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The Design of an Information System to Support Network Development

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ABSTRACT

The leaders of Networks for School Improvement (NSIs) have complex, challenging jobs which require constant learning and adaptation. To support these leaders, the contributors to this volume have developed a survey-based data visualization system—the Improvement Network Health Development (INHD) Information System—designed to generate insight about key aspects of network health and functioning. The INHD Information System constitutes the third leg of the boundary object, described in the introduction, that was developed by our project. This article describes and provides the rationale for six key design features of this system: (1) offering bounded customization of key terms used in different improvement networks; (2) anchoring results in the Improvement Network Health and Development (INHD) Framework and the measures from the INHD Survey; (3) signaling the information that merits further consideration; (4) illuminating variation in beliefs and practices; (5) providing evidence in a timely fashion to inform network improvements; and (6) safeguarding the system as a formative tool supporting network development. We also share preliminary evidence of the uses of the system by NSI leaders.

The leaders of Networks for School Improvement (NSIs) have complex, challenging jobs (Kinlaw et al., 2020; Peurach, 2016). They are charged with managing the collaborative work of distributed teams that operate across traditional organizational boundaries. These local teams take an iterative, developmental approach to their work, which means their leaders cannot rely on clear blueprints or simple implementation guides, but instead must iterate alongside them. Moreover, NSIs operate within school districts in the United States, which are politically contested environments that experience frequent leadership turnover. All these characteristics (and more) mean that their leaders face a continuing need to sense what is occurring in their environment and their network, learn from it, and adapt. Our collective project confronts a challenge as to how we might best design a learning system to support these efforts in individual networks and across the entirety of the NSI community.

In recognizing the nascent state of understanding improvement networks, our project team conceptualized this task as one of designing a boundary object to inform this work both within and across these different networks (Carlile, 2002). Boundary objects are artifacts that can help bridge different communities in negotiating shared meaning and collective interpretation (Akkerman & Bakker, 2011; Lave & Wenger, 1991). Our aim was to create an artifact that might generate important observations and stimulate reflective conversations about the tasks involved in catalyzing and sustaining productive improvement networks. We took as our user-community the hub leaders charged with developing their respective networks, the Gates

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Foundation's Community of Practice where hub leaders joined in ongoing conversation, and those involved as support partners and evaluation contractors for the NSI initiative.

The learning system detailed across the first three articles in this special issue operates like a three-legged stool working to support hub leaders in deepening their understanding of the dynamics of the work occurring within these organizations. We use the term learning system because the different components function interdependently (i.e., as a *system)*. The system is grounded conceptually in the Improvement Network Health and Development (INHD) Framework (Russell et al., 2025, this issue) and grounded empirically in tested measures from its complementary INHD Survey (Bryk et al., 2025, this issue). This article focuses on the third component—the design of the INHD Information System.

The technical aspects of the design involved the development of a reporting platform consisting of an interrelated set of targeted data visualizations and an integrated flow of numerous statistical algorithms that create the inputs to these visualizations. Complementing this, we also focused our attention on designing a set of social learning processes intended to support the uses of this information in continuing efforts to develop these networks. One primary concern was bridging the structural divide between schools and their respective hub leaders. Additionally, we sought to support the evolution of a cohesive community of practice among the NSIs that, while providing evidence specific to each network, remained tied to a shared conceptual framework. This was intended to anchor conversations that might foster learning among these networks about how to achieve the practices and norms hypothesized as central to productive networks. Likewise, we sought to support the efforts of Bill & Melinda Gates Foundation program staff, many of whom were also new to this way of working and who valued the opportunity to learn from and with network leaders about the NSI initiative's progress and the challenges that arise in vitalizing its aspirations.

In this article, we describe and provide a rationale for key features of the system designed to advance these aims. The structure is as follows: First, we describe the process through which we created and iterated on data visualizations and designed supportive social processes for their use. Then, we articulate six key design features of our Improvement Network Health and Development Information System and provide examples that illustrate their use. Next, we describe the key activities that we organized to support interpretation and use of survey results. We close with an exploration of early evidence regarding the usefulness of the Improvement Network Health and Development Learning System for hub leaders and foundation staff.

The process of creating the INHD Information System

Our process followed established design routines (see, e.g., Dillman et al., 2009) in moving iteratively through idea generation, prototyping, analysis of pilot data, user testing, and implementation. Our initial design for the information system drew heavily on prior experiences of members of our team, Anthony Bryk and Stuart Luppescu, who were integrally involved in the development of another highly used survey and reporting system project—the *5Essential Supports for School Improvement Survey* by the Consortium on Chicago School Research and Chicago Public Schools (Bryk et al., 2010).[1] It was also informed by pre-NSI pilot efforts with earlier versions of the survey used in developmental evaluations for several Networked Improvement Communities (see Bryk et al., 2025, this issue). To evolve the visualization and social support systems implemented for the NSIs, we held discussions with hub leaders about their interpretations of the initial reports they received to learn what was most and least useful. We also studied emergent data trends from the survey itself in order to better target our subsequent support efforts with networks.

Taken together, these experiences shaped the core design features that undergird the reporting platform described in the next section. While these design principles are based both on extant research and the practice-based experiences of key members of the project team, they should still be understood

[1]For further information about the current survey and reporting platform, see UChicago Impact, https://uchicagoimpact.org/our-offerings/5essentials.

as a set of conjectures about what might maximize the learning of hub leaders. They remain objects of our own improvement inquiry; we continue to evaluate and iterate on them over time.

Key principles undergirding the technical design of the system

In broad terms, the INHD Information System was intended as a development resource for the NSI initiative. It aimed to make visible the beliefs and practices of network members, how these may evolve over time and how they align with the idealized conception of improvement networks that appear in the literature (see Russell et al., 2025, this issue). Also, mindful that improvement networks depend on local agency and that local contexts offer different resources and constraints, the system should make visible the sources of variability at work in these processes, both within individual networks and across the initiative. The six principles discussed below emerged in response to these concerns.

