Leveraging adaptive approaches to tackle opportunity gaps in STEM higher education

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Many institutions in the United States are struggling with opportunity gaps that disproportionately affect key populations within their communities. As national conversations about the legacies of racism and other forms of systemic bias in higher education continue, they are being met with strong resistance in the form of anti-DEI (Diversity, Equity, and Inclusion) and anti-WOKE policy agendas. While acknowledging the existence of these opportunity gaps is an important first step, it is crucial to develop strategic approaches that are adaptable to the changing national context in order to foster systemic change. These ongoing challenges are often viewed as technical issues that require an expert to step in as a change leader. However, technical approaches do not lead to transformational change. To achieve transformational institutional change, stakeholders must be engaged in adaptive and cultural change efforts. This is particularly relevant in today's climate of culture wars. The Four-Frame Model for academic leadership provides a strategy for reframing how persistent challenges should be approached in higher education. This perspective article explores how this model may be employed for transformative leadership in addressing systemic opportunity gaps.

KEYWORDS

higher education leadership, organizational change, opportunity gaps, four-frame model, adaptive and technical challenges, adaptive leadership, change management in academia, STEM higher education

1 Introduction

Across the United States (U.S.), many institutions are realities of opportunity and outcome gaps within higher education (National Center for Science and Engineering Statistics, 2023; Gretzinger et al., 2024; Shavers et al., 2005; Taffe and Gilpin, 2021; Chen et al., 2022; Graves et al., 2022; Heidt, 2023; Kim et al., 2024; Masters-Waage et al., 2024; Pew Research Center, 2018; Fry et al., 2021; Velez and Heuer, 2023), while also navigating the challenges of censorship related to race and sex-based discrimination (Agathocleous et al., 2024) and the proliferation of anti-DEI (Diversity, Equity, and Inclusion) and anti-WOKE (Cross, 2012) policy agendas (Trainor, 2025; Chronicle Staff, 2023). Consider the low representation of women and racial and ethnic minorities in the U.S. science, technology, engineering, and mathematics (STEM) workforce. While women comprise about 50% of the U.S. population, they occupy about 30% of STEM jobs (Martinez and Christnacht, 2021). Additionally, Caucasian and Asian racial groups in the U.S. represent a higher percentage of the STEM workforce compared to their share of the overall U.S. population, while Black racial groups and Hispanic ethnic groups make up less of the STEM workforce relative to their population percentages (Martinez and Christnacht, 2021; Fry et al., 2021). Similar trends can be observed in the U.S. higher education

system, where Caucasian and Asian individuals are well-represented in faculty ranks while Black individuals and Hispanic individuals are not-well-represented in faculty ranks. The differences in representation suggest that opportunity gaps persist in STEM higher education and that these gaps may be systemic in nature.

Valantine and co-workers suggested that in order to achieve significant changes in opportunity gaps and outcome differences, it is crucial that we understand that individuals' decisions are shaped by both their personal circumstances and their lived experiences within the systems they navigate (Valantine et al., 2016). To this end, they recommended interventions aimed at both individuals and systems as the game changer for addressing persistent opportunity and outcome gaps.

Consequently, if the opportunity gaps occur because the *"legacies of racism and its exclusionary practices are both subtle and intricately woven into the fabric"* (Burrows et al., 2020) of higher education, we can and should consider new ways of transforming policies and practices to improve the system for all (Wilson-Kennedy et al., 2020). However, moving beyond recognition to action through systemic changes to advance outcomes and opportunity gaps in our organizational systems will require intricate and direct solutions because the systems themselves are inherently complex.

Consider this ambitious scenario: A campus recognizing a need to address the low participation of women and minorities in the professoriate develops a committee to evaluate and change institutional search procedures. The committee, comprised of faculty, leadership from academic affairs and human resources, is formed to design guidelines for hiring plans with priorities for practices that reduce exclusionary practices. They develop and implement search committee training that recognizes bias can impact perceptions of merit (Eaton et al., 2020; Helmer et al., 2017; Squazzoni et al., 2021), identify and evaluate different forms of merit, create awareness of unconscious bias in high-stakes decision-making processes like hiring (Hardy et al., 2022; Davidson, 2022), and recommend appointing advocates to each critical decision-making juncture within the search process (Liera, 2020; Weak, 2022). The new hiring practices are required for all new faculty searches. Hiring reports are written for each faculty search that summarize specific actions that the committees took to increase the size of the applicant pool and broaden the representation of candidates in those pools. New hiring initiatives for spousal and opportunity hiring are initiated and funded. In 2 years, no net demographic change in faculty hiring has occurred, and in fact, in some departments/colleges, the participation of women and minorities among tenure-track faculty has decreased.

