

‘Participation’ in the Context of Building a Large Scale Information Infrastructure – a ‘Future School’ Case

Eija Halkola¹, Netta Iivari¹, Leena Kuure², Tonja Molin-Juustila¹, Marianne Kinnula¹

Department of Information Processing Science¹, University of Oulu; Department of English Philology², University of Oulu,
Post Box 3000, FI-90014 University of Oulu
{Eija.Halkola, Netta.Iivari, Leena.Kuure, Tonja.Molin-Juustila, Marianne.Kinnula,
LNCS}@oulu.fi

Abstract. This paper examines the building of an information infrastructure for an educational network, focusing on its participatory development involving various actors. A discourse analysis was performed following nexus analysis that extends the focus from micro level to organizational and institutional dimensions. The paper contributes by offering a careful analysis of what participation entails in this case, acknowledging both users and other stakeholders. Discourses justifying broad participation of actors are identified as well as users’ concrete participation practices. Discourses arguing for challenging, while also for appreciating and utilizing, the existing installed base were identified as well as discourses advocating equality, sustainability, continuity and cutting-edge solutions. Those all justified wide-ranging participation of various actors. In practice, users had varying possibilities to influence the co-evolution of practices and technology teachers having more influence than pupils. The importance of enabling practices – supporting participatory information infrastructure building – was also identified.

Keywords: Information infrastructure, participation, children

1 Introduction

This study focuses on the participatory process of building an information infrastructure [24] for an educational network of a Finnish city. The educational network refers to local schools and the municipal educational administration. In the initial stages of the process, the city encouraged the schools in the district to submit applications for development projects. Through this process teachers and headmasters were invited to participate in a ‘future school programme’ to develop school culture and to look for the best practices in pedagogy and technology use for ‘school in the 21st century’, ‘the future school’. Ten schools were shortlisted as ‘Smart Schools’, i.e. pilots in technology use and renewal of pedagogic practices. The best practices from the Smart Schools were to be utilized in a future school, so-called ‘Integrated Pilot School’, which was under construction in a new town area. The school was to be built as part of a multipurpose centre also including a library, a nursery, a school as well as other facilities and services. Experiences of the best practices from the conducted pilot projects were to be exploited in the Integrated Pilot School and later to be extended to other schools in the city and the whole country.

Various actors have been active in the effort, including the educational authorities as well as school staff and children. This case allows us to contribute to the topic of user participation in Information Systems (IS) research, in which user participation has been a traditional topic of study, but as the nature of IS practice has changed, new challenges and perspectives have emerged and the traditional IS participation theory has become deficient. As a response, Marcus and Mao [15] have, among other things, made explicit the concept of 'actor', which they argue was largely implicit in traditional theorizing. Today's IS projects often affect many more stakeholders than was the case earlier. Not only do today's IS projects affect more users; they also affect more types of users. Altogether, there is a need for a fine-grained conception of participants and participants' proportions of various affected stakeholder groups. [15.]

This paper thus offers a fine-grained analysis of participation of various actors in this complex case including both users and other kinds of stakeholders. This study utilizes literature on user participation and literature on the development of complex information infrastructures, within which some studies have already discussed participatory processes for infrastructure development [4], [11], [18]. This study can be located between research arguing for participatory design in information infrastructure development efforts [18] and research discussing participatory design 'in the wild' as a natural part of information infrastructure building [11]. In this case, the participatory process has emerged without our intervention. Novel in our study is also the focus on pupil's participation, among other actors. Children's participation has not been studied before in information infrastructure development efforts (except in [blinded for review]), although there is existing research on interaction design with children, but within this research the development efforts have small-scale, i.e. particular design or evaluation sessions have been carried out with children with a genuine interest in working with them (e.g. [2], [3], [19]). In information infrastructure building efforts with a multitude of actors the integration of children into the development is evidently more challenging.

We will examine the topic through a discourse analysis of thematic interviews with the key persons responsible in the effort. The study relies on the broader research framework of nexus analysis [21], which allows extending the perspective from the micro level to the organizational and institutional levels of social analysis that are necessarily intertwined. Nexus analysis provides tools to explore participation as social action [20] from the point of view of concrete practices and wider discourses. The present study examines how participation of the various actors has evolved over time in such a complex setting, acknowledging participation both as discursively constructed and as executed through practical activities within the effort.

The structure of the paper is the following: The next section presents literature on user participation, including also some studies on children's participation. The third section introduces the concept of information infrastructure and literature on designing information infrastructures. The fourth section describes the research method as well as the procedures of data gathering and analysis. The fifth section outlines the empirical results and the sixth section their implications and limitations.

