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# Multiple voices in ICT design with children – a nexus analytical enquiry

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**Abstract**. Children's participation in information and communication technology (ICT) design is an established interdisciplinary research field. Methods for children's participation have been developed, but a closer link between theory and design has been called for, as well as an examination of various participants influencing children's participation in ICT design. This paper addresses these gaps by introducing the research strategy of nexus analysis as a promising theoretical framework. Especially the concepts of 'interaction order' and 'historical body' are utilized in the analysis of six empirical studies on ICT design with children. The analysis shows that through the participating children there were also 'others' involved, multiple voices to be heard, often invisible but informing design. Some of these 'others' have already been acknowledged in literature but the issue has not been examined in depth and common vocabulary for this is lacking. Some practical implications will be offered by illustrating how to consider these concepts in different phases of ICT design: when establishing relationships with children, involving children as participant designers, and analysing the results of these participative processes.

**Keywords**: Nexus analysis; interaction order; historical body; involving children; interaction design; genuine participation

## 1   Introduction

The range of information and communication technologies (ICT) in our everyday lives has increased, also among children. Children's participation is needed when designing ICT for their use. Indeed, children's participation in ICT design has become an established interdisciplinary field within Human Computer Interaction (HCI) research. Although numerous methods have been developed for involving children in ICT design, Read and Markopoulos (2013) identify a lack of understanding of how 'other actors' and contexts affect work with children. They have also called for a closer link between theory and design to better guide ICT design with children for children (Read and Markopoulos, 2013). There are relatively few studies that explicitly use theory to inform research and design with children, although an increasing interest has been identified (Yarosh et al., 2011). This has inspired us to build a better theoretical understanding of children's participation in ICT design as regards the 'others' taking part and influencing the outcome. Our research questions are: What are the multiple

voices in ICT design with children and how can they be taken into consideration when collaborating with children?

In the following, the theoretical background of the study will be presented. Nexus analysis (Scollon and Scollon, 2004) including the concepts of 'interaction order' and 'historical body' will be introduced as a promising theoretical framework to guide research and analysis on this challenging area. A review of previous research on the 'others' in ICT design with children will follow. After illustrating the method for data analysis, the section three delineates six of our empirical studies involving ICT design with children. Using the nexus analytical perspective, each study will be critically reflected upon and some 'others' involved revealed – multiple voices, often covert but still informing design through the participating children. Finally, the practical implications of the study will be discussed, e.g. how to consider 'interaction order' and 'historical body' in different phases of design in order to help us to become more responsive to the contributions of the children involved. A consideration of the potential multiple voices discernible in children's contributions will help us clarify, appreciate and support children's participation with their own interests and preferences.

## 2 Theoretical background

The theoretical lens applied in this paper will be introduced and related findings from previous studies dealing with ICT design with children will be discussed.

### 2.1 Theoretical lens

*Nexus analysis* (Scollon and Scollon, 2004) allows us to extend the perspective from the actual here-and-now situation to wider cycles of discourse on a long-term basis. It is characterized as "the mapping of semiotic cycles of people, discourses, places, and mediational means involved in the social actions we are studying" (Scollon and Scollon, 2004: viii). 'Nexus' refers to social action in real time and space, taking place as the intersection of 'interaction order', 'historical body' and 'discourses in place' (Scollon and Scollon, 2004: 19). In this paper, we will focus especially on the concepts of 'interaction order' and 'historical body'.

Regarding **interaction order**, Scollon and Scollon (2004) draw upon Goffman's (1955; 1983) idea of people behaving differently, organizing themselves as conversational partners when they are in smaller 'withs' rather than in larger groupings, or with friends rather than distantly familiar others. Relationships between participants engaged in social action can be seen as shaping up through different types of interaction order, *in situ* but also mediated across time. With respect to a data collection situation with children, for example, the presence or absence of parents, teachers or researchers will have consequences for how interaction delicately builds up. There may also be traces of more distant and invisible participants having their impact on what is going on. For example, a child may seem to provide concise 'homework' answers to the teacher as an 'obedient' pupil even if the aim of the researchers were to capture children's own life world at home (example from our data). Some interactions can be characterized as

stage performances, `platform events´ in Goffman's (1983) terms, one or more people performing a "spectacle" for the observation of another group as an audience (e.g., children joking and showing off for their classmates in a design session, leading to several group members copying elements in their designs, as in our data). A researcher needs to bear in mind that participants' talk and doings in research situations is a matter of more complexity than just providing reliable data for the researcher (e.g., Iivari et al. 2014). In a design session, it is important to take into account the multiple interactional features of the situation affecting the ways participants relate to each other.

The configurations of interaction order in social action are tied with the participants' **historical bodies** (Scollon and Scollon, 2004:13, originally from Nishida 1958). Scollon and de Saint-Georges (2013) highlight historical body as the abstraction of people's social practices or repeated experiences in the course of their lives. These life-time histories and experiences are the basis for habits that become to feel so natural that actions are carried out seemingly without being told (Scollon and Scollon, 2004:13). Children, for example, become gradually socialized into school life, i.e. being school-pupils, learning appropriate behavior in the classroom. Considering a design session in a school environment, the presence and placement of desks, textbooks, whiteboards and classroom decorations among others tie together various school-related practices that may heavily influence children's behavior. Nevertheless, teachers or parents may function as facilitators in the design process and data collection, being aware of children's historical bodies as for participative practices, familiarity with digital media, and literacy background among others.

