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A Nexus Analysis of Participation in Building an Information Infrastructure for the 'Future School'

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Abstract

Information systems projects nowadays often affect more stakeholders than before and the range of users is also more versatile. Thus, a need for a fine-grained conceptualization of involved actors, including users and developers as well as various other affected stakeholder groups, has been identified in the literature. Some studies have already discussed participatory processes for information infrastructure (II) development. Our study complements this research theme by offering a nexus analytic discourse analysis of participation of various actors in an effort of building an II for an educational network of a city, the actors including educational authorities as well as school staff, children, companies, and researchers. We found a number of discourses as well as concrete participatory practices justifying wide-ranging participation of various actors. Based on this, we suggest advocating for more genuine participation of teachers and pupils as part of the infrastructuring process, e.g. by creating enabling practices.

1. Introduction

User participation has been a traditional topic in Information Systems (IS) research. Today's IS projects, however, often affect more stakeholders than before and the range of users is also more versatile. Along with such changes, new challenges and perspectives on user participation theory have emerged. Among other things, there is a need for a fine-grained conceptualization of actors involved, including users and developers as well as various other affected stakeholder groups. [15]

This study focuses on the participatory process of building an information infrastructure (II) [25] for an educational network of a Finnish city. The educational network refers to local schools and the municipal educational administration. Through this process, teachers and headmasters were invited to participate in the program for 'the future school', to develop school culture and to look for the best practices in pedagogy and technology use for 'school in the 21st century'. We will examine how participation by various actors has evolved over time in this complex setting, including the educational authorities as well as school staff and children, through an analysis of interviews with the key persons responsible in the effort. We rely on the research framework of nexus analysis [22], 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 [21] from the point of view of concrete practices and wider discourses.

This study utilizes literature on user participation and literature on the development of IIs, within which some studies have already discussed participatory processes for II development [6, 13, 18, 8, 19]. In this study, various actors have taken part, but without our intervention. This allows us to contribute to the recent II discourse, and particularly to that dealing with participatory design 'in the wild' without interventions by researchers (in line with [13]). Moreover, our study addresses an everyday life context of school, including school children as one user group participating in this II building effort. Extant literature, has remained silent about children's participation in II building efforts (except in [5]). Nevertheless, IS literature has long ago indicated the importance and benefits of user participation in the development [15, 17], which likely apply also in the case users are children. However, in complex II building efforts with a multitude of actors the integration of children into the development is likely very challenging, and thus in need for future research. We will offer insights into such a process, showing that children have been considered as an important group of actors, albeit with low impact during development. Our research approach allows acknowledging this through viewing participation both

as discursively constructed and as executed through practical activities within the effort.

The structure of the paper is the following: First we present research on user participation, including children's participation. Next, we introduce the concept of II and literature on II design. Then, our research design is described, including nexus analysis as our research framework and the procedures for data gathering and analysis. Finally, we outline and discuss the empirical results and conclude the paper.

2. Research on user participation

It has been acknowledged long ago that users should somehow take part in IS development [15]. In IS research user participation has implied participative activities including formal and informal, direct and indirect, active and passive activities, performed both alone and with others [1]. Participatory Design (PD) research, moreover, has emphasized the users' right to take part and have a say in IS development affecting their lives. However, it has appeared to be challenging to involve every user as participants in decision making in contemporary IS development that has extended outside the workplace [14, 15].

There is variety in the roles offered for users. In 'consultative' user participation, data related to users is gathered to inform decision-making, but the decision-makers are not required to comply with the data. Within 'representative' user participation, a user group stands for a larger user population and is 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, e.g. when those affected have been too numerous or unreachable [14, 15]. In such circumstances, it has been relatively common to rely on user representatives that are not users themselves (e.g. interest groups representing users' interests as in PD projects). [14] 'Professional' user representatives, such as usability specialists, assumed to 'know the users' and to 'speak for the users' may also be involved in the development (e.g. [10, 11]).