Offering bounded customization of key terms

The NSI grant-making process and the characteristics of applicant organizations yielded a diverse set of networks. The Gates Foundation's request for proposals described several core features of NSIs, but left open for applicants to specify much of the operating details about the composition of their proposed network and how it would work. The applicant organizations funded to become "new" NSIs brought their extant organizational practices, understandings and work norms with them. As a result, there was considerable diversity both in how different NSIs organized their work and the language they used internally to describe it. This variability in practices and language posed a challenge for developing a common survey to work across all NSIs. The survey would need to simultaneously: (1) measure the key concepts of network health as derived from the INHD Framework; (2) accommodate NSIs with varied structures and processes; and (3) craft items that used language interpretable by participants in these varied organizations.

In order to address these concerns, the authorship team first identified an underlying set of core practices and beliefs that were present both in the INHD Framework and fundamental to the NSI initiative. These included, for example, the importance of using inquiry routines (e.g., PDSA cycles) and having some central organization (e.g., a "hub") leading a network of schools.

Then, we offered "bounded customization" for the survey items associated with these anchor elements. This allowed hub leaders to customize the expressions used for these phenomena in their particular network. Table 1 provides an example of how common phenomena were named differently across networks.

So while some of the item-level language used in the survey was not technically identical for members of all networks, it was still possible to develop common measures that could offer insights to each network, support opportunities for NSI-wide learning conversations to occur, and discern more generally how the initiative as a whole might be evolving.

Anchoring results in the INHD Framework

In recognition that many hub leaders were new to their roles and had not led an organization with this particular structure before (Peurach, 2016), we structured the information system to bring users into the complexity of network functioning without overwhelming them. We worried about the challenge

Table 1. Examples of survey language customization for different networks.

Underlying Concept	Network 1 language	Network 2 Language	Network 3 language
Network Leaders	Hub Leaders	Leadership Team	Anchor Team
Inquiry Routine	PDSA	Inquiry Cycle	PDCA

for hub leaders in trying to interpret results and discern meaning from simple descriptive statistics on many different survey questions (Coburn & Turner, 2011).

In response, we emphasized the reporting of measures, created from multiple survey items, where each measure directly connected to a specific domain in the INHD Framework.[2] We also added cursor roll-overs to the web-based reporting platform that pop up brief descriptions as to the significance of each domain and measure. This platform design feature offered a way to continue to "teach the framework" through network participants' ongoing use of the tool. It was hoped through their multiple engagements with the information system over time, a common language might emerge within and across networks and in turn increase possibilities for shared learning to evolve about developing strong improvement networks.

The home screen for the reporting platform brings the user to a simplified version of the INHD Framework. Figure 1 presents an example of the home screen based on results from one NSI in 2023. It displays the six core domains forming the INHD framework and uses color-coding to distinguish between the parts of the framework on which their network might be relatively strong and other areas where that were less developed. As seen in Figure 1, participants' reports in this sample network were characterized as "emerging" with regard to Contexts for Improvement (i.e., weaknesses in the alignment of the NSI aims with district and school priorities); "developing" where some strengths have been noted in Hub Leadership; and "achieving" in the other domains where respondents' reports were characteristic of a well-developed improvement network.[3] This display is where hub leaders begin an investigation of the state of their organization.

Signaling the information that matters

All told, the core of the INHD Survey consists of 97 items composing 22 measures and five single-item indicators. We recognized, based on lessons from the earlier design experiences with the *5Essential Supports Survey*, that simply providing item by item results in an undifferentiated mass was a recipe for overwhelm. Therefore, we aimed to create an architecture for the platform that respected the complexity of the work that users were engaged in, but also provided an instructive way to navigate through this complexity.

This concern led us to organize the reporting platform as an "information pyramid." Users are first presented with a summary of their current status on the six major domains of network health as displayed previously in Figure 1. Thoughtfully interpreting the results from the Likert-type scales typically used in surveys is often difficult absent some external comparative reference. The INHD reporting platform offers users three different perspectives in this regard: (1) a comparison of current results to "development standards" anchored in the data from all of the NSIs in the 2021 base year. This provides the descriptive classification of results into "emerging, developing and achieving" as displayed in Figure 1; (2) the location of the network's current report on each measure in a given year relative to the distribution of results across all NSIs that same year; and (3) current results in the context of a network's developmental trends over time on each measure. Regardless of where a network started, we knew it was important for participants to be able to see their progress over time.

[2]The emphasis on reporting measures rather than single items also reflects a longstanding psychometric concern. The evidentiary signal in any single item may be weak, but signal strength can be amplified through a set of items carefully written to capture some specific practice or belief. The challenge in developing a practical survey measure is to maximize the "signal-to-noise ratio" with the smallest number of items.

[3]An empirical Bayes estimate is computed for the average response on each measure for each network each year. Based on the distribution of these network estimates in 2021, we created cut-points for each measure at the 25th and 75th percentiles. These cut-points established in 2021 remain constant. We scored each measure for each network as + 1 (top quartile using 2021 cut-points), 0 (middle 50% using 2021 cut-points), and −1 (bottom quartile using 2021 cut-points). We then aggregated these scores across the set of measures assessing a domain (i.e., hub leadership, continuous improvement, network roles and engagement, internal team connections, cross team connections, and network culture) as the basis for classifying the state of the network's development in that domain.

