Infrastructuring as Social Action

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Abstract

Recent developments in information system research have increased the interest in understanding complex and large-scale efforts. This study examines infrastructuring as social action within the novel context of an educational network of a Finnish city. This longitudinal case involves various sub-projects and a multitude of actors. This study contributes to current research by offering nexus-analytic concepts—discourses in place, interaction order, and historical body—as theoretical tools for a better understanding of the complexity involved in infrastructuring. We identify the central social actors and their contributions to infrastructuring. The study acknowledges the longer temporal timescales of infrastructuring, especially the past temporal horizon and shared histories of the communities involved, which are examined using the concept of the historical body. In addition, the study delves into multi-sitedness, multi-vocalities, and political aspects of infrastructuring through the concept of interaction order. Implications for research and practice are discussed.

Keywords: Information infrastructure, information systems, information technology, participation
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Introduction

Traditional information system (IS) development was about in-house development of isolated systems from scratch using IS methodologies designed to support these systems. Developers began IS development by uncovering and specifying user needs from scratch. Traditional IS methodologies aimed to develop a closed system with a closed project organization for a closed customer organization within a closed time frame. However, recent changes have increased the interest in understanding more complex efforts and the evolution of large-scale complex technological systems. (Hanseth 2010.) Within the systems engineering field, the use of “coalition” design has been suggested for managing the complexity inherent in the assemblage of independently controlled and managed systems. This has been suggested for both new and existing systems. (Sommerville 2012.) The attention of IS scholars has also been drawn to the increasing scope and scale of ISs (Pollock and Williams 2010, Williams and Pollock 2012). Accordingly, some researchers have recommended a greater focus on the shaping of large-scale workplace information technologies (ITs), such as packaged workplace technologies, rather than a focus on single site implementation (Williams and Pollock 2012). “Biography” studies have been introduced to help researchers understand the implications of such technologies on organizations. This type of study is preferred over the method of studying technologies at particular locales or moments within organizations. (Williams and Pollock 2012.) Overall, today’s solutions are significantly different from traditional ISs, as a number of systems have been integrated across organizational and geographical borders (Hanseth 2010) and have become connected and intertwined with complex information infrastructures (IIs) (“exempli gratia (e.g.)”, Ciborra 2000; Hanseth 1996; Star and Bowker 2002; Star and Ruhleder 1996), involving significant numbers of independent actors, developers as well as users (Hanseth 1996). Moreover, the concept of infrastructuring has been brought up in the research literature as appropriate for characterizing the building and evolution of complex, large-scale IIs (Star and Bowker 2002; Pipek and Wulf 2009; Björgvinsson et al. 2010; 2012, Karasti and Baker 2008; Karasti 2014). Infrastructuring includes many kinds of people—it is not limited to professional designers (Karasti and Syrjänen 2004; Karasti and Baker 2004; 2008; Pipek and Wulf 2009). The potential “users” and “designers” involved in infrastructuring have become greater in number and more diversified, as these groups include citizens and varied kinds of publics (Björgvinsson et al. 2010; 2012; Karasti 2014).

This paper examines infrastructuring within the educational network of a Finnish city within which an ongoing effort to construct a future school concept and related II building has been carried out (for a more focused study of II building, see Halkola et al. 2014). This study examines this longitudinal case carried out through various sub-projects, involving a multitude of actors: the educational officials of the city, subjects from local schools (teachers, headmasters, and pupils), and researchers, as well as local and global companies. The infrastructuring effort included architectural, interior, and pedagogical developments. These developments co-evolved with IT solutions and were introduced into the city’s educational network. In the pilot projects, IT solution suppliers provided expertise and IT solutions for use in the schools. A learning environment platform was provided by a global IT company; this platform included a set of hosted collaboration services; communication tools; mobile, desktop, and web-based applications; and data storage capabilities. This virtual learning environment gave students access to calendar and e-mail applications, as well as online storage space, instant messaging, and video conferencing. This system was introduced throughout all the schools of the city. Though the same system was introduced, there were some differences between infrastructuring in the schools. The schools in the district were invited to participate in a program for developing school culture and finding the best practices in pedagogy and technology use. Ten schools were selected to act as “Smart Schools,” i.e., as pilots in technology use and the renewal of pedagogical practices. The Smart Schools were also expected to advance their locally defined school-level goals and activities. Furthermore, one of these schools, a so-called “Integrated Pilot School,” which was under construction in a new town area, was selected to be equipped with new pedagogical practices and technologies. Examples of the best practices from the Smart Schools were to be used in the Integrated Pilot School and later to be extended to other schools in the city and the whole country.

Overall, this study addressed the role of IT in the school context; this is a relatively new context for IS research, as well as a very challenging context. Compared to other contexts, schools are lagging in terms of their adoption of recent developments in IT. The adoption of IT developments in school settings is a complicated process, as it involves the intermingling of IT and pedagogy. Due to this complexity, studies
like the present one are needed to help researchers understand and overcome relevant challenges (Kinnula et al. 2015). This study is also unique due to its inclusion of school children as an important user group of IT. To date, children have hardly been studied in IS research (Vodanovich et al. 2010).

The research question being addressed by the present study is: “What are the characteristics of infrastructuring in the school context?” The research framework is drawn from nexus analysis, which uses social action as a theoretical center of study. Social action, in this case infrastructuring, is seen as occurring at the intersection of three aspects: the historical bodies (Nishida 1958) of the participants in the action; the interaction order (Goffman 1983) that the participants mutually produce; and the discourses in place, which enable the action or are used by the participants as mediational means in their action (Scollon and Scollon 2004, pp. 153–154). Various socially oriented lenses have been applied in IS research to theorize the relational aspects between technological and organizational issues. These social perspectives also acknowledge the longer time scales and the variety of stakeholders, as well as the evolving relationships between these stakeholders. For instance, the technological frames (Davidson 2006; Orlikowski and Gash 1994), the institutional logics (Friedland and Alford 1991; Lounsbury 2007; Thornton 2004; Thorton and Ocasio 2008) and the “biography” approach (Williams and Pollock 2012), as well as the actor–network theory (Monteiro 2000; Monteiro and Hanseth 1996), can be considered valuable, along with the existing research on IIs and infrastructuring (Star and Ruhleder 1996; Star and Bowker 2002; Pipek and Wulf 2009; Björgvinsson et al. 2010; 2012, Karasti and Baker 2008; Karasti and Syrjänen 2004). The Nexus analytic framework, however, is considered particularly valuable for the study of this complex process, as it assumes that (1) broader social issues are ultimately grounded in the micro-actions of social interaction, but also that (2) the most mundane of micro-actions form a nexus through which the largest cycles of social organization and activity circulate (Scollon and Scollon 2004). Nexus analysis allows for the extension of the research perspective from the actual here-and-now situation to wider cycles of discourse on a long-term basis (Iivari et al. 2014). This analysis therefore guides researchers to approaching the social action being studied ethnographically—that is, within the everyday-life context of the various actors—but at the same time, these micro-level instantiations of the social action are connected to the macro-level—that is, to the broader context of shaping infrastructuring. Additionally, the nexus analysis concepts of interaction order and historical body help researchers delve into longer temporal timescales of infrastructuring, especially into the past temporal horizon and shared histories of the communities involved, as well as into the multi-sitedness, multi-vocalities, and political aspects inherent to infrastructuring.