The studies on interaction design with children (IDC) have addressed children's participation. During the early days, the focus was on children as users of technology and on the consequences and impacts of technology on children. The focus has moved towards involving children as testers, informants and design partners [4]. However, the reported development efforts are usually small-scale, i.e. particular design or evaluation sessions carried out with children with a genuine interest in working with them (e.g. [3, 4, 20]). In IDC as well as in IS research more generally, there is a lack of studies on children's involvement in more complex efforts, with a longer time span or many partners [5].

3. The definition and design of information infrastructure

The concept of infrastructure has traditionally been related to large technical and material structures (e.g. water pipes, electricity supply, road networks, Internet) understood as a background structures or as a platform, which the other structures depend on [24]. In case of II, the mere concept of infrastructure has been considered insufficient for covering the multidimensionality of the use context and practices [25] or analyzing large-scale technological systems [24]. Star and Ruhleder [25] see infrastructure as a socio-technical, "fundamentally relational concept, becoming real infrastructure in relation to organized practices" (see also [23, 12]). They [24] relate the concept of infrastructure to their analysis of distributed IS. The salient features of infrastructure include: 1) embedded in other social and technological structures, 2) transparency of the supporting tasks, 3) certain (spatial, temporal) reach or scope - infrastructure has reach beyond a single event or one-site practice, 4) learned as part of membership – the artifacts and organizational arrangements are taken for granted, 5) shape and are shaped by, or linked with the conventions of practice, 6) plugged into other infrastructures and tools in a standardized fashion, though they are also modified by scope and conflicting (local) conventions, and 7) 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. [25] 'The inertia of the installed base' refers to the influence of the base of infrastructure, which the new elements always have to be adapted to. Infrastructure is never built from scratch. [6] New systems should be designed for backward compatibility. Failing to account for constraints may be fatal or distorting to the development [16]. Finally, the normally invisible infrastructures become visible upon breakdown [25].

Star and Ruhleder [25] describe 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. In organizations, the locally tailored applications and repositories begin to interweave themselves with the formal infrastructure to

create a unique and evolving hybrid, in response to the community evolution and adoption of infrastructure [25]. Infrastructures have to be changeable to support current conventions in local organizations. Therefore, an infrastructure emerge by resolving tensions between the local and the global and by large-scale technology affording local practices in their natural, ready-to-hand fashion. [25]

According to Star and Ruhleder's [25] definition, infrastructures evolve and are constructed over time on the existing installed base. This implies that the technologies to be developed should be seen in relation to the social and organizational structures and practices where the infrastructure is embedded. Star and Bowker [24] share this view of infrastructure as relative to working conditions and never apart from those 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 [24] 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].

In the existing literature, the socio-technical aspects of IIs have been attended to address the interaction with the inherent social use contexts [2, 6, 7, 16, 25]. Within these socio-technical approaches, IIs have been described as large-scale systems involving significant numbers of independent actors, developers as well as users [7]. II has been defined as a shared, open, standardised, heterogenous, socio-technical installed base in transformation [6, 7], consisting of a set of technological capabilities and their user, operations and design communities [8]. The relevance of stakeholder participation has been acknowledged in the recent literature, yet from the designer's perspective [8]. Furthermore, a framework for supporting creative activities of users' contribution to work infrastructure improvement has been provided [19].

Neumann and Star [18] have studied the design principles of PD in II building. As social scientists co-developing an II, they aimed at understanding the interplay between potential use, new and old infrastructure, and a large project organization. In their study, 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 users, focus groups with potential users and interviews with students and staff. They characterize II building as mediating demands of multiple groups and enabling connections among them, reaching towards the unknown. In their venture, they brought together funding agencies, publishers, software developers, librarians and users, each having their own interest and idea of the unknown. However, during the II building process they discovered difficulties in articulating the end product and differing meanings of the overall project among the participants.

