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Inclusive Professional Framework for Societies: Changing Mental Models to Promote Diverse, Equitable, and Inclusive STEM Systems Change

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Abstract

Science, technology, engineering, and mathematics (STEM) professional societies (ProS) are uniquely positioned to foster national-level diversity, equity, and inclusion (DEI) reform. ProS serve broad memberships, define disciplinary norms and culture, and inform accrediting bodies, thus providing "excellent leverage with which to design and promote change" (National Academy of Sciences et al., 2005). ProS could be instrumental in achieving the DEI culture reform necessary to optimize engagement of all STEM talent by leveraging disciplinary excellence resulting from diverse teams. Inclusive STEM culture reform requires that underlying "mental models'' be examined (Kania et al., 2018).

The *Inclusive Professional Framework for Societies* (*IPF:Societies*) can help ProS change leaders (i.e., "boundary spanners'") and organizations identify and address mental models hindering DEI reform. *IPF:Societies* uses four "I's"—**I**dentity awareness and **I**ntercultural mindfulness (i.e., equity mindset) on which **I**nclusive relationships and **I**nfluential DEI actions are scaffolded. We discuss how *IPF:Societies* complements existing DEI tools. We explain how *IPF:Societies* can be applied to existing ProS policy and practice associated with common ProS functions (e.g., leadership, membership, conferences, awards, and professional development). Next steps are to pilot *IPF:Societies* with a cohort of STEM ProS. Ultimately, *IPF:Societies* has potential to promote more efficient, effective, and lasting DEI organizational transformation, and contribute to inclusive STEM disciplinary excellence.

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Facilitating STEM Excellence through Inclusive STEM Cultures

Addressing complex global challenges, such as climate change and health disparities, requires optimal engagement of people trained in science, technology, engineering, and mathematics (STEM). Diverse STEM teams have greater capacity for complex problem-solving, innovation, and resilience under collective stress than do teams that are less diverse (e.g., Page, 2007; Page, 2017; Borman et al., 2010; McGee, 2020). Because diverse teams can embody enhanced capacity for problem solving, innovation, and resilience, they advance disciplinary excellence in a way that homogenous groups cannot. Unfortunately, STEM cultures often discourage diversity by reproducing exclusionary norms and values (Baillie et al., 2012; Riley et al., 2014; Pawley & Tonso, 2011; Tonso, 1996, 1999, 2007; McGee, 2020; Seymour & Hewitt, 1997; Cech & Rothwell, 2018).

Inclusive Disciplinary Excellence Requires STEM Culture Reform

STEM culture is the sum of explicit and implicit beliefs, values, and practices in which scientists, technologists, engineers, and mathematicians engage wherever disciplinary education and work is performed (e.g., corporations, laboratories, and academy). U.S. STEM culture privileges individuals from majoritized identities (e.g., white, male, non-disabled, heterosexual), and is often unwelcoming to marginalized identities (e.g., Black, female, disabled, LGBTQ+) (McGee, 2020; Metcalf et al., 2018; Campbell-Montalvo et al., in press; Hughes, 2018). Numerous studies illustrate how STEM cultures embrace and center whiteness (Lohan & Faulkner, 2004; Pawley & Tonso, 2011; Tonso, 2007; Baillie et al., 2012; Eisenhart & Finkel, 1998; Foor et al., 2007; Hacker, 1981, 1989). Further, systems of power, privilege, and oppression related to gender intertwine with those shaped by race, ethnicity, sexuality, disability, nationality, class, and more (Collins, 2015; Crenshaw, 1989; Crenshaw, 1991; Griffin & Museus, 2011; Metcalf, 2016; Metcalf et al., 2018; Warner & Shields, 2016). Collectively, these intersecting systems influence opportunities, create barriers, and promote exclusionary experiences for people who are marginalized, especially women with intersecting identities. Existence of the STEM bias in favor of white men is demonstrated in research, such as equating masculinity with technical ability (Faulkner, 2007; Hacker, 1989). Ultimately, these social mechanisms at play in STEM cultures are rendered invisible and are replicated in and sustained by an education system and STEM workforce that does not mirror the broader population (McGee, 2020; Metcalf, 2017; Foucault, 2007; Trouillot, 1995; Tonso, 2006, 2014).