This study uses the nexus analysis approach to contribute to the existing body of research on infrastructuring. The study offers insights into the already identified gaps and limitations of this research stream. In her recent review on infrastructuring in participatory design (PD) research, Karasti (2014), identifies these gaps and limitations despite the topic being a long-lasting research interest. She also suggests a number of paths for future work, including the acknowledgment of longer temporal horizons in infrastructuring. Furthermore, because current literature mainly deals with the scopes of communities and organizations, multi-sitedness, and the local–global dimension of the multi-scope, socio-material-technical political assemblages and processes of infrastructuring should be explored. Additionally, political aspects should be examined more strongly. Infrastructuring deals with heterogeneities and multi-vocalities, multiplicities and marginalities, inclusions and exclusions, silences and absences, and standards and invisible work. These components add further complexity to ongoing power-related debates. (Karasti 2014.) This study responds to these challenges by using the analysis to highlight the longer temporal timescales involved in infrastructuring, especially the past temporal horizon and the shared histories of the communities involved, as well as the multi-sitedness, multi-vocalities, and political aspects inherent to infrastructuring.

The paper is structured as follows. The section below discusses the concepts of II and infrastructuring. The next section presents the research method used in this study, as well as the procedures for data gathering and analysis. The following sections present the empirical results, while the last section discusses the implications and limitations of the results and identifies paths for future work.

**Information Infrastructures and Infrastructuring**

This section introduces the socio-technical definitions of II as well as the concept of infrastructuring.
**Information Infrastructures**

Concepts and frameworks for the analysis of large-scale technological systems, such as infrastructures (Hughes 1987), have been provided within the tradition of Science and Technology Studies. Infrastructure has been viewed as a socio-technical, concept that is fundamentally relational and becomes real in relation to organized practices (Star and Ruhleder 1996; Star 1999; see also Jewett and Kling 1991). The salient features of infrastructure include embeddedness, transparency, and a wide reach or scope. Infrastructure can be learned as part of membership, is linked with conventions of practice, embody standards, is built on an installed base, and becomes visible upon breakdown (Star and Ruhleder 1996). The definition implies that the technologies to be developed should be seen in relation to organized practices, and that these technologies should be considered as parts of the social and organizational structures where the infrastructure is embedded (Star and Ruhleder 1996). Traditionally, the concept of infrastructure has concerned large technical and material structures (e.g., water pipes, electricity supplies, road networks, the Internet) that are understood as background structures or platforms on which other structures depend—that is, these structures are what run “underneath” actual structures (Star and Bowker 2002).

Some researchers have argued that the concept of infrastructure is insufficient for covering the multidimensionality of the use contexts and practices (Star and Ruhleder 1996) or analyzing large-scale technological systems (Star and Bowker 2002); hence, the concept of II has been recommended.

In the literature, the concept of II has been characterized from different perspectives. To understand the socio-technical nature of the IIs, interactionist (e.g. Star and Ruhleder 1996) and actor network theory (ANT) originated approaches (e.g., Ciborra et al. 2000; Hanseth 1996; Hanseth 2010; Hanseth et al. 1996; Hanseth and Monteiro 1997; Monteiro and Hanseth 1996; Monteiro 2000; Nielsen 2006) have been applied. II has been viewed as a shared, open, standardized, heterogeneous, sociotechnical installed base in transformation (Hanseth 1996; 2010); consisting of a set of technological capabilities, as well as their user, operations, and design communities (Hanseth and Lyytinen 2010). Infrastructural inversion has been useful for analysis of IIs (Bowker 1994), as this notion foregrounds the transparent, background, and historical elements (Star and Bowker 2002). This inversion implies a struggle against the tendency of IIs to disappear; analyzing an II involves learning to look closely at the background elements of the system’s technologies and arrangements (Star and Bowker 2002).

II design has been characterized as a complex, continuous, evolving process (Hanseth 1996; Star and Bowker 2002; Star and Ruhleder 1996). II has evolved over a long period of time, and its new infrastructural elements have been designed as extensions and improvements to fit with the existing elements (Hanseth 2010). Never built from scratch, the installed base of each II strongly influences the potential to change and design new elements for that II (Hanseth 1996; 2010). ANT implies that the existing installed base is an actor in the development process; this base works as a mediator and coordinator between the independent non-technological actors and development activities (Hanseth 2010). Heterogeneity is one of the fundamental characteristics of II. This characteristic challenges developers, and it has raised questions regarding II management of corporate infrastructures; more specifically, heterogeneity has raised concerns regarding control—and the lack thereof—over technologies. (Ciborra et al. 2000, Hanseth and Lyytinen 2004; Hanseth and Monteiro 1997; Nielsen 2006.) The concept of heterogeneity—in combination with the concepts of control, standards, and evolution (Ciborra et al. 2000)—has been discussed as making IIs inherently uncontrollable (e.g., Ciborra et al. 2000; Nielsen 2006). Additionally, more extended conceptualizations regarding the heterogeneity of IIs have been suggested for differentiating between the heterogeneous materiality and diversity significant to the building of IIs (Nielsen 2006). The complexity, uncontrollability, and open-endedness inherent to the creation of IIs—especially in terms of their globalization within organizations—has also been acknowledged (Ciborra et al. 2000).

Many empirical studies have been carried out regarding the design and evolution of IIs. For example, the interaction between potential uses of new and old elements of II were examined within the context of a large digital library project. In this context, II building seemed to be about mediating and designing connections between multiple groups and between different people, including making connections between the different world views and goals of these people. (Neumann and Star 1996.) Healthcare systems, as “work-oriented infrastructures,” have been viewed as shared resources for the community. Users design and implement such IIs based on their actual need for and use of the technology. Although the heterogeneous components (both human and technological) of IIs were integrated via standardized
interfaces, IIs were open in the sense that there was no strict limit for what could be included in the II. There were also no restrictions on who could use the II, nor were there limitations to its purpose or function. (Hanseth and Lundberg 2001.) Hence, the support that users contribute to infrastructure improvement is vital; professional IT designers may be involved, but improving IIs requires the creative activity of ordinary users (Pipek and Wulf 2009). The ongoing and long-term method for designing IIs has also been examined in research on non-professional design within communities unfolding “in the wild” (Karasti and Syrjänen 2004; Karasti and Baker 2004; 2008). Community members collectively “grow” their own community IIs without the intervention of professionals (Karasti and Baker 2008). Continuing design of IIs has been suggested to broaden the focus to the long-term perspective required for sustainable collaborative II development that blurs the boundaries of use, design, implementation, maintenance, and redesign (Karasti and Baker 2004; Karasti, et al. 2006).