Karasti and Syrjänen [13], on the other hand, have explored PD in two communities, in which technology development has been thoroughly and complexly embedded and interwoven in their activities. 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 shaping design as artful infrastructure processes which are tentative, open and flexible. The study shows how important it is to broaden the existing understandings of the social and organizational context of PD even to nonprofessional designers 'in the wild'. [13]

4. Research design

The aim of this paper is to shed light on the process of participation in II building both as discursively constructed and as executed through practical activities within the effort. The study was guided by nexus analysis (NA), a research framework focusing on social action taken by an individual with reference to a social network [22]. Social action is viewed as mediated by cultural tools or mediational means [21], 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 [21]. NA examines the cycles of discourse that come together to form a nexus of practice, a recognizable group of mediated actions. The researchers enter the community being researched, look 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. [22] NA was seen as a fruitful choice 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 addressed in this study is the development of the future school, encompassing the concept of a 'school in the 21st century' where children are 'apt technology users', as our interviewees put it. In the initial stages of the process, the city encouraged the local schools to submit applications for development projects. 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 new school, so-called 'Integrated Pilot School', which was under construction in a new town area. This school was to be built as part of a centre including a library and a nursery as well as other facilities and services. Best practices from the Smart School 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.

The process was facilitated through II development involving new solutions in technology as well as pedagogy, architecture and interior design for the whole educational network of the city. The participants in the effort include local educational authorities, various companies, researchers, and the Smart Schools including their headmasters, teachers and pupils (age 7–16). The Smart Schools were all public schools within general education, following the national curriculum, but showing special interest in developing technology supported pedagogy.

The development effort spanned the years 2007–2010 and was in progress during our data gathering, years 2009–2010. The data was gathered first by examination of publicly available material online, on the basis of which the most important participants in the nexus of practice, either due to institutional status or media representation, were selected for the interviews. Two of the key interviewees were project managers [I2 and I3] in the future school development endeavor, two were headmasters of the Smart Schools [I1 and I5], one a city level development manager [I4], and two Smart School teachers [I6 and I7]. The open-ended in-depth interviews were based on the prepared themes concerning the history, the current state and the future prospects of the future school effort. Special interest was given to the development of the technological infrastructure, technology use, and participation of the various actors. Additional themes introduced by our multidisciplinary research team concerned community, acquisition and purchasing-related aspects. The interviews (ca. one hour each) were transcribed (127 pages in total). Interviewing children was considered out of the scope of this study as the numerous children involved in the conducted projects were dispersed in different schools in the city, and had possibly been involved years ago. The data includes also 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, various reports, newspaper and magazine articles, and material produced by the schools involved). We acted here as outsider observers, not being involved in the effort in any other way. 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 on IIs was applied to make sense of participation in the venture. Particularly, three Star and Ruhleder's II dimensions [25] provided perspective for us to make sense of the participation in this effort: IIs reach and scope, the issue of IIs being built on an installed base, and, IIs links with conventions of practice, i.e. how the II both shapes and is shaped by the conventions of a community of practice. The participation of the various actors in the effort was considered in relation to these three dimensions. This study characterizes the nature of participation in II building, acknowledging participation both as discursively constructed and as executed through practical activities within the effort.

5. Participatory building of information infrastructure

The development efforts in the Smart Schools of the city have varied from building new schools to renovating old ones and, further, creating new operating models for schools. The architectural and interior designs have co-evolved with technological solutions. For example, in one of the Smart Schools, all nine-year-old pupils and their teachers gained laptops for personal use and two classrooms were equipped with electric socket pillars facilitating the use. In some existing schools building layouts were changed, and learning technologies were adopted to create learning environments (e.g. one of these called an 'innovation hall'). The Smart Schools have served as examples of development projects that culminated in building of the Integrated Pilot School, argued to have been designed to support the reform of school work. In that school, classroom spaces are flexible to enable collaborative teaching (e.g. foldable walls, smartboards). The technologies enable sending materials, also smartboard notes, to pupils via e-mail. Teachers employ laptops, video projectors and video cameras in teaching. The school, the library and the yard are equipped with modern technology. 7-8-year-old pupils work in groups with shared desktops. Older pupils and their teachers

have own personal laptops. A new virtual learning environment has been adopted in the Integrated Pilot School as well as schools throughout the city. It brings into students' use a calendar, e-mail, online storage space, instant messaging and video conferencing. [Background documentation]

Next, we will discuss this effort with a focus on participation. We identify discourses justifying and characterizing participation in the effort as well as users' concrete participation activities.