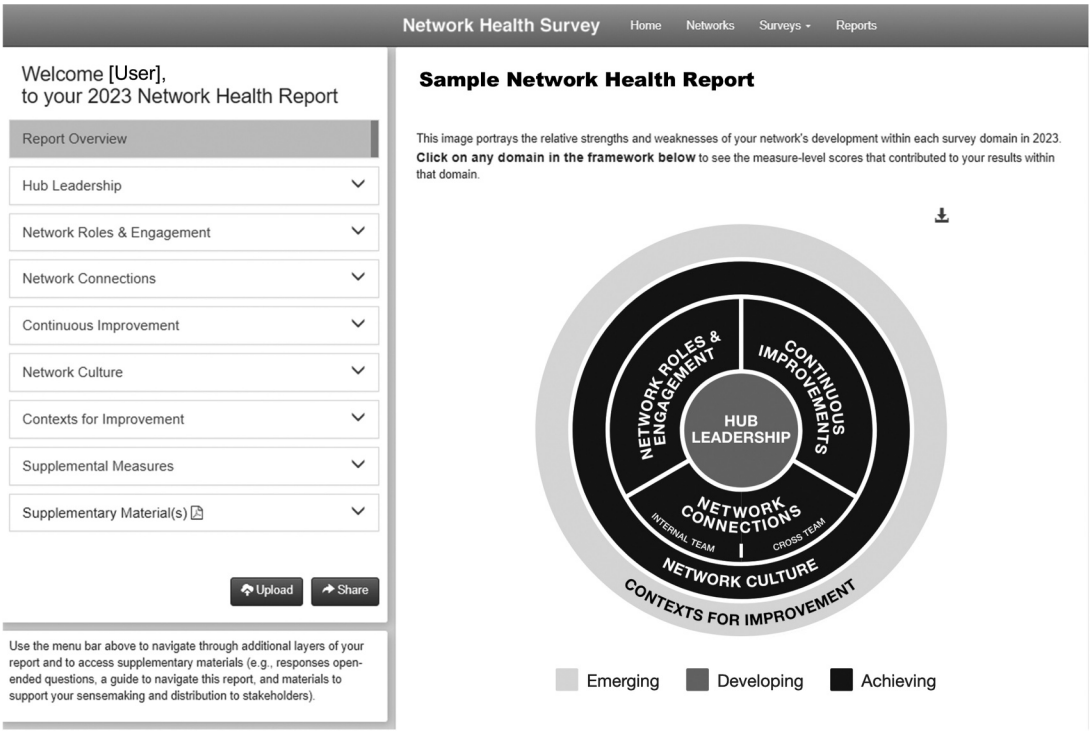

Figure 1. Home screen of summary survey results embedded in the INHD Framework.

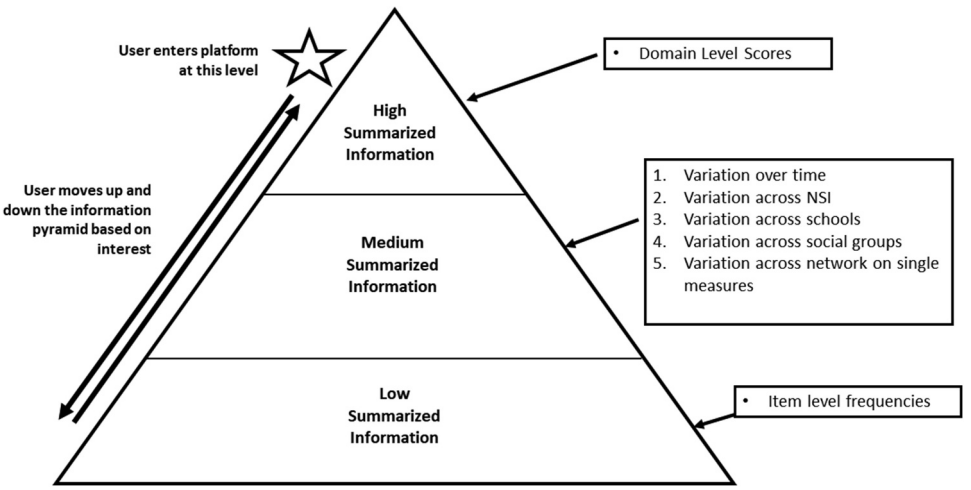

Figure 2. Information pyramid to inform network leaders.

Based on these initial high-level data observations, users are encouraged to "click down into" the different domains in order to get more detail about a particular area of interest. For example, if a user notices that their Hub Leadership is still "emerging," they might click down to examine which specific measure(s) of Hub Leadership were found weak. They might learn, for example, that relational trust between hub leaders and network members was a concern.

Figure 2 illustrates both (a) the entry point for users, where they are faced with highly summarized information at the level of the network health domain and (b) their potential movement through the platform to access information with greater granularity and specificity based on considerations that they identified as worthy of deeper exploration. The overall architecture of the reporting platform was designed to promote guided inquiry—to support users in conducting their own investigations by giving them agency to access different "slices" of the data based on what they think is most important. The visualization system allows them to seek out distinct types of information summarized in different ways in order to probe more deeply and better understand the performance of their network.

Illuminating variation in beliefs and practices

Variation in performance as the problem to solve is a core improvement science principle (Bryk et al., 2015). We took this to heart in the design of the reporting platform, focusing on five key potential sources of variation. (These are highlighted on the right-hand side of Figure 2.) The first source, already noted, is variation over time. As has been documented in extensive work on quality improvement analytics (see e.g., Langley et al., 2009), the display of results over time is fundamental to the improvement process because it allows individuals to take stock of their efforts and make an explicit connection between actions taken and results achieved.

A second source of variation is across different networks. We learned, in response to early feedback from hub leaders themselves, that they wanted to know how their network's reports compared to peer networks in the initiative. They felt that this source of benchmarking could help them in multiple ways. Knowledge of the existence of higher-functioning networks could serve a motivating purpose, demonstrating that better results were possible, and potentially spur reflection and action. It could also advance improvement learning by opening inquiries about what well-developed networks were doing to achieve these results. Key to securing this productive use of "competitive evidence" were safeguards put in place both in the technical design of the system and in the social design of the Community of Practice that was created around the initiative. Each network's results were presented as a single point located against a box-and-whiskers plot of NSI-wide results. (No network-by-network comparison was ever released to NSIs.) And given the formative purpose of these data, foundation staff assured networks that their results would not be used against them in subsequent funding decisions.

