The Intermediation of Community and Infrastructure

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Abstract

The concepts of *community* and *infrastructure* reverberate throughout the information sciences. As digital information technology becomes ubiquitous in work and everyday life, scholars analyze how communities adapt to, and adapt, information infrastructure. This paper explores this topic through a cross-study of field scientists' changing data practices and of older adults learning technology. The contribution of this comparative study is the concept of an *intermediary space*. Both studies found individuals, referred to as intermediaries, who enable their communities to speak back to information infrastructure—that is, to have a voice in infrastructural development. In particular, the study noted the roles of those outside positions of power in the design and development of effective information infrastructure. Understanding this intermediary space involves attending to issues related to design and narrative. The implications of these findings include more effectively preparing the information sciences' workforce for these intermediary roles.

Introduction and Background

Information activities depend on the arrangements of communities and infrastructure. These two concepts, *community* and *infrastructure*, are at the heart of social challenges associated with the increasing ubiquity of digital technology and digital information throughout our lives. As Weick (2016, p. 333) explains in another context: "We're learning how to talk about distributed interdependence and how to hold it together." In our respective doctoral projects undertaken at the School of Information Sciences of the University of Illinois, we investigated the distributed interdependence

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of infrastructures and communities in the arenas of data work by field scientists and digital learning among older Americans. We are informed by a number of perspectives that have developed in the information sciences, including community informatics, information literacy, information management, and information systems. Although studying diverse phenomena in the workplace and everyday life settings, we nonetheless found many similarities in terms of how infrastructure and community are interconnected and held together in the digital world. This paper explores these cross-case findings.

Information Infrastructure

In recent years theories of information behavior have increasingly focused on information use within the contexts of information systems (Courtright, 2007). This shift relates to trends in both social informatics and science and technology studies (Van House, 2003). In the theoretical frameworks of information infrastructure (Star & Ruhleder, 1996), cyberinfrastructure (Atkins et al., 2003), and sociotechnical systems (Lamb & Kling, 2003), among others, the focus is on the interplay of information systems and users.

An ongoing discussion in this literature concerns how users shape systems. In widely cited research on cyberinfrastructure, Atkins et al. (2003) demarcate the infrastructure of science and what they call "end-users." A somewhat different tradition comes from the work of Star (1999) and Bowker, Baker, Millerand, and Ribes (2010). Star theorizes information infrastructure as resulting from the interactions of information users and information systems. Information infrastructure, she writes, is "a fundamentally relational concept, becoming real infrastructure in relation to organized practices" (p. 380). Infrastructure here consists of those information systems that have been integrated into the organized practices of a group.

Drawing on these trends, some have called more recently for the creation of infrastructure studies. Within this nascent field the issue of power relations in and around information infrastructure has central theoretical importance. Scholars increasingly recognize that infrastructure creates both opportunities and challenges in terms of people's ability to make effective use of technology. In a special issue on this topic in the *Journal of the Association for Information Systems*, Edwards, Bowker, Jackson, and Williams (2009, p. 372) write, "Questions of distribution, power, and justice need to be addressed urgently and systematically by our field. How can claims on, through, and against infrastructure be formulated, organized, and heard? What constitutes adequate representation or participation in the process of infrastructural change and development?" These questions relate to the characteristics and dynamics of how infrastructure is created through use (Karasti, 2014), as well as to the codesign of social and techni-

cal systems. A central concern is understanding how diverse communities contribute (or do not) to infrastructural development and design.

Community

Within the information sciences, multiple conceptualizations of *community* exist (Veinot & Williams, 2012). A common theme uniting these various definitions is the idea of a group of people with shared culture, practices, and/or history. One strand of research draws on conceptualizations of community developed in the field of sociology during the late nineteenth century (Williams & Durrance, 2009). Influenced by the work of scholars like Wellman (1979) and drawing on the development of trends in social informatics (Lamb & Kling, 2003), the subdiscipline of community informatics focuses primarily on understanding how historically marginalized local communities function in the digital age (Gurstein, 2003). Here, the concern is with how preexisting communities navigate the new affordances made possible through the mass availability of digital information technologies.