The faculty search scenario described above is not uncommon, and research suggests that the outcomes of the interventions are also not uncommon. Frank Dobbin and coworkers have extensively studied diversity programs and efforts similar to this scenario (Dobbin and Kalev, 2016; Dobbin et al., 2011; Kalev et al., 2006). This work found that 5 years of reducing exclusionary outcomes in hiring processes through mandatory diversity training triggered psychological resistance, which culminated in opposition to control tactics and an increase in bias (Dobbin and Kalev, 2016). This, in turn, resulted in a negative impact on the representation of

Black women and Asian men and women. Conversely, voluntary training leveraged intrinsic motivation and encouraged genuine engagement (Dobbin and Kalev, 2016). The primary outcome of the voluntary activities was a willingness to apply what participants had learned, along with behavioral changes that contributed to overall increases in the representation of Black men, Hispanic men, and Asian men and Asian women (Dobbin and Kalev, 2016). Moreover, unit-level task forces with significant stakeholder engagement had high hiring gains for all women (from Caucasian, Black, Hispanic, and Asian groups) as well as Black men, Hispanic men, and Asian men (Dobbin and Kalev, 2016).

As we consider outcome gaps in higher education, similar to the ones that we face with reducing exclusionary outcomes in faculty hiring, what could be limiting our success in producing the intended results by this work? What could have been done differently? Why do so many efforts (even well-intentioned and carefully designed ones) fail?

The U.S. Higher Education ecosystem is facing crucial questions about how to reform policies and practices to address opportunity and outcome gaps. Recognizing that systemic racism, sexism, ableism, and other discriminatory phenomena are woven into the fabric of our institutional cultures and systems is a crucial first step (Burrows et al., 2020). Pursuing meaningful systemic change in an era marked by the rise of anti-DEI and anti-WOKE policy requires a thoughtful and strategic approach. We must carefully access the challenges that have negatively impacted students, faculty, staff, and other stakeholders. Additionally, we need to engage in effective, transformative leadership that can reshape our systems to better address these longstanding challenges. The question, then, is: how do we successfully implement changes within our organizations to effectively address these outcome gaps and create more welcoming environments for all?

2 Understanding technical and adaptive challenges

In the scenario above, increasing the share of women and minorities in the professoriate is being treated as a technical problem, and the leaders are developing and implementing logical solutions to that problem. Technical problems often rely on an expert (or group of experts) to design and implement interventions (or solutions) to fix the problem. The use of experts to address challenges is a standard practice within the academic culture. In higher education, this reliance on technical solutions aligns with cultural norms that emphasize meritocracy and expertise in thought leadership. When we approach challenges in this way, we assume that the problem is technical and has a *known* solution. Not all problems are technical. Some are cultural and adaptive, and the ways in which we approach adaptive problems require different strategies. We must understand the difference between technical and adaptive problems in order to develop more effective strategies for change (Fullan, 2006, 2004).

The Adaptive Leadership Foundation uses the problem of a broken instrument as its example to explore the difference between technical and adaptive problems (Adaptive Leadership Foundation,

2025). In this case, an instrument in a research laboratory breaks down, so a technician is hired to come in and fix it. Once the technician is finished, the instrument works as it should. However, what does it mean if the instrument breaks down every couple of months, despite having a top-of-the-line maintenance plan? Is it the instrument that is malfunctioning (a technical problem), or is it something else (an adaptive problem)?

Adaptive problems harbor solutions that are not clear because they often include human dynamics, thus making them more amorphous (Heifetz et al., 2009). Consequently, adaptive challenges require a deeper understanding and transformation of systems or behaviors. Addressing these challenges, particularly in organizations, requires deeper investigation to explore the nature of the problem and understanding how institutional culture and mindsets are impacting actions and activities. Having insights from an expert is critical, but understanding and providing adaptive solutions that engender buy-in from all stakeholders and members of the community is vital, largely because adaptive solutions will often require new strategies, collaborative efforts, and changes in mindset of the stakeholders and community members. Social inequality, climate change, and organizational cultural shifts are just a few examples of adaptive challenges. When we think of the complexities of these examples, it is important to note that effective approaches will require all stakeholders to be flexible, patient, and committed to collaboration and understanding.

