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Infrastructuring to Scale Multi-Institutional Equity and Inclusion Innovations

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In Short

- In order for multi-institutional STEM education collaborations to scale justice-oriented change, the infrastructures they depend on must be designed—or redesigned—with equity and inclusion in mind.
- Lessons from the Sloan Equity and Inclusion in STEM Introductory Courses (SEISMIC) Project show how the infrastructural revision of multi-institutional collaborations can shape which *people* they include, whose *voices* they elevate, and what *data* they collect and use across sites.
- Ultimately, these lessons from SEISMIC highlight that building equity and inclusion into our multi-institutional infrastructures is not a one-time commitment, but an ongoing, collaborative process.

INTRODUCTION

Caught between an unjust past and an uncertain future, higher education in science, technology, engineering, and mathematics (STEM) is at a threshold moment. Inequities and exclusions remain widespread. Addressing them requires something more than siloed departments, national workshops for a self-selecting population of faculty, and isolated charismatic instructors working independently toward change. Structural change at scale arguably necessitates new interinstitutional infrastructures and “networks of networks” (Kezar et al., 2019) capable of catalyzing equity- and inclusion-oriented collaboration across departments, disciplines, and schools.

Yet while interinstitutional collaborations promise large-scale change, they can also introduce new challenges, including the potential loss of attention to local contexts and needs. We focus below on one interinstitutional collaboration as an example: the Sloan Equity and Inclusion in STEM Introductory Courses (SEISMIC) Project, which assembles 10 large public research-intensive institutions to study and promote equitable, inclusive STEM education. Referencing early lessons from SEISMIC, we discuss three domains where infrastructural design considerations shape how (and how well) interinstitutional collaborations advance equity and inclusion: *people*, *voices*, and *data*. Each domain involves design tensions and tradeoffs, highlighting the importance of understanding justice-oriented organizational (re)design as an ongoing process. What SEISMIC shows is this: If we want interinstitutional collaborations to promote change, we must also be prepared to iteratively change collaborations themselves.

KNOWLEDGE INFRASTRUCTURES/ INFRASTRUCTURING KNOWLEDGE

“Infrastructure” refers to the ecology of elements that undergird everyday life and work—including the work of education and knowledge production (Edwards et al., 2013; Hammond et al., 2020; Kezar, 2019). Whether knowingly or not, those of us in the academy take part in *knowledge infrastructures* that “include individuals, organizations, routines, shared norms, and practices,” as well as technologies and standards (Edwards et al., 2013, p. 5). These elements inform what kinds of work are done in research environments and classrooms, by whom, to what ends, and at what scales (Hammond et al., 2020). Reorienting higher education

toward collaboration (Kezar & Lester, 2009) and diversity, equity, and inclusion (McGee, 2020; Posselt, 2020) may thus require infrastructural changes that disrupt “historically embedded patterns that seep into policies, facilities, resource allocations, and daily decision-making” (Kezar, 2019, p. 5). In this regard, interinstitutional collaborations can intervene in existing knowledge infrastructures by breaking down “traditional” silos, pooling expertise/data across sites, and scaling equity- and inclusion-oriented initiatives.

Institutions often treat infrastructures as largely fixed, inflexible, and inertial systems, reliable in their resistance to change. Yet infrastructures are less “fully coherent, deliberately engineered, end-to-end processes” than they are dynamic “ecologies or complex adaptive systems” that can shift and change as their “individual elements change and new ones are introduced” (Edwards et al., 2013, p. 5). Put another way, we do more than rely on knowledge infrastructures: we remake and revise them continually through the actions we take, the standards we endorse, and the policies we put in place. “Infrastructure” can thus be understood not just as a noun but also as a verb (“infrastructuring”)—as something we do (Karasti et al., 2010). To engage in “infrastructuring,” as we use this term, is to participate in the ongoing, active, and collective work of (re)forming infrastructure.