2 Research on User Participation and Children

It has long ago been acknowledged that users should somehow take part in ICT development [15]. Participatory Design (PD) research has even emphasized that users have the right to take part and have a say in ICT development affecting their lives. However, the political concerns of the PD tradition have decreased in importance lately. It has also proven out to be challenging to enable every user's participation and power of decision in contemporary ICT development that has extended outside the workplace [13], [15]. There is also variety in the roles offered for users. User participation may be divided into three types. In 'consultative' user participation, data related to users is gathered and used as a basis in decision-making, but the decision-makers are not required to comply with the data. Within 'representative' user participation, a group stands for a larger user population, i.e. selected or (preferably) elected user representatives are involved in the design process and assigned some decision-making power. Within the 'consensus' type, the goal is to enable all those affected to take part in the design process and to have decision-making power. [17.] This may be impossible, however, due to practical reasons. For example, those affected may be too numerous or unreachable [13], [15]. In this case it has been relatively common to rely on user representatives that are not users themselves, such as on some interest groups representing users' interests as in PD projects [13]. 'Professional' user representatives, such as usability specialists or ethnographers, assumed to 'know the users' and to 'speak for the users' may also be involved in the development (e.g. [7], [9]). One might ask, however, where from and how do these user representatives gain legitimacy for their work, as users might not even be aware of others 'standing for them' in the development as their representatives [7].

Children's participation in ICT development has been tackled in the studies on interaction design with children. During the early days, the focus was on children as users of ICT and on the consequences and impacts of the ICT on children. The focus has moved on involving children as testers, informants and design partners [3]. However, in ICT research there is a lack of studies on children's involvement in more complex cases, with a longer time span or many partners (see a review in [blinded for review]). However, there are some such studies carried out within other disciplines. Next, some relevant studies of this kind are presented.

In a study exploring the social shaping of educational technology, the notion of participation and valuation for inclusion of various social groups, including schoolchildren, was brought up [12]. However, children were not involved directly in the development of educational technologies. Instead, in the analysis of strategic and political issues concerning educational technology in the project, schoolchildren were identified as a relevant social group. The study aimed to widen the perspective on the development and adoption of technologies in education, not only as technology-driven but as influenced by relevant social groups, e.g. schoolchildren. [12].

In another study, children were directly involved in developing and implementing a participatory approach in a children's ICT project in a voluntary childcare organization. The aim was to improve access to and usage of ICT by disadvantaged children and their families. The initially one-year-project included training sessions at six sites with local youth projects and community centres. Community development and child-centred participatory approaches were applied to encourage children's

participation and parents' involvement. During the learning sessions, active participation, shared decision-making and maintenance of ongoing attendance were encouraged. Children were also encouraged to take the lead in their choices during the activities. [1.]

Children's participation as co-researchers has been explored in the children's participatory action research (PAR) study conducted within the UNICEF initiative on child participation. It aimed to identify what it is that supports and hinders child participation. Children collaborated in three municipalities with Support Groups (adults who helped children implement their activities). A Children's PAR Group consisted of approximately 20 children (aged 12-14 years), who participated in choosing members for their Support Groups. At the beginning, children were informed about the methodology and earlier studies in the field. They prepared presentations on issues they wanted to address and questions used in subsequent discussions. They identified activities they found lacking in their communities, through which they wanted to support child participation. Finally, based on their research, children identified several issues supporting child participation. [14.] In all the studies presented above, children's genuine participation was considered meaningful, adding value for the surrounding society. Children's contribution and their role varied somewhat but in all these studies enabling children in shaping their own environment was seen as an empowering aspect. This is highlighted in the present study as well, while concentrating on the ICT context.

3 The Definition and Design of Information Infrastructure

Star and Ruhleder [24] see infrastructure as a sociotechnical, "fundamentally relational concept, becoming real infrastructure in relation to organized practices" (see also [22], [10]). They [24] have characterized the salient features of infrastructure through eight features: 1) Infrastructures are embedded in other social and technological structures (embeddedness). 2) The supporting tasks are transparent (transparency). 3) Infrastructures have a certain reach or scope. This may be either spatial or temporal - infrastructure has reach beyond a single event or one-site practice; 4) They are learned as part of membership (the artifacts and organizational arrangements are taken for granted). 5) Infrastructures shape and are shaped by, or linked with the conventions of practice. 6) Infrastructures are plugged into other infrastructures and tools in a standardized fashion, though they are also modified by scope and conflicting (local) conventions (embodiment of standards). 7) Infrastructures are built on an installed base, i.e. they do not grow de novo but wrestle with "the inertia of the installed base" and inherit strengths and limitations from that base. [24] 'The inertia of the installed base' refers to the influence of the existing base of infrastructure, which the new elements always have to be adapted to. The infrastructure is evolving and never built from scratch, which then influences the possibilities to change and design the new elements of the infrastructure [4]. New systems are designed for backward compatibility; and failing to account for constraints may be fatal or distorting to new development processes [16]. Finally, 8) the normally invisible infrastructures become visible upon breakdown.