Yet, while STEM culture excludes minoritized groups and purports to be apolitical, there is a widespread expectation that minoritized and marginalized people will and should be the ones tasked with changing a system by which they are oppressed (Forrester, 2020). Majoritized people

receive disproportionate power within the current system, so it is incumbent on them to be leaders in STEM culture change to promote inclusive disciplinary excellence. This change must be supported through both "intentional introspection and subsequent action" (Chaudhary & Berhe, 2020, p. 3).

Mobilizing STEM Culture Systems Change through ProS Mental Models

We argue that intentional introspection for systems change can be fostered through exploration of mental models. Systems change is "shifting the conditions that are holding the problem in place" (Kania et al., 2018). Kania and colleagues (2018) identified six conditions of systems change that are explicit (*policies*, *practices*, *resource flows*) and semi-explicit (*relationships & connections*, *power dynamics*). These conditions are held in place by *mental models*, which are critical for transformative change. Mental models are "deeply held beliefs and assumptions, and taken-for-granted ways of operating that influence how we think, what we do, and how we talk" (Kania et al., 2018, p. 4). Unless we learn to work at the mental models level, other structural changes "will, at best, be temporary or incomplete" (Kania et al., 2018, p. 8). While work addressing mental models has been increasing in academic institutions (e.g., NSF ADVANCE-funded initiatives) and industry settings, few projects have undertaken these efforts within ProS in a scalable way.

Given the multiple, varied disciplinary functions they perform, and because they often engage other STEM culture gatekeepers (e.g., corporate, laboratory, and academic organizations), STEM ProS are uniquely positioned as critical levers for STEM systems change (e.g., National Academy of Sciences et al., 2005). Students enter STEM degree programs with varying levels of social capital (Skvoretz et al., 2020), and ProS keep them in their programs (Smith et al., 2021). Some STEM ProS are actively engaged in STEM systems change (e.g., Segarra et al., 2020a, b; Campbell-Montalvo et al., 2020; Etson et al., 2021). However, we believe that to foster greater engagement by STEM ProS, more STEM ProS-specific tools are needed, especially those that can help make explicit and reframe mental models underpinning STEM ProS systems.

IPF:Societies as a Tool for Mental Model Changes

We offer the *Inclusive Professional Framework for Disciplinary and Professional Societies* (*IPF:Societies*) as an approach to help elucidate and adjust mental models that underlie STEM ProS systems. *IPF:Societies* is a framework that can be used to explore how internal conditions support and hinder current ProS DEI aspirations and help set a foundation for lasting organizational change. Specifically, *IPF:Societies* is a research-informed approach that focuses on awareness and skills development to build an equity mindset—an orientation in which actions are grounded in understanding how social positionings affect access to resources. This mindset creates greater capacity for inclusive relationships and supporting actions that can lead to DEI change. *IPF:Societies* includes the four "I's": **I**dentity awareness, **I**ntercultural mindfulness, **I**nclusive relationships, and **I**nfluential DEI actions.

IPF:Societies derives from the *Inclusive Professional Framework for Faculty* (*IPF:Faculty*), which was developed by the Aspire Alliance's National Change Initiative, which is part of the National Science Foundation's Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (NSF INCLUDES). *IPF:Faculty* is meant to promote inclusive skills development for faculty across their roles within academic institutions (e.g., teaching, advising, research mentoring, collegiality and leadership) (Dukes et al., in press; Gillian-Daniel et al., 2021a; Gillian-Daniel et al., 2021b).

Given the parallel role that mental models play in university and ProS systems, it is valuable to adapt the *IPF* for use in ProS. *IPF:Societies* was developed with input from leaders from the NSF ADVANCE-funded *Amplifying the Alliance to Catalyze Change for Equity in STEM Success (ACCESS+)* Initiative. The mission of ACCESS+ is to "accelerate the awareness, adoption, and adaptation of NSF ADVANCE evidence-based, gender-related, DEI policies, practices, and programs within and across [ProS] by providing support to … Boundary Spanners." (Home-ACCESS+, 2021).

