# THE SOCIAL STRUCTURE OF NETWORKED IMPROVEMENT COMMUNITIES:

## Cultivating the Emergence of a Scientific-Professional Learning Community

Jennifer Lin Russell, University of Pittsburgh
Anthony S. Bryk, Carnegie Foundation for the Advancement of Teaching
Donald. J. Peurach, University of Michigan
David Sherer and Paul G. LeMahieu,
Carnegie Foundation for the Advancement of Teaching
Edit Khachatryan, Carnegie National Faculty
Jennifer Z. Sherer, University of Pittsburgh
Maggie Hannan, Carnegie Mellon University

**Carnegie Foundation**
for the Advancement of Teaching

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## ABSTRACT

A burgeoning set of education-related organizations join networks each year, reflecting a shared belief that problems in education are too complex for any one educator or organization to solve on their own and that collaboration can support educational improvement. The goal of this paper is to describe how networked improvement communities (NICs) create a social structure to catalyze the type of community that can solve complex problems. We draw from prior theorizing, the research literature on network and learning community development, and observations of developing NICs to articulate a framework for network development. The framework is intended to be an analytic tool for thinking and reasoning about NIC emergence and maturation.



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# INTRODUCTION

A burgeoning set of education-related organizations join networks each year with the aim of improving a range of processes and outcomes. This interest in networks reflects a shared belief that problems in education are too complex for any one educator or organization to solve on their own, and that collaboration can support educational improvement. While inter-organizational collaboration is lauded as a productive mechanism to bring diverse human and social resources to bear on complex problems of practice, there is a limited body of educational research that has unpacked the inter-organizational roles and practices that facilitate productive collaboration to solve pressing educational problems (Wohlstetter & Lyle, 2019). What we do know from other sectors in which inter-organizational networks are common (e.g., national security, environmental conservation, public health) is that successfully integrating diverse organizations and professionals into a work agenda that advances a shared aim is a complex endeavor that requires careful attention to organizational structures and strategies.

Networked improvement communities (NICs) are one type of a designed network that is gaining popularity in education, due in part to the work of the Carnegie Foundation for the Advancement of Teaching that has been exploring how NICs can accelerate improvement in education.[1] In the idealized vision of a NIC, a leadership group referred to as the network's "hub" recruits and coordinates the work of the practitioners, researchers, and designers who constitute the network's membership. The network members can be organizations (e.g., schools,

[1] Carnegie's specification of the concept was inspired by the networked improvement work that has driven substantive quality improvement in hospitals and other healthcare organizations (Berwick, 2008; McCannon & Perla, 2009).

school districts, professional development providers) and/or individuals (e.g., university-based researchers, principals, teachers) united in their commitment to working together to solve a specific and pressing practical problem in the participating organizations (Bryk, Gomez, Grunow, & LeMahieu, 2015; Engelbart, 1992).

Guided by the hub, network members begin by working together to develop a deep understanding of the problem they are trying to solve, and then specify a theory about how to improve that problem. This process also includes the articulation of a clearly defined and measurable outcome that the network commits to accomplishing. Guided by the theory of improvement, members of this idealized NIC utilize improvement science methodologies, such as data-based inquiry cycles, to learn how to improve systems and processes and to achieve the desired outcomes. The network hub creates organizational structures and routines that support network members as they develop, test, and refine interventions. It also creates opportunities for network members to learn about promising practices in order to enable their spread across the different organizations in the network and beyond. This includes fostering connections among network members within and across organizations in order to foster learning and exchange.

Interest in the NIC concept has grown rapidly in the educational field since Carnegie began promoting its use to solve high leverage educational problems (Bryk, Gomez, & Grunow, 2011; Bryk et al., 2015; Lewis, 2015). Carnegie tested and elaborated the concept through its work launching two NICs. The first of these, the Community College Pathways NIC (or CCP), was formed to improve the educational attainment of community college students by improving how developmental mathematics courses are organized and taught. In CCP, a network of community colleges tested and refined curriculum materials, student supports, and pedagogical practices that ultimately resulted in substantial gains in student success in achieving mathematics credit. The second NIC, the Building a Teaching Effectiveness Network (BTEN), brought districts together to improve supports for beginning teachers. School-based teams of educators tested new routines for providing coherent feedback and support to beginning teachers, eventually resulting in the hub's specification of a change package—a consolidated set of tools and routines for addressing high rates of beginning teacher attrition—that can be a resource for schools within the network and beyond. These networks illustrate the substantial promise of the concept, but also the challenges associated with ambitious, collaborative work (Hannan, Russell, Takahashi, & Park, 2015).

With evidence of their potential accumulating, many education leaders and reformers are looking to the NIC concept as a model for their improvement work and seeking guidance as they try to launch and manage this complex organizational form. In prior articles, we emphasized the technical side of NIC formation and operation (Gomez, Russell, Bryk, LeMahieu, & Mejia, 2016;

Russell, Bryk, Dolle, Gomez, LeMahieu, & Grunow, 2017). Yet equally important are the social and cultural dimensions of NICs as organizations, including shared narratives, norms, and values as key for success in real world settings. Our intent is to address this under-conceptualized component of NIC development by positing a theoretical framework for the development of the social organization of improvement networks. It is intended as an analytic framework for thinking and reasoning about NIC operation and not as a normative model of how all NICs develop.

The paper begins with a description of NICs as scientific-professional learning communities. We then articulate a framework focused on the social and cultural components of NICs. As we do so, we illustrate components of the framework drawing on examples from two emerging NICs. We offer these examples as practical, real-world manifestations of otherwise abstract concepts. In forthcoming studies, we will be using this framework to analyze cases of NIC emergence and maturation, with the aim of refining it and of strengthening its empirical warrant.

# NICS AS SCIENTIFIC-PROFESSIONAL LEARNING COMMUNITIES

In observing and studying emerging NICs, we came to realize the value of describing them as learning communities to call attention to a fundamental feature of the idealized from of these networks: Network members are working collectively to learn how to solve a pressing problem of practice. For example, NIC members engage in inquiry and experimentation to learn about (a) the system that produces the focal problem of practice and (b) what changes lead to improvement in their sites of practice. In so doing, NIC members learn essential problem-solving processes, such as how to gather and analyze data about their practice, through the modeling of network leaders and colleagues, as well as from their own experience. Through this social participation, network members learn how to work together in a professional community.

In our experience supporting emerging NICs, focusing on learning also helps to shift educators' mental models of a NIC from a project or program to be implemented to the enactment of a learning organization. This shift is essential for two reasons. First, for many high leverage educational problems, there is a lack of consensus on what shifts in system design and practice delivery are necessary to produce substantive improvement (Gomez et al., 2016). Additionally, even when there is a compelling research base that points to best practices, encouraging widespread adoption is a complex implementation and learning challenge: Educators must learn how to take up new practices and embed conditions to support implementation in school and system structures (Bryk, 2009; Honig, 2006; Penuel, Fishman, Cheng & Sabelli, 2011; Spillane, Reiser, & Reimer, 2002; Stein & Coburn, 2008; Spillane and Resnick, 2006). Additionally, a focus on learning helps to distinguish a NIC from other kinds of networks in education. While many

educators have had experiences with networks that facilitate sharing resources or instructional strategies (e.g., Pinterest or the Math Forum), NICs differ from these less intensive forms of collegial interaction because members are engaged in the complex task of solving a specific problem of practice (Gomez et al., 2016). NICs aim to support educators accomplishing a specific goal in their schools in ways not typically present in sharing networks.

