From improvement to relationship management: A case study of data artifact creation and use in a school improvement network

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Improvement networks are a relatively recent phenomenon in US education that create inter-organizational networks of educators working together to improve specific educational problems. A shared emphasis of these networks is the use of data to support the improvement process, but little is known about their data use in practice. This study takes an in-depth look at the 800+ data artifacts created and used in a single focal network's third year, applying a mixed methods case study design. The findings show that while data artifacts are predominantly created to support the improvement process, they are frequently used for relationship management as network hub members navigate the sociopolitical dynamics typical of a complex change effort – if they are used at all. The study has implications for practitioners as they decide what data artifacts to create and use, as well as for researchers' theory-building about productive data use in improvement efforts.

Keywords: improvement networks; improvement science; continuous improvement; data use

Introduction

In the last decade, we've seen rapid growth in the form of inter-organizational networks, composed of educators working together to improve specific educational problems. These networks are a relatively recent phenomenon in US education, although they have been a recognized form of inter-school collaboration internationally for many decades prior (Atkinson et al., 2007; Muijs, 2010). Networks were used as a novel approach to urban school reform in the late 1990s and early 2000s in response to the Annenberg Challenge in LA (Wohlstetter et al., 2003) and the children first networks in New York City's Autonomy Zone (Wohlstetter et al., 2013). They were further popularized in the US by scholars at the Carnegie Foundation for the Advancement of Teaching (Dolle et al., 2013; Bryk et al., 2013) in the form of networked improvement communities.

Networked improvement communities and improvement networks, more broadly, utilize the tools of improvement science to support educators solving persistent problems of practice. Improvement science is a particular problem-solving approach focused on identifying changes that address our best understanding of the problem we are trying to solve and using data and evidence to reflect on whether the changes they introduced are, indeed, improvements (see Associates in Process Improvement [API] website: https://www.apiweb.org/). While diverse, these networks share a commitment to bringing educators from across schools and districts together to support collaborative problem solving and improvement by accelerating their knowledge-building and change efforts.

Data use is central to improvement networks' theory of action (Bennett & Provost, 2015); however, there has been insufficient attention to whether and how networks support data use to guide educational improvement in operation. This gap in the literature is particularly concerning as understanding the extent to which productive data use is or is not occurring is essential to understanding how the improvement network concept is being realized in practice. Further, while data is recognized as being core to technical improvement work (Daly, 2012; Helms-Lorenz & Visscher, 2022; Schildkamp et al., 2016), its potential for use in navigating the complex social and political dynamics typical of these networks is largely unexplored.

In a time of rapid proliferation of improvement networks in the education field, we therefore ask: how are networks using data to support their improvement aims? Specifically, we broaden the conceptualization of data use within improvement networks by attending to (1) sociopolitical pressures for data use in addition to technical-rational ones, (2) uses of data beyond the support of improvement work, (3) how data use varies in different network contexts, and (4) how data changes from creation to use.

Case Context

This study's focal improvement network formed in 2018 through funding from the Bill & Melinda Gates Foundation's Networks for School Improvement Initiative.[1] The focal network is led by a hub team, composed of researchers and professional learning and technical assistance providers, working in collaboration with an American urban school district. The network's aim is to improve middle and high school students' literacy skills to support their college- and career-readiness, particularly focusing on historically underserved students, including students of color, low-income students, and English learners.[2] The network hub focuses on providing professional development and instructional materials to teachers, building the continuous improvement capacity of school-based improvement teams, facilitating opportunities for cross-school collaboration, and partnering with educators to expand equitable learning opportunities within their classrooms.

In general, hub teams function as an initiator of activity and an integrative force for the

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1. The Networks for School Improvement Initiative was launched by the Gates Foundation in 2018 to support organizations bringing together and serving as intermediaries for networks of middle and high schools. These networks work together to improve high school graduation and college success rates for their Black and Latino students and students experiencing poverty through the use of continuous improvement methods, proven indicators of future student outcomes, and unwavering commitment to equity (Bill & Melinda Gates Foundation, n.d.). To date, the initiative has supported the formation and operation of over 40 networks for school improvement.

2. The first and second authors of this study were both researchers in the focal network's hub team, which afforded access to network information and special insight into network functioning. The first author was a graduate research assistant who joined the focal network in its third year and continued as a network member through the end of the network's fifth and final year. The second author was involved with the network from its initiation, serving as a faculty member affiliated with one of the research centers.

network (Russell et al., 2017; Bryk et al., 2011). To achieve its improvement aims, the focal

network employs continuous improvement methodologies, such as data-based inquiry in the

form of Plan-Do-Study-Act (PDSA) cycles and data-based decision making in the form of adopt-

adapt-abandon choices about instructional practices as they are implemented. Data use is often

heavily mediated and structured by the network hub (Russell et al., 2017), as was the case in our

focal network, driving our choice to focus our study on hub data use, specifically.

Improvement networks operate in complex social and political environments. As

temporary organizations, they rely on the partnership and engagement of actors from multiple

partnering organizations. For example, the focal network brought together actors from a

university-based research center and a professional learning and technical assistance provider

(the network hub), a large urban school district (teachers, instructional coaches, and supporting

district leaders), and the Gates Foundation (the funder). Each of these organizations is subject to

different pressures that we argue shape the design, implementation, and sustainability of a

system of data use. There is additional complexity introduced by the dynamics of district-level

insider-outsider partnership (Coburn et al., 2008) when the hub team comes from outside the

district, as was the case in the focal network.