Third, we designed our visualization system to make visible variation across sites. NSIs are nested organizations in which site-based improvement teams (e.g., teachers working together) are engaged in improvement work in their specific schools to advance the same network aim (Russell et al., 2017). Even in a well-developed network demonstrating some "on average" success, it would not be unusual to find variation across sites in their reported functioning. It follows that having insight into the relative strengths and weaknesses of different school sites could help hub leaders target extra supports where needed and identify productive places that might operate as supportive partners to others. Thus, we designed the INHD Information System to make site-by-site differences visible as well. Because the number of participants in any single school was often small, identifying reliable differences among schools within networks was not generally possible based on these data alone. We specifically cautioned against this. (That said, using these data to consider site-by-site differences could be helpful if used in conjunction with other information available to hub leaders.)

Fourth, we attended to variation across social-demographic groups within the network, including professional role groups, groups organized by race and ethnicity, and groupings that were chosen by networks and customized to their needs. These sub-groupings represent potential cleavages among network members that might function as barriers to the formation of norms sought in a scientific-professional learning community. NSI members fall in different role groups, most commonly: Hub leaders; organizational sponsors (e.g., school board members, district administrators); improvement coaches who support the work at specific sites; site-level team leads; and site-team members. Individuals with different roles may experience the network differently, and recognizing this variation could also prove beneficial for hub leaders (Kinlaw et al., 2020). Individuals from different ethnic and/

or racial groups may also have different network experiences, constituting another relevant source of variation to explore. This was especially important given the NSI initiative's equity objectives and a corresponding belief that activating the voices of educators of color was a key resource in this regard.

The fifth source of variation captured in the reporting platform directs attention to the extent to which NSI membership had formed as an intentional community. In a well-developed NSI we would expect to see a core set of beliefs and practices strongly endorsed and widely shared across the network. Such normation operates to create social boundaries that define community membership. In contrast, participant responses in newly formed networks would typically be more varied with a significant number offering tepid or even negative responses in these regards. The probability density displayed, described by Bryk et al. (2025) in this special issue, were specifically designed to make this information visible and clear.

Providing evidence in a timely fashion

The ability to provide feedback in a timely manner to NSIs represented another key design concern. Hub leaders face a "learning imperative" to inquire about the success of their efforts and make adjustments accordingly (Peurach, 2016). However, it is common for surveys and traditional assessments to suffer long time lags between data collection and the availability of results (Gordon & Conaway, 2020). This can impede leaders' ability to act on evidence because by the time the evidence is shared, the chance for targeted decisions has long passed.

In response to this challenge, we designed the information system to substantially reduce the time between the close of survey administration and the delivery of a report. Initially, producing reports took six weeks, but over the course of the project we have refined our own internal processes in order to deliver reports back in less than 10 days. To accomplish this, we used Apache Airflow,[4] an open-source platform for developing and executing efficient workflows in a virtual environment, to organize the sequence of tasks from raw data to draft report (e.g., cleaning data sets, calculating Rasch measures and standard errors, performing statistical operations on different forms of data, and visualizing the statistical results). This process codified the dependencies between these tasks, and automatically executed them with minimal human involvement. Figure 3 is a screenshot from the Apache Airflow platform that details the multiple statistical scripts that need to be run in order to produce a draft network health report at the touch of a button.

Safeguarding the system as a formative tool supporting network development

The INHD Survey ran the risk of being perceived as an evaluative tool designed to provide summary judgment about the worth of individual NSIs. Indeed, the survey covers topics thought to be central to network effectiveness, such as the characteristics of collaboration occurring in the network, the quality of continuous improvement enacted by network members, and the degree to which network members think their work was making a difference for students. The authorship team was concerned about the potential for the survey to be perceived as evaluative because such a perception might lead networks to try to "game" the survey—encouraging members to voice inauthentically positive perceptions in an effort to score high in any evaluative contest. Furthermore, the authorship team worried that if the survey were to be perceived as evaluative in nature it might create anxiety among hub leaders, and with that, reasons to discount the information rather than operating as a resource for their own improvement and learning.

To alleviate this risk, the authorship team worked closely with program officers from the foundation to ensure that all communication regarding the survey emphasized that its purpose was to support network learning and development. We framed our data collection and reporting as a learning opportunity for hub leaders, based on members' perceptions at a snapshot in time. Program officers

[4]An overview is available here: https://airflow.apache.org/docs/apache-airflow/stable/index.html

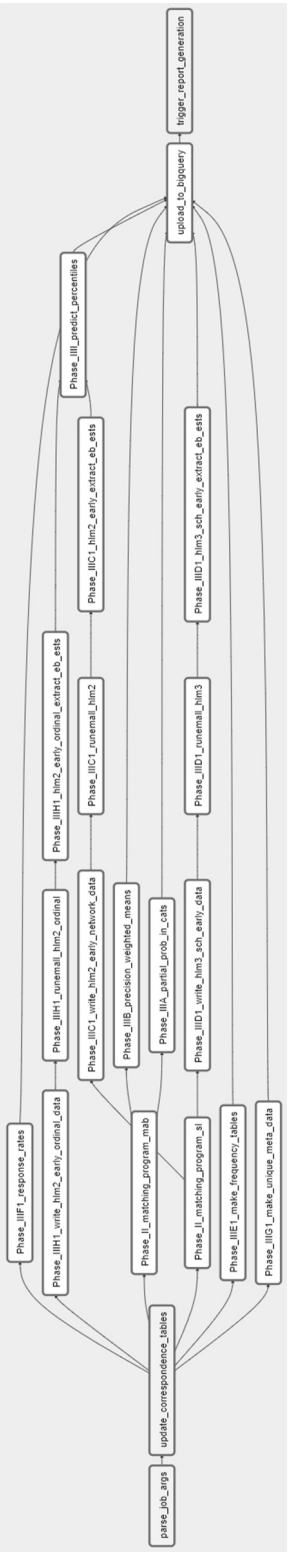

Figure 3. Visualization of statistical workflow required for rapid report production within Apache Airflow.

emphasized to hub leaders that the survey results would not be used to determine the continuation of funding for any individual networks, thus eliminating possible stakes to individual networks in this regard. The authorship team was also intentional about the sequence of data reporting. Hub leaders always received their individual reports well before any summary information was shared with foundation program officers. This allowed hub leaders time to study the reports, reflect on possible implications and draw inferences about what they might prioritize going forward. This left them well positioned to ground their proposed plans to the foundation for the next year ahead.