**Infrastructuring**

Infrastructuring may be appropriate for characterizing the building and evolution of IIs. From this research perspective, the design of IIs has been seen as tentative, flexible, and open (Star and Bowker 2002). The concept of infrastructuring takes distance from the notion of design that refers to professionalized design activities (Pipek and Wulf 2009). Infrastructuring can be perceived as an ongoing design process. This perception calls for designing for infrastructuring, “i.e., how to design for the blurring of borders between use and design, for ongoing changes, ease of maintenance, and tailoring of flexible and adaptable systems”. (Karasti and Baker 2004, p. 9.) The processuality and ongoing character of activities related to infrastructuring with the extended timespan are essential (Karasti and Syrjänen 2004). Basing their work on existing literature (Karasti and Baker 2008; Twidale and Floyd 2008; Pipek and Wulf 2009), Björnvinsson and colleagues (2010; 2012a) characterize infrastructuring as entangling and intertwining potentially controversial “a priori infrastructure activities” (selection, design, development, deployment, enactment), with “everyday design activities in actual use” (mediation, interpretation, articulation), as well as “design-in-use” activities (adaptation, appropriation, tailoring, redesign, maintenance).

The concept of infrastructuring has also been related to the development of large-scale systems that serve a wide range of needs of varied “publics” (Clement et al. 2012). This shift to a new milieu—i.e., open public spaces rather than spaces within an organization—also entails a reorientation away from “democracy at work” to “democratic innovation.” In the same vein, there has been a movement away from “projecting” and towards processes and strategies of “infrastructuring”. (Björnvinsson et al. 2010; Björnvinsson et al. 2012a.) In Björnvinsson et al.’s (2012b) study, concepts such as “agonistic public spaces,” “thinging” and “infrastructuring” are explored in relation to democracy, innovation, and other future-making practices. Agonistic democracy does not assume the possibility of consensus and rational conflict resolution; instead, the hegemony of dominant authority is potentially challenged within this system through manifold forceful but tolerant disputes amongst passionately engaged publics. (Björnvinsson et al. 2012b.) Björnvinsson et al.’s (2012b) research reflects upon three successive and interconnected design explorations and the publics that have been articulated, as well as the agonistic public spaces that have emerged from them. They consider infrastructure to be a central issue for innovation; as such, they today demand extensive collaboration over time and among many stakeholders (Björnvinsson et al. 2012b). If infrastructuring is seen as an approach to innovation that differs from the project-based design approach, design could move beyond the “design project” and towards a more open-ended long-term process where diverse stakeholders can innovate together (Hillgren et al. 2011).

The public is to be understood as a plurality of voices, opinions, and positions. There is not one single public, but rather, there are a multitude of publics. The idea of infrastructuring through design requires the distinction between design-for-use centered on useful systems and the focus on design-for-future-use structured to create fertile ground to sustain a community of participants. (Le Dantec and De Silvo 2013.) This distinction involves a shift in the treatment of design systems; more specifically, a change must occur from treating designed systems as fixed products to treating them as ongoing infrastructures and as socio-technical processes that relate to different contexts (Le Dantec and De Silvo 2013; Star and Ruhleder 1996). Infrastructuring, then, can be conceptualized as the work of creating socio-technical resources that intentionally enable adoption and appropriation beyond the initial scope of the design, a process that might include participants not present during the initial design (Le Dantec and DiSalvo 2013). Additionally, Ehn (2008) maintains that, the challenge and object of design for professional design at
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Project time is the design of such potential public things that as infrastructuring can become objects of design-in-use leaving partly open the participants and the way they may appropriate them. Ehn (2008) argues that there will be a shift in focus; the focus will shift from design aiming at useful products and services to design aiming to create good environments for design at use time. This, according to Ehn (2008), will at project time lead to an occupation with identifying, designing, and supporting social, technical, and spatial infrastructures that are configurable and potentially supportive of future design in everyday use. Ehn (2008) also argues for shifting the focus of involving users in the design process towards seeing the every use situation as a potential design situation (i.e., design “at project time,” design “at use time,” and design-in-use after design in the design project); that is, viewing the design process as “infrastructuring” of public things. The challenge and object of design is the creation of potentially public objects that can become objects of design-in-use as “infrastructuring” (Ehn 2008).

In this context, infrastructuring is thought of as reconceptualizing one’s work in the context of existing, potential, or envisioned ICT tools as a natural part of users’ activities (Pipek and Wulf 2009). However, the “design for use before use” taking place “at project time,” rather than just the “design-in-use” after design in the design project (i.e. ‘infrastructuring’), should also be acknowledged (Ehn 2008). Design-in-use includes various kinds of activities such as tailoring, configuring, appropriating, and negotiating (Pipek and Wulf 2009).

Nexus Analysis as a Theoretical and Methodological Framework

This study relies on nexus analysis as a theoretical and methodological framework. The essential problem of a nexus analysis is to discover the social actions and social actors that are crucial to the production of a social issue and to bring about social change. “Social action” refers to any action taken by an individual with reference to a social network. (Scollon 2001; Scollon and Scollon 2004.) “Nexus analysis” refers to the mapping of semiotic cycles of people, discourses, places, and mediational means involved in the social actions under study (Scollon and Scollon 2004, p. 14). One of the central tasks of a nexus analysis is to examine how “the broad discourses of our social life are engaged (or not) in the moment-by-moment social actions of social actors in real time activity” (Scollon 2001, p. 139). The term “discourse” refers to the ways people engage with each other in face-to-face communication or to the ways in which they engage with a broader set of concerns. Consequently, discourse analysis may concern these different levels of analysis, while nexus analysis provides a way to unify different levels: namely, the micro-analysis of social interaction and a broader socio-political-cultural analysis of the relationships among social groups and power interests in society (Scollon and Scollon 2004, p. 8). Scollon (2001) articulates three principles that comprise a theory about social action with a special focus on discourse as a kind of social action as well as upon discourse as a component of social action. These principles are social action, communication, and history. These principles maintain that social action occurs at the intersection of the historical bodies (Nishida 1958) of participants in the action; the interaction order (Goffman 1983) that participants mutually produce among themselves; and the discourses in place, which enable the action or are used by the participants as mediational means to complete the action (Scollon and Scollon 2004, pp. 153–154).

The term historical body was originally introduced by Nishida (1958). This term refers to each participant’s individual history, including their social identity and role with the action (Nishida 1958). The basis of social action is known as a habitus (Bourdieu 1977; 1990) or historical body (Nishida 1958): “an individual’s accumulated experience of social actions.” Any instance of concrete, real-time social action entails the simultaneous production and reproduction of the structures of the social world, and such an instance must therefore be conceptualized in a way that takes the sociocultural histories of our habitus into account (Bourdieu 1977; 1990). Nexus analysis also makes use of Goffman’s (1983) term interaction order. This refers to possible social arrangements by which the relationships in social interaction can be formed. People behave differently depending, in part, on whether they are alone or acting as part of a group. All social actions involve implicit or explicit claims to the social groups and positions of the participants as speakers, hearers, and those talked about or in front of. Any action taken reproduces the identities of prior social actions as well as negotiates new positions among the participants. (Scollon 2001.) Scollon and Scollon (2003) maintain that in most cases, the actions of the social actor are only vaguely purposive and conscious, while almost always these actions are multiple and complex. Scollon and Scollon (2003) see humans in the physical world as bundles of histories—bundles of language,
discourses, and experiences; and of social and political performances. Humans must juggle multiple social roles and performances, largely unconsciously, and they must act as the physical bodies for carrying these roles and performances out. The term **discourses in place** refers to selecting for empirical analysis the relevant discourses of the social actions of interest. This method examines social interaction on a micro level, but also from broader socio-political-cultural perspectives. Here, discourse analysis provides a powerful tool for understanding social life on the interpersonal, organizational, and institutional levels of social analysis. (Scollon 2001.)