As for **discourses in place**, social actions are always situated, i.e. accomplished at real, material places in the world. In these places complex aggregates of discourses circulate, some more rapidly (e.g., intensive conversations between friends) and others at a slower pace (e.g. regulatory discourse visible in street junctions as traffic signs) (Scollon and Scollon, 2004:14). Discourses arise in place from interactions between participants with their historical bodies, configured through their situationally emergent interaction orders. Thus, the three aspects of social action, interaction order, historical body and discourses in place are analytically inseparable, still heuristically perceivable as different angles to the social action under scrutiny.

In this paper we will use the concepts of interaction order and historical body to conduct an interdisciplinary analysis of six of our previous empirical studies. We will shed light on the diversity of the multiple voices, even from distant 'timeplaces' that may have become alive in the moments of data-collection. In other words, we will examine whose voices it is that are discernible in ICT design with children, in addition to the voices of the children themselves. We will trace the interaction, asking who the participants are – not only the actual participants such as children and researchers *in situ*, but also those whose voices become identifiable in the research situations in one way or another. Likewise, the traces of the historical bodies of children will be analyzed as for their impact on the data acquired. Next, we will discuss related findings from the existing studies on ICT design with children to see how the multiple voices and related challenges have already been identified.

## 2.2. Influential participants in participative ICT design with children

Different parties are involved in ICT design with children; be they researchers or practitioners, they are usually adults. Druin (2002:1) suggests that the relationship between adults and children can be viewed in terms of the traditional power structure between the 'all-knowing adult' and the 'all-learning child', which implies children's dependency on their parents and teachers as for everyday needs and educational experiences. In a similar vein, Read and Bekker (2011:163) argue that in research on interaction design with children it is important to consider issues related to the adult participants' involvement in children's interactions. They highlight that it is the adults with whom children interact daily (e.g. parents and teachers) and the adults who govern culture and society (e.g. policy makers) that are key actors on what children do with technologies, how they interact with technologies, and which technologies are designed for them. Thus, the influence of such adult actors needs to be considered when planning and implementing design sessions with children.

The **teachers**' role in the design sessions with children has been widely discussed. Many times design sessions are carried out in school environment, where one needs to adapt to the administrative and regulatory framework of the school (Rode et al., 2003). The teachers' approval and engagement in many practical arrangements (e.g., group formation and maintenance of order) is required (Druin, 2002; Read et al., 2002). Teachers may be engaged in arranging the settings, determining the learning goals, ensuring that the design activities and language are appropriate, interesting and understandable for the children involved, and even in data collection in the classroom as well as the evaluation of the project and the product afterwards (Druin, 2002; Garzotto, 2008; Mazzone, Read, and Beale, 2008; Mazzone et al., 2010; Pardo, Howard, and Vetere, 2008; Read and MacFarlane, 2006; Rode et al., 2003; Scaife and Rogers, 1999).

Traditional **power structures** between children and teachers, or any adults, may also affect the design process in an undesired way. Thus, adults and children should be seen as equal partners in the design team (e.g. Druin, 1999, 2002; Druin et al., 1999; Guha, Druin, and Fails, 2013). A single adult in a group of several children, however, may create team dynamics with the feel of a classroom, the adult leading the class. Adults interviewing children might also lead children to feel being tested for correct answers. (Druin et al., 1999, Read, MacFarlane, and Gregory, 2004), Adults should consciously try to avoid being positioned as authority figures (Druin, 1999; Druin et al., 1999) even if they may have responsibilities that cannot be removed, e.g., providing the structure for the design sessions and adopting the caregiver role when needed (Guha et al., 2013). Traditional power structures may be resisted, when both children and teachers are unfamiliar with the technology in question, by giving them the possibility for elaborating shared meanings and practices (Pardo, Vetere, and Howard, 2005). The design activities may be placed outside the school environment, or teachers may be integrated into the design later, thus letting them learn from children (Druin et al., 2001). In literature, other kinds of **adult professionals** have been brought up as participants in the design process as well, having useful expertise for the design team but possibly influencing children's participation. These professionals include

educational researchers, artists, psychologists and health care professionals (e.g. Scaife et al., 1997; Scaife and Rogers, 1999; Moraveji et al., 2007; Mazzone et al., 2010), and ICT researchers or practitioners themselves. When working with children with special needs, adult proxies or helpers may also be important participants in the design process (De Leo and Leroy, 2008; Guha, Druin, and Fails, 2008; Holone and Herstad, 2013).

**Parents** have also been considered an influential actor group in design sessions with children. First of all, parents are gate-keepers: their permission is needed for children to be able to join a design team. Sometimes researchers may wish to visit children's homes, which involves their parents. (Druin, 2002.) Parents are also needed for taking children into research labs or other out-of-school locations where the design activities are taking place (Druin, 2002), or for supporting young children in their design work at home if they need assistance in typing, for example (Walsh et al., 2010). When children collect data independently, e.g. at home, parents may be present (Iivari et al., 2014). Parents may also be involved in the design team together with their children (Druin, 1999; Read et al., 2002). Here the traditional power structures may easily appear in the sense of parents steering their children (Druin, 1999). It is important then to highlight adults' role as facilitators instead of imposing their ideas on the children (Read et al., 2002).