In conceptualizing NICs as learning communities aimed at solving a high leverage practical problem, we turned to complementary literatures on professional and scientific learning communities to further elaborate our conceptualization. The concept of a *professional learning community* (PLC) is consistent with the notion of NICs as associations of professionals working together to solve pressing problems faced in their work practice (Stoll & Louis, 2007). Such a professional community aims to draw on and build a specialized and technical knowledge base (Stoll & Louis, 2007; Hiebert, Gallimore, & Sigler, 2002). A professional knowledge base is a critical resource for practitioners who can draw on it to reason about and identify pedagogical actions (Shulman, 1987). In addition to the notion of professional community, the PLC concept emphasizes a learning orientation. Not all strong communities focus on practice improvement (McLaughlin & Talbert, 2001; Little, 1999). PLCs are more than a collection of professionals engaged in collaborative, sharing activity, but rather communities that can access and distribute knowledge as a vehicle for continuous improvement (Dolle, Gomez, Russell, & Bryk, 2013; Stoll & Louis, 2007).

As a complement, we also posit that NICs are scientific communities because of their disciplined, collaborative, and inclusive approach to knowledge production, consolidation, and dissemination. This vision of a scientific community is consistent with new notions of networked or open science (Fecher & Friesike, 2013; Nielsen, 2012). Scientific communities have methods for building knowledge through replication and observation across multiple trials (Mayer, 2000; Hiebert, Gallimore & Stigler, 2002). As in scientific communities in which the discipline of science has authority to adjudicate competing knowledge claims, the notion of a scientific-professional learning community includes a process for continually verifying the learning produced by the community. The functioning of scientific communities is the model for development of a professional knowledge base because of the infrastructure for recording, sharing, and accumulating knowledge (Hiebert, Gallimore, & Stigler, 2002).

By focusing on the concepts of learning, professional, and scientific communities, we arrive at the scientific-professional learning community concept. In the remainder of this section, we elaborate three ways NICs embody this concept.

## NICS ARE GROUNDED BY SHARED GOALS, NORMS, THEORIES, AND PRACTICES

In principle, NICs are communities that are held together by shared goals, language, norms, theories, and practices. In a scientific-professional learning community, we posit that a shared theory and aligned measures contribute to clarity in goals, common language, and normative expectations for practice. In collective communities, a sense of responsibility can be created by shared norms and values developed around goals, actor roles, and desired outcomes (Bryk, Camburn, & Louis, 1999; Newmann, 1996; Westheimer, 1999). For example, professional learning communities in the education context exemplify a clear and consistent focus on student learning (DuFour, 2004; Supovitz, 2002; Supovitz & Christman, 2003; Louis & Marks, 1998). Additionally, knowledge exchange is facilitated by the development of shared language (Weber & Camerer, 2003). Shared language and stories are communal resources that enable joint work and collective action in communities (McAdams, 1996; Wenger, 2000).

Scientific communities have the added feature of commitment to building and testing shared theories, which frame scientific exploration and anchor the accumulation of knowledge. Like scientific communities, improvement work in NICs is organized around a shared theory of improvement, which is defined as "a testable prediction of the activities and infrastructure necessary to achieve a desired outcome" (Bennett & Provost, 2015, p. 38). Visualization of the theory of improvement in the form a driver diagram provides a representation for making the network's working theory public, helps to coordinate the work of NIC members, and supports the accumulation of knowledge about how to improve systems (Dolle et al., 2013; Bennett & Provost, 2015). As in scientific communities, the working theory of improvement in a NIC interacts dialectically with its measurement system: Theory guides the identification of measures, and the empirical evidence gathered through measurement contributes to a sharpened theory of improvement. Shared measures enable (1) changing the testing system as aligned with the theory of improvement and (2) tracking progress toward the network's aim (Yeager et al., 2013; Bryk et al., 2015).

## NICS SUPPORT LEARNING AND PROBLEM SOLVING THROUGH DISCIPLINED INQUIRY

In principle, NICs enable participating members to learn from one another by accessing novel information and engaging in reflective dialogue, collaborative problem solving, and disciplined inquiry. Learning communities are different from sharing communities because practitioners collaborate to reinvent practice and support professional growth (Little, 1999; Stoll et al., 2006).

Learning communities engage in reflective professional inquiry through practices such as participating in reflective dialogue, converting tacit knowledge to shared knowledge through interaction, and applying new ideas and information to problem solving (Stoll et al., 2007). In professional communities, educators learn by observing each other and/or reviewing artifacts of practice and engaging in joint problem solving and planning for teaching improvement (Louis & Kruse, 1995; Louis & Marks, 1998).

Drawing on the practices of scientific communities allows NICs to further augment their vision of learning and problem solving (Bryk et al., 2015). First, NICs seek to break down traditional boundaries between producers and consumers of knowledge by providing structures and routines for practitioners to produce knowledge about practical improvement. Specifically, practitioners engage in disciplined inquiry using established methods drawn from improvement science. For example, the Plan-Do-Study-Act (PDSA) cycle is a modified version of the scientific method for use in work settings (Cleghon & Headrick, 1996; Langley et al., 2009; Tichnor-Wagner et al., 2017). The PDSA cycle presses practitioners to plan for the introduction of a change in their practice by making predictions about the change's expected impact, collect and analyze data that enables judgment about whether the change improved process outcomes, and reflect on the course of future action warranted by the test. An aim of routines such as the PDSA is to add a more formalized, scientific process to the reflective practice that is characteristic of PLCs (Tichnor-Wagner et al., 2017).

## NICS COORDINATE AND ACCELERATE LEARNING THROUGH STRATEGIC KNOWLEDGE MANAGEMENT

In addition to supporting the learning of individual members, a key aim of NICs is to coordinate and accelerate learning through strategic knowledge management. Central to the production of knowledge in a network is the consolidation of diverse contributions into new knowledge products. In NICs, practitioners engage in small experiments with their professional practice and learn through successive inquiry cycles. But accelerating learning in such a community requires that a central hub harvests, manages, and makes visible this learning to others in the network and facilitating the spread of the most promising change ideas (Wohlstetter & Lyle, 2018).

Organizational learning scholars consider the attention to such processes as the critical role of knowledge management (Argote, 1999; Argote, McEvily, & Reagans, 2003). By knowledge management, we mean the processes that leaders and organizations engage in to manage and support the process of knowledge creation, use, and diffusion (OECD, 2000; Wiig, 1997). The successful transfer and adaptation of routines and tools across units or organizational boundaries

requires that recipients benefit from the knowledge gained by the people originally involved in the design and testing of the innovation (Argote, McEvily, & Reagans, 2003). This process can be facilitated by a coordinating unit or hub (Peurach, 2016; Winter & Szulanski, 2001).

Through strategic knowledge management, a NIC's hub can integrate the diverse contributions of participating members and accelerate learning. This process in a NIC is similar to a scientific community such that it involves social proofing mechanisms in which network leaders shape the direction of innovation and learning, evaluate the evidentiary warrant that changes contribute to improvement, and, in so doing, determine what changes are worthy of distribution (Bryk et al., 2015).