Star and Ruhleder [24] see infrastructure as evolving while the locally tailored technologies become interweaved with the elements of the formal infrastructure. Infrastructure is thus shaped by the conventions of a community of practice while these, again, have to be adapted to the existing infrastructures, i.e. these elements are intertwined, shaping each other. They argue that in organizations the locally-tailored applications and repositories begin to interweave themselves with the formal infrastructure to create a unique and evolving hybrid. Thus the emergence of a transparently supporting infrastructure is “organic” and evolving in response to the community evolution and adoption of infrastructure [24]. As the information infrastructures have to support current conventions in local organizations, they also have to be changeable in order to support also the evolving practices and use involved. An infrastructure emerges when the tension between the local and the global is resolved and local practices are afforded by a larger-scale technology, which can then be used in a natural, ready-to-hand fashion [24].

The development of infrastructures is considered as processual, evolving and constructed over time on the existing installed base [24]. Star and Ruhleder’s [24] definition of infrastructure also implies that the technologies to be developed should be seen in relation to organized practices, as part of the social and organizational structures where the infrastructure is embedded. Star and Bowker [23] share this view of infrastructure as relative to working conditions and never apart from the people who design, maintain and use it. As regards the socio-technical design process and the political and ethical concerns in the design of infrastructures, they [23] consider the Scandinavian school of PD successfully responding to these challenges. The participatory design of infrastructures has been accordingly examined in other studies with the socio-technical approach [11], [18].

Neumann and Star [18] have weighed the possibility to apply design principles of PD in a large information infrastructure building effort. As social scientists co-developing an information infrastructure, they aimed at understanding the ways in which potential use, new and old infrastructure, and large project organization interact in the context of larger digital library projects (six US government- funded projects at different universities). During the study, they collaborated with users and developers following the ideas of PD. The potential and actual use of the working prototypes constructed by the developers were examined through usability studies with the emergent test-bed (prototype), observations on current library users, focus groups with potential users and interviews with students and staff. They characterize infrastructure building as mediating demands of multiple groups and making connections between them possible, reaching towards the unknown. In their case, they needed to bring together funding agencies, publishers, software developers, librarians and users, each of these having their own interest and idea of what the unknown would be. However, during the infrastructure building process they discovered that articulating the end product or the meanings of the project as a whole were difficult and differing for people working on it.

Karasti and Syrjänen [11] explored PD ‘in the wild’ in two communities sharing features in collaboration in ICT design. They revealed the importance of broadening existing understandings of the social and organizational context of where PD traditionally takes place by extending the study of community ICT development even to the nonprofessional designers ‘in the wild’. ICT development in both communities

has been characterized as thoroughly and complexly embedded and interwoven in the activities of the communities. In both communities, the blurring of boundaries between use, tailoring, maintenance, reuse and design, as well as attention directed to local, situated everyday practices with technologies, have been forming design as artful infrastructure processes which are tentative, open and flexible. [11.]

4 Research Design

The aim of this paper is to shed light on the process of participation in information infrastructure building. The development effort spanned years 2007-2010 and was in progress at the time of this study. The study was guided by the research framework of nexus analysis (NA), which focuses on social action that is any action taken by an individual with reference to a social network. [21.] Social action is viewed as being mediated by cultural tools or mediational means [20], discourse being one by which social action may be taken. Discourse is also viewed as one among the means by which society and culture is constituted. [20] NA examines the cycles of discourse that come together to form a nexus of practice, a recognizable group of mediated actions and it proceeds through three cycles. The researchers first enter the community being researched, looking for important social actions to be studied and key actors, thus, engaging the nexus of practice. They continue by navigating the nexus of practice through various methods and data. By participating in the practices they are also involved in changing them. [21] NA was seen as a fruitful choice in the study of the complex process under scrutiny as it may unify the micro-analysis of social interaction and a broader socio-political-cultural analysis of the relationships among social groups and power interests in society.

The nexus of practice that this study addresses is the development of the school for the future, encompassing the concept or ideology of a 'school for the 21st century' where children are apt technology users. This involves the concrete aim of designing a new school building in a Finnish city (the Integrated Pilot School) as well as technology- mediated pedagogical practices for even broader use. The process was facilitated through information infrastructure development involving new solutions in ICT as well as pedagogy, architecture and interior design for the whole educational network of the city. The participants in the effort include educational authorities of the city, different kinds of companies, researchers, and the Smart Schools including their headmasters, teachers and pupils.

On the basis of a broad discourses survey [21] the most important participants in the nexus of practice, either due to institutional status or media representation, were identified from the research data. Those participants were selected as the interviewees of this study. Two of the interviewed key persons were project managers [interviewee 2 and interviewee 3] in the future school development endeavour, two were headmasters of the Smart Schools [interviewee 1 and interviewee 5], and one a city level development manager [interviewee 4]. The research data includes also interviews of two Smart School teachers [interviewee 6 and 7].