In other parts of the information sciences, scholars investigate how information technologies enable forming communities. Influenced by theories developed in ethnography and anthropology, such as Lave and Wenger's (1991) work on communities of practice, these scholars explore how individuals engaged in shared (or similar) pursuits form communities online around their common interests (Haythornthwaite & Kendall, 2010). This work has led to a focus on virtual communities (Kendall, 2011), information communities (Fisher & Durrance, 2003), and other theories focused on understanding how communities emerge and sustain themselves through the mediation of information and information technologies.

Our Contribution: The Intermediation of Community and Infrastructure

In our respective studies we analyzed what we are calling the "intermediation of community and infrastructure" (fig. 1). By this, we mean the ways in which community participation in infrastructure is supported. Here, we join scholars like Guribye (2015) who analyze how learning communities form in, alongside, and through infrastructures. Our contribution is to tie conceptualizations of infrastructure and community together, exploring how they can be used together to better understand the empirical realities of groups of people in both workplaces and everyday life navigating the new digital world.

As we juxtaposed our two studies, we highlighted the intermediation of communities and infrastructure. We found that narratives are constitutive elements in the development of this intermediary space, and that participants, including researchers, can contribute to these processes. We also found that how this space is designed is complex and influenced by

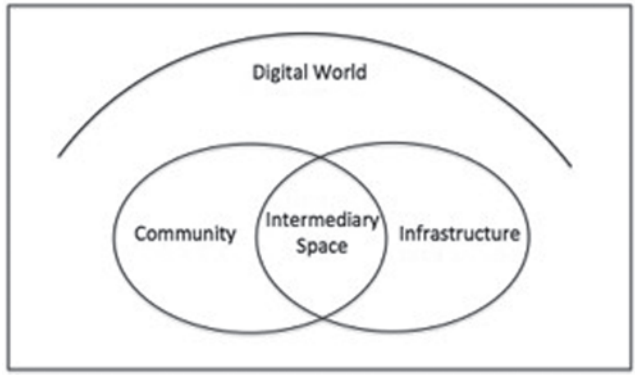

Figure 1. The conceptual overlap of *community* and *infrastructure* in the digital world. This paper explores the *intermediary space* created at this intersection.

multiple, sometimes competing priorities. Further, the intermediary space unfolds within the context of social inequalities; that is, not all actors involved in this space have equal ability to participate in the process of designing it. These findings are important because they enrich scholarly understanding of the challenges associated with developing and sustaining participatory digital infrastructure.

Methods and Approaches of Studies

Table 1 articulates conceptually the approaches we took to studying *community*, *intermediary space*, and *infrastructure* in our respective studies. Below, we discuss in more detail how these studies were organized and carried out.

Community

Older adults. The communities of older adults are multiple and overlapping. They include families spread across space, work-based colleagues, friends, and others. Lenstra's (2016) research focused on understanding the roles of local communities in the digital-learning practices of older adults. The decision to focus on the local community was motivated by a grounding in the field of community informatics, which is concerned with understanding how local, historical communities—those communities that have formed over time in particular places—are navigating the transition into the digital information society.

The local community was studied by analyzing older adults who live in a particular geographic space and who participate in technical-support services in local public libraries and senior centers. Over years of living within this space, these older adults have deeply invested their lives into the place-based networks that extend into public libraries and senior cen-

Table 1. An intermediary space approach to studying *community* and *information infrastructure*

	Community	Intermediary space	Information infrastructure
Older adults	Geographically based community in U.S. urban area	Staff and volunteers who assist older adults in learning technology	Technical-support services in public libraries and senior centers
Field scientists	Project-based collaborative research in the field sciences	Specialists who assist in organizing project data and preparing it for reuse by others	Systems and processes that enable assembly, accessibility, and preservation of research data

ters. Many of the older adults who participated in this study regard public libraries and senior centers as parts of their local communities. This recognition contributes to their decision to come to these spaces to learn digital technologies in their retirement. In other words, for the older adults who participated in technical-support services, these services were part of a much larger and in some cases lifelong engagement with these institutions.