The analytical focus of this study was on the micro-actions involved in the actual infrastructuring effort, while the use of nexus analysis also led to recognition of the connectedness of small-scale development efforts within the wider context of the entire infrastructuring effort. This study focused on the future development of the school, encompassing the concept of a “school for the 21st century” wherein children are apt technology users. This goal involved the concrete aim of designing school facilities (the Integrated Pilot School) within a new multipurpose center in a Finnish city. It also involved creating technologically mediated pedagogical practices for even broader use. The data from this study are illustrated in Table 1. On the basis of a broad discourses survey (Scollon and Scollon 2004), mapping the prominent discourses on the Internet in the field of this study, the most important participants, either due to institutional status or media representation, were identified from the research data. The most important participants were selected for interviewing. In addition to the in-depth interviews (see Holstein and Gubrium 1997) conducted with these five “key actors” involved in the development effort, a vast amount of documentation related to the future school concept and the infrastructure building effort was collected. The thematic interview guide was applied flexibly in the interview situation. The primary interviewer presented the questions to the interviewee and was in charge of the event, while the other research group members were allowed to engage in the discussion. All the interviews were recorded and later transcribed. During the study, data were also gathered from interviews of Smart School teachers and from interviews and workshops held with children to investigate the children’s ideas and expectations regarding the Integrated Pilot School as part of the multipurpose community center. The results related to children’s participation have been reported elsewhere (see Halkola and Iivari 2014; Molin-Juustila et al. 2015).

<table>
<thead>
<tr>
<th>Interviews of key actors</th>
<th>Background, history, nature of effort; collaboration between the public, business, and research sectors; building the IT infrastructure and technology use; community aspects and visions on the new town area and multifunction center for the Integrated Pilot School</th>
</tr>
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<tbody>
<tr>
<td>2 headmasters [Interviewees 1 and 5], 2 project managers [Interviewees 2 and 3], 1 development manager [Interviewee 4]</td>
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<tr>
<th>Interviews of key actors</th>
<th>Purchasing process, acquisitions for schools, user-engagement in purchasing (children and adults)</th>
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<td>2 teachers [Interviewees 6 and 7]</td>
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<tr>
<th>Documentation</th>
<th>Issues related to the future school; Issues related to the infrastructure building effort</th>
</tr>
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<tbody>
<tr>
<td>102 items of background documents, minutes, city web portal pages, project pages, reports, articles, and materials from the involved schools</td>
<td></td>
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**Table 1. The data from the study**

The analysis proceeded through a succession of data-driven stages. In the first phase, the researchers worked on the data by making initial observations and becoming acquainted with the interviews. Next, an in-depth analysis was performed on the transcripts from the interviews to map the topics discussed by the interviewees and to see what kinds of discourse emerged. In the next phase, the analysis was extended to the rest of the data. Thereafter, the data were examined in regard to the participants involved and their engagement in the effort. Both participatory practices and discourses were attended to, e.g., school children’s participation. Later on, the concepts of II and infrastructuring were utilized as sensitizing devices for making sense of participation. In the final phase, a more detailed account was given of infrastructuring as a social action. This analysis focused on the three facets of social action: the historical body, interaction order, and discourses in place (Scollon and Scollon 2004). In the qualitative data analysis, NVivo software was drawn upon. Using a nexus analysis, this paper illustrates how all these aspects—the discourses in place that are emerging here and now, the interaction order among the various kinds of stakeholders in the effort, and the historical bodies of the participants—were shaping the process of infrastructuring as social action.
of infrastructuring the future school. The identified discourses were legitimizing, i.e. justifying and making acceptable either by appealing to the shared values or scientific facts (see van Leeuwen and Wodak 1999), shaping or characterizing this particular case of infrastructuring.

Discourses in Place: Infrastructuring Taking Shape

“Child's best” as an undeniable motivation for legitimizing infrastructuring

The future school infrastructuring effort involved constructing learning environments using IT intertwined with novel pedagogical practices. The discourse emphasizing the “child’s best” legitimized the construction of these modernized learning environments with IT. The future school effort has been considered vital for providing technology and media skills to learners of the 21st century, as these learners are the future experts and members of our changing society: “Basic education must provide pupils with basic skills for utilizing technology and so forth to cope with society today and in the future” (Interviewee 4). Hence, many of the study’s participants considered the construction of learning environments with up-to-date learning technologies to be important for preparing pupils for their future roles in a technologically advanced society: “The school, if anything, should use that good, most up-to-date technology and teach these growing young people to cope with it” (Interviewee 1). On the other hand, the changing everyday lives and the improved technological skills of the school children were regarded by many of the study’s participants as challenges to students’ learning and pedagogical practices at school. New learning practices involving the use of IT were suggested for increasing school children’s motivation to learn. As children’s abilities to utilize technologies has also expanded the sites for learning to reach their leisure time, the mismatch between current learning practices at school and students’ lives beyond the school day has become an argument motivating new learning practices: “It is a challenge for us to consider how they [free-time interests] could be drawn on in the school world—it is extremely important for the motivation level” (Interviewee 5).

The future school infrastructuring also involved renewing the operational models of the school and the connections of these models with IT solutions. Addressing the concerns of the “child’s best” demanded the development of collaborative practices among the personnel. As a new operational model, the different administrative sectors were to be represented collaboratively in order to create a community basis for the entire school day of a child: “Developing the whole school day—that’s how this community aspect, so those people present in the child’s daily life would collaborate (...) now we are talking about comprehensive basic education, so all of those who are involved in supporting the child’s growth and learning for the best, they will work together” (Interviewee 4). The renewals also concerned the teachers’ work practices. The future school effort actively experimented with new collaborative models among teachers in conjunction with the increased use of IT in teaching. Along with these changes, the teachers’ responsibility for developing their pedagogical practices for the “child’s best” was increasingly addressed. The concern of making teachers to become developers of their own work was brought up “how you make the teachers committed to development work and, well, see how development is part of every teacher’s work so that everyone has the responsibility for developing that work for the best of the child and youth” (Interviewee 4). Furthermore, in addition to IT appropriation, the learning practices were to be reorganized due to the altered interaction order among teachers and their pupils; that is, students were to become more responsible for their own learning. The teachers were thus supposed to act as supporters of pupils’ learning by providing novel pedagogical arrangements. The children’s roles as future members of society were considered, and the desire for a more active position for the school children became evident during the interviews. The discourse on the “child’s best” addressed the idea of involving children as planners of their own school activities: “Then, I must say that involving children and young people in planning activities, and after the launch, the action itself, has been highlighted more” (Interviewee 5). Furthermore, the institutional role to be played by the school in terms of operating more collaboratively for the “child’s best” concerned not only the school personnel, but also the school itself as an active actor in society: “The school really isn’t another island in the middle of society, but it embraces everyone that is there in the day of the child or youth” (Interviewee 5). Collaborative operational models were also developed to extend to school–home communication between teachers and parents: “One of the most important issues is to get collaboration with homes going so well that parents and caregivers have a strong presence in the everyday life of the school” (Interviewee 4).
Equality in education and its role in legitimizing infrastructuring