The data include interviews with these seven actors involved in the development effort as well as a considerable amount of documentation related to the future school

concept and the infrastructure building effort (e.g. minutes, city web portal pages, project pages, different kinds of reports, newspaper and magazine articles, material produced by the involved schools). With the 'key actors', the future school development effort was discussed in the in-depth interviews based on the prepared themes of 1) background and history, 2) the nature of the effort, 3) collaboration between the public, the business and the research sectors, 4) building the ICT infrastructure and technology use, as well as 5) the community aspects and future visions concerning the new town area and multifunction centre including the Integrated Pilot School there. This thematic interview guide was applied flexibly in the collaborative interview situation. With the Smart School teachers, the following themes were discussed: the purchasing process, acquisitions for schools and taking users into account in purchasing. The interviews, approximately one hour each, were transcribed. Interviewing children was not done as the numerous children involved in the conducted projects were dispersed in the different schools of the city, and information on the future pupils of the to-be-developed Integrated Pilot School was not available. The interviews and the collection of other data took place as part of 'engaging' the nexus of practice, when the researchers were looking for attachment points with the various social actors in the effort. The study then continued as 'navigating' the nexus of practice through an analysis of discourses circulating around.

The analysis proceeded through a succession of data-driven stages. In the first phase, the researchers worked on the data making initial observations and becoming acquainted with the data. Next, an in-depth analysis was made on one of the interviews mapping the topics discussed by the interviewees and the discourses that were seen to emerge in the course of the talk. Thereafter, the analysis was extended to the rest of the data. Afterwards, the theoretical framework presented in this paper was applied to make sense of participation in the case. Three Star and Ruhleder's dimensions [24] that particularly well characterized the case were used as special perspectives into the effort: its reach and scope, the issue of the infrastructure being built on an installed base, and, its links with conventions of practice, i.e. how the infrastructure both shapes and is shaped by the conventions of a community of practice. The participation of the various actors in the case was considered in relation to these three dimensions. This study characterizes the nature of participation in a complex information infrastructure building case, acknowledging participation both as discursively constructed and as executed through practical activities within the effort.

5 Participatory Building of Information Infrastructure

In the construction of the future school concept and its information infrastructure building, openness for various actors to participate has been emphasized from the outset. Representatives from a global and several local companies including technology and interior solutions suppliers and companies developing ICT solutions have been involved. The Smart Schools contributed through smaller scale development projects ('pilot projects') advancing the local, school-level goals and

activities. The Smart Schools have offered living lab environments, where new technological solutions have been trialed and developed.

Collaboration has involved headmasters, teachers and some schoolchildren participating in the pilot projects in the schools. Furthermore, a general orientation for community participation, emphasizing both parents' and schoolchildren's involvement in the process of construction of the future school can be identified from the background documents characterizing the case. Researchers have also been invited to contribute to the future school concept construction process and assessing the impact of the renewed pedagogical practices.

Next, we will discuss this case with a focus on its participative aspect. Discourses justifying and characterizing participation in the case are identified as well as users' concrete participation activities.

5.1 Discourses arguing for challenging but also appreciating the installed base

Star and Ruhleder [24] stress the influence of the installed base on all future developments. Information infrastructures always inherit strengths and limitations from the installed base [24]. The influence of the installed base has been addressed in many ways in this case. On the level of discourses, the various actors involved have, on the one hand, been invited to challenge the installed base, while, on the other hand, the existing installed base has been positioned as highly valuable and the adaptation to local settings highlighted. In both cases, the discourses identified have contributed towards justifying broad participation of different kinds of actors in the case.

The invitation to participate to challenge the installed base has been brought up through the discourses describing the vision of challenging the 'traditional school' for constructing the future school concept and information infrastructure. The installed base of the infrastructure of the traditional school has been envisioned to be modernized through the process of constructing the future school with the pedagogical practices and learning environments of the 21st century, the future school being discursively constructed as follows: *"It is a kind of ideology, which involves a consideration of the learning environments of the 21st century, learning in the 21st century. How should the traditional school boat be updated, then, for us to reach these, to offer our future experts the skills of the 21st century in the changing world?"* [Interviewee 2] The renewal of the technological equipment has been legitimized with the technological skills of the children in their everyday-life *"as children already have at home their computers and mobile phones."* [Interviewee 1] In the interviews, a discourse on all-embracing renewal was brought up. It was needed for the change towards the future school, involving experts of various kinds: on teacherhood, leadership, physical learning environments, technology etc. *"And there is change ... we want to develop the whole or in other words develop all of it as a whole... On all levels something has been done – teacherhood, leadership, physical learning environment, infrastructure, technologies."* [Interviewee 2]

However, the effort has involved not only arguing for challenging the installed base. The educational authorities interviewed also emphasized the importance of the local actors' knowledge of the local settings, referring to the installed base: *"We [in the educational section] 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 schools have profiled their own strategies for their educational development projects and for the adoption of learning technologies based on the installed base of their school. This way of working has been positioned as necessary, while the way of building a model and then transferring it to different contexts as ‘old-fashioned’: *“This model is good for starting to support the schools in this way, so that they get started from 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] For the reason of appreciating the installed base of each school, broad participation of schools is required.