Moving along a path of inquiry: A vignette of learning platform use[5]

To demonstrate the learning opportunities embedded in the reporting platform, we share a vignette of how a particular network navigated through the information pyramid from a general observation to specific insights for action. Returning to Figure 1, this was the network's home page on the reporting platform in 2023. This network launched in 2018. Its survey results that first year were among the weakest of all of the NSIs. It was classified as "emerging" on all six framework domains. Over the next three years, it continued to develop despite the extraordinary stresses introduced by the pandemic. In 2022, it was now "achieving" in every domain except Contexts for Improvement. This network was located inside a large urban district. Although hub leaders felt supported by senior system leaders, the improvement work in schools often had to compete with other district and local school initiatives. So, there was nothing new in the continuing expressions of concern, seen in the 2023 report, about challenging conditions regarding local school and district support for their work. Managing this concern remained ongoing work for the hub.

What was new in 2023 were the weaker reports about Hub Leadership. Results for this domain had fallen back into the "developing" category. When hub leaders looked at their trend data, they observed declines in both of the core measures in this domain (see Figure 4). While relational trust in hub leaders remained broadly held (see the probability density display in Figure 5), network member responses were more varied with regard to knowledge management (Figure 5). This result led hub leaders to dig deeper into the items composing this measure (notice the Item (s) tab on the web-based visualization). The weakest responses occurred on two items: (1) encouraging the use of changes that other teams found successful; and (2) creating access to what other teams were learning (see Figure 6).

These results suggested a closer look at network members' reports about their Cross-Team Connections. Although overall results in 2023 were strong (i.e., the "achieving" designation in Figure 1), trend data showed a decline in 2023 on all three of the Cross-Team Connection measures (see Figure 7). Given the energy and attention that hub leaders had directed in this domain and given their past positive results, these new findings were puzzling. One hub leader speculated, "Maybe this is related to the two new affinity groups that we started up with new members this last year?"[6]

To explore this, they turned back to the reports about Hub Leadership and then clicked on the "Custom Subgroup tab" to see reports broken down by affinity groups. The relational trust and knowledge management reports were weaker for affinity groups 3 and 4, which had just formed that year (see Figure 8). Subsequently, they checked and found similar results for two of the three measures for Cross-Team Connections. A clear pattern emerged; newer members were offering weaker reports.

This led in turn to a related question, "What were participants saying about how new members joined the network?" To examine this, hub leaders turned to the results on the selection and induction measure in the Network Roles and Engagement domain (see Figure 9). Here again the same data

[5]Some details have been masked in this vignette to honor our commitment to preserve the anonymity of the individual networks participating in the INHD Survey. All reported data results, however, are real.

[6]In this NSI, an affinity group consisted of a number of educators from different schools who joined together to develop and test a set of change ideas relative to a particular primary driver. All of the primary drivers targeted the same shared network aim.

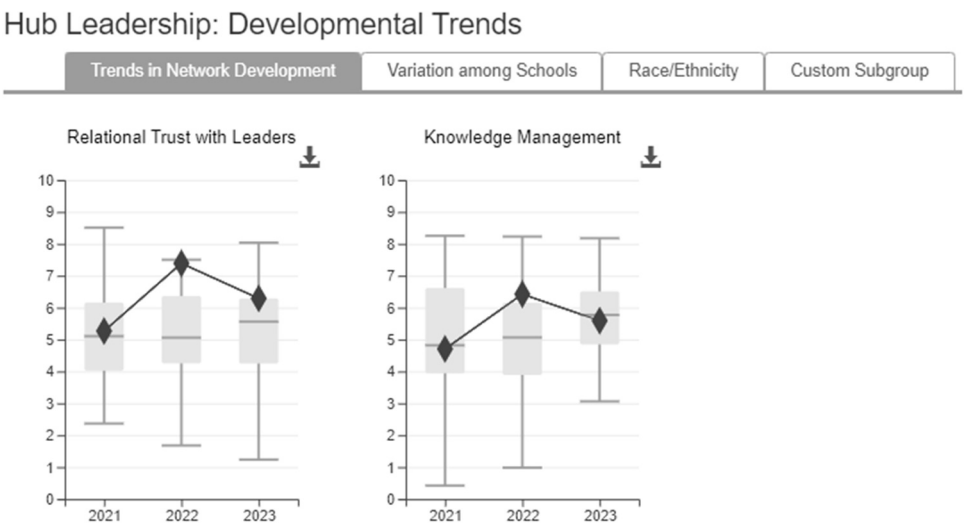

Figure 4. Declines in hub leadership measures in 2023.