Beside the many adult actors **peers** and **schoolmates** may influence the design sessions (e.g. Frauenberger et al., 2012; Giaccardi et al., 2012; Kuure et al., 2010). Children tend to prefer what their peers have, as this is considered 'cool' (Druin et al., 1999). This can be relied on as a resource: children may be asked to observe other children to draw upon their thinking and ideation (Guha et al., 2004). Children seem to learn more effectively from each other, which has been seen as useful in the design process (Giaccardi et al., 2012). Child groups may be intentionally formed for the participants to work symbiotically together (Guha et al., 2004). Children may also end up collaborating during design sessions without a specific request from the adults (Mazzone et al., 2010; Kuure et al., 2010; Iivari et al 2014). Children may initiate collaboration between groups, placing attention also on inter-group collaboration (Garzotto, 2008). Moreover, non-disabled children may act as co-designers of technology for their disabled schoolmates (Garzotto and Gonella, 2011). In addition to schoolmates, children may collaborate with **siblings** or **friends** (Go, Ballagas, and Spasojevic, 2012; Gritschacher and Slany, 2012). The ability to learn and cooperate with other children and the ability of the children to entertain their friends have been identified as key success factors in ICT design with children (Gritschacher and Slany, 2012). However, challenges have been identified in relation to children collaborating during ICT design. Collaboration may be challenging especially for young children (Guha et al., 2004). When children work in pairs, there may also be a dominant partner, taking control over the work (Wyeth and MacColl, 2010). Peer pressure may also affect the design sessions with children. Children have also been reported to adopt ideas from their peers' designs (Kuure et al., 2010; Mazzone et al., 2010; Read, Horton, and Mazzone, 2005; Desjardins and Wakkary, 2011).

## 2.3 Prior knowledge and experience influential in participative ICT design with children

Today's children and young people live in a technology- and media-rich world. Abundant research is available on their media worlds, youth culture and (multimodal) literacy and technology practices, revealing that technologies and new digital and social media are embedded, even immersed, in children's lives from an early age (Lankshear et al., 1997; Marsh and Thomson, 2001; Kress, 2003). However, there are also more critical voices doubting the equal spread of technology-mediated literacy practices, suggesting that most of the young people might rather be consumers of new media than active content producers (Buckingham, 2010).

During the design process, it is essential to understand the life world of today's children as we should be able to design future ICT in a way that resonates with children's expectations on how the world around them works – or should work (Hinske, Langheinrich, and Lampe, 2008; Kinnula, Moilanen, and Kinnula, 2012). Children's mental models affect their thoughts and expectations related to the world around them, including technologies, which should be taken into account when designing systems (see e.g. Kierkels and van den Hoven, 2008; McKnight and Read, 2009; Read, MacFarlane, and Casey, 2003; Kinnula et al., 2012).

We should also acknowledge that during design children's life world merges with their contributions, reflecting their everyday life such as their home, personal interests and activities, and people of importance to them (Mazzone et al., 2010; Katterfeldt, Dittert, and Schelhowe, 2009). Children's experiences, preconceptions, understandings, associations with familiar real-world experiences, memories, expertise and knowledge affect the data children produce for the researchers (Desjardins and Wakkary, 2011; Frauenberger, Food, and Keay-Bright, 2010; Iivari et al., 2014; Kuure et al., 2010; Price and Falcão, 2009; Read et al., 2004). Hence, there is also a strong tendency among children to borrow and recycle elements from their life world during design. This is how children learn, but it may be problematic from the viewpoint of ICT design (Vaajakallio, Lee, and Mattelmäki, 2009). Prior experience may limit children's creativity: not having an idea about future ICT, children may rebuild already existing technologies familiar from their everyday life (Read et al., 2004; Weiss et al., 2008). This also shows when using technology probes: the experiences with the limits of these probes provide the baseline from which the participants propose new ideas (Edwards et al. 2014). On the positive side, children can exploit their current social reality as well as their previous experiences with computers and digital games as resources when expressing their design ideas (Kuure et al., 2010; Hemmert et al., 2010; Kafai, Burke, and Mote, 2012). Prior experience has, indeed, been emphasized to be beneficial; children without prior experience with computers have been observed to be unable to contribute as expected in design sessions (Duveskog et al., 2009).

As the survey of earlier research shows, the array of factors influencing research situations with children is complex. The aim of this study is to search for a deeper understanding of the field by using the nexus-analytical notions of interaction order and historical body as a theoretical lens to examine our research cases further.

# 3 Multiple voices in six design projects involving children

The interdisciplinary research group has organized ICT design projects in several settings. Figure 1 summarizes six studies dealing with children's participation in different phases of ICT design. All these empirical, qualitative studies have been conducted within our research group, independent of each other, with varying purposes and motives. The empirical material of the studies has also been gathered using different kinds of methods. In the following (3.1), the process of data analysis for this paper will be described. Then (3.2-3.7), each study will be discussed by characterizing the multiple voices evident in them. Each study displays a diversity of voices but provides some unique characteristics of these 'others' peculiar to the participative ICT design with children in question. The analysis will not be all-encompassing. Instead, specific aspects of each study will be highlighted pointing to the value and potential of the new concepts in different phases of ICT design.