5.2 Discourses arguing for equality, sustainability, continuity and cutting edge solutions

According to Star and Ruhleder [24], infrastructure has temporal and spatial reach beyond a single event or one-site practice. In this case, discourses arguing for extending the temporal and spatial reach of this information infrastructure even further have been evident. Discourses arguing for equality, sustainability, continuity and cutting edge solutions call for extending the reach of this information infrastructure, justifying broad participation of different kinds of actors in the case.

The discourse on equality identified from the data has demanded broadening the development of a single school, the integrated pilot school, to concern also other city schools. The new integrated pilot school to be built was from the outset planned to become a model for other schools, where new learning technologies with new practices would be developed and further exposed to other schools. However, discourse on equality in education becomes prevalent and argued for as providing equal opportunities to all schools in the city if not even nationally, e.g. through a similar level of technological equipment: *“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] *“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] Broad participation of schools and collaboration on national level are therefore necessary.

The continuity of the development effort from the viewpoint of the school children has also been placed into an important role. For instance, in one of the smart schools collaboration with the other local schools for ensuring continuity for the children has been considered necessary: *“Our contribution with respect to this age group ends on grade six, but it is not the aim to finish with that age group but create ground for them for continuation so that they could then until the end of comprehensive school utilize or use the methods that we have here launched. Enrich and develop them.”* [Interviewee 1]. The pedagogical practices employed with the new learning technologies have been envisioned to be further applied in the elementary school with

smaller children as well. This emphasis on continuity again justifies the inclusion of numerous schools into the effort, through cooperation with other schools at least.

Furthermore, the discourse on sustainability was also evident in the data. This emerged, for example, in the talk of the interviewee representing educational authorities emphasizing the importance of the possibility to continue with the practices and technological solutions in schools developed during the pilot projects: *“One should find such sustainable solutions that can be funded even if the economic situation deteriorated a little.”* [Interviewee 4] The development of the infrastructure for the educational network of the city had been started mainly by applying funding for separate pilot projects, but the development work has since been considered as part of the continuous development in the educational administration of the city.

An emphasis on world-class, most up-to-date, cutting-edge solutions was also evident in the interviews, the interviewees highlighting how they have relied on *‘technologies as innovative as possible’* [Interviewee 2] or arguing how *‘we have tried to be a few years ahead’* [Interviewee 3]. The process has been characterized even as “soaring” [Interviewee 1] or taking *“quantum leaps”* [Interviewee 4] in the technology development. This can be connected with collaborating with the global network, related to which a vision of *‘bringing the technological solutions all over the world’* [Interviewee2] was boldly expressed. The educational authorities and project managers indeed have collaborated within the global network with pedagogical and technological experts to define the general goals for action in constructing the future school of the city. Via the network, participants have been able to visit other schools or sharing experiences internationally: *“we have together met other schools, developer schools, internationally and there has been teacher-, headmaster-, (...) and then also the representatives from [the global company]. (...) There have been international experts related to learning (...), at every stage we have figured out the experts, who have given their own input to this work”* [Interviewee 3] The need for cutting edge solutions has justified the inclusion of even global companies and schools into this information infrastructure building effort.

5.3 Concrete participatory practices among teachers’ and pupils’

Star and Ruhleder’s notion of infrastructure [24] stresses its socio-technical nature which implies that infrastructures are always shaped by the conventions of a community of practice while these conventions of a community of practice, in turn, also have to be adapted to the existing infrastructures [24]. In the process of constructing the future school the adopted technological solutions and pedagogical practices have entwined as pedagogic practices have been developed along with technology to meet the needs of the learning objectives in the future school. A learner-centred view has been raised as a basis for shaping pedagogical practices. Supporting the personal objectives of each learner as well as viewing learning in a wider context have been given as a foundation for the use and in some cases also the selection of the learning technologies. The learning environments were constructed with the ICT solutions (e.g. ICT providing remote connection and access to information) supporting both collaborative practices and personalization of teaching.

The concrete participatory practices shaping the ICT and pedagogical practices have mainly been carried out by teachers in this case, while also pupils have played a role.

Especially teachers' contribution in developing the pedagogical practices linked with the information infrastructures has been crucial. The teachers have contributed both within the general framework of curriculum and in more specific-level projects. The Smart Schools have created new practices supporting teachers' development work. Instead of detailed pre-planning, the development work has been characterized as evolving: *"We haven't had and we cannot have had such a detailed preliminary model, how we will proceed, but we have sort of created it all the time in the course of the process (...) We have for example started creating this co-teaching system so that when the goal is to get teaching and learning more learner-centred, and also utilize these teacher strengths, strengthen the teachers' wellbeing, innovation, those models that have sort of been developed during the process."* [Interviewee 1]