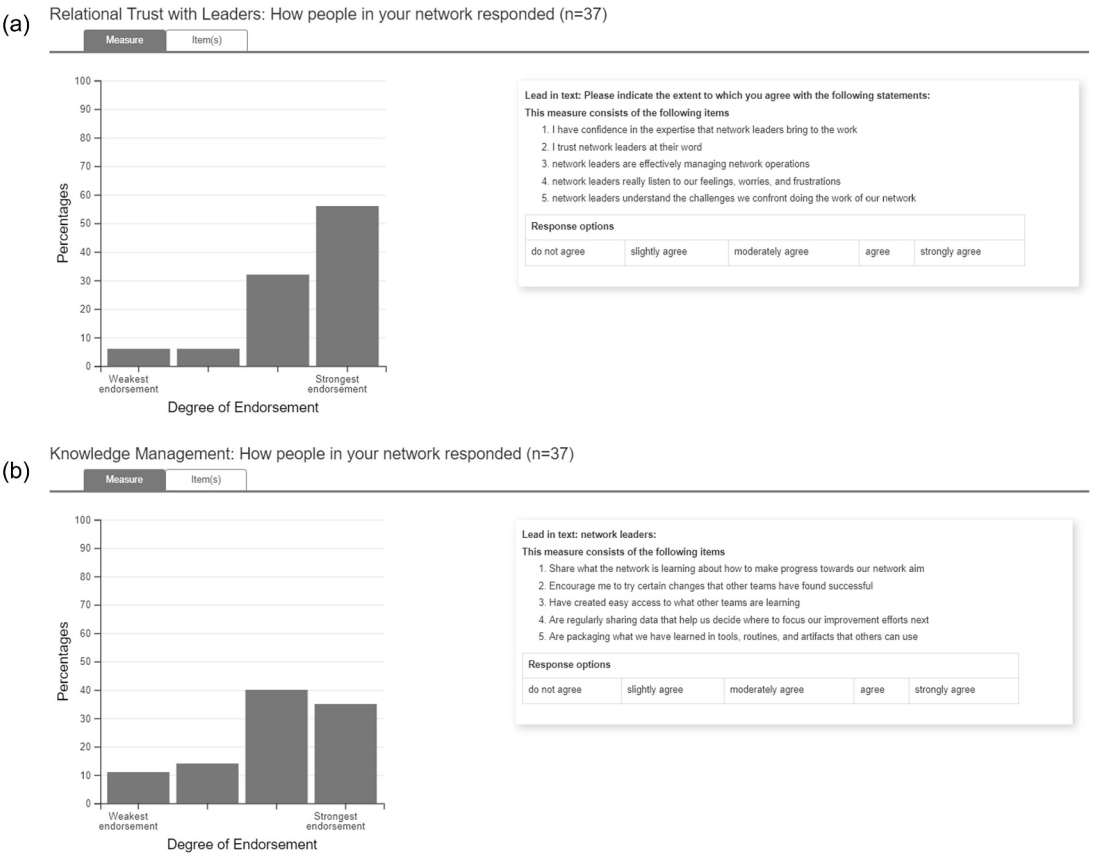

Figure 5. (a). Probability density display for the relational trust with leaders measure. (b). Probability density display for the knowledge management measure.

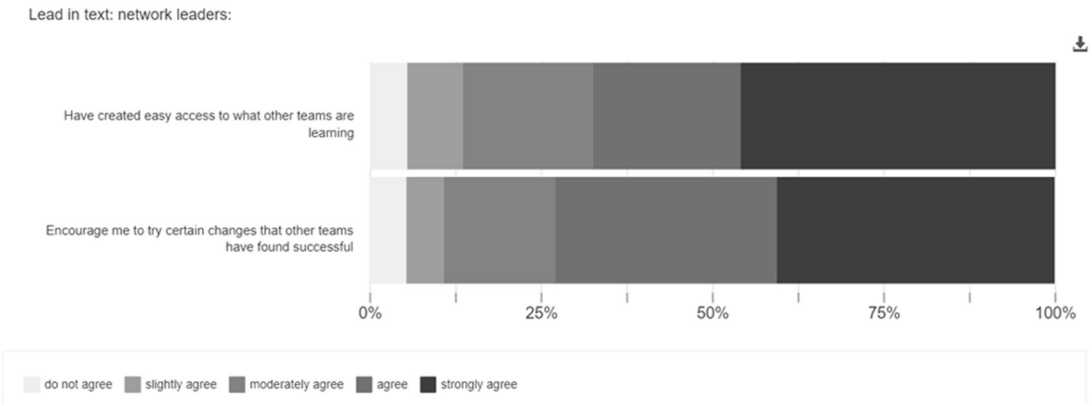

Figure 6. Responses on two items from the knowledge management measure.

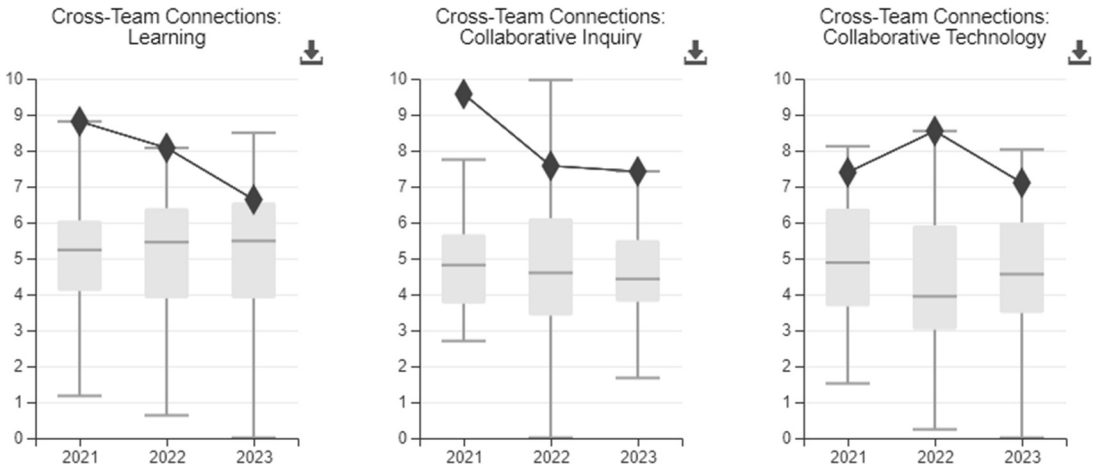

Figure 7. Declines in Cross-Team connections measures.

pattern was observed: overall reports were strong, but weaker responses were offered by members in the two newest affinity groups.