Because infrastructures require ongoing maintenance and modification (Karasti et al., 2010), those seeking to build interinstitutional collaborations may benefit by shifting their focus from *infrastructure* (as a static thing) to *infrastructuring* (as a dynamic, ongoing process). Relatedly, “equity” can be understood as not merely a “static goal” but rather a process of “continual adaptation,” whereby we iteratively reexamine and revise institutions and their (infra)structures so that they “better sustain and empower all” (Pearson et al., 2022, p. 3)—a process some have termed “justicing” (Gere et al., 2021). Reframing “equity” and “infrastructure” as processes can shift how we think about our knowledge infrastructures, reminding us that these infrastructures can—and perhaps should—be subject to ongoing, justice-oriented intervention and revision.

THE SEISMIC PROJECT

Established in 2019, the SEISMIC Project advances an *interinstitutional* approach to research and intervention, engaged in infrastructuring for equity and inclusion in STEM education. SEISMIC’s vision is to advance “a new standard for STEM reform projects: a

class cannot be successful unless it is equitable and inclusive” (SEISMIC, n.d., para. 3). Introductory STEM courses thus should be gateways for opportunity, not used for exclusionary gatekeeping. Because the national need to build equity and inclusion into STEM education cannot be fully addressed by individual institutions or disciplines, SEISMIC provides a multi-institution, multidisciplinary infrastructure for researching and reforming STEM education (Figure 1). It assembles stakeholders from 10 public research-intensive institutions, which together annually enroll more than 60,000 new students (Table 1).

Designing a collaboration like SEISMIC requires continually questioning the degree to which its emerging infrastructure moves the collaboration itself *toward* or *away from* equity and inclusion (Kezar, 2019). Because emerging knowledge infrastructures can be malleable in ways established infrastructures typically are not, there may be significant opportunities for intentionally revising a collaboration’s infrastructure during its early years. Below, we offer examples from SEISMIC’s first years to describe three kinds of interrelated design considerations for infrastructuring interinstitutional collaborations: *people*, *voices*, and *data*.

People

While interinstitutional collaborations can build community and shared sense of purpose, increasing scale does not *necessarily* increase diversity. After all,

STEM disciplines have long been dominated by white, able-bodied, straight, cis-gendered men (McGee, 2020; Posselt, 2020). Without intentional, ongoing (re)design, interinstitutional collaborations may inadvertently lean into and expand existing representational disparities.

Infrastructurally, SEISMIC is configured to sponsor channels of exchange across departmental/institutional divides. For instance, the collaboration convenes an annual summer meeting and institution-specific “Weeks of SEISMIC” to bring members together, facilitates a speaker exchange program, keeps members connected and updated through a website and newsletters, and funds a project manager to coordinate collaboration-wide communication. These silo-bridging elements may bring people together but do not directly address matters of representational diversity. Notably, SEISMIC was designed to assemble large, historically/primarily white, research-intensive public institutions—each with documented representational disparities and a clear need for equity- and inclusion-oriented change. During its first years, SEISMIC lacked systems for collecting demographic data concerning its membership, leaving it unclear whether representational disparities endemic to the collaboration’s member institutions were being reproduced within SEISMIC itself.

Recognizing the need to be the change it wants to see in STEM, SEISMIC has acknowledged the importance of developing structures for routine, self-reflexive attention to membership diversity (Kedharnath &

FIGURE 1. SEISMIC’S ORGANIZATIONAL STRUCTURE (ADAPTED FROM [HTTPS://WWW.SEISMICPROJECT.ORG/](https://www.seismicproject.org/))