# A FRAMEWORK FOR NIC DEVELOPMENT

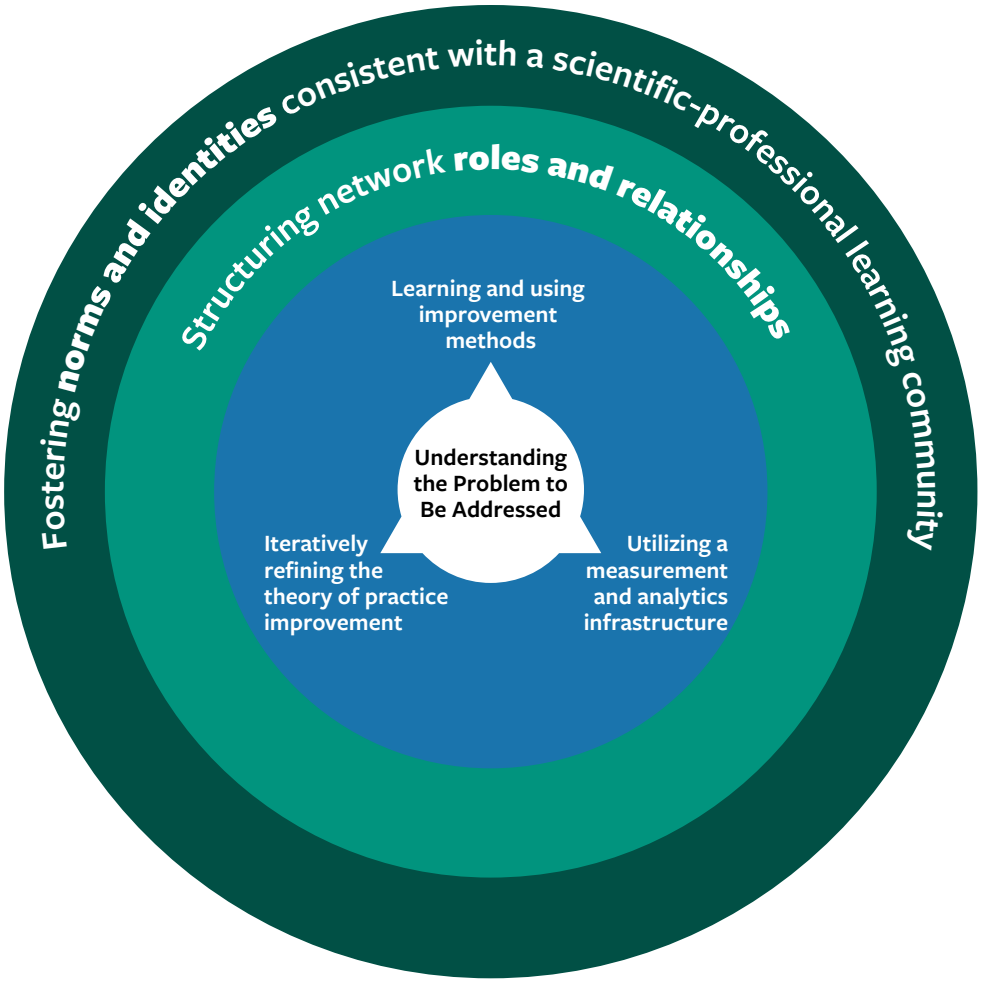
The preceding analysis suggests the possibility of accelerating improvement in education by catalyzing scientific-professional learning communities aimed at solving high leverage educational problems. An essential question follows: What is entailed in developing the social organization of NICs so that they function as scientific-professional learning communities?

We take up this question by positing a framework for NIC development that highlights the social and cultural dimensions of this organizational form. The framework identifies six domains of activity that we theorize are essential components of developing a networked improvement community (see Figure 1).

As represented in Figure 1, a NIC seeks to function as the type of scientific-professional learning community previously described. The components of the framework in green describe the social and technical work of a NIC. At the center, we emphasize that the work of a NIC starts with understanding the problem of practice to be addressed.

Guided by the theory of practice improvement, participants learn and use improvement methods to generate novel solutions and knowledge of how to put them into practice. Network members draw on a measurement and analytics infrastructure to track whether changes introduced into systems are improvements and iteratively refine and elaborate the working theory of practice improvement. These four domains of the framework—the technical core of a NIC—have been described extensively in other publications (Dolle et al., 2013; Hannan et al., 2015; Bryk

## Figure 1: The NIC Development Framework




**Scientific-Professional Learning Community**

- Grounded by shared goals, norms, theories, and practices
- Support learning and problem solving through disciplined inquiry
- Coordinate and accelerate learning through strategic knowledge management

et al., 2015; Russell et al., 2017). Therefore, in this article, we focus on the social and cultural components of networked improvement communities depicted in the outer two rings.

Solving problems of practice in education requires complex, interdependent technical solutions embedded in a social organization that coordinates the collective action of people with different roles and expertise. Additionally, networks can develop cultures that support their technical work such as evidence-driven practice and a collective commitment to network aims. Consequently, our framework posits that, to grow and sustain a scientific-professional learning community, networks should cultivate intentional roles, relationships, norms, and identities.

## ELEMENTS OF THE FRAMEWORK IN PRACTICE: TWO EXAMPLES[2]

The Tennessee Department of Education (TDOE), with support from the Gates Foundation and the Carnegie Foundation for the Advancement of Teaching, launched the Tennessee Early Literacy Network (TELN) in November 2016. TDOE undertook this endeavor with the aim of empowering districts to solve complex problems, such as inadequate literacy achievement among students in the state. TDOE and its regional support offices (Centers of Regional Excellence, CORE) acted as the network's hub that supported the collaborative improvement carried out by school-based teams. The hub and school-based teams worked together to improve the proportion of students proficient in literacy by 3rd grade.

The American Institutes for Research (AIR), with support from the Nellie Mae Education Foundation, launched the Better Math Teaching Network (BMTN) in 2015.[3] BMTN sought to improve student engagement in 9th-grade Algebra I classes in New England through student-centered mathematics teaching and learning practices. The AIR-based hub recruited a network of high school algebra teachers and has guided them in the use of disciplined inquiry to identify and test ways to make their teaching more student-centered.

In the next section of this paper, we utilize selected examples from TELN and BMTN to illustrate the way in which framework dimensions manifest in practice and highlight the challenges networks grapple with as they seek to catalyze a scientific-professional learning community.

[2] Authors Russell, Sherer, and Hannan are engaging in developmental evaluations of these two NICs and had extensive opportunities to observe their emergence. They did not, however, organize or operate the networks.

[3] The genesis of the network built off findings from a prior study led by AIR's network leaders that identified the student-centered approaches to mathematics teaching employed by highly regarded high school mathematics teachers, such as encouraging students to justify and explain their solution strategies (Walters, et al., 2014).

## THE SOCIAL ORGANIZATION OF A NIC: STRUCTURING NETWORK ROLES AND RELATIONSHIPS

We begin by describing the social organization of a NIC; that is, how a NIC structures roles and relationships to catalyze a scientific-professional learning community. (For reference, this aspect of NIC development is depicted in Figure 1 as the second ring that surrounds the technical core of the framework.) We posit that there are four key dimensions of structuring roles and relationships. Network leaders identify and define **network membership** and foster and enable member **participation and engagement** in the network. These formal aspects of the social organization of the network give rise to supportive informal social structures including **social connections** among network members and the emergence of **relational trust**.

### 1. NETWORK MEMBERSHIP

As a collectivity of people and organizations, a critical component of cultivating a NIC is recruiting and retaining network members. Innovation and learning in organizations depend on the knowledge, expertise, and commitments of participating members (Argote, McEvily & Reagans, 2003; Chen & Huang, 2009; Youndt, et al., 1996). Learning networks should recruit people with different expertise and perspectives because diversity supports the generation of novel solutions (Wenger, Trayner & de Laat, 2011; Page, 2008). Additionally, network members should come from organizations representing diverse sites of practice because this provides contexts for testing how promising solutions may work within varying contextual conditions. While diversity in expertise and context can be a resource, communities need to devise intentional processes by which new members are selected and newcomers are socialized to ways of working that enables them to take up productive roles in the community (Wenger, 2000). The distribution and activation of expertise in a networked improvement community is, therefore, a critical, yet challenging, design consideration.