5.1 Discourses for challenging but also appreciating the installed base

Installed base influences all future developments, as IIs always inherit strengths and limitations from the installed base [25]. Schools with their practices in pedagogy and technology use brought diversity to the installed base of the educational network II. On the level of discourses, the various actors in this effort have been invited to challenge the installed base. At the same time, the existing installed base has been positioned as highly valuable so that all development efforts need to appreciate and rely on it. In both cases, the discourses have contributed towards justifying broad participation of different actors in the effort. The invitation to challenge the installed base has become salient in the discourses describing the vision of challenging the 'traditional school' for constructing the future school concept and the II. The installed base of the II has been envisioned to be modernized by constructing the future school with the pedagogical practices and learning environments of the 21st century: *"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?"* [I2] The renewal of technology has been legitimized with children's technology skills in their everyday-life *"as children already have at home their computers and mobile phones."* [I1] 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, technology, physical learning environments: *"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."* [I2]

However, in addition to 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."* [I4] The schools have profiled their own strategies for their educational development projects and for the adoption of learning technologies based on their school settings. This was considered necessary as opposite to 'old-fashioned' way of building a model and then transferring it to different contexts: *"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."* [I4] For the reason of appreciating the diversity of practices with technology use brought by the schools to the installed base, broad participation of schools is required.

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

II has temporal and spatial reach beyond a single event or one-site practice [25]. In this case, discourses arguing for extending the temporal and spatial reach of this II even further have been evident. Discourses arguing for equality, sustainability, continuity and cutting edge solutions call for extending the reach of this II, justifying broad participation of various actors.

The discourse on equality in the data has demanded broadening the development focus from the Integrated Pilot School. 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 has become 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."* [I2] *"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."* [I1] 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 highlighted. In one of the Smart Schools, collaboration with the other local schools was considered necessary to ensure continuity for the children: *"Our contribution with respect to this age group ends on grade six [12 year olds], 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."* [I1] The pedagogical practices employed with the new learning technologies have been envisioned to be further applied in the elementary school with younger children. This emphasis on continuity again justifies the inclusion of numerous schools into the effort, through cooperation with other schools at least.

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."* [I4] The development of the II for the educational network of the city was started 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 reliance on "*technologies as innovative as possible*" [I2] or arguing how "*we have tried to be a few years ahead*" [I3]. The process has been characterized even as "*soaring*" [I1] or taking "*quantum leaps*" [I4] 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"* [I2] was boldly expressed. The educational authorities and project managers indeed have collaborated within the global network with pedagogical and technology 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 share 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."* [I3] The need for cutting edge solutions has justified the inclusion of even global companies and schools into this II building effort.

5.3 Concrete participatory practices among teachers and pupils

Star and Ruhleder's notion of II stresses its socio-technical nature which implies that IIs are always shaped by the conventions of a community of practice while these, in turn, have to be adapted to the existing II [25]. In the process of constructing the future school, the adopted technologies and pedagogical practices have become entwined and co-evolved 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, were the basis for the use and the selection of the technologies sometimes as well. The learning environments were constructed with the technologies (e.g. technology providing remote connection and access to information) supporting both collaborative practices and personalization of teaching. The concrete participatory practices shaping the technology and pedagogical practices have mainly been carried out by teachers in the effort, while also pupils have played a role.