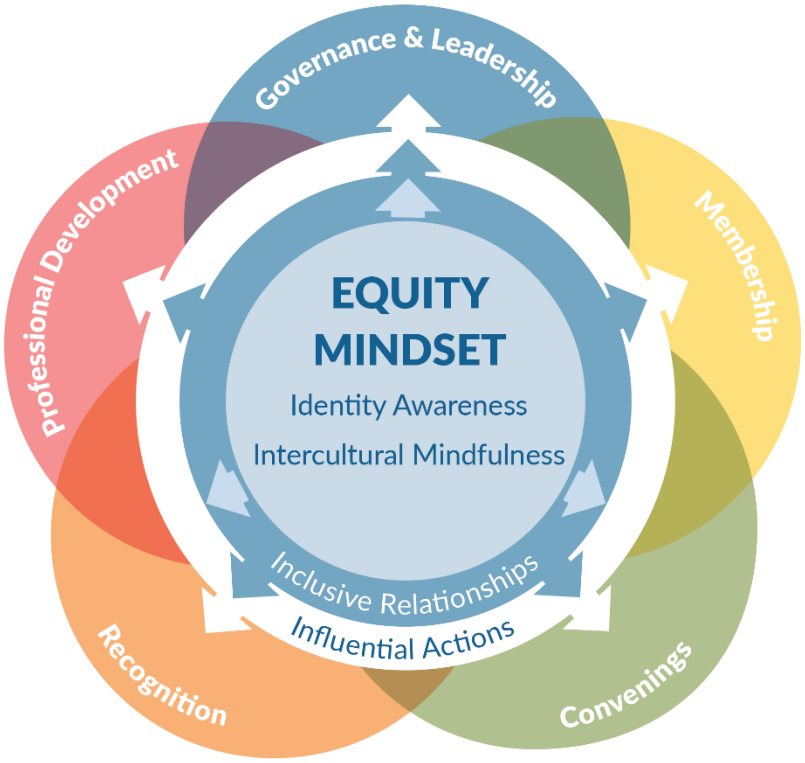
IPF:Societies has dual target audiences of DEI change leaders (individual focus) as well as ProS as systems (organizational focus). Key are ProS DEI change leaders, known as "boundary spanners," who are individuals within an organization who connect ideas, resources, and stakeholders (Hill, 2020). These individuals engage in finding (Ancana & Caldwell, 1992; Tushman & Scanlan, 1981), translating (Katz & Tushman, 1981), diffusing (Rogers, 2003), gaining support (Brion et al., 2012; Faraj & Yan, 2009), and/or social "weaving" behaviors within and between professional societies (Burt, 1992; Kania & Kramer, 2011). Boundary spanners are an ideal lever for enacting and promoting DEI change because they are often in positions to reach other boundary spanners in their ProS and beyond (Hill, 2020; Aldrich & Herker, 1977; Ancona & Caldwell, 1992; Katz & Tushman, 1981). Uptake of *IPF:Societies* by boundary spanners to develop and refine DEI awareness, knowledge, and skills can better position these change leaders to make systemic improvements within their ProS. This has potential ripple effects extending to the wider STEM culture (Leibnitz et al., 2021). Similarly, by STEM ProS using *IPF:Societies* to explore the ProS organizational system, both internal-focus (i.e., the STEM ProS business infrastructure) and external-focus (i.e., member and disciplinary serving STEM ProS infrastructure) DEI awareness and organizational capacity is enhanced, better positioning ProS to enact DEI systems change.

Figure 1 depicts the flow of *IPF:Societies'* processes, showing how the equity mindset is developed and expands into relationships and actions that guide ProS core programming, catalyzing STEM culture change. *IPF:Societies* can be usefully applied at both individual and organizational levels. Below we describe specific aspects of *IPF:Societies*.