Field scientists. Scientific researchers belong to many communities, including institutional, professional, disciplinary, and project-based, in academic, government, business, and nonprofit sectors. Baker's study (forthcoming) focuses on communities of field scientists who work collaboratively. Their work is tied together by sampling collectively within a designated geographic location, and by their research commitment to finding a shared understanding of the dynamic natural environment being studied.

Baker analyzes two place-based research projects in the environmental sciences, and one platform-based research unit in the atmospheric sciences. Research scientists form teams that propose projects to funding bodies, and when successful, carry out their investigations via observations and measurements made during fieldwork. After collecting data, scientists work with the data both individually and collectively. Baker's focus on local or project data infrastructure arose from concerns about perceived inefficiencies with the existing diversity of data arrangements. Each case studied illustrates how communities of field scientists work with the existing infrastructure for assembling and sharing data with one another, but also how they must create new arrangements to meet new data needs and requirements.

Information Infrastructure

Older adults. In his dissertation Lenstra (2016; see also Lenstra & Williams, 2014) analyzed the information infrastructure of digital learning used by older adults. In particular, it analyzed technical-support services in public libraries and senior centers as a type of information infrastructure. Rather than setting out with a predefined notion of older adulthood, he followed the lead of the institutions where the studies were carried out, allowing these institutional definitions to shape fieldwork. He did this by conducting a year-long ethnography of technical-support services at three public libraries and three senior centers located in one urban area in the United States.

The services studied have both technological and social dimensions. The former dimensions consist of public computing equipment (computers, printers, scanners, cameras), wireless internet networks, and the buildings in which these are based. The social dimensions consist of the people (staff members and volunteers) available to help older adults, and others, learn digital technologies. To understand how this infrastructure relates to the digital-learning practices of older adults, Lenstra worked alongside staff and volunteers in these technical-support services. He also interviewed both staff members and some of the older adults who participated in these services, and reviewed institutional records about these services.

Lenstra focused on this infrastructure after his review of the scholarly literature revealed significant gaps in it on the digital-learning practices of older adults. The infrastructural dimensions of digital learning in this population are understudied. This literature has not closely attended to how digital learning is shaped and conditioned by infrastructural arrangements.

Field scientists. In her dissertation work Baker (forthcoming; see also Baker, 2014; Baker & Duerr, 2016) studied infrastructure that supports field scientists working together to assemble research data. In particular, she investigated the social and technical arrangements in scientific projects as data were moved from individual use to collective assembly for open access and preservation. In carrying out a multiyear ethnographic study of three cases in the natural sciences, Baker observed and engaged in data-related discussions, conducted semi-structured interviews, and participated in the development of posters, presentations, and technical reports with information specialists.

From the perspective of the information sciences, scientific projects historically have played a central role in the production of scientific knowledge, and more recently in the production of data for unanticipated reuse. Of primary concern is the design of infrastructure to support the reuse of research data over time and in ways that respond to the needs of

scientists and other users outside the project. Design and effective use of the emerging infrastructure requires continuing learning on the part of researchers in terms of developing new data practices. This investigation focuses on local collective-data efforts within a digital landscape often dominated, to date, by a focus in the literature on the development of large-scale projects and infrastructure. Baker's study considers the growth of midlevel data infrastructure, which is one part of an overarching infrastructure supporting the management of an earth able to sustain human society today and in the future.

Findings

The first part of this section briefly introduces some of the findings from our respective dissertation research that illuminate the intermediary space between communities and infrastructure. The second part discusses how placing our studies into dialogue enriches our understanding of both information infrastructure and community.