One shared tradition of the Finnish school system is the strong legislative basis for equality in primary school education. This topic was discussed in the interviews in relation to the IT infrastructuring of the educational network: “Compulsory education: there, children, young people should have equal opportunities for receiving instruction in technology and media skills in different subjects” (Interviewee 4). However, the issues of positioning the city schools differently in relation to each other were displayed. To maintain the equality aspect of Finnish primary school education, accounts were given to explain the specific role the Integrated Pilot School would play as a model for the other schools. This school would act as a pilot for constructing learning environments and experimenting with the related operational and pedagogical models. Furthermore, the pilot school would act as a pioneer by creating models with IT use. This would also work for the benefit of the other schools in the city, or even on the national level. As Interviewee 5 expressed: “We will have quite a strong leading position when teaching is developed, even on a national level within Finland. We would be able to bring in new approaches and models—I even believe that we will eventually be spearheads [in the city]” (Interviewee 5). The concern some of the interviewees had regarding providing equal opportunities to all schools in the city (for example through a similar level of technological equipment) was conveyed within the narratives that concerned the educational network development for applying the new models more broadly: “At that stage in the educational administration, it was wisely determined that we cannot be building one innovative school, one elitist school in a way that other schools envy” (Interviewee 2). Hence, the discourse for ensuring consistent education equality was related to expanding the best practices with IT appropriation within the entire educational network: “Maybe from the point of view of other schools, the development may be unfair, like all eggs are put in one basket, so we launched this smart school project then, aside” (Interviewee 4); “Best practices have already been shared with these ten Pilot Schools” (Interviewee 2).

As a counterpoint for building the new, highly IT-equipped school buildings, there were also suggestions to promote equality by budgeting resources for the modernization of old school buildings and their learning technologies. In other words, some participants suggested drawing on already-existing resources rather than building new schools: “One should definitely invest in how these [old school buildings] are made as functional as possible. Now the usual excuse is having to wait until there’s a new building” (Interviewee 1). Concern for equality in education arose because while there were financial resources allocated to technological infrastructuring for the selected Smart School development projects, there were hardly any concrete action plans or funds for developing the other schools within the educational network: “And the remaining 50 schools then—it is something to deal with still—something should be done about it little by little. So, we know that there are about 50 schools that are quietly waiting while these ten plus one schools [eleven schools] are enjoying additional resources and get support. [They are] expecting to get support eventually, these schools” (Interviewee 2). Despite these budgeting concerns, some of the interviewees’ accounts confirm that there is actually an equal technological budgeting basis for all of the city’s schools, in accordance with the relevant legislation for regulating budgeting and purchasing in the school domain. In an attempt to create consensus or reduce criticism, accounts were given to ensure that the learning technologies for the schools of the city were always purchased through similar processes. The negotiation procedure and collaborative decision making within the planning group of the Integrated Pilot School were also reflected upon: “We were planning this school in the working group, so it has been built according to the same funding principles as our other schools. So, there is no more investment in technology there” (Interviewee 4).

The discourse on equality in education occurring during the interviews was also constructed for the purpose of toning down the “wild plans” (Interviewee 4) concerning the technological renewals. The “wild plans” (Interviewee 4) were not considered realizable in all schools: “The wildest plans, at some point, have kind of remained in the background also because of lacking resources. And then, there hasn’t been enough evidence for them having such great significance for the developing work” (Interviewee 4). On the other hand, the traditional school was paralleled with the cutting-edge learning technologies of the future school II. These technologies were also suggested to become available equally across the city’s schools, and even to become available nationally: “They [learning technologies] just simply are so much better when compared to this former range of equipment and there is already so much well-functioning, usable material that should be available in every single school in Finland, in every municipality” (Interviewee 1).
Accountability to taxpayers and society shaping infrastructuring

The shared tradition of the Finnish public school system was expressed throughout this discourse. Accountability to the taxpayers, especially to the parents of the pupils, was considered very important, as were the assumed expectations of those taxpayers: “I am sure there will be some challenge coming from the taxpayers, the parents. It somehow seems that the expectations today from parents, for example, towards the school grow all the time” (Interviewee 5). The legislation and administrative agreements controlled by the National Board of Education were described as tightly binding the infrastructuring of the schools. They were described as normative and restrictive, and many interviewees recommended challenging these restrictions: “(...) how we could challenge the traditional way to build and plan schools—it followed largely the norms set by the National Board of Education all class sizes and furniture and you wouldn’t get the state subsidy if you didn’t follow them” (Interviewee 2). However, external and city funding within the future school effort enabled altered building and infrastructuring processes.

Furthermore, advancing the possibilities for the public use of the various facilities, including the school’s IT features, also became a prevalent topic in the discourse regarding accountability to the taxpayers: “Another challenge is communal use. How would this technology and premises acquired with taxpayers’ money serve the surrounding community?” (Interviewee 2). The topic of communal use was one manifestation of this discourse. The new multipurpose center with the Integrated Pilot School was described using a metaphor, wherein the school was the center of a village and was envisioned as becoming an active meeting place for the local residents: “I see communality in that case as some kind of communal use and its cultivation. A little bit like the old village school used to be the center of the village where everything happened—let’s now move it into the city-like environment, the suburb” (Interviewee 2). This model was used to legitimize the high costs of this infrastructuring effort. Accountability to taxpayers was paralleled with the traditional planning of schools based on the stakeholders’ needs and activities and those of the local inhabitants: “Especially in smaller municipalities, these kinds of building projects being planned are like the most expensive projects in the village history, which means that they would really be planned for those needs and those activities” (Interviewee 3). Drawing on this vision, which was shared by the key actors in this research effort, the multipurpose center and its integrated school were displayed as an environment available for multiple actors and activities: “... as a kind of active, virile and functional environment full of action and with actors of different ages and many kinds of participants” (Interviewee 3).

Etiquette for tripartite collaboration intermingled with infrastructuring

Tripartite collaboration with the public, research, and business sectors for joint development work was arranged within the effort. Infrastructuring within the pilot projects included IT solution suppliers providing their expertise and solutions for the Smart Schools. Architectural, interior, and pedagogical solutions also co-evolved with the IT solutions. The shared tradition focused on educational officials as the controllers of the public procurement and collaboration with commercial companies, as this tradition followed the legislative basis of the Finnish school system. The tripartite collaboration model, however, challenges this tradition: “Traditionally, the companies have been kept out of the school domain” (Interviewee 3). With this model, the school was to become a more interactive actor in the community, rather than acting as a “solitary island in society.” Company collaboration was also needed, according to this model. External experts were invited to define the ground rules for company collaboration; to define the principles of etiquette, clear agreements, and contractual bases: “We have the capacity and the mindset for the time when business life, working life creates new innovations for the market, so we would boldly test them for our purposes, too. The way it happens then, we need to think about it then so that it would be based on a contract” (Interviewee 5). A consultant report for recommendations for company collaboration within the school environment was created: “About the etiquette [ground rules] and this we have the first consultant’s report” (Interviewee 3). This discourse not only foregrounded the insistence for neutrality in company collaboration, but it also concerned ensuring that decision power remain on the school’s side: “You just need to establish an etiquette that preserves the neutrality, the independence of the school” (Interviewee 1). Even though involving new actors changed the interaction order in the school domain, the legislation-based tradition insisting on neutrality in company collaboration remained unaltered. Subsequently, the concern regarding keeping the decision power or control in infrastructuring on the school’s side during development efforts was highlighted.
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**Scientific evidence for legitimizing, if not guiding, infrastructuring**