Important domains of needed expertise in a NIC include knowledge about the problem of practice, proficiency in improvement science methods, and an understanding of how to organize and operate a network. Therefore, in the case of forming TELN, TDOE established a network hub composed of individuals with reform management expertise and knowledge of the state's education system. The hub recruited districts, which in turn selected school-based improvement teams that were highly motivated to improve early literacy. The hub also forged connections to individuals and organizations with expertise in literacy and improvement science through strategic consulting relationships.

Given that this hub was located in the state education agency and working with geographically dispersed districts, the hub designed roles for staff in TDOE's regional support offices and for designated team leads in participating districts that could coordinate the improvement work conducted by school-based teams. In collaboration with regional and local leaders, the hub selected local coordinators that had relevant content expertise—knowledge of literacy teaching and learning—occupying roles such as literacy coaches and professional development specialists.

While regional and district level coordinators had literacy expertise, they needed to rapidly build improvement capacity in school-based teams to identify and test changes aligned with the network's theory of improvement. Hub leaders brought in improvement specialists to train regional and district-based coordinators, but capacity building efforts were complicated by the coordinators' competing professional responsibilities that limited the time they could devote to network activities. As a result, district leads struggled to learn how to coordinate networked improvement activities while also leading teams in improvement work. These challenges illustrate the importance of careful attention to the selection of network members and the construction of members' roles in the network.

## 2. PARTICIPATION AND ENGAGEMENT

In principle, learning within communities emerges as people have opportunities to participate in the practice of a community and to develop a community-aligned identity—both of which foster a sense of belonging and commitment (Handley et al., 2006; Wenger, 1998). As individuals and organizations become members of a NIC, network leaders create opportunities that shape members' participation and engagement trajectories. Members of communities enact different participation trajectories, and not everyone aspires to (or can achieve) full participation (Handley, et al., 2006). Wollebaek and Selle (2002) conceptualize dimensions of variation in community participation, including intensity (time spent), type (specific form of engagement), and scope (single versus multiple forms of participation). Consequently, understanding network development requires attention to the varying ways network members participate and engage.

In the idealized NIC, participatory events align with the community's sense of purpose and help it develop an identity (Wenger, 2000). T*hese participation structures* are a key component of organizational learning: Organizations influence knowledge exchange by providing opportunities for members to learn from one another, reducing the physical or psychological distance between people (Argote, McEvily & Reagans, 2003). We posit that viable participation structures should be created that present opportunities for network members to learn with and from each other. Given that network membership is often voluntary, at least to some extent, members must also perceive value through participation that sustains engagement.

During its first year of operation, the Better Math Teaching Network brought together a network of 23 high school mathematics teachers who applied to join the network. Network leaders designed a range of participation structures to promote teacher engagement and social learning. Teachers met quarterly in face-to-face meetings during which they received training in improvement science methods, developed a common understanding of deep engagement in algebra, and shared what they were learning. During action periods between network meetings, teachers engaged in disciplined inquiry cycles (utilizing the PDSA routine) to test instructional changes aimed at producing deeper student engagement in algebra and met monthly with a team of teachers working on similar components of the mathematics engagement problem. Additionally, the network promoted informal interactions among teachers through an electronic mailing list and a Google drive system in which teachers posted resources and PDSA documentation.

We posit that network leaders need to be strategic about the design of participation structures that create efficient and effective methods for learning and improvement. The intentionally designed set of participation structures in BMTN enabled teachers to engage in the network and contribute to its aims. However, it was not without challenges. Network leaders had to train teachers how to execute data-based inquiry cycles within limited opportunities for direct engagement with teachers. Some teachers struggled to integrate aspects of the work such as PDSA documentation and collecting and analyzing data during inquiry cycles, with their other professional responsibilities. For the network to benefit from what teachers learn from their inquiry cycles, teachers needed to document and share their learning, which added to the time demands of the process. Teachers highly valued their opportunities to learn from colleagues through face-to-face or video-based interaction, but these are resource-intensive activities for network leaders that are challenging to sustain as the network grows.

## 3. BUILDING SOCIAL CONNECTIONS

A key problem to solve in a learning network is how to ensure the transfer, receipt, and integration of knowledge across participants (Argote, McEvily, & Reagans, 2003; Weber & Khademian, 2008), which requires attention to the ways that network members are connected. While improvement networks sometimes leverage existing social connections, in most cases network leaders will need to cultivate new connections and strengthen existing and emerging connections. Social connections are often built through the participation structures that define how members engage with others in the network.

Generally speaking, a networked learning community benefits from two types of social connections: dense, local bonding ties and weaker bridging ties. Dense bonding ties (e.g., among

members of a school-based improvement team) support the transfer of complex knowledge and facilitate the building of trust that supports learning (Hansen, 1999; Wenger et al., 2011). It is challenging to integrate knowledge in a problem-solving network because participants hold tacit, practice-based knowledge that is difficult to transfer. Bonding ties, characterized by strong relationships and frequent social connections, facilitate the integration and transformation of this knowledge (Podolny & Page, 1998; Weber & Khademian, 2008), in part because strong ties tend to be governed by norms of reciprocity and relationship-specific heuristics that ease knowledge transfer (Uzzi, 1997).

Weaker, bridging ties among members of different organizations in a network support the discovery of novel information. Bridging ties connect people from diverse knowledge pools and or dispersed geographic location (Goldsmith & Eggers, 2005). In a previous section, we discussed the different types of knowledge and expertise that network leaders need to recruit a networked improvement community—specifically, leveraging different types of expertise requires attention to building social connections. Bridging ties within networks promote novel interactions and the exchange of information by bringing people together who would not normally interact (Granovetter, 1973; Burt, 2000; Burt, 2004).

In sum, the social network literature suggests that fostering a scientific-professional learning community would be facilitated by network structures with specific characteristics. Strong bonding ties within improvement teams facilitate the integration and transformation of tacit practical knowledge. Additionally, NICs might facilitate the emergence of strong bonding connections among members that work in affinity groups that align with the high leverage drivers for improvement identified in the network's working theory of improvement. We would expect that weaker, bridging ties between organizations and affinity groups emerge that provide members with access to relevant expertise and novel ideas they would not have access to in their local communities.

The emergence of new connections among network members is visible in both BMTN and TELN. In TELN, school improvement teams strengthened connections with school-based colleagues through meeting routines that brought them together more regularly and intentionally to identify and test changes to their literacy support systems. District leads that coordinated the work of school-based teams and interacted more directly with hub network leaders also appreciated the weaker, yet significant connections they formed with hub leaders in the TN Department of Education.

In BMTN, teachers met regularly in affinity groups organized around different aspects of algebra engagement, which allowed then to, at times, form strong connections as they discussed, for

example, the results of their PDSA testing. However, not all designed participation structures resulted in strong, bonding ties; in some affinity groups, teachers did not report robust exchanges that facilitated learning due to factors such as inconsistent teacher attendance or preparation, and limited overlap in the nature of the changes teachers were testing. The BMTN experience is consistent with social network studies suggesting that not all formally designed networks lead to robust informal connections (e.g., Daly et al., 2014).

In both TELN and BMTN, strong bonding ties seemed easier to foster than the weaker bridging ties that enabled educators to learn from colleagues in other schools or districts. Educators were motivated to make these connections, but they found it challenging to find time or opportunity to connect with network members outside of formal participation structures. Again, the BMTN and TELN experience illustrates the importance of how network participation structures are designed. This difference in the emergence of bonding and bridging ties may, in part, be explained by the fact that bonding ties were often facilitated through formal participation structures, while the weaker bridging ties were expected to emerge informally in BMTN and TELN. This suggests that formal participation structures may not be sufficient for ensuring

## 4. RELATIONAL TRUST

In addition to the structure of connections among network members, the quality of those relationships matters. Improvement networks aim to provide an organizational structure to facilitate learning within and across sites of practice, such as schools. The kind of collaboration that supports learning and problem solving is facilitated by trusting relationships which can ease collective action and increase the likelihood of positive outcomes (Bryk & Schneider, 2002; Isett et al., 2011; Provan & Kenis, 2008; Milward et al., 2010).