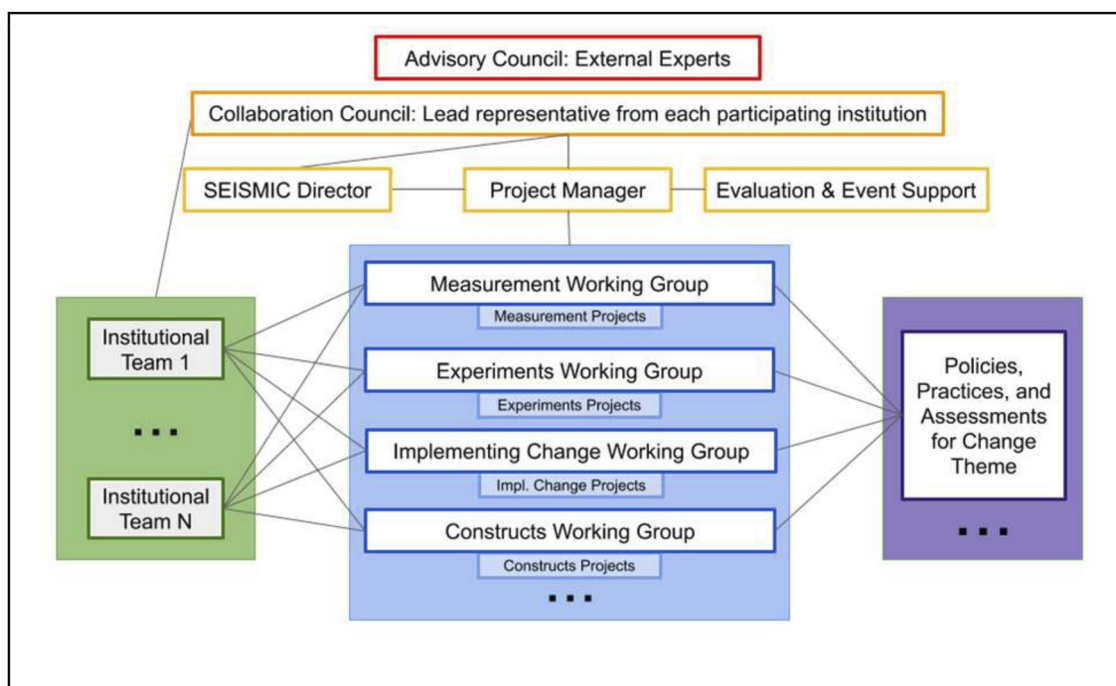


TABLE 1. SEISMIC PROJECT INFRASTRUCTURE

Collaboration-level leadership	Director, Project Manager, and Collaboration Council
Current member institutions	Arizona State University, Indiana University, Michigan State University, Purdue University, University of California Davis, University of California Irvine, University of California Santa Barbara, University of Michigan, University of Minnesota, University of Pittsburgh
SEISMIC working groups	<ul style="list-style-type: none"> • <i>Measurement</i>: Establishes metrics for measuring equity and inclusion in foundational STEM courses, conducts measurements, and identifies actionable data to promote change. • <i>Experiments</i>: Uses experiments to understand disparities/foster equity in the classroom and across disciplines/universities, emphasizing replication and context. • <i>Implementing Change [originally called “Structures”]</i>: Presents analyses on student outcomes to campus stakeholders, leveraging institutional knowledge/tools to promote policy changes toward creating equitable and inclusive introductory STEM courses. • <i>Constructs [added in SEISMIC’s second year]</i>: Integrates critical frameworks and histories into STEM education research, centering perspectives, expertise, and experiences from marginalized communities.
Major ways SEISMIC supports collaboration	<ul style="list-style-type: none"> • <i>Working groups</i>: Collaborative work is catalyzed through four working groups (described above). • <i>Themes [added in SEISMIC’s second year]</i>: “Theme Leaders” facilitate communication across working groups, promote collaboration-wide goals, implement the SEISMIC Scholars undergraduate research program, and make collaboration-level recommendations. • <i>Speaker exchange</i>: SEISMIC publicizes a speaker list of members; member institutions commit to hosting six or more speakers annually. • <i>Annual meeting</i>: The collaboration convenes annually to share research/updates, review/revise the collaboration, propose new projects, and engage with speakers. • <i>Weeks of SEISMIC [added in SEISMIC’s fourth year]</i>: Institutions host a local “Week of SEISMIC” conference to share developments/strengthen relationships. • <i>Funding opportunities</i>: SEISMIC provides funding for members to conduct, present, and/or publish research; serve in positions (e.g., Theme Leader); attend annual meetings; and host speakers. • <i>Communication and other resources</i>: SEISMIC sends monthly newsletters; maintains “Getting Started” information and a member database; provides authorship guidance; shares events calendars/external opportunity information; posts blogs; and updates a “SEISMIC Voices” webpage, publicizing member perspectives/experiences.

