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RESEARCH

Networking Networks:

Leveraging STEM Professional Society "Boundary Spanners" to Advance Diversity, Equity, and Inclusion

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How can STEM professional societies leverage boundary spanners to promote inclusive faculty practices?

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Abstract

STEM professional societies serve a central role in defining and reinforcing national STEM professional cultures. Within these societies, there are key individuals focused on diversity, equity, and inclusion (DEI) who play a crucial part in connecting ideas, resources, and stakeholders within and between professional societies to influence and enact change. These "boundary spanners" engage in finding, translating, diffusing, gaining support, and social "weaving" behaviors to advance DEI in these societies. DEI boundary spanners who oversee the engagement of multiple societies (i.e., multi-society DEI boundary spanners) may be especially important and underutilized agents of change. The NSF INCLUDES Aspire Alliance postulates that synchronizing DEI training and the efforts of these boundary spanners could facilitate multi-society awareness and adoption of evidence-based DEI policies and practices within and between these societies. If successful, this would accelerate DEI culture-change in STEM professional societies, and ultimately result in more diverse, equitable, and inclusive national STEM professional cultures.

Keywords

STEM boundary spanners, multi-society boundary spanners, STEM professional societies, diversity, equity, inclusion, DEI

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Project Context and Challenges

The U.S. science, technology, engineering, and mathematics (STEM) professoriate has been, and continues to be, dominated by white men. The lack of diverse representation makes it more challenging for students from groups underrepresented (UR) in STEM to visualize, due to explicit and implicit bias, their belonging and success in STEM fields and the professoriate; and for STEM faculty in UR groups to actually achieve belonging and success in the academy. The NSF INCLUDES Aspire Alliance (Aspire, or the Alliance; NSF #1834518, 1834522, 1834510, 1834513, 1834526, 1834521) seeks to increase the learning, persistence, and completion of postsecondary UR STEM students, and thereby increase their contributions to the U.S. STEM enterprise, by focusing on current STEM faculty DEI professional development in the areas of teaching, advising, research mentoring, colleagueship, and leadership, as well as DEI faculty hiring, and retention practices. Evidence-based faculty DEI professional development, hiring, and retention practices can then be aligned and reinforced at institutional, regional, and national levels by identifying and supporting STEM professional societies' DEI boundary spanners.

Aspire leaders argue that:

- The lack of change in academic STEM culture is no longer due to a lack of examples of faculty DEI evidence-based practices and policies (e.g., practices including implicit bias training for decision-makers and inclusive teaching, research mentoring, advising, colleagueship and leadership professional development; policies on work-life integration such as opt-out tenure-clock stopping, modified duties, dual-career hiring), but rather varied and unsystematic awareness, knowledge, and adoption of these strategies (e.g., twenty years of NSF ADVANCE-funded work.)
- STEM professional societies (STEM ProSs) are well-positioned to support multi-level DEI change efforts because they serve diverse constituencies that cross-cut institutional, regional, and national levels (e.g., academic institutions and academic influencers such as accrediting agencies, national laboratories, corporations, and government representatives.)

STEM ProS DEI Boundary Spanners are...

Individuals such as the dean of an engineering college who serves as the chair of the Council on Diversity, Equity, and Inclusion in her engineering education professional society, and as a member of the Women in Mechanical Engineering subcommittee through her disciplinary society.

- STEM ProSs provide "excellent leverage with which to design and promote change" (NAP #11153, p. 137-8) because they influence the culture of STEM professions by helping set standards of professional excellence, recognizing disciplinary exemplars, providing professional development, publishing professional journals, and promoting public awareness of issues affecting or impacting the discipline, and

- Individuals known as **boundary spanners** are critical change leaders for effecting DEI awareness and action within STEM ProSs because they facilitate the transfer of knowledge and resources and help garner support for initiatives by spanning boundaries between different organizations and units within a common organization (Aldrich & Herker, 1977; Tushman & Scanlan, 1981). Boundary spanners hold multi-organizational memberships, fill structural holes between networks, and promote the application of social capital towards the advancement of individual and organizational goals (Burt, 1992). By the nature of their location within networks, boundary spanners ***find*** important information across their constituencies (Ancona & Caldwell, 1992; Tushman & Scanlan, 1981), ***translate*** what they find to fit their organizational context (Katz and Tushman, 1981), ***diffuse*** what they find to colleagues (Rogers, 2003), and ***garner support*** from key stakeholders on either side of the boundary they span (Brion et al., 2012; Faraj & Yan, 2009). In addition, boundary spanners can convene multiple organizations to ***weave*** interests and goals toward collective impact (Burt, 1992; Kania & Kramer, 2011).