Conceptual Framework

With applications of continuous improvement and improvement science methodologies

proliferating in education, educators are being pressed to use structured methods to understand

the root causes of their problems of practice and engage in data-based inquiry cycles to test

whether system changes are resulting in improvement (Lewis, 2015). Continuous improvement

scholarship emphasizes how data can be systematically collected and analyzed to generate

information that deepens understanding of the system producing a problem of practice (Bryk,

2020; Meyers & VanGronigen, 2020). This emphasis contrasts with that of the testing movement in education, which foregrounds data for accountability - sometimes as a means for school improvement and other times in direct contrast with improvement (Ehren & Swanborn, 2012; Robinson & Timperley, 2000).

Prior studies on data use suggest that how, why, and in what context data is both created and used can significantly impact the initiative's efficacy and impact (Hannan et al., 2015; Pentland et al., 2016). Our conceptual framework, illustrated in Figure 1, focuses on both the creation and use of "artifacts," such as memos, planning documents, raw data, and templates. In this study, we use artifacts as a more general term for any data product that is created to support the improvement network, extending beyond more restrictive conceptualizations of data common in education, e.g., assessment data, school climate data, behavioral data (Gummer & Mandinach, 2015; Mandinach & Gummer, 2016).

Much of the literature considering data in education focuses on data use explicitly, or treats the data lifecycle as a single process (Farley-Ripple et al., 2020; Gummer & Mandinach, 2015; Mandinach, 2012). In this study, we have separated creation and use into two phases. Moving from left to right in the conceptual framework, the discrete phases of artifact creation and artifact use are laid out, each with their own uses, pressures, and contexts.

We draw on three primary bodies of literature to conceptualize the role of data within improvement networks. Literature on data in improvement networks largely speaks to its technical function in the improvement process. For example studies have emphasized the use of practical measures that are timely, minimally burdensome, and strongly related to the problem of practice and goals of an improvement initiative (Cobb et al., 2019; Takahashi et al., 2022;

Yeager et al., 2013). These practical measures can take many forms, such as a measure of student engagement using data from a brief survey administered at the end of class.

Literature on data use in education speaks to varied uses, including decision-making, developmental evaluation, capacity-building, and instructional improvements (Datnow et al., 2012; Farley-Ripple & Buttram, 2015; Mandinach, 2012). The still broader organizational theory literature suggests data can also be used to navigate the social and political dynamics of complex change. In particular, Ansari and Euske's longitudinal study of a public sector organization's use of data (1987) proposes a definition of the sociopolitical role of information centered on the pursuit of power in order to assert self-interest, justify action, and gain influence. Further, Prado-Roman and colleagues (2020) take a more institutional perspective in attending to the role of communication of information in improving organizational legitimacy and performance. Information shared through robust internal and external communication systems can be a valuable tool for consensus-building and decision-making. While such conceptualizations of data use have been less explored within education research, they are particularly relevant to improvement networks given their complex web of organizational relationships, power dynamics, and need for active collaboration (Wohlstetter et al., 2003).
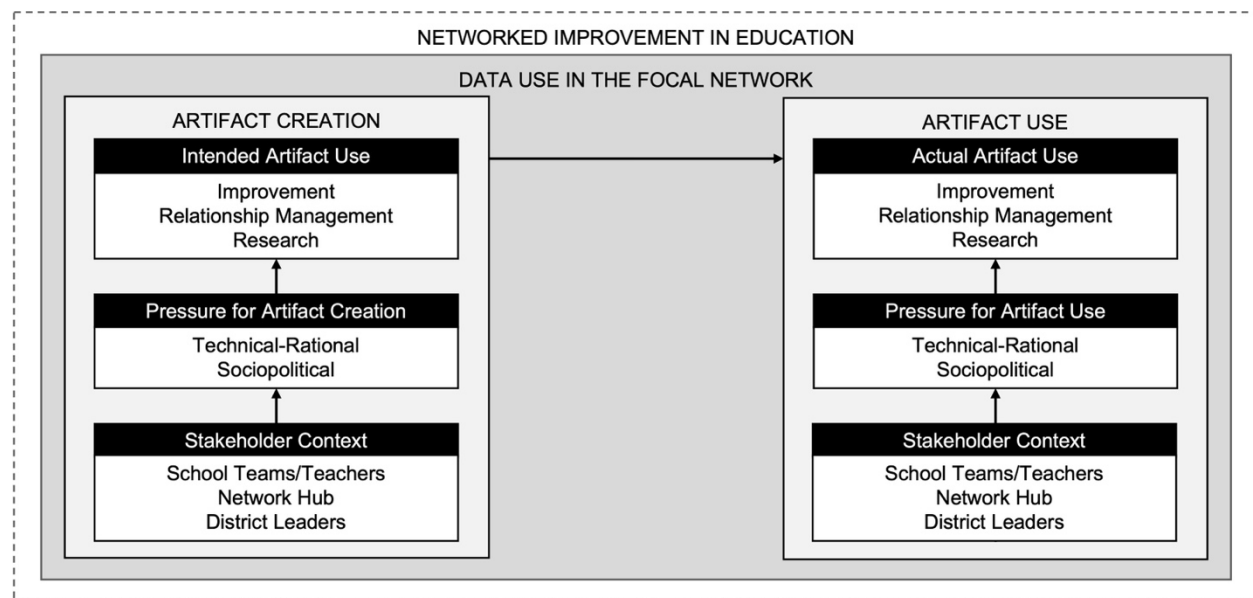
Figure 1. Conceptual Framework

Intended and Actual Artifact Use

Given the diverse range of aims for data use in education, we sought high-level categories that could encompass those present in literature. Solberg and colleagues (1997) suggest there are critical differences in the use of data for improvement, accountability, and research (see Table 1); these uses serve as a foundation for our conceptualizations of intended and actual artifact use.