The teachers' contribution in developing the pedagogical practices linked with the IIs has been crucial. They have contributed both within the general framework of curriculum and in more specific-level projects. The teachers have also developed e-learning materials to support the use of emerging digital learning environments. *"I make quite a lot of material [for the digital learning environment] myself (…), which then modifies according to the pupils. So that there is this individual consideration and different kinds of learners."* [I6] Different styles of learning were supported with e-learning materials, the use of personal laptops as an example of enhancing the adaptation of pedagogical practices for personalized learning. *"We have personal PCs in use; it does change the nature of teaching a lot. We can consider the pupils so that s/he who is not able to read that much can listen and the one who cannot write that much can produce speech with the computer."* [I6]

Interior design and technology developments have required teachers' pedagogical expertise for grounding the developed practices to the local Smart School settings. Both educational administrators and teachers have participated in the development projects as pedagogical experts: *"We may have a more pedagogic orientation to what should be done with the equipment. There is no point in ordering a huge amount of screens*

if we have nothing to present. (...) I am involved in our development effort of innovative hall, in a kind of group of developer teachers. (...) We have together in this group designed everything, made these activity descriptions and planned what is needed for different activities possibly. (...) we have made very detailed descriptions of all the situations, learning situations and some other school-related situations." [I7]

The Smart Schools have created new practices supporting teachers' development work. Instead of detailed pre-planning, the development 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."* [I1]

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."* [I1] 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."* [I1]

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 [9 year olds] 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."* [I1] Occasionally, 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 [11-12 year olds] and wishes concerning the upper grades and also the training of the other teaching staff, share the positive experiences about technology use"*. [I1] Furthermore, teachers of the other Smart Schools were 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."* [I1] However, involving teachers also challenges their work arrangements possibly also exposing tensions from 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 if teachers themselves wish, the work could be developed."* [I4]

Pupils have also been involved as participants in the II building for the future school (see also [5]). As users and learners, the pilot projects have offered possibilities for experimental and collaborative learning in the emerging smart learning environments: *"Cross-curricular projects offer opportunities for experiential and collaborative learning in new learning environments, using technology"* [Background document]. In addition, the pupils have acted as informants and testers (cf. [4]) of the learning technologies. As informants, elected representatives of the pupils have been asked for comments concerning architectural plans and plans for the selection of specific learning technologies in meetings. *"In these joint meetings when the premises have been planned and put into practice, at regular intervals, the representatives of the student council, representatives of children and of pupils have been present in planning meetings."* [I2] Pupils have also participated as testers in user evaluations of the learning technologies produced during the learner-centred product development, e.g. a mobile learning environment and a learning game. *"So this kind of usability information, now <mobile environment>, is just one example, another good example of what's been done well is <a learning game>, it was used with fifth-graders [11 year olds], ninth-graders [15 year olds] and pupils in upper secondary grades [16 year olds and older]. 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."* [I4]

Besides in technology development, children's participation has emerged as a topic in the discourses

Table 1. Characterizing participation of various actors in information infrastructure building

	Discourses on challenging and appreciating the installed base	Discourses on equality, continuity, sustainability, cutting-edge solutions	Concrete participatory practices shaping technology and practices
Pupils	Offered motivation to challenge the traditional school – as apt technology users	Offered motivation for ensuring continuity and equality	Mainly related to shaping technology, 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 technology, 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, in-service education, school-company cooperation)
Global network	Invited to challenge the traditional school as inevitably relying on the local settings	Needed for ensuring cutting edge solutions	Providing technology, developing pedagogical practices

in the sense of school's role in enabling children's genuine participation [9]. 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."* [I5] 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 councils at each school, and there is sort of really favourable ground.*" [I4] 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. 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 II building efforts (e.g. [15, 18, 13]). For this, our study offers a fine-grained nexus analytic discourse analysis of participation of various actors in an effort of building an II for an educational network of a city (Table 1). We found a number of discourses as well as concrete participatory practices.

Related to **discourses about the installed base**, interestingly, not only the discourse calling for all the actors to challenge the 'traditional school' 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 II [25]. In this case, the installed base was emerging not only in the sense of inertia, but also in a positive sense relating to its preservation and appreciation (while perfectly in line with the notion of II in [25]). Wide-ranging participation was needed for challenging the installed base and for appreciating it. The same goes with **discourses on equality, continuity, sustainability and cutting edge solutions** that all contributed to this effort involving such a variety of actors. Discourse advocating children's genuine participation and right to participate in matters concerning their life was also evident in the data (in line with [9]), even though it had not become fully realized in actual practices yet.