**1. Field study:** *Children recording video diaries of their daily ICT use*
**Time and arrangements**: autumn 2008, homework assignment
**Participants**: 10–11-year-old pupils (11 girls, 12 boys)
**Primary data**: 92 video clips recorded at home on 4 consecutive days (52 files from girls, 40 files from boys) with webcams on personal laptops, average clip length 52 sec/girls, 38 sec/boys; questions and themes given as guidelines
**Complementary data**: project report, field notes, various project documents (e.g. initial plans and instructions provided by the researchers)
**Reference**: Iivari et al. 2014

**2. Idea generation for new products:** *Children innovating new ICT with stones as probes*
**Time and arrangements:** May 2012, homework assignment
**Participants:** 15–16-year-old pupils (18 girls, 2 boys)
**Primary data:** 20 essays on technology innovation as part of the English as a foreign language syllabus; small stone as a probe, carried around for one week (24/7)
**Reference:** results not published previously

**3. Idea generation for specific application area:** *Children generating ideas for a learning environment for a multipurpose community center*
**Time and arrangements**: 2009–2010, interviews and workshops
**Participants:** 6–12-year-old children interviewed (24), 1 workshop with 7–8-year-olds (5), 2 workshops with 9–12-olds (5 in each).
**Primary data:** video-recordings of interviews and workshops
**Reference:** Halkola and Iivari 2014; Halkola et al. 2012, 2014

**4. Design:** *Children designing a learning portfolio application*
**Time and arrangements**: autumn 2008, design workshops at school
**Participants**: 7 Master's students, ca 30 third-graders (8–9-year-olds) and 30 fourth-graders (9–10-year-olds)
**Primary data**: 68 drawings of portfolio interfaces (41 by the younger and 27 by the older group) from two application design workshops
**Complementary data**: project report, field notes, various project documentation (e.g. initial plans and instructions)
**Reference**: Kuure et al. 2010

**5. Application development:** *Children participating in a learning application development project*
**Time and arrangements**: 2008–2011, interviews, different types of design and evaluation sessions
**Participants**: a multinational, multidisciplinary and intergenerational design team (four countries, two IT companies, five research institutions); children from numerous schools and kindergartens (3–15-year olds).
**Primary data**: Project documentation (e.g. project plan and agreements), project deliverables, memos, unofficial documentation (e.g. sketches, scenarios, and drawings) and email correspondence among the project participants.
**Reference**: e.g. Mazzone et al. 2010 , 2012; Tikkanen and Iivari 2011

**6. Prototype development:** *Children as members of an intergenerational project team in a learning game prototype development project*
**Time and arrangements**: summer 2011, intergenerational project work
**Participants**: 12-year-old boy and 13-year-old girl, 5 Master's students on an advanced project course (1 female, 4 male) and 2 HCI researchers (children's mothers) supervising the project course work and supporting the planning of collaboration between students and children
**Primary data**: All project documentation (project plan, project reports, meeting memos, etc.), email correspondence among project participants, video recordings of collaborative project workshops, interviews of project participants (children and students)
**Reference**: results not published previously

**Figure 1. Six studies dealing with children's participation in different phases of ICT design**

### 3.1 The process of data analysis

In the course of conducting research with children, an understanding started to emerge; despite our attempts to apply the best practices suggested in literature for embracing the contribution of the participating children, we still observed 'multiple voices' in children's contribution interfering with the children's voices. The children in our studies seemed to 'bring with them' their families and other important persons in their lives as well as their various backgrounds, which all affected their contribution in the design process. In the extant literature, some of these 'others' and their influence had already been acknowledged but no common understanding prevailed among researchers. We considered the nexus-analytical concepts of interaction order and historical body as very useful in explaining the multiple voices involved in ICT design with children.

In the first phase of data analysis for this paper, our interdisciplinary research group chose the studies to be used to illustrate the phenomenon under study. The research projects were examined in group sessions, using the nexus-analytical (Scollon, 2001; Scollon and Scollon, 2004) concepts of interaction order and historical body as sensitizing devices for the analysis. As for interaction order, the focus was directed on the signs of social interaction or relationships between people, discernible in the data. Different actors were identified, present or implied, when these were seen to have an impact on children's contribution. As for historical body, the analysis focused on traces of children's media and technology landscape and references to other recognizable cultural trends, concepts and artefacts in children's creations. Evidence was found on acquaintance with computer games, children's digital literacies (e.g., familiarity with the web browser user interface), as well as media and literacy practices (e.g., referring to familiar genres such as fantasy literature). In the second phase of analysis, different researchers were assigned certain studies for closer analysis in terms of interaction order and historical body. In the final phase of the analysis, the researchers gathered together to share their observations. At this point, the specific role of each study was also settled. Although we wished to address the theoretical concepts in their full richness, each study will bring along something different and specific from the point of view of interaction order and historical body.

### 3.2 Field Study

In the field study (Study 1 in Figure 1), the intention was to investigate children's technology-rich everyday life. Children from a local primary school were asked to document their daily use of technologies through a webcam of their personal laptops (provided by the school for each pupil). The video diary method, i.e. producing short entries during four subsequent days at home, was used to allow the children to report their observations in a peaceful environment.