Note. Adapted from <https://www.seismicproject.org/>

Renbarger, 2021) and has begun formally collecting collaboration-wide demographic data via its annual meeting process. SEISMIC also has published a statement formalizing its commitment to addressing its underrepresentation of people of color generally and Black people specifically (SEISMIC, 2020)—work that may require revisiting SEISMIC’s approach to recruitment and membership. Importantly, a capacity for organizational revision is built into the collaboration’s design: SEISMIC has developed processes for extending membership to new institutions and to individuals unaffiliated with its member institutions. Further infrastructuring remains necessary to ensure the collaboration embodies the kind of demographically inclusive community it seeks to foster in STEM.

The lesson SEISMIC is now learning is this: Inter-institutional collaborations may help to support and sponsor transformative diversification in STEM

education. But diversity must also be part of the process of infrastructuring collaborations themselves (Kezar, 2019), ensuring they are designed to grow and change in response to growing, changing populations and their needs.

Voices

Increasing the number of people in the room does not automatically mean everyone’s voice is heard. Within collaborations like SEISMIC, an apparent convergence of ideas may actually be the sound of diverse or divergent voices being drowned out by those who have historically held the “sonic space” of STEM: academics who are white, men, tenured, and/or senior (Posselt, 2020). Designing for equitable and inclusive collaborative work requires taking up questions about power, participatory culture, and the potential for infrastructures to reinforce or disrupt existing hierarchies within STEM.

Because SEISMIC's membership ranges from undergraduates to vice provosts, power disparities and dynamics can jeopardize equitable participation. Initially, SEISMIC's governing body (the Collaboration Council) was composed only of faculty members, many of whom were administrators and/or white. And while all SEISMIC members are technically enfranchised to propose/lead research projects, determinations about launching/leading SEISMIC's initial projects have—in practice—privileged those who physically attended the collaboration's inaugural annual meeting and who thus did not have to champion their ideas from a distance. As a result of design choices concerning *where* and *when* decisions are made, *how*, and by *whom*, some voices within SEISMIC have disengaged or remained unheard.

In its ongoing infrastructuring, SEISMIC recently convened a Task Force to offer recommendations concerning voice within the collaboration (Castle et al., 2021), resulting in revisions to SEISMIC's Collaboration Council, which now includes representation from graduate students, staff, and postdoctoral researchers—the majority of whom are non-white and/or women, ensuring SEISMIC's leadership more meaningfully centers identities historically minoritized within STEM. SEISMIC has also designed multiple programmatic venues for soliciting, safeguarding, elevating, connecting, and crediting members' voices—including by publishing authorship guidance to clarify norms and circumvent disagreements resulting from power differentials or divergent disciplinary conventions. And during its second year, SEISMIC introduced a funded “themes leader” position that carries, amplifies, and synthesizes perspectives across projects, helping to counter siloing (and silencing).

Crucially, SEISMIC engages in routine programmatic self-study, partnering with the University of Michigan's Center for Education Design, Evaluation, and Research (CEDER) to evaluate the collaboration's practices and processes, including by confidentially interviewing members about how SEISMIC is supporting them—or not. Gathering input in this way formalizes opportunities for members to voice ideas that may have been drowned out in the din of interinstitutional collaboration, to name how existing infrastructural conditions are inadequate, and to advocate for infrastructural changes.

This partnership with CEDER speaks to a broader infrastructuring lesson: Collaborations seeking to promote equity and inclusion must iteratively (re)design themselves with an attention to listening *for* and *to* voices that may otherwise be dismissed or disempowered.