Identity awareness is an awareness of aspects of one's own social and cultural identities, and how those identities are situated within larger intersecting systems of power. ***Intercultural mindfulness*** is the "ability to understand cultural differences in ways that enables one to interact effectively with others from different racial, ethnic, or social identity groups in both domestic and international contexts" (Gillian-Daniel et al., 2021b). Collectively "these domains encompass many features of intercultural humility, including: (a) awareness of one's own

cultural backgrounds, including intersecting social identities; (b) recognizing one's biases and privileges in relation to self and others; (c) committing to learning about others' cultural backgrounds; and (d) addressing disparities in relational power by, in part, learning to recognize power differentials" (Gillian-Daniel et al., 2021b). The more aware one is of aspects of one's own social and cultural identities, the identities of others, and how those identities are situated within larger, intersecting systems of power, the more equitably mindful one can be of impacts, decisions, and programming driven by those identities.

***Figure 1. IPF:Societies* Graphic**



Source: Aspire Alliance (2021).

Equity mindedness underpins building ***inclusive relationships***. At both personal and organizational levels, willingness, capacity, and the communication skills to effectively engage those whose lived experiences may not match one's own is vital for examining mental models and advancing inclusive ProS DEI reform. At the boundary spanner level, inclusive relationships means reflecting on whose voices are, and are not, centered and carry decision-making power when discussing important ProS policies, processes, and activities. From the STEM ProS perspective, building inclusive relationships could be reflected in collaborations with a range of organizations with intention to build mutual capacity. Inclusive relationships at the society level help shift social narratives and can inform sensemaking around information collected about the ProS, two examples of how mental models have critical impact on organizational culture (Kania et al., 2018).

Influential actions are how boundary spanners and ProS drive STEM systems change. The focus of DEI action can be informed by core ProS functions. Peters and colleagues (in press) identified eleven functions of STEM ProS for action-focus when considering how to begin explicit and implicit ProS DEI change. The outer circles of Figure 1 convey five of these ProS functions, and these same functions are further highlighted below (see also Table 1).

Discussion

IPF:Societies complements the use of other DEI organizational tools and increases both individual and organizational capacity to more efficiently and effectively identify and engage with DEI actions resulting from use of these tools. As an example, we offer the Women in Engineering ProActive Network's (WEPAN's) *Four Frames for Promoting Gender Equity Within Organizations.* Adopted from Simmons University's Center for Gender in Organizations (1998), the four frames are: (1) Equipping the Individual, (2) Creating Equal Opportunity, (3) Valuing Difference, and (4) Revisioning Culture. A STEM ProS DEI boundary spanner employing *IPF:Societies* can evaluate and introduce more inclusive professional development programs (Frame 1); examine and recommend DEI changes to organizational structures, policies, and practices (Frame 2); call attention to ways in which ProS leaders and the organization are not "walking the DEI walk," (Frame 3); and identify and remedy incongruences between ProS existing practices and goals outlined in the ProS strategic plan (Frame 4). Similarly, from an organizational perspective, WEPAN's frames could be used to evaluate the equity of professional development programs and educational pathways (Frame 1); examine and revise organizational structures, policies, and practices to support greater DEI integration across all society functions (Frame 2); ensure that all leaders are, and continue to be, trained and coached on how to enact DEI-focused changes (Frame 3); and create opportunities to re-vision ProS culture and reflect that updated vision in the ProS mission and strategic plans (Frame 4).

As with WEPAN's four frames, *IPF:Societies* complements the *Equity Environmental Scan Tool (EEST)* adapted (Peters et al., in press). The *EEST* is a DEI self-assessment tool for ProS adapted by ACCESS+ from The Royal Academy of Engineering and Science Council *Diversity and Inclusion Progression Framework* (2021). Boundary spanners skilled in using *IPF:Societies* can more efficiently and effectively enact changes in areas identified by the *EEST*. Table 1 illustrates how *IPF:Societies* can inform ProS DEI practices in relation to a ProS's core functions, each of which have an internal focus (i.e., the STEM ProS business infrastructure) and/or an external focus (i.e., member and disciplinary serving STEM ProS infrastructure). Using an *IPF:Societies* lens on the policies and practices associated with each of these functions helps uncover and change ProS mental models. We use questions to illustrate application of *IPF:Societies*. In each core ProS function (column one), existing policies or practices are presented that might appear reasonable to some (column two), but when the *IPF:Societies* lens is applied (column three), systemic and structural inequities affecting how the ProS engages with staff and members become more visible. This shows how the ProS may not be making programming decisions with an understanding of structural issues (i.e., equity mindset), therefore missing out on the opportunity to address them and counter obstacles to DEI through Inclusive relationships and Influential actions.