This study illustrates well how the concepts of interaction order and historical body may work as research tools bringing multiple voices into foreground, even if the children were producing the video diaries as an individual task (see also Iivari et al., 2014). The analysis showed how children adhered to a range of different subject positions (e.g. news anchor, diarist, stage performer) and drew upon various literary or media genres (e.g. factual news broadcast, intimate and confessional diary entry, entertaining stage performance). These became evident in the speech intonation, degree of formality of the presentation, style of starting and ending the videos, to mention some. The positions and genres highlight the children's historical body, showing their familiarity and knowledge of different literacy practices, and also setting them in the cultural-historical positions within society.

Regarding interaction order, the children were clearly putting forth performances for different, sometimes invisible, audiences thus bringing different communities and voices into the data collection situation. Family members and peers were sometimes even physically present, influencing the effort. For example, a child was arguing with his mother during the video diary creation, two girls were producing their separate video diary entries in collaboration, or a child was making fun of the situation in the presence of another child in the room. To conclude, the actual video diaries showed that even in a case where the participating children produce design material on their own, there may be other persons involved in one way or the other, more or less visible, indicating the significance of the more widely traceable interaction order even for individual task assignments with children.

### 3.3 Idea generation for new products

The second study focused on idea generation of new products (Study 2 in Figure 1). The aim of the study was to open new spaces for future design of interactive smart technology by engaging adolescents as participants. For this purpose, the probe approach (Gaver, Dunne and Pacenti, 1999) was followed. The probe used in this study was a small stone that the adolescents were to carry along for a week. The adolescents were invited to envision all the possibilities that the stone would provide them if embedded with future smart technology for social interaction. After the probing period each adolescent wrote a one-page essay in English on this task. The essays were analyzed for this paper as adolescent's contribution to generating ideas for ICT products.

There were several signs of the current media and technology landscape in adolescent's texts, e.g., *chat*, *free Wi-Fi, Wi-Fi-detector*, *portable GPS*, *world map,* interactive *buttons* on the stone and *camera included*. The contemporary media and literacy environment of the childhood of these adolescents shows also in references such as *lie detector*, *teleport*, and *superman*. The historical body also seems to constrain these adolescent's imagination. For example, one pupil mentioned that the stone enables free access to the Internet only when connected with a laptop. An idea of a stone to *share your dreams*, on the other hand, is a nice example of adolescents mixing new elements with familiar ones: some examples were given to them as suggestions for potential use

for the stone and among these there was a *memory recorder* of one's social life that could also be used for sharing purposes. Dream sharing can be considered as a creative mixture: recording dreams instead of memories, and sharing this virtual life. Their everyday life, with hobbies and habits, was visible as well, e.g. *McDonald's* and *hockey* game as places where the stone would provide the *teleport*. The essays also showed acquaintance with burning social and civic issues such as rage management problems (e.g. the *stone of happiness* can help *people who have problems with rage*), health (e.g. *I still cycle with my friends so my muscles won't atrophy* vs. using the *teleport stone*), pollution (e.g. *teleport doesn't pollute the environment*) and solar energy (e.g. *it takes its energy from sunlight*).

### 3.4 Idea generation for a specific application area

The third study (Study 3 in Figure 1) dealt with generating ideas for a learning environment for a multipurpose community centre. The aim was to involve children in this process. They were interviewed and workshops were arranged with methods such as games, playing (well-known children's plays with questions about ICT), idea development, and collaborative planning (based on e.g. Druin et al., 2001; Scaife and Rogers, 1999).

Compared to the previous studies in this paper, this study deepens our understanding of interaction order and specifically of adults as important 'others'. Interestingly, in the data it was revealed that the children were somewhat hesitant in contributing with ideas that they found to be in conflict with the accustomed practices of learning: *I don't know if it is allowed, but a mobile phone could be used as a calculator*, although that should not be *allowed to be used in exams* (Boy, 1st grader[1]), *Mobile phone could be used in every other orientation lesson and a map in every other* (Girl, 5th grader), *Using of a map would help in the development of the sense of direction. Old traditions would be forgotten, if the usage of a map and a compass would... not be studied* (Boy, 3rd grader). The children also expressed a need to be supervised and controlled by adults while using ICT: otherwise *one would not learn anything* (Girl, 5th grader), *Nowadays computers are used too much at school. [...] It would be nice if there were one computer lesson a week when one is allowed to do homework with a computer* (Girl, 5th grader). It seemed that in these occasions the children were echoing the voice of an adult, requesting supervision and control for their ICT use.

However, adults may also mediate children's contribution by their own attitude. In this study a teacher's positive attitude towards ICT use in learning was reflected in children's contributions. Video projector combined with touch screen, introduced by the teacher, was envisioned to be useful also in another context when doing homework: *We could for example test if we have learned the issue, we just could go to the homework page, press [the touch screen] and see what happens ther*e (Girl, 5th grader). The habits

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[1] According to the Finnish school system 1st graders are 6-7 years of age.

and hobbies of parents also seem to be reflected in children's contribution, learning music at school with a computer as one example: *My father plays the guitar at home and he is saving it to the computer and composes, so it is a good idea in principle [to use the computer in teaching music]* (Girl, 5th grader).

### 3.5 Design

While in the previous studies children's contribution was related to early phase information gathering for design and brainstorming for the future ICT, in this study (Study 4 in Figure 1) the children's contribution focused on designing a specific application, a new learning portfolio, in participatory design workshops (see Kuure et al., 2010). In the workshops, the children were asked to draw a user interface for a personal digital portfolio application for their own use.