These arguments collectively form the foundation for the proposed theory of change, namely that evidence-based faculty DEI professional development, hiring, and retention practices can be best aligned and reinforced at institutional, regional, and national levels by identifying and supporting STEM ProS DEI boundary spanners. Directing such information, professional development, and support to STEM ProS DEI boundary spanners can amplify awareness and application of DEI evidence-based strategies within and between STEM ProS, and can ultimately promote and accelerate national STEM culture change.

With over 24,000 American membership associations (2020, Gale), Aspire faced two challenges in implementing its theory of change. First, Aspire had to identify appropriate STEM ProSs to engage and become familiar with STEM ProS DEI efforts. From the preliminary review, it was clear that STEM ProSs range in composition diversity, as well as DEI focus, and there has been limited, but emerging, research on ProSs DEI efforts (e.g., Segarra et al., 2020a; 2020b). Second, Aspire needed to identify STEM ProS DEI boundary spanners, and understand how best to engage, sustain and amplify their DEI work. Below we discuss the Aspire Alliance approach and the ongoing process for addressing these challenges.

Project Team and Collaborative Infrastructure

Aspire has selected the **collective impact** framework (2011, Kania & Kramer) as its collaborative infrastructure to help coordinate the work of inclusive STEM culture-change. Aspire is composed of six primary teams: Institutional Change, Regional Change, National Change, Backbone, Research, and Evaluation. Each team engages with STEM ProSs in different ways—National Change, whose efforts are the focus of this paper, works with STEM ProS DEI boundary spanners.

Aspire's National Change (NC) team, working with the Backbone team, was charged with identifying and engaging STEM ProS boundary spanners to help align and reinforce inclusive professional development (PD) and hiring practices for STEM faculty.

NC and Backbone teams began the work by reviewing Aspire partners. Aspire has over 40 partners, which include two-year through doctorate-granting academic institutions, knowledge and professional development organizations, as well as STEM UR group-serving ProSs and disciplinary societies.

Initially NC team work with boundary spanners focused on contracted partners such as the President for Access and Success of the Association of Public and Land-grant Universities (APLU), the Founding Director of the ADVANCE Implementation Mentors (AIM) Network, and the Chief Academic Officer of the American Society for Engineering Education (ASEE).

Additional partnerships were fostered with the PI and Backbone Leader of the INCLUDES Inclusive Graduate Education Network (IGEN), the SEA Change Director of Operations of the American Association for the Advancement of Science (AAAS), the co-PI of the Alliance to Catalyze Change for Equity in STEM Success (ACCESS), and the ADVANCE Resource and Coordination (ARC) Network PI of the Women in Engineering ProActive Network (WEPAN).

Reflection Questions and Process

Aspire's NC team sought to answer the following four questions regarding creating shared vision and STEM ProS partnerships for collaborative action: (1) Which STEM ProSs should be engaged? (2) Who within STEM ProSs could serve as DEI boundary spanners? (3) How should DEI boundary spanners be engaged? And (4) What infrastructure and processes could be used to sustain and amplify STEM ProS boundary spanner involvement to affect long-term change?

To answer these questions, the NC team applied snowball sampling, starting with a convenience sample of existing STEM ProS Alliance partners and gradually incorporating engagement by partner-affiliated organizations. Additional strategies used to answer the questions included:

1. Conversing with the ASEE Executive Director and Chief Academic Officer to compare and contrast how engineering ProSs are similar and different from each other; similar and different from other science-, technology-, and mathematical-based ProSs; as well as identifying prominent engineering ProSs;

2. Conducting a preliminary review of STEM ProS websites for inclusive teaching and hiring practices, only to learn that DEI work can often be difficult to parse out of STEM ProS website reviews;

3. Networking at the annual Aspire Alliance meeting and other in-person partner conferences followed by an email inquiry to STEM ProS contacts to ascertain information about existing inclusive faculty teaching practices (virtually non-existent) and faculty recruitment strategies for UR groups (mostly inclusion of notices of vacancy on an electronic listserv or job board);