Within the pilot projects, teachers have brought their pedagogical knowledge together with their understanding of the local school practices and organizational settings: *"The whole age group was in one large group, two teachers, who between themselves, very freely started planning how to do things with that grade, how to divide them into groups, in which subjects etc. ... the aim was to start working at the beginning of the autumn term so that each one [pupil in the large group] would have had a personal TabletPC of his/her own."* [Interviewee 1] The exploitation of best practices from pilot projects has also been planned to be developed further by teachers: *"Well, this framework is there. This teacher pair continues with this age group and they further elaborate and develop that co-teaching model and the synergy of several teachers. Now we'll start to emphasize it more in the curriculum, which means that there are two teachers and they have the liberty of arranging the work in class, now we'll get rid of rigid subject division ... We are aiming at this kind of holistic, wider learning."* [Interviewee 1]

The teachers' participation and more general awareness of the objectives of the future school have been promoted through in-service education. In one of the Smart Schools, weekly meetings with mentors have been arranged to support teachers' development work: *"And every week these teachers of the third-graders at that time plus the teacher-pair, who would start the following year in the same way and these mentor teachers, they were meeting on a weekly basis discussing where we are and what sorts of plans there are, what kinds of partners can be engaged."* [Interviewee 1] In some cases teachers' resources have been reserved for planning work and also education of their colleagues: *"They will take one day to plan something like, depends on how much they need, for three days or as long as a week when they then discuss the fifth and the sixth grades and wishes concerning the upper grades and also the training of the other teaching staff, share the positive experiences about technology use"*. [Interviewee 1] Furthermore, teachers of the other Smart Schools have been invited to participate in the arranged planning and training days: *"we offer it [training given by the developer teachers] also to other teachers in the future school project so that they could come along and pick from there whatever they wish."* [Interviewee 1] However, involving teachers would necessitate additional arrangements for their participation, possibly also exposing tensions from the direction of the trade union as explained by the representative of the local educational authority: *"We could have a more flexible time plan for teachers, but unfortunately this has not been successful ..."*

the teachers' union is quite strong and they don't necessarily always see that even teachers themselves wish the work could be developed." [Interviewee 4]

Pupils have also been involved as participants in the information infrastructure building for the future school (see also [blinded for review]). As users and learners, the pilot projects have offered possibilities for experiential and collaborative learning in the modernized learning environments supported by ICT solutions: "*Cross-curricular projects offer opportunities for experiential and collaborative learning in new learning environments, using ICT.*" [Background document] In addition, the pupils have acted as informants and testers (cf. [3]) of the learning technologies. As informants, elected representatives of the schoolchildren have been asked for comments concerning architectural plans and plans for the selection of specific learning technologies in meetings. "*Well in these joint meetings when the premises have been planned and put into practice, at regular intervals, the representatives of the student body, representatives of children and of pupils have been present in planning meetings.*" [Interviewee 2] Schoolchildren have also participated as testers in user evaluations of the learning technologies produced during the learner-centred product development. Schoolchildren have evaluated a mobile learning environment and a learning game to be developed. "*So this kind of usability information, now <mobile environment> is just one example there, another good example of what's been done well is this <learning game>, it was used with fifth-graders, niners and pupils in upper secondary grades. And during that half-hour gaming session one saw that it was meaningful, pupils were smiling, everybody had a good time and stuff had been learnt.*" [Interviewee 4]

In addition to children's participation in ICT development, their participation emerged as a topic in the discourses concerning the school's role in enabling children's more genuine participation [5]. The headmaster of the new Integrated Pilot School envisioned school children's involvement as a subject to be learned along the construction process of the new school: "*Then there's one topic that has kept appearing - engaging children - children and young people in the design of the activities and in starting the activities themselves. We should also have practiced that - in designing this house, for example, and considering the things that should be purchased, furniture, for example, so that is actually what we have sort of practiced and thought about.*" [Interviewee 5] There are already structures in the school that enable children's participation as stressed by the representative of the local educational authority: "*We do have well-functioning organizations, student bodies at each school, and there is sort of really favourable ground.*" [Interviewee 4] Therefore, children's genuine participation could be realized by allowing them to take part in constructing their school and planning the activities in there more comprehensively.

6 Concluding Discussion

There is a need to broaden our understanding of participation of various actors in contemporary IS development settings such as in large-scale, longitudinal infrastructure building efforts (e.g. [15], [18], [11]). The results of this study, offering

a fine-grained analysis of participation of various actors in the case of building an information infrastructure for an educational network of a Finnish city, are summarized in table 1. In the results, discourses justifying and characterizing participation of various actors are identified as well as users' concrete participation practices.

Table 1. Characterizing Broad Participation in Information Infrastructure.