Trust in a network is based on the expectation of reciprocity and the quality of relationships among participating individuals and organizations (Popp et al., 2013). Studies of relational trust in organizations suggest that quality relationships are forged as individuals discern whether their relationships with others are characterized by respect, personal regard, competence in core responsibilities, and personal integrity (Bryk & Schneider, 2002). In particular, it is important to attend to the essential role relationships for which trust is critical. In the case of NICs, examples of these essential relationship areas include: within teams working together to improve their local context, among members in different teams (so that there is a belief that the products of improvement work are worthy of taking up and further testing), and between network leaders and network members.

While its natural to think of the trust needed among individuals engaged in joint work in the network, interorganizational trust can also be a facilitator or barrier to network development because individuals from different organizations will weigh whether other organizational partners can be relied on to fulfill obligations, behave predictably, and act in good faith (Gulati et al., 2011). Because building relationships forms the basis for developing trust, the ability to facilitate and nurture social connections is a critical leadership and management responsibility for network leaders (Popp et al., 2013). Trust takes time to develop, and it may even decline initially as partners begin to work together and start to get to know each other (Huxham & Vangen, 2005; Provan, Fish, & Sydow, 2007; Popp et al., 2013).

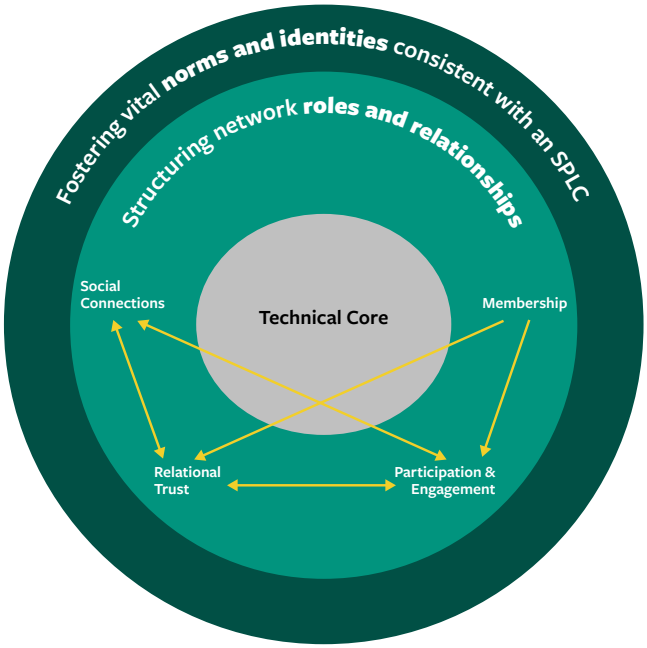
Both BMTN and TELN grappled with the need to build trust among participating members during the early phases of NIC development. In the context of a networked improvement community, trusting relationships are critical among members working closely together (e.g., school teams), as well as between network members and network leaders. In BMTN, the relatively small size of the network enabled regular face-to-face interactions among network members and with hub leaders. This facilitated the formation of trust as members and leaders had opportunities to engage in joint work and discussion. BMTN leaders had to work to build trust with teachers given that the hub team is primarily composed of researchers. We may expect that it would be difficult to forge trust between researchers and teachers given historic disconnects between research and practice. BMTN teachers emphasized the importance of hub leader expertise and their practical experience as mathematics teachers before becoming researchers as factors that built their trust in the hub. Additionally, teachers noted they appreciated being treated with respect as professionals and honored for their practical expertise.

In TELN, network leaders had to overcome a history of distrust between the state education agency and local educators. Historically, there has been limited trust between these entities given that the relationship tended to focus on districts being accountable for complying with mandates (Hanna, 2014). District-based coordinators noted that TELN provided an opportunity for real partnership and collaboration with the state versus the typical top-down, superior-to-subordinate relationship. Other coordinators noted that the network provided opportunities for the state to listen to districts' ideas and concerns. The TELN example shows how trust becomes a social resource for improvement, as local educators are more motivated to engage substantively with state leaders. In both cases, the emergence of trusting relationships seems to be related to engagement in collaborative, joint work, and in the case of BMTN, such trust was also influenced by a belief that hub leaders demonstrated expertise and integrity in their work to develop the network.

## THE IMPACT OF FORMAL AND INFORMAL NETWORK STRUCTURE

In this section, we have argued that a critical component of network health and development is the structuring of network roles and relationships. Figure 2 highlights the aspects of formal and informal network structure that interact to form the social organization of the network. Additionally, we posit some potential relationships among the four dimensions of network structure,. While fully exploring these relationships is beyond the scope of this paper, Figure 2 provides some direction for conceptualizing relationships, especially the critical role that participation structures play in shaping social connections and trusting relationships within the network.

### Figure 2: Structuring Network Roles and Relationships

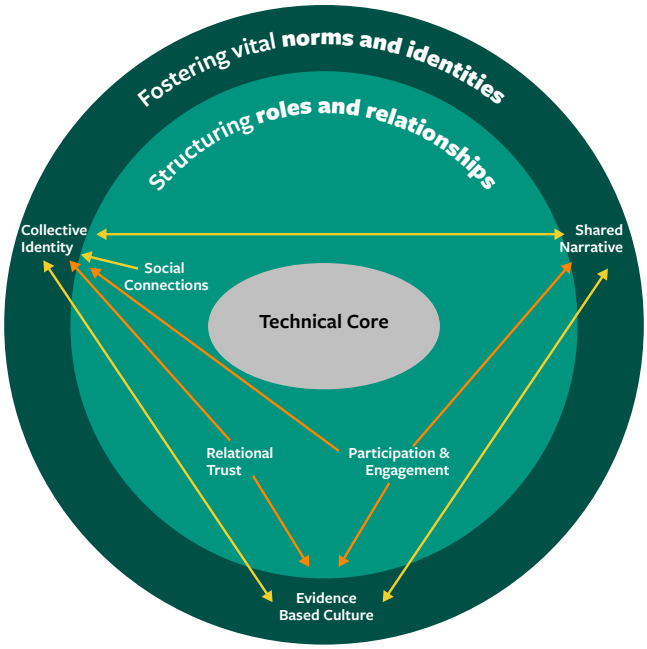


## BUILDING NETWORK CULTURE: FOSTERING NORMS AND IDENTITIES CONSISTENT WITH A SCIENTIFIC-PROFESSIONAL LEARNING COMMUNITY

The final dimension of our framework is described by the outermost ring of the NIC Development Framework (Figure 1), which points to the role of specific norms and identities associated with a scientific-professional learning community that contribute to the development of a supportive network culture. For NIC members to play productive and sustained roles in a learning community, they must develop new visions of their professional practice and related identities. Network members likely need to shift the way they think about themselves as professionals and about their potential to contribute to the field's knowledge of how to improve a problem of practice. Through participation in communities, individuals develop and adapt their identities and practices (Handley et al., 2006).

People develop practices by observing others, imitating them, and then adapting and developing their own practices in ways that match both wider community norms and their own sense of identity (Ibarra, 1999). To understand how this process occurs in a scientific-professional learning community, we look at three key cultural shifts: development of a **collective identity**, embodiment of an **evidence-based culture**, and emergence of a **shared narrative of network participation** (see Figure 3).