Literature explicating these three faces of data use provides an important perspective on how data for improvement is different from data designed for other purposes. Practical measures are typically emphasized in improvement-focused data use. In contrast, externally-defined outcome measures are often used for accountability purposes and data used for research support generation of field-building knowledge (Solberg et al., 1997).

Table 1. Intended artifact uses and descriptions

Intended Use	Description
Accountability	Data intended to reveal or compare outcomes
Improvement	Data intended to support, understand, and evaluate the efficacy of changes

Research	Data intended to generate new knowledge

Context of Artifact Use

Research underscores the importance of policy and district contexts in shaping collaborative processes surrounding teacher data use to inform instruction and drive decision-making (Datnow et al., 2012, 2013; Mandinach et al., 2006). In improvement networks, policy, local, and implementation contexts all have implications for the type and impact of work undertaken (Datnow, 2000; Datnow & Park, 2009; Peurach et al., 2016).

The importance of context is further emphasized in literature on data use, both within education and beyond, stating that for data to become meaningful it must be connected to a context (Breiter & Light, 2006; Jifa & Lingling, 2014). Both Breiter & Light and Jifa & Lingling use the DIKW hierarchy (Ackoff, 1989) - that is, data, information, knowledge, wisdom - as a typology for understanding data and data use. Jifa & Lingling speak to the DIKW hierarchy more broadly, naming context as an inherent feature of information, differentiating it from raw data by way of its relational connection. Breiter & Light attend more specifically to the creation of effective information systems for decision-making in schools and again name context as a requirement for data that carries implications for action.

This study contributes to the existing research base on improvement networks by attending to different ways in which network hub members used data in the context of their work in support of school teams and teachers, district leaders, and the network overall (see Table 2).

Table 2. Contexts of artifact use

Context	Examples
Support of school teams and teachers	● Support for teachers in making instructional decisions ● Support for teachers as they learn new instructional practices
Support of district leaders	● Support for district leaders as they make a case for continued support of the network

	● Support for district leaders as they make decisions about how to engage with the network
Support of the network	● Support for hub members as they conduct analysis of network results ● Support for hub members in ongoing network operations

Pressures for Artifact Creation and Use

There is a significant body of literature concerned with environmental and isomorphic pressures on organizations (DiMaggio & Powell, 1983; Meyer & Rowan, 1977) and how they play out in the varied contexts within education (Coburn, 2004; Smith & Washington, 2014). In particular, we can examine the creation of improvement networks through the lens of pressures exerted at the school and district level (Glazer & Peurach, 2013). Much of the literature concerning improvement networks, however, focuses on technical-rational pressures for evaluation and improvement (Daly, 2012; Peurach et al., 2016), often at the school or district level.

Within this study, we use Ansari & Euske's (1987) sociopolitical and technical-rational lenses to frame environmental sources of and organizational responses to pressures in artifact creation and artifact use phases. A technical-rational perspective "emphasizes the need to coordinate and control the activities within the technical core of an organization" while a sociopolitical perspective emphasizes how "people in organizations are influenced by and in turn, attempt to influence information systems" and an institutional perspective emphasizes "legitimiz[ing] the organization with its external constituencies" (Ansari & Euske, 1987, p. 552). Ansari & Euske further suggest that a sociopolitical perspective is inward-focused, seeking to influence organizational participants, while an institutional perspective is outward-focused, seeking to influence external constituents. Due to the fluid, more amorphous nature of internal and external organizational bounds within improvement networks, we combined the institutional

perspective and the sociopolitical category in our adaptations to the context of improvement

networks (see Table 3).

Table 3. Pressures for artifact creation, adapted from Ansari & Euske (1987)

Pressure	Examples
Technical-rational	• Pressure for decision-making • Pressure to support, coordinate, or control network or district activities • Pressure to measure network progress or impact
Sociopolitical	• Pressure to legitimize choices or justify actions • Pressure to create a common understanding • Pressure to motivate individual and group behavior

Inquiry Approach

This study pursues a holistic, mixed methods examination of data use in the case of an

improvement network (Creswell & Plano Clark, 2018). It investigates key dimensions of data

use in a complex context (Yin, 2017), ultimately using the case of our focal network to explore

how networks use data to support their improvement aims. The ultimate aim of this study is to

theorize about data use in this emerging phenomenon in education rather than to identify findings

that generalize to all improvement networks, which is particularly challenging due to the high

variability across networks (Wohlstetter et al., 2013).

Due to the insider status of the first and second authors of this study as members of focal

network's hub team, we were afforded access to network information and special insight into

network functioning. We also had to be particularly cautious of preunderstanding skewing our

interpretation of our dataset or causing us to assume too much, as well as the duality of our

network and researcher roles creating increased challenges in managing internal politics

(Brannick & Coghlan, 2007). In order to manage this tension, we used a semi-structured

interview protocol that explicitly attended to details of the specific data artifacts that were used

in each context, including their aims, pressures, origins, and other involved stakeholders. We

also triangulated our artifact coding with other network hub members in any cases where there was uncertainty.

Data Collection

Our study draws from two primary data sources in the focal network's third year (2020-2021): a repository of data-related artifacts generated by the focal network hub and semi-structured interviews with hub members. The artifact repository was used to explore facets of data artifact creation, while the semi-structured interviews were used to explore data artifact use. Finally, these two datasets were connected to support exploration of artifact creation versus use.