Part 1: Intermediary Spaces

The framing of intermediaries in technical-support services. Public libraries and senior centers are complex institutions asked by the municipal governments that fund them to do a large number of tasks with small budgets. Technical-support services are just one piece of much larger institutional goals and priorities. To manage these services alongside many others, staff may create policies that unintentionally hinder the types of learning that older adults desire. Lenstra's (2016) research found that older adults actively seek and often succeed in creating work-arounds that better meet their digital-learning needs. Examples related to personnel management illustrate this dynamic process.

The older adults who participated in Lenstra's study sought to create and sustain relationships with the people who helped them. Older adults drew on these relationships to both deepen and expand their digital learning over time. In contrast library administrators sought to anonymize these services so that staff members were not tied to particular individuals but could instead flexibly divide their time across many responsibilities. For example, one library decided to stop giving technology volunteers individual nametags; instead, generic tags were used that simply stated "volunteer." This policy was motivated by the fears of library administrators, who worried that volunteers would not be able to serve all, but instead restrict their time to a select few. This policy, although inspired by well-meaning intentions, had the consequence of alienating some older adults, and it compromised their learning achievement. Lenstra found that the older adults in his study learned best within the context of caring relationships.

Older adults did not passively accept the policies set by staff; instead, they sought and often succeeded in adapting services to meet their needs.

At all sites studied, older adults invited and encouraged staff members and volunteers to visit their homes, accept gifts, and attend other community events and spaces important in their lives. These relationships short-circuited institutional policies. At one library a staff member (whose official job title was "Children's Librarian") said that for the past two years she has worked with an older woman in her mid-seventies who came to the library every Monday afternoon to learn how to use a computer. The older woman insisted that this Children's Librarian assist her, even though this type of support is not part of her job description. These sorts of relationships show how older adults actively shape this infrastructure, which is a product of back-and-forth, in situ negotiations.

Ageism in the intermediary space. Negotiations shaping infrastructure are shaped by larger social trends. In particular, *ageism*, or ingrained social customs and practices that lead to discrimination against older people, shapes how technical-support services operate. As Bowen (2012) shows, these ageist ideas emerge at both the national and global levels. Lenstra (2016) demonstrates that ageist ideas that frame *technology* and *youth* as virtually synonymous led staff to recruit technology volunteers at the local university. These recruitment practices reinforced the ageist idea that young people are the natural (or best) individuals to help and support older people learning technology. Many older adults, in turn, had internalized this ageist idea; in interviews, they said that when they have an issue with a digital device, their first impulse was to seek assistance from a young person.

Nonetheless, Lenstra's (2016) study also showed that when older adults help one another with technology, learning is enhanced because they feel more self-confident and comfortable with it. This finding emerged from two cases from fieldwork. The first concerned a senior center where there were never enough staff members to assist the many older adults seeking technical support; to fill this gap, older adults stepped in to help one another. The second case occurred at a library where a recently retired individual joined the technology volunteer program to help others learn. These practices challenged the ageist norm of young tutors for older learners. Nonetheless, they also encountered resistance because of deeply ingrained ageist values. For instance, some staff members and older adults complained that the retired volunteer was less capable and nimble than the student volunteers, expressing a clear preference for the latter. These examples are exceptions to the larger, more general trend of this infrastructure reinforcing ageist ideas about technology and older adulthood. As such, they illustrate that the intermediary space between infrastructure and community is dynamic, subject to though not determined by larger social structures.

Data production as new work in the sciences. In order to provide data access for larger audiences and longer timeframes, research projects assemble data and partner with data facilities in response to agency mandates to share data (Holdren, 2013). As a result a new category of work was identified—data production. Traditionally, data were in local use, in a state of flux as an active element in the research process rather than considered as a static product to be packaged as a resource for future unknown uses. In some cases data production was perceived as a distraction from the focus of a scientific project, while in others it was recognized as bringing needed help at both the personal and project levels with managing an ever-increasing volume of data.