### Figure 3: Framework for Conceptualization Relationships Between Network Culture and Structure



## 1. COLLECTIVE IDENTITY

Development of a scientific-professional learning community is facilitated when individual members embrace a commitment to a network's collective identity. Social identity theory suggests that individuals who strongly identify with their role in an organization and who regard their role as central, salient, or valued are more likely to have positive feelings about conforming to role expectations defined by the community (Ashforth & Mael, 1989; Ashfoth & Humphrey, 1993). In other words, identification with the network as a collective endeavor should support norms of participation in a social learning community. Writing about learning communities and networks, Wenger and colleagues (2011) argue that participants in a network need to build a shared identity through community building processes, which enables them to see their participation as a contribution to a broader learning endeavor that will benefit them and the collective. Identification with the collective motivates sharing and collaboration, provides a rationale for helping others within the network, and contributes to shared responsibility and collective efficacy (Frank, 2009; Akerlof & Kranton, 2005).

Engagement in shared experiences and activities helps network participants develop a collective identity (Barab & Duffy, 2000; Davis & Sumara, 2001; Grossman et al., 2001; Printy, 2008). In particular, experiences with constructive collaboration in which members of a community work together to successfully improve outcomes are important in the development of a collective community identity (Goddard et al., 2015). In her study of education reform networks, Lieberman (2000) found that successful networks paid attention to developing norms of participation by building collaborative relationships through joint work that advanced the network's goals. Joint work in a community is critical to shifting from the weak norms of a sharing community to a community that embraces collective judgment and action (Little, 1990). As Jackson and Temperley (2007) argue: "Joint activity gives focus, strength, and purpose to the network" (p. 7). Networked learning involves purposeful joint activity undertaken on behalf of the collectivity (Church et al., 2002; Jackson & Temperley, 2007). In addition, cooperative norms in communities with social cohesion facilitate knowledge exchange and innovation generation (Reagans & McEvily, 2003).

Consequently, in addition to a singular focus on their classroom or school, members of a well-functioning NIC will hold a "we perspective" in which they identify as members of a scientific-professional learning community improving practice in "our" shared field. Many participants in a NIC join the network because they think it will help them with their core work (e.g., teaching in their classrooms), but participation in the network should help them to develop a vision for the possibility of what can be realized by working with others in the network. To this end, we posit that participation structures (described in the roles, connections, and responsibilities section of

the framework) shape the development of a collective identity, thus revealing a key connection between these two framework elements. Additionally, through their work in the network, members should begin to see how they can contribute to the production of practical knowledge, which may contribute to accelerating improvement in the education field more broadly.

In BMTN, network leaders worked to develop a collective identity around deep student engagement with algebra. In network convenings and small group virtual meetings, teachers were given opportunities and structures for grappling with the meaning of deep engagement and how to facilitate it in their classrooms. One challenge we see in building a collective identity is that teachers tend to enter improvement networks motivated to improve their individual teaching practice, but fail to see how their individual work can contribute to a larger collective mission. As they conceptualize participation in the network as an opportunity for professional development, they under-emphasize the components of network participation that contribute to social learning. For example, teachers resist documenting what they are learning in their inquiry cycles in ways that others could learn from and take up in their own practice.

Additionally, teachers without explicit connections to others doing similar work tend to operate in isolation. We posit that engagement in joint work in a network is critical to developing collective identity. In BMTN's first year, many teachers were designing and testing their own change ideas. They shared their processes and results in small- and whole-group collaboration forums, but, ultimately, the learning was focused on their individual classrooms. In contrast, the few groups testing common change ideas experienced richer, reflective conversations in small-group coaching sessions. In one case, three teachers who shared a local urban context formed a group based on their shared goal of improving the use of exit tickets in their classrooms. While each teacher used exit tickets for a different purpose, they used a common rubric (designed by one group member) to measure the success of their tests. This allowed the teachers to learn from each other as they grappled with similar challenges. This example, among others we observed, suggests that engaging in joint work, enabled through intentionally designed network participation structures, helps teachers see the value of the network as a collective improvement organization.

## 2. EVIDENCE-BASED CULTURE

Inquiry is a critical form of joint work in a scientific-professional learning community. Drawing on their experience with England's Network Learning Community Programme, Jackson and Temperley (2007) argue that inquiry is a "fundamental tenet" of learning networks, involving defined processes through which practitioners systematically explore research and practice evidence to support decision-making and problem solving. Routinized inquiry processes such

as lesson study have been found to shift teachers from the traditional norm of individualism in teaching to community norms of innovation and continuous improvement (Lieberman, 2009).

A NIC's problem-solving agenda is supported by an evidence-based culture characterized by a commitment to generating and building on evidence from research- and practice-based inquiry cycles. In a networked improvement community, inquiry-focused participation structures support educators as they systematically test changes in practice and document lessons learned, contributing to networkwide learning. Thus, one indicator of an evidence-based culture is members' growing commitment to the testing process, grounded in evidence (from prior research, their own inquiry, and the inquiry of others), to guide their improvement work.

Building a network culture that is grounded in evidence generated through disciplined inquiry may be challenged by educators' prior experiences and resultant norms associated with data use in schools. Studies have emphasized the persistent challenges associated with robust data use in education, such as the lack of quality, actionable data for improvement (e.g., over-reliance on annual, state test data); the lack of knowledge and skills to generate, analyze, and interpret data; and norms promoting the use of data for accountability rather than improvement (Bryk et al., 2015; Marsh, 2012; Marsh et al., 2006). Based on a review of the data use literature, Marsh (2012) concludes that data use thrives when communities ensure that data are easy to understand and use, include norms and structures supporting the safety of data discussions, and provide ongoing support for maintaining the depth of discussions about data.

Marsh's review provides guidance for building structures, practices, and norms that facilitate safe and productive evidence-based discussions. For example, data-based discussion should focus on evidence-based evaluation of practice rather than holistic evaluations of educators (Honig & Ikemoto, 2008). Additionally, the review points to strategies such as the use of protocols and specific "talk moves" utilized by facilitators to ensure a safe and productive focus (Honig & Ikemoto, 2008; Nelson & Slavit, 2007). This work suggests that an additional indicator of the emergence of an evidence-based culture in NICs is that members feel safe to both share their data and engage in critical conversations about what is and is not working.

Finally, in order to support the social learning function of a NIC, the evidence-based culture should encourage members to actively seek out others' successes, identified through evidence, so they can learn from them. In order to promote this type of social learning and the knowledge management functions of a NIC, it is critical that members systematically document their inquiry work and lessons learned. As Bryk and colleagues (2015) note, "by formalizing the identification, capture, and organization of practical knowledge, a hub can accelerate the spread and use of the

products of past improvement research." Consequently, additional indicators of an emerging evidence-based culture are (a) members embracing the need to document small tests of change so learning can guide the work of others and (b) members having access to and embracing opportunities to test and build on the improvement work of others in the network.

TELN and BMTN leaders have taken steps to promote the emergence of an evidence-based culture. In both networks, leaders introduced participation structures that encouraged network members to engage in PDSA cycles. This process was scaffolded through ongoing training, the introduction of tools such as templates for educators to fill out as they go through the process, and structured reflective conversations in which educators share what they learned from inquiry cycles. In this way, an improvement network with a robust evidence-based culture would have members actively using disciplined inquiry routines to learn how to solve the focal problem of practice.

A challenge related to fostering an evidence-based culture is the identification of efficient and reliable systems for educators to document what they are learning through disciplined inquiry. Both TELN and BMTN have struggled to develop systems that enable educators to perform two essential functions: (1) document what they are learning in ways that the hub and other network members can learn from and (2) evaluate the evidentiary warrant in support of tests. For example, in BMTN, documentation of inquiry cycles was archived in shared Google drives accessible by all network members. However, it is challenging for teachers to find time to produce documentation that is sufficiently elaborated for others to learn from on their own without direct contact with the person who produced the documentation. Inadequate documentation of improvement work also makes it difficult for network leaders to consolidate and spread what network members are learning.