Artifact Repository

First, we analyzed the focal network's 2020-2021 network hub data-related artifacts to understand artifact creation and intended use. While the global pandemic created myriad challenges in education, many of which were felt in our focal network, in the context of this study it allowed us to create a more complete inventory than may have been possible in other years where many physical artifacts were created in addition to digital artifacts. Artifacts were included if they:

(1) were created in the 2020-2021 school year

(2) were accessible to all members of the network hub

(3) were created as a result of a network hub process OR to support a network hub process (Carnegie Foundation for the Advancement of Teaching, 2020)[3]

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3. Network hubs engage in a number of key processes associated with organizing and operating a high functioning networked improvement community. The Carnegie Foundation for the Advancement of

(4) represented the final version of an artifact

Our final sample included 839 artifacts from the 2020-21 school year. 250 artifacts from the 2020-2021 school year that were accessible to all members of the network hub were excluded from this dataset on the basis of the third inclusion criterion (e.g., meeting minutes, meeting transcripts) or fourth inclusion criterion (e.g., was an earlier version of an artifact).

Coding. Next, we classified each artifact using codes derived from our theoretical frame (e.g., "pressure for artifact creation" and "intended artifact use"). After the first round of coding, we checked for consistency across codes. The codebook was updated for increased specificity as needed and some artifacts were re-coded according to the refined code definitions.

Artifacts were first coded for the "pressure for their creation" (see Table 4). Our coding was based on discussions of pressures in the content of some of the artifacts, as well as knowledge of many of these artifacts and their origins due to our positions within the focal network.

Table 4. Pressures for artifact creation and exemplar artifacts

Pressure	Exemplar Artifact from Study
Technical-rational	Student-facing exit ticket surveys, created in response to pressure for development of artifacts that elevate student voice
Sociopolitical	Annual reports for funding organization, created based on pressure for development of artifacts that legitimize network choices and continued funding

Next, we coded the same artifacts focused on their "intended use," (i.e., accountability, improvement, or research). While coding, we recognized the need for a fourth code:

Teaching has a framework for describing these hub functions, such as site-level improvement routines and capacity building.

"administration," to describe artifacts created to support basic operational processes within the network. We also widened the definition of "accountability" to reflect the broader use of artifacts to manage internal and external relationships, changing the code to "relationship management."

Table 5 provides examples of study artifacts aligned with each code. Similar to the coding of "pressure for artifact creation," we were able to code "intended artifact use" because many artifacts had a memo-like quality with a clear indication or discussion of their purpose. In cases where explanation was not present, we drew on our knowledge of artifacts as hub members.

Table 5. Intended artifact uses and exemplar artifacts

Intended Use	Exemplar Artifact from Study
Administration	Workbooks containing teacher and district administrator attendance at network events, created with the intent of supporting network operations
Improvement	Student work shared with coaches, created with the intent of enabling coaching conversations central to instructional improvement
Relationship Management	External communication documents, created with the intent of showcasing network outcomes and impact to funders and other stakeholders
Research	"Bright spot" interviews, created with the intent of supporting the network's research agenda on the uptake of student-centered instructional routines

Semi-Structured Interviews

To complement our analysis of artifact creation based on the artifacts, themselves, we used semi-structured interviews with hub members to elicit explanations of how those same artifacts were used in practice. We interviewed the focal network's eight 2020-2021 hub members who were charged with the hub's decision-making and engaged with all aspects of network operations. Interviews focused on why data artifacts are developed, how they are used, and what types of data were used. Each interview was approximately 60 minutes in length and conducted via Zoom or Teams with audio recording and transcription enabled.

The interview protocol consisted of questions on hub members' use of data artifacts in their work with the focal improvement network. The first iteration of the protocol was tested with two hub members and subsequently refined to have more explicit separation of questions into different contexts (i.e., work with teachers/school teams, district leaders, and the network).

Coding. For each mention of artifact use, theoretical codes were applied for "pressure for artifact use," "actual artifact use," and "context of artifact use," drawing from our conceptual framework. After the first round of coding, all mentions of artifact use were checked for consistency across codes. The codebook was updated for increased specificity as needed and some excerpts were re-coded according to the refined code definitions.

Each transcript was first coded for the contexts of artifact use based on interview protocol sections, which enabled structural coding by asking the same series of questions regarding how and why network members used data artifacts in each context. Next, we looked at specific mentions of artifact use, which were coded for the pressure for and purpose of their use. The first round of coding used the same values as for intended artifact use, with sub-codes added through inductive and hierarchical coding (see Table 6). We also added a disuse code to capture the many mentions of artifacts that were not used.

Table 6. Reasons that artifacts were used with associated purposes

Actual Use	Associated Purposes
Administration	● To make operational decisions (e.g., staffing, human resources)
Sub-themes:	● To keep track of who is showing up or who's doing what
Decision-making	● To communicate non-evaluatively (e.g., provide regular updates on network activities)
Communication without agenda	
Validation/clarification	● To validate assumptions or understanding

Improvement	● To surface student voice
	● To make instructional or improvement decisions
Sub-themes:	● To show connection of student/teacher learning to outcomes
Supporting/understanding student learning	
Supporting/understanding teacher practice	● To build teacher capacity
	● To support teacher sense-making
Relationship Management	● To manage relationships with district stakeholders and/or funders
Sub-themes:	● To uphold commitments to stakeholders
Communication to build support/justify	● To facilitate normalized comparisons
Understanding impact on students	
Research	● To support academic research
	● To develop theory

Table 7 illustrates how these codes were applied to exemplar quotes from the interviews.

To be considered complete and subsequently used in our analysis, an artifact mention needed to

include all three dimensions (i.e., pressure for artifact use, actual use, and context).