4. Convening recruitment experts and STEM ProS boundary spanners to determine promising, evidence-based, equitable STEM faculty recruitment practices and implementation strategies (see additional details below);

5. Developing and co-leading with STEM ProS boundary spanners a series of "pilot" faculty professional development (PD) offerings about inclusive online practices (inspired by the COVID-19 pandemic) (e.g., *ASEE's Teaching Equitably and Inclusively On-Line* workshop);

6. "Piloting" an inclusive STEM faculty PD Summer Institute and identifying an initial group of STEM ProS DEI boundary spanners, individuals specifically selected for their efforts to convene and "weave" together multiple ProSs DEI efforts, to inform how PD offerings could be transplanted to STEM ProS settings;

7. Piloting inclusive STEM faculty PD with ACCESS, a multi-society STEM ProS group composed of DEI boundary spanners, to obtain recommendations on how to shape inclusive STEM faculty PD content from the Pilot Summer Institute for STEM ProS contexts; and

8. Coordinating an INCLUDES Mechanical Engineering Conference workshop panel of STEM ProS Multi-Society DEI boundary spanners to discuss how to leverage STEM ProSs to advance evidence-based DEI practices.

In answering the first question, "Which STEM ProSs should be engaged?," the NC team discovered early in the process that not all STEM ProSs are alike. For example, engineering professional societies vary in disciplinary composition, DEI focus, and membership composition. Specifically, ASEE is the leading engineering association focused on engineering education, and as such has a predominantly academic membership of 12,000+ that cuts across all engineering professional disciplines (e.g., civil, electrical, mechanical, biomedical, environmental), and has a very diverse representation of women and men staff and members (see ASEE's Who We Are). On the other hand, the Institute for Electrical and Electronics Engineers (IEEE) is the "world's largest technical professional organization", has "419,000 members in over 160 countries, more than 50 percent of whom are from outside the United States. IEEE members are engineers, scientists, and allied professionals whose technical interests are rooted in electrical and computer sciences, engineering, and related disciplines" (see IEEE At-a-Glance).

Although globally diverse, electrical engineering has one of the lowest numbers of engineering undergraduate degrees earned by U.S. women, for example, than all other engineering disciplines except Computer Engineering (see 2019 ASEE's Engineering by the Numbers). Similar variation in membership composition and DEI practices can be found in other scientific, technical, and mathematical societies. Given the academic focus of Aspire, the NC team decided to focus alignment with leading STEM education-oriented ProSs.

In terms of the second question, "Who within STEM ProSs could serve as DEI boundary spanners?" the NC team learned there was not a single person but rather multiple people within a single ProS who engaged in DEI work to affect organizational culture change. For example, there was the "get you through the door" DEI boundary spanner—the person who understands the specific ProS system, and, importantly, the people within the society who address DEI issues. These people may be the Executive Director, an administrative staff member, and/or a ProS member. Finding the right person to help identify the key "get it done" DEI boundary spanner(s) is important.

The "get it done" DEI boundary spanners ranged in formal and informal organizational power. DEI boundary spanners might be elected members such as the President and Board Members, or staff such as Executive Director, Chief Academic Officer, Diversity Officer or Director of Membership or Career Development, or ProS members who volunteer as leaders of diversity councils, Minority Affairs Committees, ad hoc committees, and affinity groups. It became apparent to the NC team that to get a clear representation of DEI efforts within the ProS, it was important to engage two or more DEI boundary spanners within a STEM ProS.

Initially the NC team thought it ideal to engage an upper-level employee and a volunteer member of a critical DEI-focused group within the STEM ProS. The rationale was that prioritizing a high-level ProS employee engaged in DEI efforts would help address the question of DEI effort sustainability based on the assumption that employees would be more likely to engage in DEI work longer than a member volunteering to lead DEI efforts; however, this was not always the case.

STEM ProSs have members that are life-long and thus may engage in DEI work longer than those who are shorter-term employees of these organizations. The conclusion was that there is no prescriptive process to identify who to engage as STEM ProS DEI boundary spanners. Rather, identification of STEM ProS boundary spanners requires input from a long-term ProS staff person (ideally the Executive Director) or ProS member to identify the people from among the staff and members that have the greatest authority and capacity to advance ProS DEI change efforts.

