

Bringing Technology into School – NFC-enabled School Attendance Supervision

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ABSTRACT

Near Field Communication (NFC)-enabled attendance supervision trial was arranged at a primary school in Finland during the fall 2008. Total of 23 pupils between ages of 6 and 8 participated in the trial with an emphasis on security. Pupils marked their arrival at and departure from school by touching a smart card reader device or an NFC-enabled mobile phone with a contactless smart card. Teachers did not need to mark pupils' absences or delays in the backend system leaving thus more time for teaching and also enabling parents to receive real-time information on children's attendance. This paper analyzes the data related to the adoption and design process of a novel technology in a school setting. Information about user experience was obtained by using a variety of data collection methods. The findings were analyzed from the viewpoint of three end-user groups, namely children, parents and teachers. Children, as well as their teachers, became very fast familiar with the login/logout process, and the attendance supervision was soon integrated into their everyday school routines. Our analysis shows that a technology-supported attendance supervision system can bring value for all end-user groups.

Categories and Subject Descriptors

C.3 [Special-purpose and Application-based Systems]: Smartcards. H.5.2 [Information Interfaces and Presentation]: User Interfaces – *Evaluation/methodology, User-centered design*. K.4.1 [Computers and Society]: Public Policy Issues – *Ethics, Human safety, Privacy*. K.4.2 [Computers and Society]: Social Issues – *Handicapped persons/disabilities*.

General Terms

Design, Experimentation, Security, Human Factors.

Keywords

Near Field Communication (NFC), school environment, children, school attendance supervision, user experience.

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1. INTRODUCTION

This paper introduces a Near Field Communication (NFC)-enabled school attendance supervision system for school children. Traditionally, teachers conduct pupils' attendance monitoring every morning with manual roll calls, and mark absences and delays in the backend system. This requires time and effort on every school day, and the time is taken away from teaching. Also, parents of young pupils regularly call to their children's or teachers' mobile phones to ensure that the child has made his/her way to school safely. Answering parents' calls employs teachers and consumes their resources that could be used for teaching. The NFC-enabled school attendance supervision system has been designed to simplify attendance monitoring. The system replaces manual roll calls and gives parents real-time information of their children's attendance. Thus, the system supports the enhancement of school routines and practices and improves information sharing between school and home.

The goal of the school attendance supervision concept was to (1) enhance and secure children's independent mobility in home-school transition and to (2) increase rationalization of home-school communication. We arranged a field study in order to test the attendance supervision system with school children and their parents and teachers, and to examine the value the concept brings to these stakeholders. The methods we used for evaluating and modeling the value created to the user by the new system were based on collecting information on subjective user experience, i.e. the value the users themselves judged and experienced. Hence, we do not evaluate the created value through any objective measures, e.g. we did not measure whether the adoption of the system actually decreased the amount of check calls from parents to teachers, nor did we check through objective measurement of time used for teaching, if the service saved time for the teacher or not. Instead, in this paper, we explore especially issues related to the adoption of new technology in a school environment, and design considerations in this context.

The remainder of our paper is organized as follows: Related work is described in the next section. Then the field study setting is outlined describing the NFC technology and the attendance supervision system as well as procedures used in the system design. This is followed by a description of the techniques used in the user experience data collection. The paper continues with a representation and analysis of the field study findings which result in conclusions about the adoption of a novel technology in a school setting together with guidelines for the design processes of

home-school interaction systems for children and other stakeholders.

2. RELATED WORK

Developments in networked and mobile technologies now provide us with more methods than ever for supporting children in their transition between home and school [11]. For example locational systems can be used to make sure that children are safe when they move from home to school. Jernström [17] introduces a solution called The Smart-its child Surveillance System (SiSSy) that is an approach to tag children and parents with Smart-Its devices which can sense the environment and determine whether a situation is dangerous or if a child is engaged in something hazardous.