Regarding **participatory practices**, teachers and pupils as future users of learning technologies and utilizers of new teaching practices are of particular interest. In the effort, no explicit attempt of advocating PD related to these two groups was brought up. Nevertheless, the interested teachers in the Smart Schools were given the possibility to develop and experiment with teaching practices; to actively contribute to the development in the pedagogical domain, bearing important implications for the (learning) practices of the pupils. The study also reveals that the local educational administration and some headmasters were active in building new enabling practices that allowed and supported this kind of school-company cooperation and teachers' development work. The issue of teachers' work

allocation was brought up. They 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 took part.

Moreover, also pupils were invited to take part in the II building effort, even if their participation mainly concerned some specific technological solutions under development. They primarily acted as users, informants and testers (cf. [4]). Although their contribution was quite minimal, they nevertheless were allowed to provide their opinions and feedback, therefore influencing at least some specific design decisions in this large-scale II building effort, Moreover, some adults brought up that children should be involved more comprehensively, and their genuine participation (cf. [9]) supported. This is a positive observation even though no concrete actions were reported alongside the future visions.

Our data shows the value of practices supporting participation, training as well as the use of special support groups in participatory infrastructuring. Especially with the 'invisible' IIs 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 needed for better integrating the local and situated subprojects within the overall longitudinal II building efforts. Supporting potential participants is closely linked to another issue emerging from the data, the question of selecting the 'user representatives' (see e.g. [10, 11]). Based on our data we would like to highlight the current obscurity related to this aspect: it seems that only by their formal position, certain actors were expected to represent others (e.g. teachers representing pupils, headmasters representing teachers). We advocate more genuine participation of all user groups.

The concept of II [25] enabled us to describe the effort in its richness; especially the notions of reach of IIs, the inevitable intertwining of practices and technology, and the inescapable effects of the installed base. 'Challenging the traditional school' required renewal of the technology and practices intertwined, while the development projects and adoption of learning technologies were based on the local settings of each school. In terms of adaptation to local settings the importance of the local actor's knowledge was emphasized. Appreciating the installed base contributed to a broad inclusion of schools. Also broadening the spatial and temporal reach of the II 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.

The research framework of nexus analysis, having social action as its central focus, allowed us to widen the perspective from the micro to the macro level of discourses. There is existing literature on the top-down analysis of IIs, while in this study the analysis was driven from the social action point of view, seen as discursively constructed and as concrete practices. This perspective helped us to recognize the connectedness of the small-scale development efforts with the wider contexts, the entire II building effort. In addition, through this nexus analytic inquiry on participation we became better equipped to organize a participatory intervention for children in the effort – i.e. to move from engaging and navigating to changing the nexus of practice in question.

7. Conclusions

To broaden understanding of participation of various actors in contemporary IS development, we examined how the participation of various actors has evolved over time in a complex process of building an II for an educational network of a city. We made a nexus analytic discourse analysis of thematic interviews of the key persons in the effort, increasing the existing understanding of participation 'in the wild'. This fine-grained analysis revealed future paths for user participation even not yet realized in practice: More genuine participation of teachers and pupils as part of the infrastructuring process should be advocated. Their participation could be supported e.g. by creating enabling practices, as shown in this study. The results have some limitations to be noted. One is of course that children were not among the ones interviewed. On the other hand, this inquiry guided us into organizing an intervention for children to take part. As for the future paths for research, more material could be gathered of this II building effort with a variety of actors so that an even more detailed look on the dimensions of social action and the discourses as part of it could be taken. Although the Integrated Pilot School has now been built, there are new schools to be built or old schools to be renovated in the city on a continuous basis and building of this II is an ongoing, evolving process that could be examined further. Finally, the interview talk painted a

relatively positive picture of this effort. For the discourse analysis carried out the data was fruitful, but also other kind of data, concentrating more on the challenges and drawbacks encountered, could be utilized.

12. References

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