Scientists are charged now with not only producing knowledge to submit for publication but also making their research data available for reuse by others. As this focus on data products develops, new data arrangements for scientific communities emerge and persist beyond the finite periods of research grants. In one case studied, volunteers rather than research assistants added data on natural habitats into information systems. Infrastructure was extended to support field sampling that included new communities coordinated by self-motivated, lifelong learners.

The emergence of intermediaries in research science. Scientific researchers trained to collect and use data as part of the process of creating knowledge are still taken by surprise with the realization that they are now somehow expected to organize and share data as part of a new, ill-defined process of data production. For instance, a manager of a data group described the response of scientists to data planning: "Very few of them see the bigger picture. And so when I talk about data management, sometimes I get the 'deer in the headlights' look."[1] In order to cope with the challenges associated with these changed data requirements, new work roles have emerged, but because researchers lack familiarity with them, they have difficulty including them in project plans.

These *intermediaries* connect scientists and data infrastructure. Data needs vary across communities and focus on different aspects, such as assembly, processing, integrating, visualizing, and modeling. These varied tasks are reflected in the titles of intermediaries. For example, there were technicians and research assistants associated with field efforts; systems administrators and data managers in a science-oriented unit; software engineers and programmers in a data facility; and data and metadata specialists in a library unit. As one intermediary explained, "Basically I say that my role at the lab, for lack of a better term, is enabler." Regardless of title and status, these individuals facilitated data management and access; they also coordinated with a growing number of data repositories. The role of intermediaries, although disparate and emergent in the functioning

of scientific research today, is crucial in terms of work with digital data. Baker (forthcoming) found that the work of intermediaries is key to data production due to the increasing volume and diversity of it, as well as to technologies and infrastructural options that require the attention of skilled specialists.

Participation by researchers in intermediary spaces. In joining into community activities, Baker's (forthcoming) participation was invited at a time of new federal guidelines for those receiving research funding to make research data accessible. She was initially viewed by many as a data-management consultant, but became a coparticipant engaged in mutual learning as first steps in data management were taken together. Joint activities included the development of a timeline and a community workshop, creating a poster, and writing a technical report. Activities generally went through a process during which participants ensured that plans were tailored to fit the community. As one productive participant reported, "I tend to kind of move on to the next thing and not think about all the ramifications. . . . You started pushing in this more global sense." The importance of thinking about data as reusable beyond a particular scientific project was underscored as the need arose time and again to think of data activities as an ongoing process rather than a one-time task.

Preparations for a data-stewardship workshop provide an example of mutual learning among project participants and Baker, which culminated in a community discussion of developing infrastructure for data (Walk, Baker, & Sparks, 2016). Baker prepared slides about various aspects of data and their management for each of a series of team-planning meetings that took place over several months prior to the workshop. From these slides, the coleaders would select some to discuss and modify; they often interpreted the message, making it more relevant to the audience of which they themselves were members. Of course, this immersive experience also provided Baker (forthcoming) with opportunities to learn more about their data-infrastructure needs and constraints. Together, all participants learned about the complexites of planning data management that must be interwoven with existing processes and personnel.

At both the interpersonal level of working with specific older adults and the level of working with institutions, Lenstra (2016) also found that research in information infrastructure can lead to mutual, reciprocal learning. At the interpersonal level, during fieldwork he assisted older adults who participated in technical-support services. These interactions led him to learn new things about technology. For instance, during the course of the fieldwork, Lenstra worked with older adults as they sought to learn how to use their mobile devices more effectively, which involved a broad range of mobile devices with different operating systems. Within this context it was not unusual for older adults to teach him about their particular

digital devices. Other volunteers and staff members had similar moments of mutual learning, suggesting that this type of experience was common in technical-support services.

Mutual learning also took place at the institutional level. The act of discussing an issue with the researcher led staff members to consider how to address it. During the course of Lenstra's study, staff increasingly recognized the importance of understanding the effectiveness of their technical-support services. Prior to this, all staff and administrators did not regard these services as important when considered in relation to other services. Based simply on the fact that there was a researcher present focusing intensively on this facet for a sustained period led staff members to prioritize it. This trend culminated at the end of June 2016 when Lenstra presented his findings to a gathering of staff members from the six institutions studied. These findings illustrate how information researchers can shape or influence the information infrastructure studied.