Table 7. Exemplar artifact mentions and selected codes

Interview Quote	Selected Codes
With regard to analysis of the relationship between depth of teacher implementation and student reading assessment outcomes: That was a central kind of data product that got produced and talked about in relation to how it could be utilized in work with the district to make a case for ongoing district and administrative support for the work that teachers were doing.	**Pressure:** Sociopolitical **Actual Use:** Relationship Management **Context:** Network Support
With regard to attendance data: I think probably the most common sets of data that I looked at for the work I do as project manager is attendance.	**Pressure:** Technical-Rational **Actual Use:** Network Operations **Context:** School Teams Support
With regard to results from the surveys administered to network members during professional learning community sessions: There were times when we came together if there was something there that needed to sort of be brought up and said, "Hey so they're seeing these things – can you guys go back to the schools and sort of check and see what's going on?"	**Pressure:** Technical-Rational **Actual Use:** Improvement **Context:** School Teams Support

Data Analysis

We began our analysis by determining to what extent our dataset supported or refuted the

dimensions and relationships suggested by our conceptual framework. We conducted structured

exploratory analyses for data artifact use, data artifact creation, and data artifact creation versus
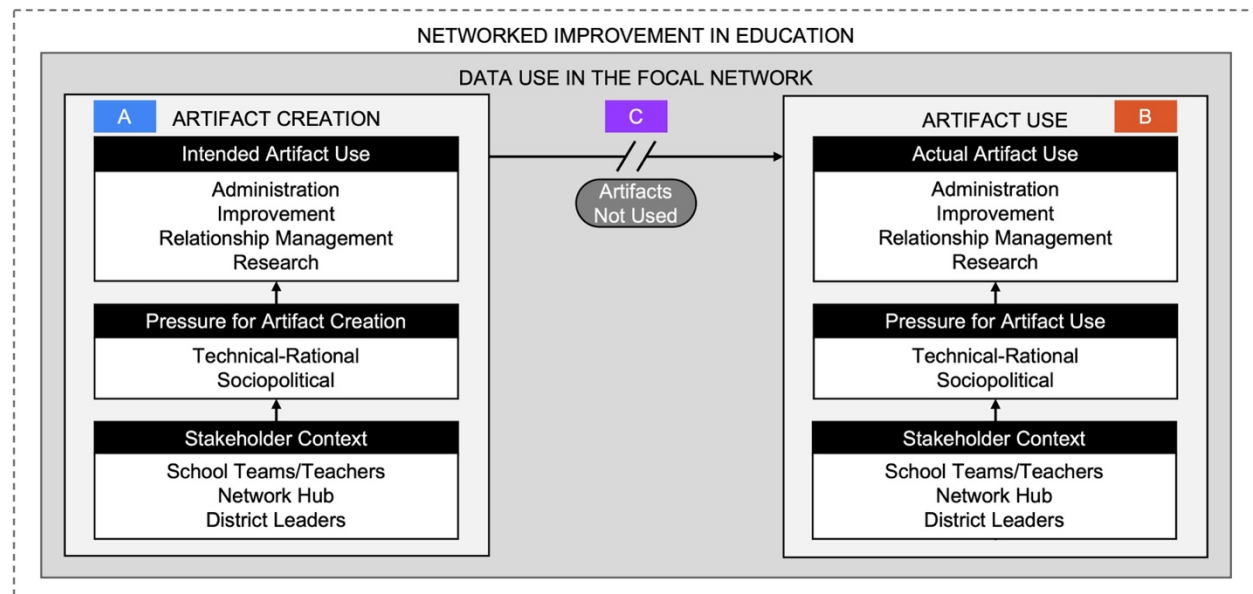
use (see Figure 2).

Figure 2. Updated Conceptual Framework with analysis approach overlay

Artifact creation

We started by exploring relationships in the first phase of the data lifecycle (see A in Figure 2),

drawing exclusively from the artifact repository. Each of these relationships was first explored

with simple descriptive statistics to understand the distributions across individual dimensions

(e.g., intended use, pressure for creation) as well as dimension dyads (e.g., intended use and

pressure for creation). Next, we determined if there was significant pairwise correlation at the

dimension level, following which the specific relationships were explored for each value of each

dimension (e.g., the relationship between the intended use of improvement and technical-rational

pressures for artifact creation) by using chi-square tests.

Artifact use

Next, we explored relationships within the second phase of the data lifecycle (see B in Figure 2),

drawing exclusively from the semi-structured interviews. The unit of analysis was an individual

mention of artifact use (*n*=176). Again, we began our exploration by looking at descriptive

statistics to understand the distributions across the individual dimensions (e.g., actual use,

pressure for use) in the use phase. We then looked at the distributions within each dimension

dyad (e.g., actual use and pressure for use) to understand the relationships present within the use

phase.

Artifact creation versus use

Last, we explored relationships between artifact creation and artifact use (see C in Figure 2) by

drawing from the connected dataset, looking at the artifact repository and interviews across data

lifecycle dimensions (i.e., creation and use). We primarily sought to understand how intended

and actual artifact use were related. We also sought to understand how pressure and context

could influence variation between the two phases.

       We began by using the descriptive statistics for artifact creation (frequencies and

proportions of artifacts) and use (frequencies and proportions of mentions of artifact use). We

compared distributions for use and pressure across our connected dataset; for example,

comparing the proportion of artifacts that were created based on sociopolitical pressure versus

the proportion of mentions of artifacts used based on sociopolitical pressure. In comparing the

distributions of pressures and uses across artifacts, we paid particular attention to areas of both

minimal change and significant change across the two phases.