In the example above, the instrument in the scenario keeps breaking down despite regular maintenance and access to highly qualified technicians. In this case, is the fault with the instrument or with the way that the workers are using the instrument? If the problems lie in the way that workers are using the instrument, is there a human dynamic or cultural element to how the instrument is being used that impacts the outcome of instrument breakdown? Can the desired behavior simply be legislated without even understanding what to legislate? It may be useful to understand how decisions are made, why misuse is occurring, and the barriers or the "immunity" to change (Kegan and Lahey, 2009).

Problems in higher education often have technical and adaptive components. Persistent and systemic challenges in any setting (including higher education) are a perfect example of this, in that these problems often require a combination of technical and adaptive solutions in order to have sustainable outcomes. When behaviors, preferences, hearts, and minds are changed, we have the potential for culture shifts and transformational change. However, technical solutions are alluring, and in higher education environments, we often approach challenges as technical problems instead of both technical and adaptive problems. Recognizing the difference between technical and adaptive solutions is only the first step. Next, we need to consider how to implement change within complex organizations.

3 Change leadership using technical and adaptive approaches with the four-frame model

Almost no one would disagree with the idea that institutions of higher education are complex organizations. To address the challenges associated with leading change in such complex institutions, Lee Bolman and Terrance Deal developed the Four-Frame Model, which provides four distinct perspectives for understanding organizational dynamics and outlines strategies for leading organizational change within each perspective (Bolman and Deal, 2017). Recognizing that no single viewpoint is sufficient for capturing the full complexity of organizational life, Bolman and Deal, through decades of research, propose these four complementary lenses—referred to as leadership frames—to facilitate more effective leadership. This four-frame approach is particularly suitable for tackling persistent opportunity gaps in organizations due to the inherent complexity of these interconnected technical and adaptive challenges. So, what is this four-frame model?

3.1 Four-frame organizational model

The four-frame model (Figure 1) uses four core elements to represent how organizations function; these four frames are (1) Structural; (2) Political; (3) Human Resource; and (4) Symbolic (Bolman and Deal, 2017). The *structural frame*, represented by the machine metaphor, focuses on how the institution operates through policies, procedures, and practices. It is the machine by which the organization runs. Within this frame, change is advanced through organizational efficiencies, adopting new policies and procedures, and evaluating outcomes. The *political frame*, represented by the jungle metaphor, focuses on concepts of power and competition within the institution, noting that there are a finite set of resources and that coalitions can be built to support organizational functions. In this frame, bargaining and negotiations are used to advance an agenda. The *human resource frame*, represented by the family metaphor, focuses on aligning personal and organizational needs to optimize how the organization functions. Herein, the human resource frame encourages stakeholders to participate in decision-making and uses consensus-building, relations, loyalty, and bilateral commitments to advance change. The *symbolic frame*, represented by the temple metaphor, focuses on institutional culture through shared experiences and shared meanings. Herein, the ceremonies and rituals of higher education bonds people together to advance a common mission. This four-frame model outlines a strategic approach for conceptualizing how organizations function and provides a blueprint of how to strategize a change approach within organizations.

3.2 Technical and adaptive change within the four-frame model

Technical change happens when an expert comes in and applies "nuts and bolts" solutions to problems. Adaptive change happens when experts engage stakeholders in strategizing solutions to problems in which they are intimately involved. Technical change requires a specific skill set to address a problem. Adaptive change requires shifts in the mindsets and behaviors of stakeholders (community members) to address a problem.

FIGURE 1
Bolman and Deal's Four-Frame Model.

Technical and adaptive approaches to change are well aligned with the Four-Frame Model. The structural frame (machine), with its focus on the "how" of change through policies and

procedures and institutional infrastructure, aligns well with technical approaches to problem-solving. It is important to consider that structural changes might be necessary to support

new strategies. This involves adaptive approaches which would necessitate redefining roles or altering organizational hierarchies to foster innovation and adaptability. The political frame (jungle), with its emphasis on building coalitions, seeks strategic ways to build influential and power networks through negotiations and conflict resolution, uses technical approaches (information) to sway constituencies or adaptive approaches (mindsets) to influence key stakeholders. Political aspects are crucial for driving change. Managing stakeholders and addressing conflicts are essential for facilitating adaptive responses to challenges. The human resource frame (family), with its focus on human capital and bringing everyone to the table for decision-making, uses adaptive approaches (mindsets and perspectives) to build consensus through relationships and stakeholder engagement. It is important to note that making sure the right skills are in place to meet specific technical requirements is critical. Development and training programs can address these challenges directly. The symbolic frame focuses on institutional culture, ceremonies, rituals, and symbols. While technical challenges might focus on concrete processes, symbols can reinforce the importance of those processes within the organizational culture. This frame often requires a shift in culture and shared values, using adaptive approaches (hearts and minds) to advance a common mission. One adaptive approach is leaders can use storytelling, vision, and symbols to inspire and align the organization toward new goals and foster a sense of purpose.