In workshops the interaction order between the children and the adults became foregrounded as the adults seemed to be some kinds of (role) models for the pupils. For instance, the children seemed to be very stimulated by the researchers' drawings provided as examples. Among others, a giraffe drawn by a researcher, as an example of an innovative user interface, was copied into several drawings by the children. Additionally, the teacher's example given (mentioning the web browser) was very influential, as almost all children drew variations of web browsers. Furthermore, the children were imitating their peers, producing very similar drawings including e.g. 'pigs and poo', but they also creatively recycled diverse ideas from their peers and the adults, e.g. one of the drawings included a jigsaw puzzle with imitation of the researcher's giraffe. For the purposes of this paper, this study highlights how the interaction order between the participants as well as their historical bodies are intertwined, shaping children's contributions through interaction with people and the environment.

In the workshops, the participating children were drawing upon the cumulative historical body of the class. When considering the actual drawings as children's contribution in design, instead of seeing the obvious similarities among these contributions as expressions of the common needs or desires of the participating children, the intertwined influence of interaction order and historical bodies of these children should be understood. This study also suggests that it is possible to either strengthen or limit interaction during design sessions based on the aspects of interaction order anticipated. Depending on the design purpose, it might even be justified to let other children deliberately follow some powerful peer with valuable ideas as the stimulus for the other children.

### 3.6 Application development

This study focused on actual application development (Study 5 in Figure 1) by an intergenerational team including children as well as adult experts in different fields such as HCI, ICT, and educational sciences. The findings of this study deepen our understanding of the role of the school teachers and kindergarten personnel as typical 'others' participating with children as well as brings into attention some interesting

issues to consider while preparing for participative ICT design sessions with children.

The way children participated in this study was quite traditional: empirical usability testing and paper prototyping, and creating prototypes and other kinds of designs with children. From the point of view of interaction order, there were some influential adults impacting the design already while establishing the relationships with children. First, the original idea for the application came from the educational science researchers. Second, the activities to be conducted with the children were drafted by the HCI researchers. Finally, the personnel of the schools and kindergartens were involved: they shaped the design process with children by commenting on or providing the suitable activities, equipment and materials to be utilized with the age group: *[The teacher] wrote that maybe activity number 3 is quite difficult with children of this age, taking into account the time frame*. (Email, HCI specialist) *[The teacher] takes care of the selection of the music.* (Email, educational science specialist) These acts of selection by the teachers, conscious or not, imply a way to contemplate the historical bodies of the children involved.

The teachers were also contributing to the construction of the interaction order during the design sessions e.g. by making children listen and assuring order in class: *It is useful (I would say necessary) to get the information from the teacher regarding how to handle the class (to get to know the everyday routines) (how to make them listen, be silent etc.).* (Memo, HCI and educational science specialists) Obviously, in a situation of this kind, the children cannot be considered equal to adults but the traditional teacher-pupil paradigm is influencing their interaction. On the other hand, the role of the 'others' may also be visible in the contributions, as kindergarten personnel in some cases do the work 'for' the children even during the design sessions: *The personnel of the kindergarten wrote down children's stories into children's drawings without an explicit request for it.* (Thesis, HCI specialist) Although the data was useful for design, it was obviously mediated by those actually writing the stories for the children.

### 3.7 Prototype development

In the last study (Study 6 in Figure 1), the intention was to give two children a possibility to work equally with adults (five master's level students) in a real software prototype development project (requirements specification, design, implementation, and testing phases) and to see what kind of problems arise and what practices seem to work. The project simulated a real-life game project, aiming for genuine participation of children (children's real contribution in the final outcome and children's ability to participate in decision making). Considering the prototype, the children were able to contribute equally and the whole group collaboratively agreed for the solutions to be developed further. However, there were problems emerging from the historical bodies of the participants and the interaction order afforded by the settings.

The historical bodies of the students (lacking previous knowledge of useful practices to draw upon) affected the way they planned the involvement of the children as it turned out to be quite traditional: collaborative design workshops in the requirements specification and graphics design phases and prototype evaluation in the

testing phase. Testing was conducted remotely, by everybody using their own computers at home and commenting in an online environment. Unfortunately, children were not successful in contributing independently at home as the students planned to communicate through systems (e-mail, Google Docs, and wiki) and practices which were not familiar to the children. In the interviews after the project, this was one of the issues that the students pondered upon: *One solution to the email problem would be to send a message to the children's parents always when you send mail to the children. Would the children then be genuine members in the project, equal to adults? Or would that imply consideration for children's age and their ability to take responsibility?* (Project student member) Regarding interaction order, hence, the role of parents was interesting. The aim was that the parents would be involved with the project as little as possible; to deliberately avoid interfering in order to support more genuine participation on the children's part. The boy's parents, however, helped him in technical problems and were generally interested in what he was doing in the project: *A couple of times I looked over his shoulder at what he was doing, asking how it is going* (Boy's mother). The girl commented herself during an interview how *in downloading the game [mother could have been of assistance], but maybe mom wouldn't have been able to do that either.* The girl was not willing to ask for help from the project manager and the girl's mother followed literally the 'researcher rule' of not getting involved.

This study gives new perspective to the role of supportive adults, especially parents. Children often need support (teacher, parents, project members), but this also affects the social interaction of the participants and in the case of genuine participation, others' help may be considered not only as a resource but also as a hindering factor.