Findings

In one year, the network created over 800 data-related artifacts, most of which were intended to support improvement work

Over the course of the focal network's third year, 800+ artifacts were created by and shared with hub members. The vast majority of artifacts were intended to be used in support of the network's improvement work. For example, hub coaches gathered student work from participating teachers' classrooms with the intent of using it in instructional coaching conversations. Improvement-related artifacts were wide-ranging and supported a number of hub processes. The common thread was that these artifacts were created to support, understand, and evaluate the efficacy of changes. Following Improvement, the next most common intended artifact use was Administration, followed by Research with Relationship Management comprising the smallest proportion (see Table 8).[4]

Table 8. Distribution of inventoried artifacts by framework dimension

Dimension	Frequency	Proportion
Intended Artifact Use		
Improvement	718	85.6
Administration	74	8.8
Research	41	4.9
Relationship Management	6	0.5
Pressure for Artifact Creation		
Technical-Rational	825	98.3
Sociopolitical	14	1.7

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4. For 63 artifacts (8% of the sample), we felt that there was a strong secondary intended use and included that secondary use into a Combined Intended Use variable for our analyses. While the inclusion of the secondary intended use did more accurately reflect the complex nature and tensions of the focal network's multi-stakeholder environment, it did not significantly impact the results of our analyses.

Consistent with improvement aims, the vast majority of data artifacts were created in response to technical-rational pressures. These pressures drive work aligned with the network aim and an improvement science approach, such as the pressure for development of artifacts that elevate student voice (e.g., student-facing exit ticket surveys) and the pressure for development of artifacts that elevate teacher voice (e.g., recordings of interviews conducted with teachers who represent "bright spots"), both of which helped the network hub to understand uptake of network-identified teaching practice changes. Conversely, less than 2% were created in response to sociopolitical pressures. One example of such pressures is the pressure for development of artifacts that legitimize network choices and continued financial support, such as annual reports for the funding organization.

Artifacts were used for sociopolitical reasons, regardless of why they were made

As the theory of improvement would suggest, data artifacts are predominantly created in order to support improvement processes. However, we found that many of the artifacts are ultimately used to navigate sociopolitical dynamics. Our analysis surfaced a disconnect between the intended use of many artifacts created and what we learned through interviews about how artifacts were actually used.

Figure 3 shows differences between intended and actual use of artifacts. Most notably, while <1% of artifacts were created with the intended use of relationship management, 35% of mentions of artifact use were about how they were used to manage relationships. Many of the artifacts mentioned as being used to manage relationships were originally created to support improvement work.
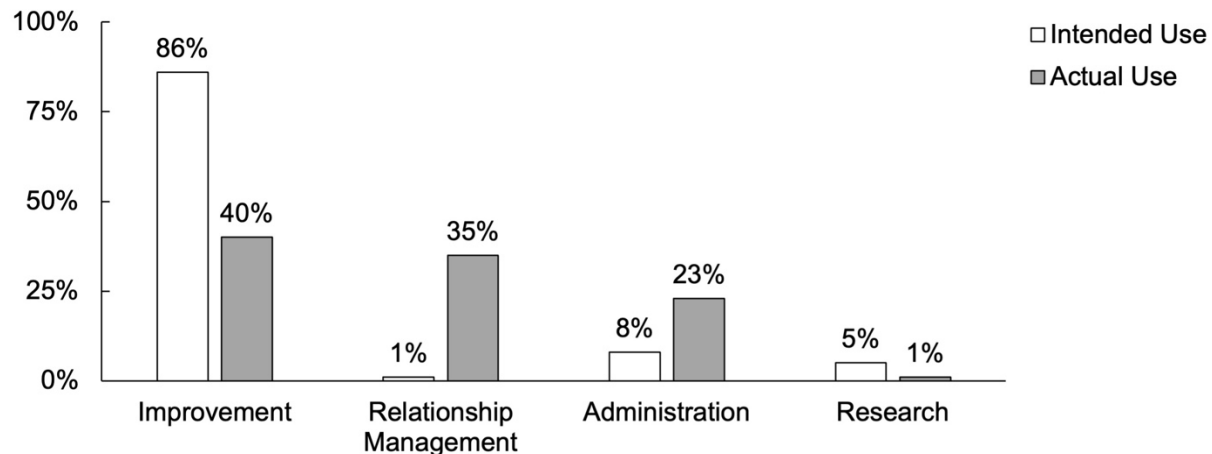
Figure 3. Intended artifact use versus mentions of actual artifact use

For example, as a way to understand uptake ofnetwork-identified teaching practice changes, the hub team developed and administered a survey to teachers. When it came to use of this data, however, the survey results were joined with student outcome data and ultimately used most prominently to make a case to the district for why they should continue to support school engagement in the network. Reflecting on their use of data, one hub member noted:

> Related to analyzing, we administered a survey to teachers to try to get them to report on their uptake of the student-centered routines that we're trying to promote, and then we related that to growth on the formative assessment that the district uses to track student achievement. That was a central kind of data product that got produced and talked about in relation to how it could be utilized in work with the district to make a case for ongoing district and administrative support for the work that teachers were doing.

Similarly, while sociopolitical pressures for artifact creation accounted for only 2% of the artifacts inventoried, sociopolitical pressures accounted for 35% of the mentions of artifact use in the interviews. This discrepancy indicates that many artifacts that were created due to technical-rational pressures likely end up being used due to sociopolitical pressures. To that end, every hub

member spoke to the pressure from district leaders to connect data originally created to support

the technical work of improvement (e.g., uptake of network-identified teaching practice changes

and network engagement) to student achievement, as measured by state test scores.

Artifacts were used most for improvement when supporting teachers, but most for
relationship management when supporting district leaders and the network

Operating the focal network required the network hub to engage with many stakeholders. The

hub provided direct instructional support and guided improvement work in collaboration with

school teams, particularly teachers, they worked with district leaders to ensure that conditions

were in place for school-based teams to engage in improvement work, and they coordinated the

work of hub members.