Data

As described above, data about collaborations themselves can support organizational self-examination and (re)design with respect to *people* and *voices* within the collaboration. More generally, interinstitutional collaborations like SEISMIC enable new methods of data collection, aggregation, and analysis concerning educational equity and inclusion at scale—supporting statistical analyses there might otherwise not be sufficient sample size to perform. Yet such methods can also intensify risks of overlooking important differences between students and contexts. For instance, combining racial data across institutions can obscure local distinctions and intragroup diversities, insofar as students who identify as “Asian” (for example) may not share the same backgrounds, challenges, or experiences—even within an institution (Byrd, 2021; Teranishi et al., 2020).

SEISMIC has, since its inception, grappled with data-related questions across its original three working groups: Measurement, Experiments, and Implementing Change (Table 1). The collaboration's institutions often collect, format, and organize data in different ways. Even when data are collected consistently across institutions, questions persist about the assumptions embedded in those data (Cheng et al., 2021). For example, institutions may collect “gender” data with categorical options borrowed from “sex” (e.g., male/female), and these data may reduce gender (and/or sex) to a binary.

These data-related challenges led many SEISMIC members to call for the creation of a fourth working group, focused on the meanings and histories of the social constructs (e.g., “race,” “inclusion”) that drive and complicate collaboration around data. This new “Constructs” working group, launched in the collaboration's second year, represents a kind of infrastructural intervention tailored to tackle questions that are essential for advancing SEISMIC's mission but outside the collaboration's scope, as originally configured. For example, in partnership with the Measurement working group, Constructs working group members developed guidance concerning antiracist approaches to STEM education research data, outlining ways to integrate QuantCrit (critical race theory of statistics) into quantitative STEM equity analyses (Pearson et al., 2022).

Development of the Constructs working group highlights an infrastructuring lesson SEISMIC has learned: To research equity and inclusion at scale, collaborations may first need to develop structures to question whether their data practices inadvertently

TABLE 2. INTERINSTITUTIONAL COLLABORATION DESIGN CONSIDERATIONS

Design consideration	Tension	Model questions
People	Collaborations can scale change by bringing people together around a common question, need, or interest. However, increasing scale may increase homogeneity rather than diversity.	<ul style="list-style-type: none"> • How is membership/leadership distributed across institutions/disciplines? • How diverse and representative is the collaboration (demographically, disciplinarily, institutionally)? • How might past and present design decisions have shaped representation? • How might future design promote greater diversity and representation?
Voices	Collaborations can create new spaces for honoring and amplifying underrepresented voices. However, more voices can mean more danger that diverse perspectives will be drowned out.	<ul style="list-style-type: none"> • Whose perspectives are centered? • How are norms for collaborative work/communication clarified and publicized? • What programmatic channels of communication are open to members? • How can the collaboration amplify otherwise-marginalized voices?
Data	Collaborations can combine data from across sites to reveal patterns that otherwise might remain hidden. However, such work can also render invisible important local distinctions in demography and context.	<ul style="list-style-type: none"> • What constructs (e.g., race) and data are central to addressing the collaboration's research questions and aims? • What kinds of data do member institutions collect (and how)—including data about the composition of the collaboration itself? • How are demographic data being (dis)aggregated within and across institutions—and what patterns are thus rendered (in)visible? • How can the collaboration promote explicitness, transparency, and critical reflection regarding its data practices?

conceal (or even exacerbate) the very inequities and exclusions they are intended to expose.

CONCLUSION

To meet the equity and inclusion challenges confronting STEM education, we must design alternative ways of working and improving together. Interinstitutional collaborations provide one promising path forward, maximizing collective impact by sponsoring new scholarly connections. Yet without ongoing reflection and infrastructural (re)design, interinstitutional collaborations risk subverting their own goals. To prompt reflection and support (re)design, we offer the questions included in Table 2, derived from experiences within SEISMIC.

As our experiences with SEISMIC suggest, designing for “seismic change” *in* and *through* collaborations is iterative and collective work, requiring ongoing attention to the *people* comprising the collaboration, the *voices* elevated within the collaboration, and the

data central to the collaboration's research. Of course, these are not the only design considerations with equity and inclusion implications. We invite readers to consider their own (inter)institutional needs and to think critically about the kinds of infrastructuring necessary to address them. ☐

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