	Discourses on challenging and appreciating the installed base	Discourses on equality, continuity, sustainability, cutting-edge solutions	Concrete participatory practices shaping ICT and practices
Children	Offered motivation to challenge the traditional school – as digital natives	Offered motivation for ensuring continuity and equality	Mainly related to shaping ICT, minor influence
Teachers	Invited to challenge the traditional school as inevitably relying on the local settings	Needed for ensuring continuity	Developing pedagogical practices
Headmasters	Invited to challenge the traditional school as inevitably relying on the local settings	Needed for ensuring equality, continuity, sustainability	Developing enabling practices (teachers' work arrangements)
Companies	Invited to challenge the traditional school	Needed for ensuring cutting edge solutions	Providing ICT, experimenting with it in local settings
Researchers	Invited to challenge the traditional school	Needed for ensuring cutting edge solutions	Developing pedagogical and enabling practices (teacher education, assessing the impact)
Educational administration	Invited to challenge the traditional school but also to appreciate the local settings	Needed for ensuring sustainability and equality	Developing enabling practices (funding, inservice education, school-company cooperation etc.)
Global network	Invited to challenge the traditional school as inevitably relying on the local settings	Needed for ensuring cutting edge solutions	Providing ICT, developing pedagogical practices

A discourse analysis of participation in this complex case was performed following nexus analysis that extends the research perspective from the micro to the organizational and institutional levels of social analysis. Interestingly, not only the discourse calling for all the actors to challenge the 'traditional school boat' but also the discourse emphasizing the appreciation of the local settings and practices of each school emerged. Both can be connected with an acknowledgement of the inescapable effect of the installed base of an information infrastructure [24]. In this case, the installed base was emerging not only in the sense of inertia, but also in a positive

sense relating to preserving and appreciating it (while perfectly in line with the notion of information infrastructure in [24]). Both for challenging the installed base as well as for appreciating it, wide-ranging participation was needed. The same goes with discourses on equality, continuity, sustainability and cutting edge solutions that all contributed to this case involving such a variety of actors. Also a discourse advocating children's right to participate in matters concerning their life was evident in the data (in line with [5]), even though it had not become fully realized in actual practices yet.

Regarding user participation, teachers and pupils as future users of learning technologies and utilizers of new teaching practices are of particular interest. In the case, no explicit effort of advocating PD or participation related to these two groups of stakeholders was brought up. Nevertheless, the interested teachers in the Smart Schools were given the possibility to develop and experiment with teaching practices; actively contributing to the development in the pedagogical domain, bearing important implications for the (learning) practices of the pupils. The case also reveals that the local educational administration and some headmasters were active in building up new enabling practices that allowed and supported this kind of school-company cooperation and teachers' development work. The issue of work allocation was also brought up. Teachers are well guarded by their unions that need to be involved in such negotiations. However, there was no particularly wide or systematic teacher participation in this effort, even though some willing and enthusiastic teachers from some Smart Schools have taken part. Moreover, also pupils were invited to take part in the information infrastructure building, even if their participation mainly concerned some ICT solutions under development. They were primarily seen as users, informants and testers (cf. [3]) providing feedback on some specific ICT solutions. On the other hand, some adults in the case brought up that children should be involved more comprehensively, and their more genuine participation (cf. [5]) should be supported. This is a positive observation even though no concrete actions were reported alongside the future visions.

The concept of information infrastructure [24] enabled us to describe the case in its richness; in this case especially the notions of reach of infrastructures, the inevitable intertwining of practices and technology, and the inescapable effects of the installed base. 'Challenging the traditional school' required renewal of the technological equipment and practices intertwined, while the educational development projects and adoption of learning technologies were based on the installed base of each school. In the adaptation work to local settings the importance of the local actor's knowledge was emphasized. Appreciating the installed base contributed to broad inclusion of schools. Also broadening the spatial and temporal reach of the information infrastructure was a continuous concern in the effort that required broad participation of various kinds of experts, the schools and children. The solutions built in the pilot schools should extend to other schools in the city-level network and preferably even further on the national and international level. The technological development with orientation to the future and for acquiring the cutting edge solutions, furthermore, connected the school participants, educational authorities and project managers with a global network. During local development efforts, the experimentation of new pedagogical practices was entwined with the new learning technologies at schools. Teachers had a major role in developing the new pedagogical

practices intertwined with the new technology, while also pupils took part as informants or testers. In this kind of information infrastructure building cases there likely is a variety of actors – users and other stakeholders – participating, for various kinds of reasons as the discourses identified indicate.

We have described a real-life infrastructuring process for the future school and increased the existing understanding of participation ‘in the wild’. As our empirical data shows, various kinds of actors participated, including some users. Our data shows the value of enabling practices supporting participation, training as well as the use of special support groups. Especially with the ‘invisible’ information infrastructures it is a challenge to arrive at shared understandings and to articulate the results and potential solutions in accessible ways (cf. [18]). New practices are also needed for better integrating the local and situated subprojects within the overall social network of longitudinal, infrastructure building efforts. Supporting potential participants is closely linked to another emerging issue from the data, namely the question of selecting suitable representatives. Based on our data we would like to highlight the current obscurity related to this representation. It seems that only by their formal position, certain actors were expected to represent others, even without a legitimate authorization (e.g. teachers representing pupils, headmasters representing teachers, etc.). We highlight the importance of understanding the organizational and social context in which the participatory infrastructuring is conducted (in line with [11]).