Most mentions of data artifact use were related to work with district leaders, closely

followed by those used in the support of school teams and teachers. The fewest number of

mentions of artifact use were in the context of network support. The majority (52%) of mentions

of artifacts used in the context of support for teachers and school teams were those used for

improvement, highlighting their emphasis on the technical core of improvement (see Figure 4).
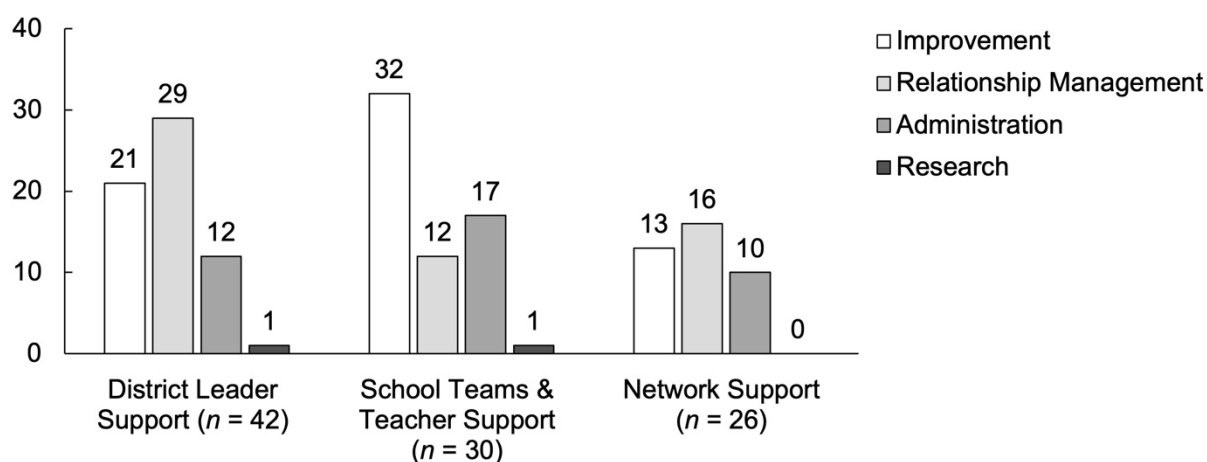
Figure 4. Mentions of actual data use in different contexts

The largest proportion of artifact mentions in the context of district leader (46%) and network (41%) support were for relationship management, which was the aim most tightly coupled with sociopolitical pressures. This speaks to the hub team's emphasis on navigating sociopolitical dimensions in the district context as well as within the network. Of note is that when using artifacts for relationship management for district leader support, the emphasis was on working with district leaders to shape the narrative of the network to share with other district leaders as well as external stakeholders. In the context of network support, a subtle but important difference in using artifacts for relationship management was that they were often used to make a case to the district rather than with them. One hub member spoke of how data was used to support the network making a case to the district for their continued support:

> I think one primary way I can think of last year in which the hub was trying to use data and evidence was in making a case to the district for the productivity of the work.

Conversely, the majority of artifacts in the context of support for teachers and school teams were used for improvement. In the case of support for teachers, a hub member noted how they used artifacts for improvement work:

> It was also like if I was looking specifically for issues or problems or large misunderstandings or even bright spots that I could back out to them and say, "Hey you might want to dig into this because something interesting is happening here, something different happening here" and we sort of want to either adjusted before it gets too far down a path that we don't want to go or we have something we can highlight.

Across all contexts, artifacts were mentioned as being used for administration at comparable levels, speaking to the need for basic operational support within an improvement initiative.

Many artifacts never got used, regardless of intended use or context

A significant volume of artifacts mentioned in interviews were not described as being used, but rather were references to explanations for why artifacts were not used. Out of 176 mentions of artifacts in the interviews, 20% of those mentions were about why artifacts were not being used across all intended artifact uses (see Table 9).

Table 9. Mentions of disuse relative to the intended use of artifacts

Intended Use	Frequency	Proportion
Improvement	18	50.0
Relationship Management	9	25.0
Administration	8	22.2
Research	1	2.8

Hub members reported that data was often not used across all contexts due to a lack of capacity. Regarding why data artifacts were not used, one hub member noted:

> There is a need for capacity building in these network hubs and also leadership buy-in in the network hub for the use of data to guide decision making and a network, and I think we don't necessarily consistently have those things in place. I think from a leadership perspective a number of key people in the hub and in the work are just not accustomed to working with practical measures or data for improvement.

While there is significant emphasis within networks on capacity-building and buy-in for network teachers and district leaders, our analysis suggests that similar attention should be paid to capacity-building and buy-in for hub leaders.

Discussion

Perhaps the most salient theme in our study is that data use is complex. It changes over the life of a network and even over the life of a single data artifact. It changes in different contexts, and it changes based on stakeholder capacity and buy-in. These variations are suggested by data use literature, more broadly, but not explored as comprehensively in the context of improvement networks.

Our findings suggest that data artifact creation largely aligns with improvement literature, which asserts that data should support the technical work of improvement. Data use, however, foregrounds the sociopolitical role that data plays in power dynamics and organizational legitimacy. Our findings further suggest that there is variation within data use, both in terms of context and over time.

Theme 1: Artifacts are created to support technical improvement work

The work of improvement is data intensive (Cobb et al., 2019; Daly, 2012). Even beyond improvement networks, the field increasingly emphasizes the importance of data in educational reform (Breiter & Light, 2006; Datnow et al., 2012). It should therefore come as no surprise that the majority of artifacts in this study were created with the intent of being used to support improvement. Creation of artifacts to support improvement work is essential to iterative, data-based change efforts. Such creation, however, requires specialized capacity and extensive time and attention from hub staff.