In a study by Fraser et al. [11], family members saw journeys between home and school as an important transition and a big issue for parents in managing their children's time. Information transfer between home and school was also raised as an important matter. Families' reactions to home-school technologies were enthusiastic; they saw benefits in the increased availability of information that can be gained through these technologies. In addition, Fraser et al. [11] identified a family as an important stakeholder in the design of school-related technologies for children. Discussion of children's privacy in technological design was identified as one core issue for the future research. Not only are there safety concerns about the protection of data collected about children, but also ethical concerns about the rights of children in gathering the data. For example, how do we justify increasing links between home and school, when children are often active in resisting it [8]?

Denmark is traditionally presented as a country where children are able to freely move around and have independent mobility to schools and leisure facilities [10] and Finland can be equated with Denmark concerning children's mobility. A Danish survey by Fotel and Thomsen [10] states that parents' supervision of children's mobility is bound up with different aspects of their travel conditions. Automobility, for instance, clearly supports the physical supervision of children's mobility, whereas bicycling or walking can be performed by the child on her/his own and thus leaves room for unmonitored movement. While statistics show a reduction in the number of road accidents involving children during the past decades, Danish parents report an increase in their concerns about their children's road safety [16].

Fotel and Thomsen [10] state that even though monitoring the mobility of children is often done with a caring rationality, it can transform into a control, which, in some cases, the child does not benefit from. On top of monitoring children's mobility through escorting them by car or other traffic modes, some Danish parents also monitor their children's mobility from a distance [10]. New technology has made it possible to monitor children by e.g. their cellular phones, and some parents use that deliberately in situations where children are testing their boundaries. Monitoring children's mobility from a distance seems to provide some parents with the feeling of control and thus seems to ease their risk worries, even though parents' opportunities to save the child from any danger are limited [10]. Qvortrup [21] and Rasmussen [22] argue that the increased protection of children by monitoring them is a central characteristic of modern childhood. According to Rasmussen [22], the possibility of impersonal supervision performed from a distance reduces children's privacy even more,

and while some parents approve of it, the majority opposes its prevalence.

In a small town in the United States the public school children's whereabouts on campus were monitored by a system that used Radio Frequency Identification (RFID) technology, which was designed to ease attendance recording and increase campus security. Children wore badges that contained a photo of the pupil, their grade level and name. The badge embedded a chip with an antenna. As the chip passed underneath a reader mounted above the classroom door, it transmitted a 15-digit number, which then was translated into the pupil's name by software contained in a handheld device used by teachers to check attendance. The proposal died after protests by parents and privacy and civil-liberties advocates, including the American Civil Liberties Union (ACLU). [24]

Also, a Rhode Island school district has announced a pilot program to monitor pupils' movements by means of RFID chips implanted into the schoolbags. Each chip would be programmed with a pupil identification number, and would be read by an external device installed in two school buses tracked with GPS (Global Positioning System). Parents and school officials could log onto a school web site to see whether and when specific children had entered or exited which bus, and to look up the current location of the bus. The ACLU has criticized the plan as an invasion of children's privacy and a potential risk to their safety. [9, 14]

Williams et al. [27] have presented that society could now perhaps openly question whether (urban) parents are good parents if they do not know where their children are and what they are doing at all times. Aitken [1] shows how some parents employ a policy of constant supervision of children even up to early teenage years while in any outdoor space. Furedi [12] and Rayner [13] both point out the damage to children and childhood this 'paranoid parenting' might be doing and call for parents to allow children to take more risks.

3. METHODOLOGY

3.1 Field Study Setting

Attendance supervision trial enabled by NFC technology began in the city of Oulu in Finland on September 2008, continuing until December 2008. Trialing phase lasted 14 weeks. Trial was conducted at a local primary school, where two classes and total of 23 pupils between ages of 6 and 8 (majority just starting at school), participated in the trial. Parents' permission for their children to participate in the trial and to the adjacent research had been asked in advance. One of the participating classes represented a first grade class (16 children out of 19 attended the trial; 9 girls and 7 boys) and the other one was a small class consisting of special-need school children (all 7 boys, 4 first-graders and 3 second-graders, took part in the trial) who were diagnosed with minor special-needs, such as dyslexia, difficulties with concentration or troubles with perceptive skills. At the same time, a similar kind of study was done at a local secondary school with more advanced technology and more complicated application features.