Legitimation based on scientific results was considered to advance the development efforts of the schools. Calls for scientific evidence for evaluating the advantages of technology-mediated learning emerged within the discourse: “We would also hope that if an environment or technology of this kind is embedded somewhere there would be research on it . . . could study the effectiveness and if it improves learning results, motivation, the teacher’s well-being at work and so on, and if we are going to the right direction through these solutions . . . that’s what we would like to see more” (Interviewee 2). During this process, the importance of scientifically verified guidance was brought into the foreground: “Last year, when we saw that we were starting to take off and fly high, if we had been guided more tightly” (Interviewee 1). Research was used to provide a wider perspective: “Someone who would have sort of a research approach and bigger visions” (Interviewee 1). In addition to providing support during the development efforts, the discourse addressed the importance of scientific evidence in the form of reports, as well as the importance of different kinds of measurable variables. These were known as “traditional comparative measurements” (Interviewee 1), and these measurements were valuable when funding was being applied for. The interviewees highlighted the importance of scientific evidence promoting convincing communication to the direction of educational or funding authorities: “for applying for funding, [scientific] collaboration brings credibility” (Interviewee 3); “It would always be easier to convince all the partners if there was a clear measurement or evidence or knowledge gathered in some way. I mean, now we have to lean on our own explanation” (Interviewee 1). Scientific collaboration, however, was to play a supportive role, while the power to make decisions and the control over the development efforts remained with the schools themselves: “[Scientific evidence] would be more in a kind of supportive role in advancing our community process” (Interviewee 5). On the other hand, somewhat conflicting viewpoints on research partners’ contribution were also revealed. From this perspective, the research partners were positioned as providing the scientifically verified models and state-of-the-art research results: “So, tell us what the latest research results are, what is available, and what we know about these things. Come and study what we have here: that is how the good result emerges, then” (Interviewee 2).

**Leadership discourse contemplating financial and human resources**

All the interviewees were in managerial positions, which became clear in the data. First, the interviewees tried to cater to all of the city’s schools. They all considered creating sustainable solutions for learning environments that would be achievable for all of the schools within the educational network of the city: “We can pilot approaches that don’t then work in practice, so if you cannot offer it to everyone, you should however find sustainable solutions” (Interviewee 4). It seemed that the future school infrastructuring was a result of the schools being able to find their own profiles within the development effort: “We [in the educational sector] believe in the constructivist view in this development work, too, that it has to be created within the organization, and there you have the knowledge once you find it and share it, and that is where the best practices emerge” (Interviewee 4). The method of building a model and then transferring it to different contexts was seen as “old-fashioned” by some of the interviewees: “This model is good for how to start supporting the schools in this way, so that they started with their own profiles and utilize their own practices and search for those strengths—take them forward. But the transferability of such models is sort of old-fashioned thinking” (Interviewee 4). On the other hand, attempts to transfer schools using the ready-built model deriving from global network experts also emerged: “In that way, we started thinking about our own work, and how development projects that were planned behind the future school ideology . . . how they are put into practice, and that’s when this smart school network or piloting group of ten smart schools was established” (Interviewee 4). Such a model for infrastructuring places schools in the position of merely being executing actors of expert-driven development projects.

Human resource management also emerged from this discourse as a potential issue of the future school infrastructuring effort. Within the pilot schools, some enthusiastic teachers were already actively creating new pedagogical practices using IT. The renewal of teacherhood was argued for in regard to the use of best practices, and teachers’ work practices were expected to become more collaborative: “Teachers must work more together, as moving away from the lesson and class division system, teachers have to deal with the whole of the school and the pupil and share their work” (Interviewee 1). Attitudes, knowledge, and skills, as well as possible in-service training, were used to support teachers in the appropriation of IT as part of pedagogical practices: “The greatest challenge, if we think about this scenario of the future, is that
increasingly everything is going on in the networks and technology is utilized. So, the fact is that even today, we do have teachers who don’t and who haven’t perhaps even woken up to the reality that this kind of expertise is needed, so we really need a lot of in-service training. So, in-service training is one big issue” (Interviewee 4). Attempts to advance teachers’ collaboration by concretely changing the division of the administrative sectors were brought up. The requirements for collaboration among personnel were considered significant, even while recruiting teachers: “Teachers … one must be able to work in a way somewhat different than before and that has been taken into account in recruiting staff, that there are teachers who are ready to have a wider look at the ideology of teaching . . . we need to be successful in recruitment to get people who are ready to experiment with things in a slightly different manner” (Interviewee 5). These concerns have changed personnel policy, as well as processes and tools for recruiting and competence management: “Regarding the teaching profession, we have cooperated with <company> and some other agents. We have thought of these competencies of the teachers of the future school and this whole curve of competence management. We have figured out ready-made models . . . on how to change the recruitment system so that it is based on the personnel plan of the school and on competencies of the teachers of the future school” (Interviewee 2). “Here, related to competence management, they [the global company] have had a strong role . . . A tool has been prepared for Finnish headmasters . . . there has been an actual tool prepared for recruitment” (Interviewee 5).

In addition to available human resources, leadership discourse circulating around financial resources enhanced infrastructuring: “Now for instance, if I didn’t have this additional funding I wouldn’t be able to order such equipment for <school> in this phase” (Interviewee 1). External funding gave the schools more decision power to select technologies and advance through new purchasing procedures. With external funding, it also became possible to allocate teachers’ resources to allow the use of independent planning and more collaborative work practices: “External funding makes these changes possible. It has always been possible to free the teachers for a planning day and the costs for substitutes have been covered from project money, so they have been able to think and plan themselves . . . I am prepared, they may even need a week when they will be free from other work” (Interviewee 1). Furthermore, to create collaborative operational models, even the teachers’ current payroll system required renewal to enable collaboration among teachers: “The teachers’ salary system must change so that we can move in this direction. Now that it is based on teaching hours, it necessarily binds you to the wrong direction” (Interviewee 1). Leadership discourse on the financial resources also foregrounded the need for change agency to promote infrastructuring the future school: “Now that there’s a recession, there’s a kind of mental depression going on quite clearly, and such a mental atmosphere is not where we build the school of the future, that’s quite certain . . . despite the diminishing amount of euros, we should keep up a drive, a drive for development there. A positive tone” (Interviewee 5).