Based on this examination of the data, hub leaders inferred that the members who had joined the NSI in the past year were having weaker experiences in their network. These data-based reflections surfaced attention to both an immediate and a longer-term improvement concern: How might the hub team strengthen their support to the two newest affinity groups in the next year; and longer term, how might the hub strengthen its processes for launching new affinity groups in ways that might promote a stronger start?

This is an example of the information pyramid at work scaffolding productive network development reflections. The aggregate status and trend data encouraged network participants to drill down into specific measures and then to consider how different subgroups were responding to these measures. Observations on reports about Hub Leadership had led them to look at reports on Cross-Team Connections and then onto a specific measure in the Network Roles and Engagement domain. They then returned to their Hub Leadership reports to test their emerging understandings about the source of the variation in responses they were observing. Through the course of this investigation, they had a learning experience in seeing the interdependence across the INHD domains and measures, more importantly their NSI as an organizational system at work.

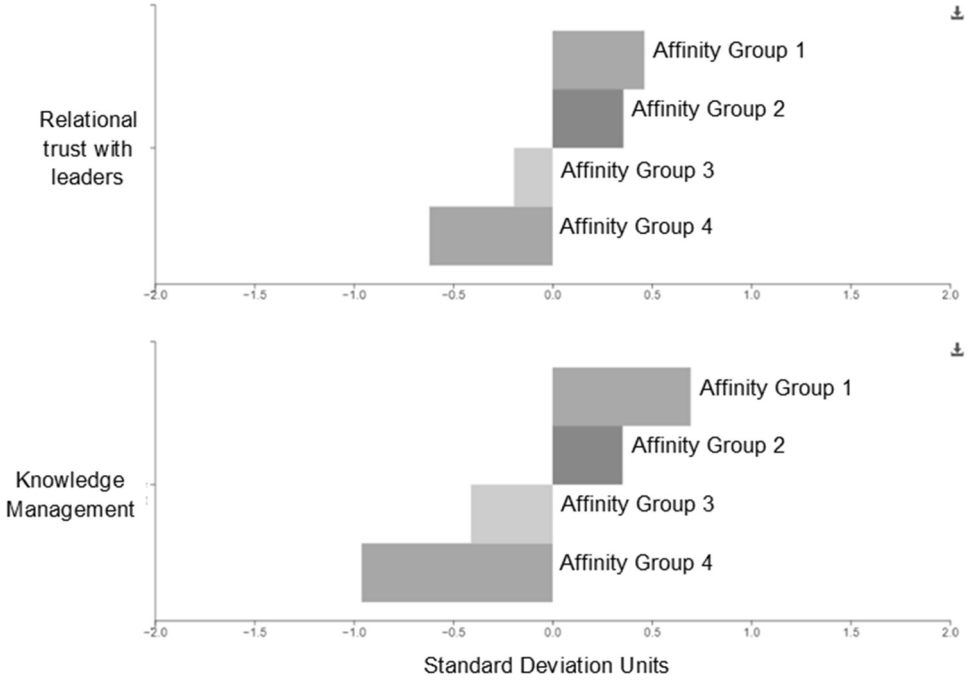

Figure 8. Weaker reports from affinity groups 3 and 4.

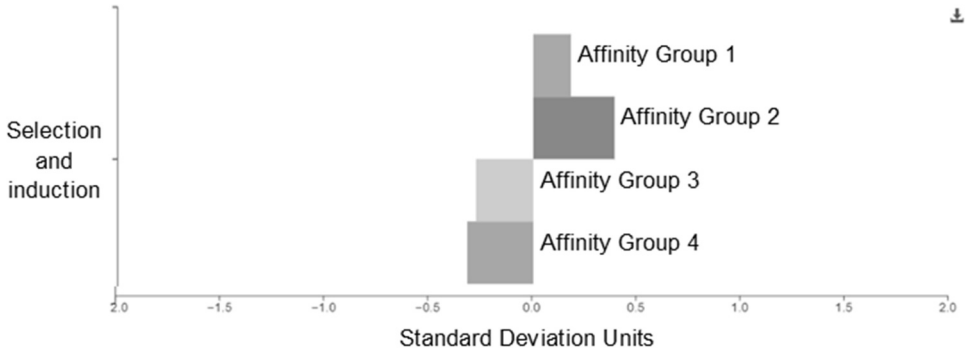

Figure 9. Breakdowns on reports for the selection and induction measure (a measure in the network roles and engagement domain).

Key processes to support social use

Complementing our attention to designing an informative reporting platform, we also organized supports for hub leaders in how to use these data. The literature on data and evidence use makes it clear that the social environment associated with specific data representations (e.g., the nature and quality of conversation about that data, the presence of routines that focus time and attention on that data) can heavily influence interpretation and action (see, e.g., Bertrand & Marsh, 2015; Coburn & Turner, 2011; Datnow & Hubbard, 2016; Molle, 2020). Therefore, we designed several strategies to support hub leaders' use of the platform, to promote valid interpretation of network health data, and to generate ideas that might guide subsequent actions.

Early in the initiative we held live webinars with NSI stakeholders and foundation staff as we were developing the reporting platform, and we revised it based on their feedback. In these sessions, we suggested taking a learning stance with the data, rather than an evaluative one.

In the first two years of the initiative, we also ran sessions during the Community of Practice, convenings hosted by the foundation for hub leaders. During these sessions we shared preliminary network-wide results, pointing out NSI-wide strengths and highlighting common challenges. Hub leaders were especially appreciative of our summary of the challenges reported by networks, as this made public experiences that many NSIs shared. These sessions were organized so that NSIs with the most positive reports on the most challenging measures were invited to describe how they were responding to these shared challenges.