Though the Four-Frame Model allows for an effective integration of technical and adaptive approaches to advance organizational change, it is entirely possible to focus primarily on technical solutions even while using this model. Intentionality, in developing adaptive and technical approaches within the Four-Frame Model, is essential for positioning efforts for transformational change.

4 Discussion

The faculty hiring scenario presented earlier is common in U.S. Higher Education, and the use of technical solutions to address this problem is also common. In the opening scenario, academic leaders employed technical expertise to formalize institutional policies, but few details were provided on how the plans would be adaptive and socialized within the departments where hiring actually occurs. Were the departments positioned and empowered to engage in the change strategy? Were they given a set of tools that they were mandated to use? Is this even important?

Frank Dobbin's study of diversity programs (Dobbin and Kalev, 2016; Dobbin et al., 2011; Kalev et al., 2006) suggests that technical approaches alone are usually ineffective in reducing exclusionary outcomes. Many of the trends seen for mandatory training may be attributed to multiple factors, including stakeholder resistance to change. Conversely, Dobbin's work found that outcomes were maximized when stakeholders were engaged in initiatives through voluntary participation and the work of taskforces comprised of stakeholders. This suggests that adaptive approaches were more transformative, and when combined, technical (information/learning) and adaptive (stakeholder engagement) strategies can position organizations and their units for more transformational and sustainable change. How might we integrate

these approaches to develop an effective strategy for approaching similar and dissimilar outcomes in higher education?

4.1 Putting it into practice—adaptive change leadership within the four-frame model

The Four-Frame Model provides a framework for developing a plan that addresses both the technical and adaptive challenges inherent to systemic change. Given that reducing exclusionary outcomes in faculty hiring is more than a technical problem, this adaptive challenge can be used as a model for considering how to apply the Four-Frame Model to other higher ed contexts. Accordingly, Figure 2 highlights a multilevel strategy focused on incorporating both technical and adaptive approaches within the Four-Frame Model. Herein, sample questions serve as a starting point for conceptualizing an implementation strategy. The most important aspect of this approach is being intentional about considering the Structural, Political, Human Resource, and Symbolic Frames in the context of the leadership challenge of interest. The next step involves considering how the approaches used within the model engage key stakeholders. It is critical to distinguish if a strategy is technical or adaptive. As interventions are developed and implemented, leaders and stakeholders must engage in reflective practice to assess what is working, what is not working, and explore the underlying reasons for these outcomes. This approach helps position systemic change as an evolving process.

Moving beyond the conceptual, we further proposed four strategic approaches aligned with the Four-Frame Model that could be used to engage a campus community in diversifying the professoriate.

- Using the **Structural Frame**, campus leaders could promote search committee training that advances knowledge on effective searches. Notably, as a high-stakes activity, most search committees want to be successful in guiding the selection process to identify the best candidate. Noting this priority, search committee training that features literature on best practices, including awareness of factors impacting high-stakes decision-making, institutional data on hiring trends, and options for re-envisioning and re-designing departmental approaches to hiring can equip departments with new tools to improve the search process.
- Using the **Political Frame**, campus leaders may articulate a campus-wide hiring initiative focused on innovation imperatives. Herein, research areas that impact traditionally marginalized populations may be a focal point, thereby advancing scholarship that tackles opportunity gaps in the institution (or more broadly).
- Using the **Symbolic Frame**, strategic planning processes at all levels can focus on envisioning the future of the institution by elevating the voices of those least heard. Herein, celebrating institutional advancement centers new and often unheard voices. A second approach could also consider hypervisibility and invisibility of faculty and intentionally reframe campus and department communication based on this awareness. This

Reimagining Hiring for the Professoriate
Adaptive Leadership within the Four-Frame Model

Structural
The Machine (primarily Technical Approaches)
- How does the unit explore the impact of current hiring policies and practices? To what extent do these facilitate or hinder efforts to attract a wide range of candidates?
- To what extent might structural impediments exist in job posting, search committee operations, screen criteria, or evaluation methods?
- How are search committee training acculturated to reimagined hiring structures? How are these refined for future iterations?
- Are search advocates used? If so, are they volunteers or appointed?
- Do search committees have a reporting mechanism for different stages of the search? Who reviews and supports search committees through the reporting processes for searches?
- Are there clearly defined roles, evaluation criteria, and resource allocation processes in place to support the reimagined recruitment of faculty from a wide range of backgrounds?