A notable finding in the quest to identify key STEM ProS DEI boundary spanners was that the NC team learned of highly-connected individuals who led DEI efforts across multiple STEM ProSs. The NC team identified these boundary spanners as ***multi-society boundary spanners*** and deemed them particularly critical to efficient information transfer and DEI change. Multi-society boundary spanners connect ProSs DEI boundary spanners to one another through an "umbrella" meta-society network structure.

The fact that the NC team identified different types of boundary spanners is congruent with emerging boundary spanning literature (e.g., Hill, 2020). Just as different members are needed on a change team within an academic setting for effective institutional transformation (particularly as the change process evolves), so too different types of boundary spanners may be critical over time for efficient STEM DEI ProS and national change.

> ***Multi-society boundary spanners*** *may be particularly critical to efficient information transfer and DEI change.*

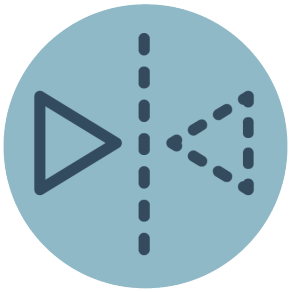
The NC team is currently working to answer the third and fourth questions as to how to engage identified boundary spanners and what infrastructure and processes are needed to sustain DEI efforts.

Initially the NC Team convened boundary spanners focused specifically on STEM ProS recruitment practices of faculty from UR groups within academic settings. Ultimately, the convening revealed a consensus among participants about the value of networking for information exchange, and the desire for more such opportunities. An additional conclusion was that there was a need to "map" the DEI STEM ProS terrain to better understand strengths and weaknesses. Finally, it was clear that a platform was needed to provide a centralized library of DEI evidence-based resources, as well as a forum providing ongoing support for STEM ProS boundary spanners engaged in promoting evidence-based DEI action.

A successful *NSF ADVANCE proposal to Amplify the Alliance to Catalyze Change for Equity in STEM Success (ACCESS+)* was funded to solicit, select, and bring together ProS DEI boundary spanners to help "map" the DEI-terrain, disseminate evidence-based DEI information, and provide a centralized platform to support a STEM ProS DEI boundary spanner community of practice (CoP). Mapping the STEM ProS DEI-terrain will be discussed below.

The ARC Network Mendeley platform will serve as the centralized support for the boundary spanner CoP. CoPs (Wegner, 1998) have long been deemed vital to educating, supporting, cultivating, encouraging, and integrating practices amongst members. Finally, the ACCESS+ project will build upon the NC team recognition of multi-society boundary spanners by having these individuals serve a foundational role in "seeding" the ACCESS+ STEM ProS DEI CoP. The ACCESS+ Project team is working synergistically with the Aspire Alliance to facilitate the accomplishment of common goals.

Constructive Criticism



In addition to a number of positive aspects of the process for engaging people around shared goals such as (1) the value of convening people for discussion, (2) the importance of networking to foster collaborative engagement, (3) the benefit of finding DEI boundary spanners, ideally multi-society boundary spanners, and (4) the merit of fostering a STEM ProS boundary spanner CoP, the NC team has faced five key challenges.

These key challenges include:

1. The unsystematic identification of DEI STEM ProS boundary spanners. Individuals, serving diverse STEM ProS DEI roles, were identified as boundary spanners as a function of convenience sampling through existing Aspire INCLUDES partnerships and expanded through subsequent snowball sampling. Until the NC team has a comprehensive list of STEM ProSs, it will be unclear how representative our sample is of STEM ProS boundary spanners.

2. The serendipitous identification of STEM ProS DEI multi-society boundary spanners. These key boundary spanners were primarily identified as a function of repeated contact in diverse contexts with Aspire leaders and/or NC team members, who have all been involved in multiple NSF-funded DEI projects, across multiple STEM ProSs, for many years.

3. Varied STEM ProS DEI boundary spanner awareness and knowledge. There is significant variation in the awareness, knowledge, and application of DEI evidence-based policies, procedures, and practices by STEM ProS DEI boundary spanners. Further, there are limited professional development opportunities for these change leaders to deepen their awareness, knowledge, and skills in these areas.