Part 2: Cross-Study Findings

Two salient themes emerged across our respective studies of information infrastructure within communities of older adults and field scientists: the roles of both design and narrative. In particular, we noted the roles of those outside positions of power in the design and development of effective information infrastructure. Our studies highlight how narratives attuned to community dynamics effect design changes in such information infrastructures. Through these findings, the studies suggest the productive ways in which researchers and practitioners can both understand and intervene in the design and development of infrastructure.

Designing infrastructure in communities. Both studies found that the administrators responsible for managing infrastructure in institutional hierarchies struggled to plan for how communities would use infrastructure in practice. In contrast, both Lenstra (2016) and Baker (forthcoming) found that the actual design work—that is, the work needed to align community practices with infrastructure—was instead undertaken and accomplished by individuals whom we call *intermediaries* (see table 1). These intermediaries work in the interstices between infrastructure and communities, adapting infrastructure to meet the needs of communities, and educating communities about how to utilize infrastructure. This work often takes place within the context of social inequities, which cause the work of intermediaries to be difficult to see or valorize, as discussed below.

The roles of intermediaries in flexible design. Working within communities, intermediaries recognize mismatches between services and situated needs, whether for older adults or field scientists. With the support of intermediaries, communities are able to become sites of innovation supported

by information infrastructure to use technology in community-specific ways. When intermediaries are present in a community, they become co-designers, working together with community members; indeed, in most cases intermediaries *are* members of the communities they serve, bringing their insider expertise to infrastructure. Nonetheless, in those cases when intermediaries are not present in communities, those communities struggle to understand or adapt infrastructure into their work and lives.

For older adults, intermediaries were the staff and volunteers who worked directly with older adults learning about technology. Based on the relationships they formed with the older adults with whom they worked, they were responsive and able to adapt their services to the specific learning needs of older adults, which were different than the learning needs imagined by the administrators of the institutions in which they worked. For instance, as discussed above, policies that attempted to discourage the formation of intimate relationships between older adults and technology helpers were interpreted loosely, or in some cases disregarded, by the intermediaries—that is, front-line staff members in libraries and senior centers—who developed deep relationships with the older adults they assisted. Among field scientists developing collective data-management practices, data specialists serving as intermediaries helped them develop skills for "data care": planning for data workflows evolved into an understanding of incremental design strategies that facilitated movement of data across various, loosely coupled data work systems.

Social inequities in infrastructural arrangements. In considering the interdependence of community and infrastructure, we attended closely to issues of power, order, and control. Those in positions of power often attempted to maintain a state of stasis between infrastructure and community. We observed that those in positions of power often pursued stability in such a way that infrastructure became a site of control. In contrast, members of the communities we studied tried and often succeeded, but sometimes failed, to adapt and tinker with infrastructure, thus changing the relationship between their communities and the infrastructure that served them. Although important to these dynamics, intermediaries were frequently marginal and at risk in terms of the overall design of infrastructure.

The infrastructure studied relied heavily upon temporary workers for the critical intermediary work that ties together general, global services to individual and community needs. Senior centers and libraries rely upon volunteers and part-time/paraprofessional staff to provide technical-support services. These individuals rarely remain working in their respective institutions for more than a few months at a time. Similarly, in research environments, graduate students or technologists are frequently employed to implement data tasks piecemeal. These temporary workers

arrive with a variety of technical and information literacy backgrounds, but their understanding of information infrastructure and its design are minimal. As such, this frontline staff is often not empowered and lacks the insight to balance local needs with general services, and to work with communities to negotiate design solutions that speak back to large-scale infrastructure in a way that would contribute to systemic change.