Each year after individual network reports were released, we offered to facilitate data conversations with any hub leaders who were interested in discussing their results. During these conversations, hub leaders would tell us what they were observing in the data, and we would co-interpret the results with them. We would also offer a primer on navigating the reporting platform, and we would share any data patterns that we noticed as well. We built artifacts, such as PowerPoint templates, that hub leaders could then use to share key results with their network members. We also used these conversations to elicit feedback from hub leaders about how we could continue to improve the reporting system to make it more useful. These conversations provided vital information to us in our own efforts to continue to improve.

Early evidence regarding use of the information system

The primary focus of this article has been to articulate the design rationale for the third leg of the boundary object developed by our project team, an information system to support each network's development. Research on the actual use of the system has been limited to date and merits further inquiry going forward. We have begun this process by reviewing annual progress reports that hub leaders submit to the foundation, quarterly check-in reports hub leaders submit to their program officer, intake information hub leaders share with our team prior to each annual survey administration, and records from our own conversations with hub leaders about their use and administration of the tool. Our early observations, based on these data, suggest that the information system is functioning within the NSI initiative as the intended third leg of a boundary object.

At the most general level, we have evidence that hub leaders are drawing on the tool to inform their work. The authorship team asks each NSI to fill out a structured intake form before they administer the INHD Survey each year. All 34 of the NSIs surveyed in 2023 indicated that they had used network health data to identify areas for subsequent attention.

Cross-validating this observation are written reflections that NSI leaders shared with the foundation about how the information system is helping them both to better understand their own efforts and identify opportunities to learn from other networks. For example, one hub leader wrote:

> [The INHD Survey] is a good way to measure the variety of factors that are involved in this work and the impact of those factors on the schools. It is also an opportunity to learn about successes and pain points in other networks and think about how we can do things differently and build on successful practices. (progress report from hub leader, 2023)

Another hub leader noted that through their work with the platform, they were able to identify a weakness in how they were engaging network members in that a number of members reported feeling that they did not have a meaningful role in network decision making. This motivated specific change ideas:

> We discussed trying to figure out more ways for network members to recognize they have a voice in shaping the work. In some cases, I feel like we need to be more explicit about where we have made shifts as a result of what we have learned from them. We also need better ways for coaches to collect information from schools to bring back to our hub meetings. (progress report from hub leader, 2021)

We also have evidence that some hub leaders have engaged their members around specific displays from the reporting platform. For example, one hub leader wrote that they reviewed the network health data alongside their members to signal that their decision-making process is evidence-based:

> . . . [We need to] continue to share the research that backs up some of the decisions we have made. I put together a slide deck with the boxplots from the report and showed the coaches which items contributed to those boxplots to allow us to break them down further.

Several networks were also using these data in their annual reporting to the foundation to either reflect on progress to date and/or identify new priorities for the year ahead. For example, one network reported:

> Although we did not meet our intended target of 85% endorsement on the benefits measure, we did significantly increase the percentage of participants that experienced positive value from 58% in 2021 to 76% in 2022 and improve on several other [network health] measures as well.

A different hub leader noted that despite adding 11 new schools this past year, their network health reports indicated above-average levels of relational trust in hub leaders, a shared belief among members that the network was making a difference for the students they serve, and an equity-driven culture within the network. A third network used network health data to confirm a strategic priority for the coming year—a need to deepen their engagement with leaders at both district and school levels. Individual team members had shared examples of friction experienced due to the lack of leadership from principals and those overseeing school counselors. The survey results supported these observations and helped elevate this concern to become an improvement priority for the year ahead. In both instances, the networks included time-trend boxplot displays in their reports to the foundation as evidence in support of their claims.

Likewise, evidence suggests that summary results from the platform were also functioning as a boundary object bringing foundation staff into shared conversations with the NSI community. Program officers and other staff of the foundation have indicated to us that this information is helping them better understand both the progress and challenges across the overall initiative. As one program officer summed it up:

> The [network health] data is strong, and we use it consistently on the trends [we are] seeing across all the NSIs. We are hoping to bump up the response rate to be able to get even more nuanced data [in the future].

In this case, the network health data was seen as valuable enough that it was worth exerting extra effort to further improve data quality.

These examples illuminate the array of benefits that the INHD Information System and supporting resources for its use *can* provide to hub leaders and program officers, but, of course, none of this guarantees that all experience such benefits. In the end, we return to the core summative improvement question: "What works for whom under what circumstances?" We have more to learn about the use of the information system, including which aspects of it are most valued by hub leaders, which are seen as most difficult to navigate and use, and how the overall design and implementation of the platform could be made more valuable.

Closing

Again, our overall project's objective was to conceptualize and operationalize an Improvement Network Health and Development (INHD) learning system. We sought to create a boundary object that might advance social learning both within and between networks about their efforts to develop as productive improvement networks. The work described in this research on the design of an information system constitutes the third leg of the three-legged stool that forms this boundary object.

The INHD Information System's design aimed to meet hub leaders where they were in terms of their experience with networked improvement and their conceptual understanding of the type

of work that such networks entailed. The system illuminates key sources of variation in network health and focuses leaders' attention on these sources. The web-based reporting platform that shares summarized survey results was designed as an "information pyramid." It provides hub leaders with a concise and focused point-of-entry, with dynamic options for further exploration of the data based on interest or early empirical patterns they can observe at the top of the pyramid. In addition, aggregate results generated from the information system support a broader learning community across the NSI initiative including foundation staff and support partners.

Although early signals about the value of the INHD Information System have been positive, there remains much to learn about how to optimize the design of this platform and others like it, in order to support the development of improvement networks more generally in education. Working in a practical domain such as this, there is an inevitable trade-off between the length and detail of an information source and the ability of that information source to generate usable insights for leaders who are often time-constrained. Future work on the development of INHD Information System might further refine the visualizations used, so that reports can become even more concise and insightful for network participants. It is our hope that the key design elements of the system shared here will support others seeking to inform and accelerate the work of improvement networks in other contexts.

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