## 4 Concluding discussion

This paper inquired how the histories of participants and their mutual interactions have been taken into account when making with children and how the nexus-analytical framework could help advance making with children in the future. The study involved an analysis of previous studies about technology design with children, using the lens afforded by nexus analysis, specifically its concepts of discourses in place, interaction order, and historical body. In the following, the results of this study will be summarized and discussed together with implications and limitations identified, before the final closing words for the paper.

### 4.1 Summary of results

All in all, different participants, often invisible but still informing design through the participating children, were inductively identified from the data, as well as traces of children's historical bodies. The framework of nexus analysis, thus, invited us to take a look beyond the actual situation, and acknowledge the dynamic aspects of interaction order and historical body. The analysis brought into foreground how the participating children necessarily and continuously relied and drew on their experiences, histories and everyday practices as part of numerous and varying kinds of social groups,

arrangements, cultures and institutions, familiar with a variety of cultural forms, conventions and conditions. In Table 1, the empirical findings of the study are summarized with reference to the notions of interaction order and historical body.

**Table 1. Key findings on the interaction order and children's historical body in the six studies**

| Study | Interaction order | Historical body |
|---|---|---|
| 1 Field study | Family members and peers influential even in independent work | Familiarity with media and literary genres |
| 2 Idea generation for new products | Researcher's examples recycled | Familiarity with technology and media both enabling and restricting imagination; New ideas created by mixing familiar and new concepts; Familiarity with burning social and civic trends; Interests and hobbies |
| 3 Idea generation for a specific application area | Adults' voice echoed; Adults' attitudes and interests showing in contributions | Beliefs about the adults' opinions related to school work and being a good pupil. |
| 4 Design | Researchers', teachers' and peers' ideas recycled | New ideas enabled or restricted by knowledge shared *in situ* |
| 5 Application development | Teachers tailoring and managing participation; Kindergarten personnel documenting children's contribution | Teachers' acquaintance with the historical bodies of the children; Teacher-selected equipment and materials mediate design with children |
| 6 Prototype development | Parents in contradictory positions, interested or interfering; Genuine participation and contribution a trade-off between necessary support vs. independence | Lacking competence in ICT use hinders participation |

We wish to highlight a couple of findings shown in Table 1. In the **Field Study**, even though the children mainly produced their diaries alone, there were still many different audiences and participants discernible, either physically present or in children's minds. Thus, the interaction order between the participants is more complex than a first sight at the situation might suggest. It was evident that children's technology and media knowledge as embedded in their historical bodies shows in the range of positions and genres they drew upon in their productions. In the probe-based **Idea generation for new products** it was interesting that children's historical bodies seemed to explain children's contribution on the one hand but also to restrict their imagination on the other. In this study, children also creatively combined familiar and new concepts, showing the power of examples and guidelines given. The study of **Idea generation for a specific application area** interestingly indicates how children, their historical bodies

involving also the ideals of good children and pupils, restrained their innovating due to their assumptions concerning adults' reactions. The study shows that adults' voices were mediated through the participating children in various ways. The intertwined influence of interaction order and historical body becomes evident in the **Design** study, with the specific observation of idea recycling *in situ*. While contributing, the participants used their cumulating knowledge, which can be considered either as a hindrance or as a powerful tool for design. In the **Application development** study, furthermore, teachers appeared as strong partners in intergenerational collaboration, reflecting on the historical bodies of children. It is an interesting question whether children's stories had been different if they had not been mediated by adults writing the stories down. In the **Prototype development** study, finally, the contradictory positions of parents directed our attention to the borderline between necessary support from adults on the one hand and reducing children's independence on the other. In this case, the adults' assumptions about the children's historical body in relation to their competence to use certain tools proved to be inappropriate and some project activities made the children dependent on the adult project participants or their parents.

Even though we have delineated the findings in terms of the theoretical concepts separately for analytical purposes (Table 1), it should be noted that interaction order and historical body are intertwined with each other, either of them offering a particular perspective into the social action under scrutiny. The analysis of the empirical studies provides evidence of the meaning and importance of interaction order and historical body as beneficial for practitioners and researchers to prepare, implement and analyse the results of ICT design with children.

### 4.2 Discussion and implications of the study

In this paper, our aim was to build theoretically a better understanding of children's participation, especially related to their contribution to design. Both related literature and our own research indicated how children bring into the ICT design process multiple voices, 'others', with them. We argue that the presence of these multiple voices may have an impact on the nature of data collected. We suggest that the basic concepts from nexus analysis, i.e. 'interaction order' (relationships between participants engaged in the social action) and 'historical body' (life-time histories and experiences of the participants), are useful in making sense of these multiple voices in the process. Regarding **interaction order**, the literature review revealed the acknowledgement of the influence of adults in ICT design with children. Teachers' positive contribution in the design process has been widely discussed (Druin, 2002; Garzotto, 2008; Mazzone et al., 2008; Mazzone et al., 2010; Pardo et al., 2005; Pardo et al., 2008; Read et al., 2002; Read and MacFarlane, 2006; Rode et al., 2003; Scaife et al., 1997; Scaife and Rogers, 1999; Virvou and Tsiriga, 2000), while researchers have expressed concerns about the teacher-pupil paradigm (Druin, 1999, 2002; Druin et al., 1999; Guha et al., 2013). Our studies indicate that teachers can be considered a valuable resource for planning design sessions with children from the viewpoint of the historical body of the children, being familiar not only with children's socio-cognitive qualities but also their everyday

practices, interests, and communities. However, while teachers may aim at representing the historical body of the children as accurately as possible, they necessarily provide only mediated and filtered interpretations. Additionally, not only teachers', but also other adults' (e.g. parents) assumptions about children and their knowledge influence the design process in important ways. The influential role of parents has also been brought up in the existing research (Druin, 2002, Walsh et al., 2010; Druin, 1999; Read et al., 2002) indicating how parents may steer their children and impose ideas on them (Druin, 1999, Read et al., 2002). Our studies provide evidence of parents interfering too much or too little. Adults may also 'speak through the children' even if in absence.