**Promotional innovation discourse**

The discourse of promotional innovation was also highly pervasive throughout the interviews. This is characterized by the following extract from the data, which highlights the extensive scope of the future school infrastructuring effort: “On all levels, something has been done—the teaching profession, leadership, physical learning environment, infrastructure, technologies. Within all the sectors something has been done and company collaboration and research collaboration has been launched” (Interviewee 2). The learning environments were to be constructed with learning technologies to be made “as innovative as possible” (Interviewee 3). The IT solution supplies were “bringing the technological solutions all over the world” (Interviewee 2), offering the most world-class, up-to-date, and cutting-edge solutions, as captured by this quote: “we have tried to be a few years ahead” (Interviewee 3). The process of constructing the future school was even characterized as “soaring” (Interviewee 1) or taking “quantum leaps” (Interviewee 4) in IT development. The presence of experts from the global network was also emphasized. “In <school>, this “inno lounge” [innovative lounge] learning environment, or in practice it means that <NN> and I have the possibility of bringing forth the ideas of the future school and what we have learnt when we have been travelling around the world in different schools: the possibility to make those thoughts transparent in <school>, make partly transparent or bring in innovative furniture, actually top-class educational technology” (Interviewee 3). Some of the schools in the city were positioned as leaders in the future school effort, while others were characterized as learners following the new operational models: “If we think about the degree of innovativeness, maybe <pilot school 1> and <pilot school 2> are those crown jewels there” (Interviewee 2). The interaction order among the schools within the educational network of
Historical Body and Interaction Order Entangled in Infrastructuring

The existing research has already acknowledged the complexity involved in infrastructuring. In our study, the nexus analysis provided theoretical tools to better understand this complexity, including the multiple voices and contributions of various actors involved in infrastructuring. Next, these components will be discussed in more detail.

**Historical body: Studying the historical aspect inherent to infrastructuring**

Existing research has acknowledged the inherited historical aspect of IIs by defining the installed base as a shaping feature of IIs (e.g., Star and Ruhleder 1996; Hanseth 1996; 2010). “The inertia of the installed base” also reminds of the existing base of the infrastructure wherein the new elements always have to be adapted to (Star and Ruhleder 1996). Regarding infrastructuring within PD research, calls have emerged for considering in more depth the temporal aspect of infrastructuring; altering from longitudinal future-orientation to accounting for the past temporal horizon, such as through dealing with shared histories, existing information systems and the installed base have (Karasti 2014).

In our empirical analysis, the concept of a historical body referred to an individual’s accumulated experience of social actions. This concept was valuable for sensitizing the analysis to the past temporal horizon in infrastructuring. The experiences and local practices inherent to the historical bodies of the local actors were appreciated as human resources. Schools actively profiled their development efforts, and the teachers’ pedagogical expertise was valued for its use for grounding the solutions of the local Smart Schools’ settings and practices. The historical bodies of the teachers arising from their understanding of the local practices of their school were valued and hence shaping infrastructuring. However, it became obvious that in addition to the local practices of the schools, the everyday practices of the children—especially concerning their technology use—were also shaping the infrastructuring. School children’s technology and media skills were embedded in their historical bodies and acted as motivation for infrastructuring. The renewal of teaching and learning practices, as well as the construction of technology-rich learning environments, were justified by the altered everyday lives and the improved technological skills of the school children.

Traditionally, the Finnish school system is based strongly on legislation, which is shaping infrastructuring. One important aspect of the Finnish school system is providing equal education for all pupils. Another is making educational officials responsible for regulating and controlling schools. These two elements relate to how school officials can balance technology renewals with sustainable solutions in both old and new schools, which is something that can be done by drawing on each school’s own profile. This issue was also present in the strategies of the educational officials, many of which prioritized local actors and school practices in an attempt to balance plans that were “too wild.” Furthermore, advancing the public use of the new Integrated Pilot School emphasized accountability to taxpayers foregrounding also the value of ensuring equality. While building the Integrated Pilot School with cutting-edge technologies, the communality model derived from old village schools, was used to legitimize high investments by the city, the taxpayers’ money. Moreover, grounding on the tradition of the Finnish school system, the position of the educational officials as controllers was foregrounded also with respect to company collaboration, even if it now was challenged. However, neutrality in company collaboration was still insisted upon, and the autonomy of the schools was emphasized. On the other hand, the traditionally legislatively regulated recruiting procedures were challenged by the use of novel recruiting and competence management processes. An alternative strategy emphasized a reliance on the schools’ human resources by providing current teachers with in-service education. Even though the system was based on the tradition of the Finnish school system, operational models and technological solutions derived from the global network were also promotionally introduced. The Integrated Pilot School was positioned as a pioneer and model for the other schools in the city—and even other schools across the country—to follow. This represent the strategy for challenging the model of the traditional school.
**Interaction order: Analyzing the heterogeneity, multi-voicedness, and tensions between local and global dimensions and power aspects inherent to infrastructuring**

As regards interaction order amongst the participants, the heterogeneity and multi-voicedness of II building and infrastructuring have already been acknowledged in the literature in terms of being able to respond to emergent social needs (Star and Bowker 2002), as modifiability anticipating, and preparing for changes in the design (Hanseth et al. 1996) of the II. Thus, these factors are related to the necessity of IIs to adapt to local needs by recognizing the tension between the local and the global (Star and Ruhleder 1996; Bowker and Star 1999). Neumann and Star (1996) characterize II building as being about designing linkages between multiple groups; making connections between many people, their world views, and their goals; and highlighting multidimensionality and multiculturalism. There are also calls for exploration of and engagement with multi-sitedness and the local-global dimension of infrastructuring, as well as for generating more awareness of the complexity and the emerging political and power-related aspects of user inclusion in infrastructuring (Karasti 2014).

The concept of interaction order leads to the examination of relationships in social interactions between the actors and their possible social arrangements; these interactions inherently include power-related aspects. The longitudinal case of the present research was carried out through various sub-projects in schools within the educational network. It involved a multitude of actors from both local and global organizations and networks. The institutional role of the school to become an active actor in society called for creating new collaborative practices. Hence, the interaction order amongst the actors was to become altered. The concerns of the “child’s best” brought the needs of the children into the foreground more clearly. The children were acting planners of their own school activities and were therefore more responsible for their own learning; thus, interaction order was rearranged. The teachers were still trusted with a considerable amount of autonomy, as they were expected to appropriate IT within the modernized pedagogical models of the development projects. The teachers still had considerable responsibility, even though the novel competence management and recruitment processes gave less power to individual teachers in terms of choosing their own respective teaching methods. The collaboration models created in this study also concerned school–home communication and the active involvement of parents. Furthermore, advancing the possibilities for the public use of the new Integrated Pilot School brought into the forefront the importance of serving surrounding communities more widely, as well as accountability to taxpayers.

Through tripartite collaboration research partners, various experts from the global network, as well as local and global companies, emerged as new actors in the educational domain. Acting in the global network brought to the forefront the voices of various kind of experts. The educational officials positioned research partners mainly as supporters of infrastructuring providing scientific evidence and by promoting convincing communication to the direction of educational or funding authorities. Funding authorities emerged as a relatively new while important actors in this domain. Inviting companies to collaborate and to provide IT for schools also changed the interaction order. Furthermore, the schools’ active roles in defining their development efforts allowed them to have their own voices in the process instead of acting as mere living-lab environments and testers for the IT companies. As a consequence, the position of the educational officials as controllers of company collaboration became less important, while more autonomy was given to the schools. This meant that the schools also had more decision power regarding development efforts. External resources assigned more decision-making power in terms of selecting and purchasing technologies for the development efforts. The educational officials positioned the Integrated Pilot School as a pioneer and model for the other schools of the city—and even of the country. Infrastructuring through the development projects and related external funding positioned the schools differently: the schools selected as pilots were seen as “crown jewels” of the future school infrastructuring effort. Here, the consideration for ensuring equality in education between schools became significant. There was also some tension concerning the strategy of transferring a ready-built model (as designed by educational experts from the global network) with cutting-edge technologies for only a few of the city’s schools. This strategy made participants consider the creation of sustainable solutions for learning environments that would be achievable for all of the schools within the educational network of the city. The latter strategy (creating solutions for all of the city’s schools) positioned schools as active participants in the shaping of infrastructuring rather than executing actors of the expert-driven models and solutions. The educational officials’ position was also altered during this process: they positioned themselves as
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Concluding Discussion

The aim of this paper was to construct a better theoretical understanding of the complexity involved in infrastructuring, which was examined as social action accomplished by various participants. The detailed analysis was especially sensitized to the three facets of social action that shape the process of infrastructuring: discourses in place (those emerging here and now), interaction order among the various stakeholders in the effort, and the historical body of the participants. We have made visible the existence and value of these nexus analytic concepts. The framework also guided us in recognizing the dynamicity inherent in the concepts of historical body and interaction order. Even when intertwined, both concepts provided distinct perspectives into the social action under scrutiny.