Additionally, both networks have grappled with identifying and developing practical methods for educators to gather and analyze data that supports their judgments about whether changes led to improvement in their teaching, students' engagement, or literacy learning. An evidence-based culture is grounded in effective data collection, analysis, and interpretation practices. In BMTN, teachers wanted to see if students improved their capacity to justify mathematical explanations during classroom talk. However, finding ways to do this short of resource-intensive recording, transcription, and discourse analysis has not yet been resolved by the network. In the absence of truly practical measurement tools and routines, educators tend to resort to impressionistic judgments, which is antithetical to the notion of an evidence-based culture.

## 3. SHARED NARRATIVE OF NETWORK PARTICIPATION

A final cultural component of NIC development is the emergence of a shared community narrative. Humans and social groups make sense of their lives and experiences by telling stories (McAdams, 1996). Deliberately storying and restorying is a form of social growth and development (Connelly & Candinin, 1990; Loseke, 2007). We posit that NICs benefit when they develop a shared narrative that includes personal stories of member's motivations for being involved in a network, and a collective story that addresses the goals of the network and the urgency to attending to the problem. The resulting shared narrative of improvement should be evident in member talk in social forums and the documentation generated by the network.

The concepts, language, and tools of a community of practice embody its history and its perspective on the world (Wenger, 2000). Narratives are day-to-day resources for organizational members because they offer a cultural tool kit of symbols, stories, and beliefs that people use to solve problems and accomplish work (Loseke, 2007; Swidler, 1986). Communities of practice have a shared repertoire of communal resources, including shared language, routines, artifacts, tools and stories; part of becoming a competent member of the community is appropriately using this repertoire (Wenger, 2000). NIC leaders should endeavor to promote a narrative of participation that helps to transform individual interests into productive collective action by specifying what network participants do and do not do. (Russell et al., 2017). Crafting a network narrative helps members see themselves as part of a group with a shared mission and develop personal identities that connect them to the network's collective identity (Bryk et al., 2015).

In BMTN, network leaders have sought to build a shared narrative around what constitutes deep engagement in algebra. In various network participation and engagement structures, through the specification of the DEAs—three ways of exemplifying deep engagement in algebra – teachers are building a shared perspective on what constitutes student-centered instruction.

In TELN, the emerging shared narrative is less about the network's focal problem of practice—early grades literacy— and more about collaboration and improvement science. In their talk in meetings and interviews, educators emphasized opportunities to strengthen social connections to TDOE, Carnegie, and other districts, and to learn from what other educators are doing. Additionally, a shared narrative emerged around improvement science methods and tools, including developing a better understanding of the literacy problem before jumping to solutions, using evidence to understand whether changes lead to improvement, and the value in testing changes on a small scale before moving to widespread adoption.

In this section, we argued that a second critical component of network development is the set of norms and identities that form the network's culture. Figure 3 highlights the three dimensions of culture that we posit are important in the viability of a networked improvement community. Additionally, we offer conjectures about potential relationships among the three dimensions of culture and the four dimensions of network structure that were alluded to throughout this section. Specifically, we theorize that collective identity, evidence-based culture, and a shared narrative are mutually reinforcing norms and identities in a networked improvement community. We also hypothesize on the nature of relationships between the social organization of the network and network norms and identities: We posit that participation structures play a critical role in the emergence of an evidence-based culture and shared narrative, and that the structure and quality of social relationships shape the emergence of a collective identity.

# DISCUSSION

Networks of educators working together to solve high leverage practical problems hold great promise for our field's capacity to accelerate improvement. Educators in the BMTN and TELN networks are working collaboratively to address critical milestones in students' educational trajectories and pathways to college and career—BMTN, by improving student engagement in high school algebra problems in New England; and TELN, by increasing the proportion of students who are proficient readers by 3rd grade in Tennessee. Yet we know from a long history with collaborative reforms such as professional learning communities and sharing networks that the results of reform efforts vary considerably due to how they are organized and enacted (Bryk et al., 2015; Gomez et al., 2016; Kahne et al., 2001; Stoll & Louis, 2007; Wohlstetter et al., 2003). The networked improvement community concept provides an in-principle approach to networked collaboration for accelerated improvement.

In this paper, we extended the NIC concept by describing these networks as a form of scientific-professional learning community. By theorizing how these communities are grounded by shared goals, norms, and theories to provide an environment in which professionals learn through disciplined inquiry, with support from leadership that coordinates and accelerates learning through strategic knowledge management, we contribute to a concrete vision of the practice that characterizes work in a high-functioning NIC. Additionally, in our work to specify and describe a NIC's social organization and the norms and identities consistent with a scientific-professional learning community, we posit a preliminary theory of a healthy and robust network. Finally, through two concrete cases of emerging NICs we put a descriptive face on what these elements of the NIC concept look like in practice.

Additionally, we begin to specify a developmental theory for NIC emergence and maturation that includes attention to the temporal unfolding of key dimensions of the social organization and cultural aspects of NICs. Specifically, we posit that intentional decisions about network membership and the design of participation structures are foundational elements of the NIC development process, and that these dimensions subsequently shape the structure and quality of social relationships in the network and network norms such as an evidence-based culture. Further, social connections, which are likely shaped by participation structures, foster the emergence of relational trust and a collective identity. Our propositions about NIC development are offered as an initial attempt at theory building regarding how key dimensions of the social organization of NICs interact and unfold over time.

Our attention to NIC development is important for a number of reasons. The NIC concept has generated considerable excitement in the field among educators looking for ways to accelerate progress toward ameliorating long-standing problems, such as stagnant and inequitable student achievement outcomes (Martin & Gobstein, 2015; Lewis, 2015; Proger et al., 2017; Tichnor-Wagner et al., 2017). Many educators seeking to launch NICs need guidance about how to initiate and support the development of these complex organizations so that they realize their promise. Networked learning communities have the potential to take the professional community concept to scale. For example, England's National Learning Communities (NLC) Programme created opportunities for educators in 7,000 participating schools to work collaboratively in networks to enhance student learning, professional development, and school-to-school learning (Jackson & Temperley, 2007). However, the NLC Programme, like other networked learning communities, grappled with the challenge of creating structures and processes that support "whole system learning" (Hadfield, 2005). By adding the principles of scientific communities to the learning community concept, we provide a method for networked learning through disciplined inquiry. Additionally, the social and cultural aspects of networked improvement communities we describe further elaborate the structures and processes that support networked learning. Without attention to the core components of operating a NIC, we risk the uptake of the NIC concept in symbolic form but without the structure and processes that enable NICs to contribute to systemic improvement (Peurach, Penuel, & Russell, 2018).

Keeping this in mind, we offer the framework for thinking and reasoning about NIC development, not as an evidence-based model that describes how all NICs emerge and mature. While the framework is inspired by the insights we developed from our deep engagement with emerging networks in dialogue and with theory and research about network development, the framework serves as theory that needs to be tested by rigorous empirical research. With this limitation in mind, we believe the framework offers considerable guidance for researchers to

explore the emergence of networked improvement communities. Additionally, the framework can serve as a practical guide for NIC leaders who are seeking to steward and reflect on the development of their networks. This practical application would be best realized in collaboration with developmental evaluators who can help leaders reflect on and interrogate their network's developmental trajectory in light of the framework (Peurach, Glazer, & Lenhoff, 2016).