4. The discovery that mapping STEM ProS DEI policies and practices is time-consuming and difficult. Originally the team explored the American Society of Association Executives' (ASAE's) Association Inclusion Index as a possible means of efficiently mapping ProS DEI practices. Although useful in certain contexts, the NC team ultimately deemed it unsuitable for their STEM ProS DEI mapping purposes. Through the guidance of the principal consultant of the UK-based consulting firm Katalytik, the NC team identified a promising STEM ProS DEI Self-Assessment Tool: the *Diversity and Inclusion Progression Framework for Professional Bodies: A Framework for Planning and Assessing Progress*, developed and used by the Royal Academy of Engineering and the Science Council. As of January 2021, the original 8-item framework has been expanded to an 11-item framework. As discussed below, an objective of the newly NSF ADVANCE-funded ACCESS+ Initiative is to adapt and pilot this Progression Framework as a means of mapping U.S. STEM ProS DEI policies and practices.

5. Finally, there are limited opportunities to regularly convene NSF-funded DEI change leaders to learn from one another. This seems an obvious omission with costly consequences given the amount of funding NSF has expended to effect DEI change. Such convening opportunities for NSF DEI-funded project leaders would allow these leaders to learn from each other about common areas of interest, and to engage in deep action-oriented collaborations. The lack of inclusive DEI dissemination convenings makes it even more important to leverage the immense capacity of STEM ProSs for coordinated national change. An exemplar of the benefit of collective STEM ProS engagement is the Societies Consortium on Sexual Harassment in STEMM. This consortium of diverse STEM ProSs collectively tackled the issue of sexual harassment occurring at ProS conferences and identified common language, similar processes, and strong sanctions aimed at DEI change. It is a great example of the power of comprehensive, cross-cutting STEM ProS action aimed at changing STEM cultures.

Current Efforts

Aspire has sought to engage STEM ProS boundary spanners, especially multi-society boundary spanners, through more inclusive, continuous, collaborative, focused, and deep networking. Leibnitz, who is the first author of this paper and serves as PI for the recently funded NSF ADVANCE Partnership ACCESS+ Initiative [HRD #2017953], notes, "We are pleased to receive funding from the NSF to help advance the Aspire Alliance national priority of fostering diverse, equitable and inclusive STEM cultures, especially in light of the nation's dual pandemics of COVID-19 and anti-black racism. Given the influential role that STEM professional societies play in defining discipline-specific cultures, we believe these organizations are key to promoting and fostering change to support diversity, equity, and inclusion (DEI). By supporting STEM ProS DEI boundary spanners to become collectively informed about, and supported in, the adoption of evidence-based DEI strategies, we expect to amplify awareness and adoption of inclusive practices so that more diverse talent will be involved in solving the complicated STEM issues we face now and in the near future." Specifically, the ACCESS+ Partnership funds will be used to help address Aspire Alliance's interest in a) developing a more sophisticated means for mapping the STEM ProS DEI terrain, b) providing evidence-based DEI policies and practices PD for cohorts of STEM ProS DEI boundary spanners, c) facilitating DEI Action Plan development by STEM ProS DEI boundary spanners, and d) building a CoP to support and sustain STEM ProS DEI boundary spanner trial, adoption, and adaptation of DEI evidence-based efforts.

In addition to the work of the ACCESS+ Partnership collaboration, Aspire seeks to learn from prior work by bringing groups together to promote sharing and synergy with sufficient time and space for deep-level engagement necessary to foster lasting change. Examples of how Aspire's different initiatives have already engaged in synergistic collaborative applications of evidence-based DEI strategies include:

- Institutional Change (IChange) – identifying and supporting cohorts of change teams from academic institutions that have signed on to a three-year institutional change process, including institutional cross-talk drawing on boundary spanning principles. The IChange Initiative awarded Catalytic funds to member institutions to support efforts in increasing diversity among STEM faculty. For example, six institutions came together to create a regional network that will provide culturally responsive training to mentors who help develop STEM faculty from UR groups. Three other institutions and a ProS will study the use and efficacy of DEI statements on recruitment materials.
- Regional Change (RC) – building and supporting strong collaborative relationships between R1 institutions and regional two-year and four-year institutions to promote success for students from UR groups. RC uses planning grants from teams of two-year and four-year institutions to identify new regional collaboratives working to 1) diversify the pool of applicants interested in pursuing a teaching career in STEM at two-year colleges, and 2) strengthen the preparation of these STEM faculty to teach diverse student populations.
- National Change - creating a CoP for faculty and faculty developer participants from the Aspire Summer Institute to promote continued PD in key inclusive practices; as well as STEM ProS boundary spanner work described above. NC team members are running the Equity in Action Professional Development Series. This monthly programming explores inclusive practices in teaching, advising, mentoring, and leadership with a national audience working to promote these practices.

