assign a mentor from The KIND leadership team to each research team; this suggestion is being implemented in 2024.

External Advisory Board (EAB): During January 2023, 15 of the 16 members of the External Advisory Board were interviewed. The analysis of the interviews revealed that most understood the overall project goals. They indicated that they had the best understanding of dashboard and mentoring and the least understanding of the IChange/Aspire committees. They indicated that the strengths of the project are the devoted faculty at the four partner campuses, the support given by top administrators, the cross-campus aspects, and the mentoring component of the project. They found the challenges to include data access and reliability, support from the Chancellor's Office, sustainability, and institutionalization.

Specific Examples of connections

Although it is difficult to capture all the connections, a few are described below that illustrate the potential of this work.

- In a speed mentoring session on engineering education, the facilitator described a project-based learning effort to produce trail mix for the local food bank in an introduction to industrial engineering class. A participant was also in industrial engineering and the materials for this project were shared.
- During the in-person annual meeting with Ichange partners, the conversation related to recruitment was very active. In this space, the activities and efforts of each campus were shared. There was even talk of collaborating on campus recruitment to encourage a stronger pool and an awareness for applications about opportunities.
- Thus far, 241 unique participants have connected with various initiatives and activities of the KIND program, and 81 individuals (33.6%) have participated in two or more activities.

- Grant writing/proposal development has been one of the most popular topics at speed mentoring events, which provide additional networking and mentoring opportunities for the faculty participating in research alliance activities.
- During the speed mentoring sessions, mentees had the opportunity to learn about the CSU hiring culture and job expectations. These sessions were particularly beneficial during the summer sessions, where PhDs and Postdocs from other institutions attended the event. Notably, one individual who participated was subsequently hired by CSU LA.

Discussions and Conclusions

The paper discusses a comprehensive account of activities carried out at CSU under the NSF ADVANCE KIND project and how the participating institutions have fostered connections through various activities such as speed mentoring, research alliance, dashboard creation, and IChange initiative implementation activities. The project's broader goal is to increase the participation of women, specifically those who have historically been underrepresented in the field of engineering. Apart from intersectionality between gender and race, the project also aims to study the FB/FT female-identified faculty experience. Additionally, data from an external evaluator from the perspective of mentors is presented, shedding light on the positive outcomes facilitated by these interconnections.

It was observed that the participants entering the research alliance program were further involved in mentoring/networking activities. In addition, some of the External Advisory Board (EAB) members were involved in multiple activities such as mentoring and networking events, research collaboration initiatives, and the implementation of the Aspire IChange initiative. For example, providing opportunities and funding support for collaborative research grant writing initiatives were included as part of action plans in IChange, which enhanced activities. During the annual IChange meeting, recruitment was actively discussed, and the related activities and efforts of each campus were shared; collaboration on recruitment across campuses was proposed to encourage a stronger pool and an awareness for applicants about opportunities.

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