For studying an information infrastructure building effort with a variety of actors, even more material could be gathered. The research framework of nexus analysis provided us a lens for examining the phenomenon from a variety of perspectives, also on macro level. Still, a more detailed look on the dimensions of social action and the discourses as part of it would be needed to gain a better picture of the dynamics and intricate arrangements of relationships. Furthermore, our interventions connected with changing the nexus of practice, an integral part of nexus analysis, are yet to be reported.

References

1. Brady, B. (2007). Developing children’s participation: Lessons from participatory IT project. *Children & Society* (21), 31-41.
2. Druin, A. (1999). Cooperative inquiry: Developing new technologies for children with children. In *Proceedings of the SIGCHI conference (CHI '99)*, ACM Press, 223- 230. 1. 2.
3. Druin, A. (2002). The Role of Children in the Design of New Technology. *Behaviour and Information Technology*, 21 (1), 1-25.
4. Hanseth, O. (1996). *Information Technology as Infrastructure*, Gothenburg Studies in Informatics, Report 10, Department of Informatics, Göteborg University.
5. Hart, R. (1992). *Children's Participation: from Tokenism to Citizenship*. Innocenti Essays, 92 (6), UNICEF Innocenti Research Centre.
6. Halkola, E.; Iivari, N.; Kuure, L.; Kinnula, M.; Molin-Juustila, T. (2012) Children’s Participation in Constructing the Future School: A Study of a Large-scale Effort Involving ICT. - *International Journal of Social and Organizational Dynamics in Information Technology* 2 (2): 48-64.

7. Iivari, N. (2010). Culturally Compatible Usability Work – An Interpretive Case Study on the Relationship between Usability Work and Its Cultural Context in Software Product Development Organizations. *Journal of Organizational and End User Computing*, 22 (3), 40-65.
8. ...
9. Iivari, N., Karasti, H., Molin-Juustila, T., Salmela, S., Syrjänen, A.-L. and Halkola, E. (2009). Mediation between design and use revisiting five empirical studies. *Human IT Journal for Information Technology Studies as a Human Science*, 10 (2), 81-126.
10. Jewett, T. and Kling, R. (1991). The dynamics of computerization in a social science research team: A case study of infrastructure, strategies, and skills. *Social Science Computer Review* (9), 246-275.
11. Karasti, H. and Syrjänen, A.-L. (2004). Artful infrastructuring in two cases of community PD. In *Proceedings of the 8th conference on Participatory design*, ACM Press, 20-30.
12. Klebl, M. (2008). Explicating the shaping of educational technology: Social construction of technology in the field of ICT in education. In *Proceedings of ICICTE*, 278-289.
13. Kyng, M. (2010). Bridging the Gap Between Politics and Techniques: On the next practices of participatory design. *Scandinavian Journal of Information Systems*, 22 (1), 49-67.
14. Maglajlic, R.A. (2010). "Big organisations" supporting "small involvement": lessons from Bosnia and Herzegovina on enabling community-based participation of children through par. *American Journal of Community Psychology*, 46 (1-2), 204-14.
15. Markus, M.L. and Mao, J.-Y. (2004). Participation in Development and Implementation. *Journal of the Association for Information Systems*, 5 (11-12), 514- 544.
16. Monteiro, Eric, Ole Hanseth and Morten Hatling, "Developing Information Infrastructure: Standardization vs. Flexibility," Working Paper 18 in *Science, Technology and Society*, University of Trondheim, Norway, 1994.
17. Mumford, E. (1983). *Designing Human Systems for New Technology - The ETHICS Method*. Manchester Business School, Manchester.
18. Neumann, L.J. and Star, S.L. (1996). Making infrastructure: The dream of a common language. In *Proceedings of Participatory Design Conference*. ACM Press, 231-240.
19. Scaife, M. and Rogers, Y. (1999). Kids as Informants: Telling us what we didn't know or confirming what we knew already. In Druin, A. (ed.), *The Design of Children's Technology*. Kaufmann, San Francisco, 27– 50.
20. Scollon, R. (2001). Action and text: Toward an integrated understanding of the place of text in social (inter)action. *Methods in Critical Discourse Analysis* (ed.), Sage, London, 139-183.
21. Scollon, R. and Scollon, S.W. (2004). *Nexus Analysis: Discourse and the Emerging Internet*. Routledge, London.
22. Star, S. L. (1999). The ethnography of infrastructure. *American Behavioral Scientist*, 43 (3), 377-391.
23. Star, S. L. and Bowker, G. C. (2002). How to infrastructure. In Lievrouw, L.A. and Livingstone, S. (eds.) *Handbook of New Media*. SAGE Publications, 151-162.
24. Star, S. L. and Ruhleder, K. (1996). Steps toward an ecology of infrastructure: Design and access for large information spaces. *Information System Research* (7), 111-113.