Theme 2: Artifacts are used for relationship management

While literature on data use in improvement networks does not emphasize the use of data artifacts in navigating the complex social and political dynamics that characterize such

communities, the broader literature on data use acknowledges this important role (Ansari & Euske, 1987; Prado-Roman et al., 2020).

As data use literature suggests, hub members in the focal network spoke of frequently using data artifacts to navigate sociopolitical dynamics, including legitimizing choices and the network, overall. Participants' emphasis on using data artifacts to manage the complex relationships within a network, especially with district leaders and foundation, undergirds the importance of and value in using data in relationship management. Much of the discussion of data use for relationship management centered on connecting data for improvement (e.g., uptake of network-identified teaching practice changes) with data for accountability (e.g., student test scores), indicating an opportunity for intentional upfront design and collection of connected datasets.

Theme 3: Context drives in-network data use variation

Context is a common theme in education literature and beyond (Breiter & Light, 2006; Datnow et al., 2012, 2013). Networked improvement literature acknowledges the importance of understanding organizational and district context but does not connect that to data use or within-network context variation (Hannan et al., 2015; Glazer & Peurach, 2013).

The context of our study's focal network undoubtedly impacted its use of data. Our findings showed how data was more likely to be used for improvement work when supporting teachers or school teams, while data was more likely to be used for relationship management when supporting district leaders. The structure of a network and other ways of organizing for improvement will inevitably change how data is used.

Theme 4: Data use can (and should) change over time

Networks are not single points in time. They are complex communities that span years and bring together diverse stakeholder groups, often from different organizations. Adaptive expertise speaks to how learning happens and understanding evolves over time (Chi & Ohlsson, 2005; Correnti et al., 2021). Equally important is the idea that much learning happens by doing (Greeno & Engeström, 2014; Lave & Wenger, 1991).

That data use changed over time in our study's focal network is not inherently bad. Rather, it supports the idea that network members' understanding of the network context evolved with time. Network members likely applied those learnings in terms of how data artifacts were used, regardless of why they were created, as well as whether or not artifacts were used, altogether.

Implications

Time is a severely limited resource for most practitioners, as was the case for the teachers, district leaders, and hub members in this study's focal network. It is rare that practitioners are able to do every single thing when and how they want in a reform or change effort. When considering that 800+ data artifacts were created in the span of a single year, it is essential to also consider the monumental associated effort.

Minimizing the effort associated with data artifact creation and maintenance while maximizing their usefulness is a Sisyphean challenge, but this study suggests strategies as practitioners work towards that aim.

Proactively create data artifacts

Our findings suggest that there is value in divergence by design. By proactively developing a

data plan that accounts for variable uses, network members may be able to reduce effort associated with (1) creating artifacts that are ultimately not used and (2) expending effort to significantly alter artifacts to increase their usefulness after the fact. Such a plan should consider:

- *Intentionally designing for different network uses beyond the technical core:* for example, explicitly designing data artifacts for relationship management (e.g., a regularly published status report)
- *Intentionally designing for different network contexts:* for example, designing different artifacts for different stakeholders (e.g., different status reports for network members, district leaders, and external stakeholders)

Attend to capacity-building and buy-in for all network members

Considerable research has been done on the importance of data literacy capacity-building for teachers (Gummer & Mandinach, 2015; Mandinach & Gummer, 2016). However, there has been minimal emphasis on the importance of capacity-building for other network members or reform stakeholders, more broadly.

In the context of improvement networks, hub members create many data artifacts (e.g., reports, practical measurement tools) and lead data-related capacity-building activities (e.g., professional development sessions on the use of data in inquiry cycles). It is therefore imperative that they, too, have adequate expertise in the use of data. Further, district leaders need to have adequate capacity to understand data artifacts being created and used in order to best scale and sustain the improvement work.

Applicability of findings

This study's focal network was selected in part because of its characteristics, which were fairly typical of other such networks that have been initiated in recent years, and its findings have implications for theory about data use in improvement networks.

However, while our study examined a singular case of a focal improvement network, the salient features of our findings speak more broadly to application in the context of complex change efforts in other approaches to educational reform, as well as in change programs in other industries.

Limitations

Our study examined a case of a single focal improvement network. While the network was selected in part due to many of its core features being common in improvement networks – e.g., a university serves as the intermediary, its funding comes from an external donor organization, many of its practices are opt-in – no two networks are the same. In addition to unique network features, the district context plays a significant role in shaping a network and its results.

Within our network, the dataset used for this study was also unique in that it came from the 2020-2021 school year, which was in the midst of a global pandemic. While few artifacts were explicitly created on the topic of the pandemic, there may well have been a higher number of digital artifacts created due to the remote and later hybrid district operations. That said, the network hub team has been geographically distributed and conducted its operations virtually throughout the life of the network. As we looked solely at the artifacts created for and used by the network hub, we believe that the impact of the pandemic on our dataset was modest.

Lastly, while this study focuses on network hub data use, the hub is only one piece of the data use puzzle. In the case of our focal network, the hub was involved in most data use activities, but the perspectives of other network members on the use of data artifacts would be a valuable data source for future investigation.

Conclusion

This study presents a single-case analysis of data use in a school improvement network. We highlighted differences between the creation of data artifacts, supported by a connected dataset of a robust repository of 800+ network artifacts and authentic network hub member accounts of data use. Our findings show that artifacts are most often created based on technical-rational pressures to support ongoing improvement work but are used frequently to support relationship management in the context of sociopolitical pressures. We also demonstrate that data use varies significantly based on the context of its use. These results suggest implications for future creation and use of data artifacts that reduce network member effort while increasing artifact usefulness.

This study represents an important contribution to the literature as there are few published practice-based accounts of data use in improvement networks. It also extends our conceptual framing of data use in improvement networks to encompass more holistic dimensions of complex change efforts.

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