This finding raises questions of infrastructural sustainability. Functioning infrastructures are embedded in the practices they support (Star, 1999). As a result, issues of sustainability often arise because of the fleeting nature of intermediary positions. In attending to these issues of design and control, we found it necessary to consider and analyze social inequities that are rarely discussed in the information-science literature. The social sciences often discuss three major inequities: race, class, and gender (Scheibelhofer & Marotta, 2013); to these we add issues related to *ageism* and *technologism*, often referred to as technological determinism. A technologist viewpoint is one that often fails to take account of the social dimensions involved in adapting technical arrangements to the realities of actual social practices. The study of scientific data practices found that large-scale data centers enforced standards in ways that overlooked local circumstances and made communication difficult. Administrators often sought to enforce standards in such a way that the local expertise of site-based findings was disregarded and underutilized. This situation led to infrastructure designs that lacked flexibility and thus failed to keep pace with current scientific practices. In other words, in considering issues of scale (local versus enterprise), the study of data practices found that the large-scale subsumes situated workplace conventions, especially when considering the development of data infrastructure. We found that in large and small ways the infrastructure reinforced rather than challenged these social inequities.

Narrating the interdependence of infrastructure and communities. The second salient theme that emerged from our studies is that story-making attuned to community dynamics can effect changes in information infrastructure. Through this finding, we suggest productive ways by which researchers and practitioners can both understand and intervene in infrastructural development and design. The stories told during our research illustrate how intermediaries represent a new form of labor in infrastructural development. These stories have power in that they contribute to mutual learning in both communities and infrastructure.

Story-making and mutual learning in the growth of information infrastructure. Story-making is the process of constructing a narrative about an issue in such a way that an individual's experience is understood in relation to social dynamics and trends (Czarniawska, 1998); story-making often involves

major shifts in thinking. In the sciences, considering data as a product to share represents a shift as foreign as considering a quilt's individual patches as precious resources for someone else's use rather than only for the quilt at hand. The identification, packaging, and access to research datasets requires reconceptualizing work with data so that new design and development activities are widespread.

Our research revealed heretofore hidden, taken-for-granted work and work roles in the institutions studied. Participation afforded opportunities for mutual learning and made use of continuing dialogue, from which stories were honed. Effective intermediaries who join in a community activity can facilitate discussions about information infrastructure that draw examples from a community's own practices. In this case, we as researchers were those intermediaries; we bridged the gap between our training in the information sciences and the communities we studied in order to help those communities understand and in turn articulate the reality within which they live—that is, learning to tell a story that describes a social reality, but that also contributes to changing that reality. In the process we contributed both to developing conceptual resources in our own respective subfields and to the development of conceptual resources useful within the communities we studied. In the study of older adults, this work involved ongoing dialogue with senior center and public library staff members, as well as with the older adults themselves, about the processes studied. This work culminated in a community defense in which the research was presented to the different institutions studied in a collective conversation. In the case of the work with scientists, it involved working with them to develop reports, workshops, and pilot projects, and to present shared findings at conferences. Through collaborative story-making with our subjects, we changed how the work we studied was seen by both participants and outsiders to whom the stories were conveyed.

This story-making work can have powerful effects. When members of a community feel excluded from the digital-information society, they do not feel that it is their place to contribute to shaping the growth of information infrastructure. Older adults coping with the challenges associated with learning new technologies within the context of ageist structures did not feel they have anything to offer to technical-support services in libraries and senior centers. Scientists collaborating on data-generating projects did show interest in collective data management, but they frequently lacked the concepts pertinent to the design of data infrastructure. Through story-making we showed the importance of these processes to communities, the infrastructure that serves them, and the wider disciplines of the information sciences.

Taking a historical approach to story-making. We worked with our respective communities to develop narratives as conceptual resources about the

social and technical dimensions of infrastructure. Independently, as we developed these narratives, we both came to realize the importance of attending to the historical development of the processes studied. This historical approach to story-making involves understanding the design of infrastructure as it unfolds over time.