Political
The Jungle (combined Technical & Adaptive Approaches)
- How does the campus focus promote conversations around and buy-in for hiring initiatives?
- To what extent do departments and colleges convene taskforces and seek resources for recruitment and external engagement activities and agendas?Whose voices, interests, or influence shapes hiring decisions, and how might those dynamics impact candidate selection?
- How do departments learn about and gain access to hiring resources?
- How are resources aligned with accountability in implementing a reimagined hiring plan?
- How do department leaders build coalitions among key stakeholders to champion efforts to reimagine hiring processes? Is there intentionality toward focusing on engaging a candidates from a wide range of backgrounds?
- To what extent does the reimagined hiring strategy include strategies for navigating potential conflicts or tensions that may arise from changing traditional hiring norms or expectations?

Human Resource
The Family (primarily Adaptive Approaches)
- How are department members engaged in reimagining their search processes?
- To what extent have key stakeholders explored the aspects of the hiring experience that makes their unit and institution attractive or unattractive to potential candidate? How is this used or addressed in reimagining their search processes?
- How is institutional learning addressed and cultivated? How are groups of faculty engaged in advancing this work in their departments/disciplines?
- How does the department leverage the networks of the department members, alumni community, and others? Are search processes relying only on the search committee or does the reimagined plan expand beyond the search committee to access broad networks of individuals?
- How are existing department members empowered and supported to participate meaningfully in recruitment efforts? What professional development, mentoring, or other support mechanisms are provided in the department to support a reimagined search process?

Symbolic
The Temple (combined Technical & Adaptive Approaches)
- Does the campus community holistically celebrate members and stakeholders as integral to its campus culture? How? Does this occur at multiple levels?
- How are implicit values and assumptions about excellence, success, and scholarship shape addressed in the reimagined hiring processes?
- How are symbolic messages around the reimagined hiring processes shared internally and externally?
- How are innovation levers used within the hiring process and more broadly within the institution?
- How are narratives about faculty identity, roles, and contibutions promoted and reinforced by the hiring practices?
- Are broader community contexts normatively highlighted in campus, college, and departmental communications?
- Are hiring goals and priorities clearly articulated in the campus, college, and departmental strategic plans?
- Are persons from all backgrounds well represented in campus leadership and the faculty?

FIGURE 2
Reimaging Hiring for the Professoriate. A sample list of questions to guide practice.

has the potential to normalize historically underheard voices and representation in our units.

- Using the *Human Resources Frame*, we can invite departments that seek to reimagine their search processes to participate in collaborative learning groups. Herein, these groups can work on developing a departmental strategy for reforming their processes with a disciplinary and departmental focus while learning from each other

across departments on strategies that work in their institutional context.

4.2 Implications

Increased awareness of the factors contributing to opportunity gaps in academia is essential for developing effective strategies to tackle persistent exclusionary outcomes. Often, the approaches adopted by institutions are criticized for offering only "surface-level" changes, rather than making the deep, structural shifts necessary to transform systems. This may stem from relying on technical solutions to address complex adaptive challenges. Adaptive approaches, wherein administrative leaders and faculty with academic freedom are able to engage colleagues in the departments, are vital for systemic change. Indeed, this work empowers stakeholders to consider ways to integrate and adapt what they have learned into their own disciplinary norms and paradigms. There are technical components to transforming practices that are needed at multiple levels within the institutions: from human resource leadership at the university level to departmental hiring plans to advocacy and accountability at the college level. However, technical approaches alone are not enough.

Adaptive problems often hide unclear solutions, requiring in-depth investigation to grasp the complexity and nuances of the issues at hand. By utilizing the Four-Frame Model, institutions aiming to improve outcome challenges—such as enhancing faculty diversity—can formulate strategic approaches to promote systemic change. Recognizing that top-down leadership methods in higher education frequently fall short, the Four-Frame Model emphasizes the involvement of stakeholders at all levels to drive transformation. Research shows that actively engaging these stakeholders through adaptive strategies is crucial for effectively addressing the outcome challenges faced by U.S. higher education today.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

ZW-K: Conceptualization, Methodology, Investigation, Writing – review & editing, Visualization, Writing – original draft, Formal analysis. FP-S: Methodology, Conceptualization, Writing – review & editing, Formal analysis, Visualization.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2025.1593337/full#supplementary-material

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