A strength of the framework is its attention to the social and cultural components of NIC development. We argue these components are critical for networks to realize their technical function, but they have not been attended to explicitly in prior work on improvement networks. For this reason, we focused this paper on the social organization, norms, and identities that we posit are critical to catalyze a scientific-professional learning community. While this paper provides some insights into the strategic actions network leaders take to support network development, particularly through the case examples, the paper does not fully explicate the role of network leadership in initiating, managing, and sustaining the social, cultural, and technical components of network operation. We view leadership as a critical driver of the domains of activity described in the framework. This is consistent with prior scholarship that points to the importance and distinctive character of network governance (Fullan, 2000; Jackson and Temperley, 2007; Peurach, 2016; Wohlstetter et al., 2003). Creating the conditions that support problem solving and networked learning requires the right mix of partnering organizations and coordination mechanisms (Goldsmith & Eggers, 2005; Kahne et al., 2001; Klijn et al., 2010; Smith & Wohlstetter, 2001; Wohlstetter et al., 2003). Leadership in networks is rooted in the capacity to foster a common vision and motivate others to engage, rather than formal power to impose roles or mandate actions (Eglene, Dawes, & Schneider, 2007). Future theorizing and empirical work that unpacks the nature of leadership in networked improvement communities stands to complement our work and make a significant contribution to the field.

## CONCLUSION

Networked improvement communities offer a new research and development strategy for addressing persistent, high-leverage problems we face in education. As intentionally designed social organizations, NICs bring together a colleagueship of expertise for tackling a specific problem. Attention to NICs as formal organizations and their attendant structures, norms and processes are critical to evaluating their utility for driving practical improvement and supporting the work of educators seeking to initiate these networks. The framework we specify in this paper is one important step to attending to the organizational structures that catalyze the development of scientific-professional learning communities.

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## ABOUT THE AUTHORS

At the University of Pittsburgh, **Jennifer Lin Russell** is Chair of Educational Foundations, Organizations, and Policy and Professor in the School of Education; and Associate Director for Educational Research and Practice and Senior Scientist at the Learning Research and Development Center. She is also a Senior Fellow with the Carnegie Foundation for the Advancement of Teaching. Her research examines policy and other educational improvement initiatives through an organizational perspective. Her recent work examines two primary issues: (1) how schools create social and organizational structures that support reform; and (2) how inter-organizational collaborations and networks can be structured to support educational improvement. Russell is a former special education teacher in urban and rural settings and is committed to more equitable learning opportunities for all students. She received a Ph.D. in education policy and organizations from the University of California, Berkeley.

**Anthony S. Bryk** is currently a Senior Fellow for the Carnegie Foundation for the Advancement of Teaching. Prior to becoming a Senior Fellow, he served as the Foundation's 9th president from 2008 to 2020. One of America's most noted educational researchers, his time at Carnegie is characterized by his leadership in transforming educational research and development. Bryk's 1993 book, Catholic Schools and the Common Good, is a classic in the sociology of education. His deep interest in bringing scholarship to bear on improving schooling is reflected in his later volumes, Trust in Schools (2002) and Organizing Schools for Improvement: Lessons from Chicago (2010). In his most recent publications Learning to Improve (2015) and Improvement in Action (2020), he argues that improvement science combined with the power of networks offers the field a new approach to reach ever increasing educational aspirations. Bryk holds a B.S. from Boston College and an Ed.D. from Harvard University.

**Donald J. Peurach** is Professor of Educational Policy, Leadership, and Innovation in the University of Michigan's School of Education. He is also a Senior Fellow of the Carnegie Foundation for the Advancement of Teaching, a Faculty Associate in the Center for Positive Organizations in the University of Michigan's Ross School of Business, and a Senior Research Specialist at the Consortium for Policy Research in Education at the University of Pennsylvania. His research examines large-scale, network-based educational improvement initiatives, focusing specifically on how these networks continuously learn and improve over time. Peurach is the author of Seeing Complexity in Public Education: Problems, Possibilities, and Success for All (2011) and co-author of Improvement by Design: The Promise of Better Schools (2014). Before pursuing an academic career, Peurach was a high school mathematics teacher. He holds a B.A. in computer science from Wayne State University, as well as an M.P.P. from the Ford School of Public Policy and a Ph.D. in Educational Studies from the School of Education at the University of Michigan.

**David Sherer** is an Associate in Evidence and Analytics at the Carnegie Foundation for the Advancement of Teaching. He joined the Foundation as a networked improvement fellow in 2017. Previously, he worked at Harvard University as a researcher and educational consultant, including at the National Center for Research in Policy and Practice investigating how school and district leaders use research in their decision-making. He is particularly interested in helping educational leaders promote effective collaboration within their organizations and across broader improvement networks. He uses varied methods, including surveys, ethnography, and social network analysis, to understand the implementation and effects of such efforts. Earlier in his career, David was an analyst and evaluator at SRI International's Center for Education Policy, where he studied leadership development, comprehensive school reform, and the teacher workforce. Sherer holds a bachelor's degree from Pomona College in Psychology and Public Policy Analysis, as well as a master's degree and Ed.D. from the Harvard University Graduate School of Education.

**Edit Khachatryan** is an improvement facilitator, researcher, and educator who serves on the Carnegie National Faculty. She is also the Founder and Principal Consultant at Sovoroom, where she designs and facilitates professional learning for teachers and leaders utilizing continuous improvement tools and processes, coaches school- and district-based improvement teams and individuals around their improvement efforts, and conducts research on facilitating and coaching improvement. Khachatryan started her career as a high school teacher before moving into federal policy as a Teaching Ambassador Fellow at the U.S. Department of Education. More recently, she was an associate at Carnegie Foundation for the Advancement of Teaching. Khachatryan holds a B.A. in sociology, two master's degrees and teaching and administrative credentials from UCLA, and a Ph.D. in curriculum and teacher education from Stanford University.

As Senior Vice President of the Carnegie Foundation, **Paul G. LeMahieu** manages all of its programs. He came to Carnegie from the National Writing Project at the University of California, Berkeley where he was Director of Research and Evaluation. He has also served as Superintendent of Education for the state of Hawai'i—the only state in the nation that is a single unitary school district. He has held top educational research and policy positions for the state of Delaware and in the Pittsburgh Public Schools. He has many publications, including as a co-author of Learning to Improve (2015) and Improvement in Action (2020). LeMahieu holds a bachelor's degree from Yale College, a master's degree from Harvard University, and a Ph.D. from the University of Pittsburgh.

**Jennifer Zoltners Sherer** is a Research Associate at the University of Pittsburgh's Learning Research & Development Center and is a member of the Partners for Network Improvement team. Her work includes the developmental evaluation of networks, offering evidence-based support of network leaders as they design, initiate, and develop networks that improve K–12 teaching and learning. Her research interests focus on distributed leadership, organizational change, and improving teaching and learning in K–20 systems through networks, tool design and implementation, professional development, and curriculum. Sherer holds a B.A. in American Studies from Wesleyan University, an M.A. from both Lewis & Clark College and Northwestern University, and a Ph.D. in Learning Sciences from Northwestern University.

**Maggie Hannan** is the Simon Initiative Associate Director for K–12 at Carnegie Mellon University. A learning scientist and engagement specialist, she has worked in numerous education policy networks and partnerships, collaborating with state departments of education and nonprofit foundations to build and evaluate large-scale policy initiatives. Her work focuses on interorganizational networks, policy implementation, scaling innovations in complex systems, fostering equity in educational technology, and the interplay between organizational context and educational technology. Hannan holds a B.A. in English Language and Literature from Duquesne University, an M.A. in English Literature from West Virginia University, and a Ph.D. in Learning Sciences and Policy from the University of Pittsburgh.

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