Community members had an implicit understanding of the continuity of their communities through time, and the roles played by infrastructure in this process, but this understanding was not explicit. For instance, administrators in senior centers and public libraries did not, prior to Lenstra's study, understand how groups of older adults had, as members of a community, advocated for these institutions over time. Administrators tended to regard older adults as atomized individuals needing services, and not as an organized, collective force with a history. The historical narrative related by Lenstra's (2016) research about the roles of older adults in advocating for senior centers during the 1970s illustrates this dynamic. By framing older adults as members of a community with a history, as opposed to frail individuals needing services, the narrative produced through this research changed the perception of older adults and aging.

Similar processes unfolded in Baker's (forthcoming) research. She observed increased engagement by scientists in conceptual discussions regarding data assembly as they heard their history and work reflected not only in metadata but also in conversations about infrastructure. As the need to assemble and package data in new ways took shape, there emerged in scientific communities the recognition that these issues could not be addressed through quick fixes, but would instead require long-term planning that involved taking stock of the historical development of scientific data infrastructure since 1850. Participation by scientists in the process was essential, because it would change their existing data practices. Baker, working alongside scientists and data intermediaries, contributed to developing narratives and conceptual resources that enabled better understanding of these dynamics.

Final Thoughts

Although the objects of our analysis were from different disciplines within the information sciences, similar themes and findings emerged. In particular, we showed that scholars throughout the information sciences can productively explore what we are calling the *intermediary space* that exists between communities and information infrastructure. The ways that communities shape infrastructure are often missing from studies that focus on different levels of scale, such as those that analyze the planning and implementation of large-scale, network-level infrastructure. Being framed at such a high-level, these studies are unable to attend to the ways in which infrastructure is incorporated in distinct communities.

In analyzing communities and infrastructure, we found issues of de-

sign and story-making to be important. Taking into account the design of infrastructure illustrates how people *intermediate* within a community, as well as between a community and its larger-scale infrastructure. We found that intermediaries are part of both communities and information infrastructure; it is for this reason that their work is so powerful and important. Story-making contributes to reflection and community-building, thereby empowering individuals to recognize and exert more effectively the agency that they already have with respect to information infrastructure.

The practical implications of this paper are to underscore the importance of a task at hand for the information sciences: namely, the need to better prepare proactive intermediaries capable of cultivating changes in infrastructure by identifying and bridging the gaps between communities and infrastructure. We found this to be true within the contexts of the digital learning of older adults in public libraries and senior centers and the work of field scientists in developing data-sharing practices. The information sciences could support this work in multiple ways and within other contexts. Through research, the field could better understand the roles of intermediaries in information infrastructure in diverse domains. Moreover, through teaching both at the master's level and continuing education, information scientists can support these intermediaries by fostering conversations and dialogues that lead to more community-based participatory design in information infrastructure. In particular, this education could cross the disparate subfields of information sciences, fostering conversations that could enable synergistic thinking among, for instance, data managers and public librarians about how they might effectively integrate global, digital infrastructure-design approaches into the communities that they aim to support.

Our experience in the doctoral program at the University of Illinois is an example of the power of this approach. Starting with our courses on information in society and continuing in field exams on the use and users of information, we set about discussing historical and cutting-edge readings in the information sciences in relation to our distinct fields of interest. These discussions developed shared approaches and resources that enabled the development of a more expansive approach to our research into community informatics and scientific data work. Through our collaborative research and education, we were prepared to become intermediaries in the fields we studied, as well as to bridge our subfields within the information sciences. As a result we were able to create conceptual linkages that could advance the field as a whole. This type of multiperspective approach to large-scale, participant-oriented thinking is essential in the world in which we live today, where transformations of science and society challenge those at all levels to rethink the interdependence of elements in the digital world in general, and the relationship between communities and infrastructure in particular.

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Note

1. Quotes that appear in this paper without attribution derive from dissertation fieldwork conducted by the authors. For more information on these studies, see Lenstra (2016) and Baker (forthcoming).

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