The extant literature has already pointed out the importance of peers for ICT design with children. Children should be encouraged to work together to support their motivation, creativity and learning, among others (Giaccardi et al, 2012, Gritschacher and Slany 2012, Guha et al., 2004). Challenges have also been identified in children's collaboration (Guha et al., 2004) one problem being children's tendency to replicate ideas from their peers instead of producing original creations (Kuure et al., 2010; Mazzone et al., 2010; Read et al., 2005; Desjardins and Wakkary, 2011). This tendency was evident also in our studies, although children not only adopted ideas from each other but also from teachers, researchers and from their surrounding life world in general. Furthermore, some children tended to give 'appropriate' answers (as in Read et al., 2004), apparently adopting the position of an adult, worrying about the implications of ICT in the school setting and demanding more control for children's ICT use. Thus, they seemed to be echoing the more general societal discourses and discourses of home, revealing perhaps how people, cultural trends, concepts and artifacts, not necessarily explicit, gain a voice also in children's interactions.

The **historical body** of the participating children is also shaping their creations - either stimulating or inhibiting – and therefore should not, and in fact could not be eliminated or intentionally managed. Examples in our studies included current technology and media environments strongly picturing in children's creations, confirmed in other research as well (Duveskog et al., 2009, Hemmert et al. 2010, Kafai et al. 2012, Read et al., 2004, Kuure et al., 2010; Vaajakallio et al., 2009, Weiss et al., 2008). More generally, children's background, knowledge, experiences and interests are guiding their creations (Frauenberger et al., 2010, Katterfeldt et al. 2009, Mazzone et al., 2010). All this was also prevalent in our studies, sometimes providing resources for and sometimes restricting children's imagination. The nature of examples, descriptions and support offered for the participating children further contributes to shaping their historical body, orienting them in the future in particular ways. Thus, even the most original ideas will always emerge through previous knowledge and experience. Children's historical body arising from familiar practices and ideas may be enriched by providing them with new knowledge for the basis of their design work.

We suggest that both researchers and practitioners apply the concepts of interaction order and historical body in planning and implementing ICT design with children as well as in analysing the results. We argue that the awareness and the use of these concepts would help in formalizing the process and in making conscious choices between different possibilities, bearing in mind that these issues need to be considered

beforehand. The nature of children's contribution depends strongly on how the role of the 'others' is taken into account during the process of ICT design.

In the **planning** phase, when establishing relationships with possible participants, their mutual relationships anticipating certain configurations of interaction order as well as their historical bodies (family background, living area, interests, and hobbies, familiarity with technology and media, skills in technology use) can be considered. One may choose the participants to eliminate undesirable situations or intentionally configure interplay between participants to advance certain types of interactions and, hence, design results.

In the **implementing** phase, in terms of interaction order, the relationships between the participants can be weighed; e.g., the roles adults have in the process. A more careful analysis of the relationships between the participants would also allow arranging working conditions for interaction order most preferable for the design purpose (e.g., seating arrangements to either promote or prevent children imitating each other). Being aware of participants' historical bodies, it would also be possible to provide children with information or experiences to stimulate their thinking, for example. Thus, acknowledging and examining the historical body of the participants offers the possibility to 'feed' new knowledge into the process, giving fuel to the ideating process.

In the **analysis** phase, one may, for example, try to understand how the participating adults or peers have mediated the children's contribution or how the historical bodies of the participants have otherwise shaped the results. We argue that the concepts of interaction order and historical body would help researchers to understand the design sessions and the data received as well as to report their findings, by giving them theoretical tools for the reflection purposes.

To conclude, if we are looking at a particular situation as a design resource, it cannot be detached from its social and historical context to be considered as an exclusive action on its own. It is the interaction order predominant between the participants and their historical bodies *in situ* that provide the ground for the potential design contribution. Instead of searching for the 'most innovative' contribution from the children, or even the most genuine ideas provided by the children, the concepts of interaction order and the historical body redirect our focus towards the reasoning behind children's desires. From this perspective also the reflection on the usefulness of the emerging solutions at the end of the design process can be interpreted in a new light.

### 5.3 Limitations and paths for future work

The results have some limitations to be noted. The data in the six studies was not originally gathered for the purpose of this analysis. The analytic focus was revealed through our inductive, collaborative data analysis, as is quite common in qualitative research. Furthermore, our literature review is extensive but not exhaustive. Nevertheless, we have been able to show the existence of the phenomenon highlighted in this paper. Regarding further research paths, it would be interesting to gather data considering these concepts in all the research phases, as suggested in the current study.

Some additional, previously collected data could also be analyzed using these concepts, to see what kind of further insights into earlier results the approach would provide.

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