Within this study, the analysis was directed to micro-actions in the actual infrastructuring effort, while nexus analysis also instructed a recognition of connectedness in small-scale development efforts and the infrastructuring effort as a whole. The nexus-analytic concepts allowed a close look at sociocultural histories and social arrangements behind the social action (Scollon and Scollon 2004) through the “infrastructural inversion” (Bowker 1994) that foregrounds the transparent, background, and historical elements of infrastructure (Star and Ruhleder 1996). The concept of the historical body provided a tool for us to acknowledge the past temporal horizon in infrastructuring. The concept of installed base refers to the existing socio-technical system in which IIs evolve (e.g. Hanseth and Lytyinen 2001), which inherently contains previous decisions concerning the design of a technology (Hanseth 2010), we see the concept of historical body to offer related but complementary insights. On the other hand, the concept of historical body refers to the accumulated experiences of the social actors that are inevitably present in social action. In the future school infrastructuring, we see the concept of historical body to offer related but complementary insights as it refers to the accumulated experiences of the social actors that inevitably are present in any social action. Focusing the analysis on the historical body of the actors provided a closer look at their in-situ practices, thus foregrounding local aspects in infrastructuring. In the future school infrastructuring it was prevalent that the experiences and expertise of the local actors were appreciated, but also challenged. The innovative IT solutions and operational models derived from the global network and from various experts were grounded on the practices of the local teachers, who were considered human resources and experts of the in-situ setting of the schools. These solutions were also balanced in respect to the shared understanding within the schools, such as the traditional concerns of equality in education. Hence, based on the existing research and our empirical findings, we emphasize that it is necessary to value and understand the historical aspects of infrastructuring in order to better respond to the local social needs in infrastructuring, but also counterbalancing the expanded multi-sited and local-global scales (e.g., in Karasti 2014).

Furthermore, the concept of interaction order allowed for recognition of the dynamicity in the actors’ relationships and social arrangements in relation to infrastructuring and the production/reproduction of their roles. In our empirical analysis, we identified the central social actors and their contributions to the future school infrastructuring. Children’s participation was emphasized in the discourse as giving motivation for modernizing the traditional school and constructing up-to-date learning environments and practices, although their contribution in infrastructuring remained indirect. Furthermore, interaction order displayed the power-related aspects between educational officials and the actors within the schools. Expectations for more flexibility in the direction of educational officials from their traditional positions as centralized controllers, in relation to the development efforts and collaboration with new actors within the school, were foregrounded. On the other hand, while the school was to become a more dynamic actor in society, new actors were invited to collaborate. The interaction order, however, displayed that schools kept the decision power and positioned new collaborators in a supporting role. In respect to complex infrastructuring efforts, understanding the dynamic nature of social relationships is essential for identifying and responding to the altering social needs, as well as the potential conflicts among the various actors involved. For example, recognizing the actors’ roles that increase awareness of power-related aspects could be considered as arrangements for participation in infrastructuring; as in our case emphasizing various actors’ participation in infrastructuring.
To conclude, we maintain that the concepts of interaction order and historical body are both useful in analyzing the development and evolution of complex and heterogeneous large-scale technological systems and infrastructuring involving a multitude of actors. Therefore, the contribution of this paper is to offer IS researchers tools to make better sense of the complexity involved in infrastructuring. As emphasized in the existing literature, infrastructuring, as a notion, takes distance to professionalized design. It is instead seen to include various kinds of people as potential “users” and “designers” who have also become greater in number and more diversified (Björgvinsson et al. 2010; 2012; Karasti 2014; Karasti and Baker 2004; Karasti and Syrjänen 2004; 2008; Pipek and Wulf 2009). Acknowledging this, the concept of interaction order provides valuable insight into the power-related aspects that could be useful; for example, when arranging possibilities for various actors to participate and contribute to infrastructuring. For mediating and designing linkages between multiple actor groups (Neumann and Star 1996), the concept of interaction order as an analytical tool is also valuable. Our study moreover advocates acknowledging the openness of infrastructuring, or leaving partly open the participants and the possible ways they may appropriate II (Ehn 2008). Furthermore, using historical body as a tool sensitized the analysis to the local practices and shared history of the community, accumulated in the actors’ experiences and in elements of the socio-technical installed base (Hanseth 2010), as the existing base of II, to which the new elements have to become adapted (Star and Ruhleder 1996). These historical and power-related understandings may also be considered as promoting further development or as points for infrastructuring (Pipek and Wulf 2009) valuable also for informing the participation of social actors. Moreover, recognizing historical aspects may help respond to the emerging local social needs in infrastructuring and inform the balancing of changes, in respect to the expanded multi-sited and local-global scales in infrastructuring (e.g. in Karasti 2014). Our study contributes to socio-technical infrastructuring approaches by emphasizing the power-related aspects that shape infrastructuring. The nexus-analytic concepts should also be more generally useful to IS researchers for acknowledging the evolutionary development and complexity of the current ISs. The provided theoretical tools respond to increased interest within IS research towards complex IS solutions that link diverse systems and numbers of actors organizationally and geographically. For IS practitioners, we suggest the concepts of historical body and interaction order for gaining a better understanding of the local settings and the power relationships of various actors. Such a knowledge should help in mediating the specific needs of the affected actors and user participants. Overall, we suggest that both IS researchers and practitioners apply the concepts of historical body and interaction order in cases of IS adoption and implementation involving multiple actors, as well as in analyzing results. Moreover, our findings from the school context may be applicable for infrastructuring efforts in other administrative fields that place similar historical emphases on the equal availability of services. Our study also contributes to the IS field by addressing the school context and the user group of children, which have hardly been studied before in the IS field or in infrastructuring efforts.

Although the contained data and documentation related to infrastructuring and the future school concept was gathered with intervention from children, the discourse analysis for this paper focused on adult interviews, which is a limitation of our study. However, these informants were considered key actors in the effort, and thus offered valuable insights. Moreover, nexus analysis provided a lens for examining the data and phenomenon in a detailed manner from a variety of perspectives. Regarding further research paths, it would be interesting to gather data from a different infrastructuring effort. It could be analyzed using the same concepts in order to provide a comparison and further insight into our results. It would also be beneficial for further studies to address the differences between the ANT-originated concept of installed base and the nexus-analytic concept of historical body, in respect to historical aspects of infrastructuring. The trait of control, discussed in the research literature, would also be a fascinating perspective for further infrastructuring analysis.

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