The Aspire Alliance, and the NC team are excited about the opportunities the ACCESS+ ADVANCE Partnership award affords, and we look forward to coming to a deeper understanding of critical levers for STEM DEI change across institutional, regional, and national levels.

Implications and Insights

We propose three ways to further evolve the boundary spanning concept and increase its utility and application within Aspire's work with STEM ProSs and/or other INCLUDES Alliances.

First, social network analyses could be employed in Aspire, STEM ProSs, and other collaborative STEM projects to better understand the range, distribution, and intensity of the five boundary-spanning behaviors, as described above (i.e., finding, translating, diffusing, gaining support, and weaving) (Burt, 1992; Hill, 2020; Kadushin, 2012; Kania & Kramer, 2011).

Second, additional examination of key behaviors of STEM ProS DEI multi-society boundary spanners is necessary. Of particular interest are behaviors associated with convening STEM reform stakeholders, and with maintaining and sustaining network connectivity (similar to the work of Kezar & Gehrke, 2017). These boundary-spanning behaviors are likely in concert with those of additional individuals who, over time, share this ongoing role of weaving together individual and multi-society STEM ProS DEI change efforts.

Third, further work needs to occur to draw clear relationships between the five boundary-spanning behaviors (i.e., finding, translating, diffusing, gaining support, and weaving); how collaborative STEM reform initiatives, such as Aspire, function; the ways in which change goals and activities are pursued; and the resultant impact. It is crucial to elucidate the phenomenon of boundary spanning at work in STEM education reform while at the same time drawing clear connections between how boundary spanners influence the activities and outcomes of collaborative work.

By better understanding network dimensions through social network analyses and a deeper investigation of the behaviors of DEI Multi-Society boundary spanning individuals, we will be able to further operationalize and expand the potential and impact of boundary spanning to advance inclusive STEM culture reform.

We encourage NSF Alliances, including Aspire, and collaborative STEM projects to consider two major elements in applying the concept of boundary spanning to their initiative.

First, following the methodology of Hill (2020), change initiatives should reflect on and map the extent that boundary-spanning behaviors are currently being leveraged (and by whom), identify areas of investment related to the achievement of their change goals, and decide how to distribute boundary-spanning behaviors in an efficient way. For instance, Hill recently conducted a boundary-spanning workshop with the Alliance to Catalyze Change for Equity in STEM Success (ACCESS, https://stemaccessforall.org), a group leveraging professional societies to advance DEI in STEM. In the workshop, participants recorded key connections within and outside of the Network, explored connections in relation to boundary-spanning behaviors, and then discussed as a network how to best leverage and build upon these behaviors to advance their STEM education reform goals. In particular, through workshops or other mapping processes it is important to seek out individuals playing similar roles as the DEI multi-society boundary spanners described in this article and explore their influence on collective goals of the initiative, especially during the early stages of network development.

Second, change initiatives, including Aspire's, should proactively explore how the distribution and application of boundary-spanning behaviors might change as the initiative matures. Initiatives could find ways to measure/track boundary-spanning behaviors by mapping these behaviors and collecting data about boundary spanning through social network analyses' instruments as described above. Change initiatives can then revisit the purposeful application of boundary spanning regularly by reviewing qualitative and quantitative data in their assessment of project functioning and the influence of boundary spanning on project activities and outcomes.

Ultimately, key takeaways from this work are: 1) the recognition that STEM ProSs can serve a critical role in effecting STEM DEI culture change, 2) the value of focusing resources and support for STEM ProS DEI boundary spanners to efficiently and effectively amplify and accelerate STEM ProS DEI culture change, 3) the importance of identifying and leveraging multi-society STEM ProS DEI boundary spanners to help promote national STEM DEI culture change through adoption of DEI evidence-based practices across a strategic collective of STEM ProSs, and 4) the critical need for deep-level research and analysis to better understand the role of boundary-spanning behaviors in networking networks for efficient DEI reform.

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