When and where *IPF:Societies* is brought into the ProS DEI change cycle will likely be dictated by the culture of the ProS and/or ProS leaders. For example, for ProS that already embrace a DEI orientation, *IPF:Societies* can support reflection on efficient engagement of DEI tools. For ProS where there may be resistance to DEI efforts, a DEI self-assessment tool like the

EEST may provide a critical first step to gauge needs, with *IPF:Societies* used subsequently to frame and inform follow-up actions.

***Table 1*: Examples of how *IPF:Societies* informs Practices in ProS Functions**

ProS function name and definition (Peters et al., in press)	**Example ProS policies/practices**	**ProS questions generated using an *IPF:Societies* lens**
Governance & Leadership. How ProS is run and major decisions made. (Internal focus)	Governing board members are selected based on seniority within the discipline.	How is seniority a result of structural inequality within the ProS and U.S. broader society? How does using seniority as a measure of qualification shape the pool of possible governing board members?
Membership. ProS members and the structures that shape membership makeup. (External focus)	To reduce survey burden and avoid being too intrusive, the ProS collects limited demographic data through its membership application.	What data are collected? Do members feel that the measures accurately capture their social and cultural identities? How is the rationale for collecting demographic data articulated to members, as being both valuable and aligned with ProS DEI priorities and efforts?
Convenings. Who, where, and how people participate in ProS events. (External focus)	Conference committees are composed of volunteers who determine the speakers, program, content, and social activities.	How do social and cultural identities of the committee members affect decisions about speakers, program content, or social activities? How does the ProS create buy-in from membership around DEI-focused programming? How does selection of the event's location reflect dominant views about what feels comfortable, safe, or enjoyable?
Recognition. Established procedures in which people apply or are nominated for recognition or support. (Internal and external foci)	Institutional affiliation is required on membership applications, award nominations, and presentation proposals.	How is institutional affiliation tied to structural inequality? Is using institutional affiliation necessary? Does it serve as a proxy for exclusionary notions of legitimacy, excellence, and thus bias selection? How are scholars in career transition and without institutional affiliation provided access to ProS resources?
Professional Development. Job boards, mentoring, practitioner continuing education, and similar efforts to cultivate members' successful careers. (External focus)	Professional development offerings provide suggestions to members about how to be successful job candidates.	What are the biases or assumptions in career training that reinforce and normalize whiteness and masculinity? What systems can be introduced to improve these society offerings?

Conclusions

Identity awareness and **I**ntercultural mindfulness create an equity mindset that supports **I**nclusive relationships and **I**nfluential actions. The four "I's" provide a framework for reflecting and acting on ProS culture at individual (e.g., boundary spanner) and organizational levels. *IPF:Societies* offers a way to guide change of mental models. ProS DEI boundary spanners employing *IPF:Societies* can leverage their positionality and ability to straddle groups to affect cultural change across STEM ProS, in combination with the efforts of other boundary spanners and in the disciplines in which they engage.

Of critical importance when working with mental models in ProS is the expectation that there may be resistance to DEI initiatives, especially among members with majoritized identities who may be invested, even subconsciously, in maintaining existing power structures (Lipsitz, 1998). Because people occupy a constellation of identities of various positionings, awareness of common discourses rejecting DEI could help ProS navigate them (Bonilla-Silva, 2006). *IPF:Societies* offers a framework to begin difficult discussions and offers a structured approach for working toward change. Of course, to be effective, *IPF:Societies* requires sustained mobilization of its pieces, vis-à-vis making DEI concerns part of the fabric of ProS.

Potential outcomes of widescale implementation of *IPF:Societies* could be ProS actions in service of a more diverse, inclusive, and equitable STEM culture. Resultant increased individual capacity to engage in the articulation and reframing of legacy mental models in turn guides organizational transformation and culture reform through broader systems change. As organizations engage in systemic change, greater ProS and STEM culture DEI can be made. Eventually, DEI change becomes less about individual efforts for specific DEI actions, and more about broad, structurally patterned ProS organizational transformation, and ultimately, STEM culture reform.

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