Curtis et al. [5] have argued that disabled children, children excluded from school, and children for whom the discursive

nature of conventional interview-based research is less accessible have been less well represented in participatory research than children who are easier to interview. For a range of methodological and practical reasons, children who communicate well, or who are regular school attendees, are more likely to be given a voice in the research literature [5]. Therefore, the class with special-need children was chosen to participate in the trial along with the 'normal' first grade class.

3.2 NFC Technology

Touching with a mobile terminal has been found to be an intuitive, natural and non-ambiguous interaction technique that does not incur much cognitive load for users [23]. Väikkynen et al. [25] state that touching is an effortless way to select objects in the environment and it is easy to learn and use. NFC is a very short-range wireless technology that allows electronic devices to be used in interaction with other devices simply by touch. NFC technology is based on existing radio frequency communication standards, so it is a special case of implementation of RFID technology. The touch-paradigm prevents reading from a distance, because a short physical proximity (a couple of centimeters) is needed to transfer information. Even though NFC technology uses touch-paradigm, it is technologically possible to read information through NFC from a distance with special powerful reader devices. In this attendance supervision field study, we explore a usage scenario where NFC-enabled mobile phones and smart reader devices located in the classrooms are used to read information stored on pupils' contactless smart cards through touch-based interaction paradigm.

3.3 System Description

Designed to simplify attendance monitoring and replace manual roll calls, the NFC attendance supervision system does not require teachers to mark pupils' absences in the backend system leaving thus more time for teaching. In the attendance supervision trial pupils were given contactless smart cards named "Robo" containing the pupil ID. Upon arriving at school pupils in the first grade class touched a smart card reader device with their cards and pupils in the special-need class touched an NFC-enabled mobile phone to mark themselves present at school. The smart card reader device was chosen for the larger group of children in first grade class because it works faster than an NFC-enabled mobile phone. We were also interested in seeing whether the type of the reader device somehow affected use of the system. At the end of the school day pupils touched the reader devices again to mark their departure. The application in both reader devices (the smart card reader device and the NFC-enabled mobile phone) stored the card ID (the child's name), the direction (in or out) and a time stamp in the backend system. NFC attendance supervision was also used in extended day care programs where some children went after school.

The log of arrivals and departures was automatically compiled by a background system, and could be read by a teacher in a classroom in real time. If a login did not occur, the pupil was marked absent by default. If a pupil logged in late, the backend system recorded the lateness. Parents were able to get information of their children's attendance details via an online 'citizen's portal', and through a text message sent to their mobile phones. The school staff members could also update the backend system;

for instance, should the pupil have a dental appointment. In this case, the pupil did not need to worry about being absent. The system prevented truancy by informing tutors, administrators, and parents of absences in real time, enabling instant intervention.

In Figure 1 is shown an overview of the attendance supervision system at school and in extended day care programs.

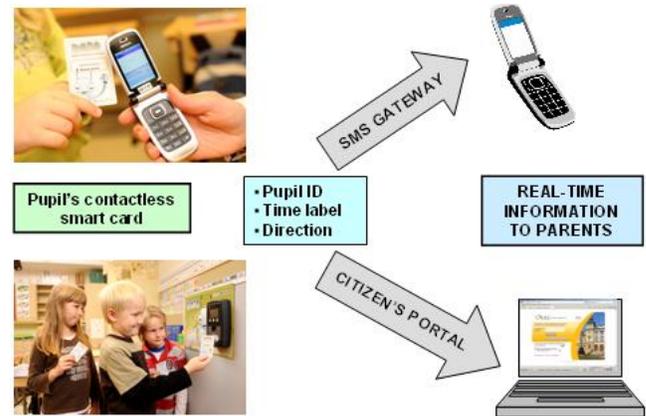


Figure 1. An overview of the attendance supervision system.

At a local secondary school in a concurrent trial students used personal NFC-enabled mobile phones for marking their attendance for classes. The younger primary school children were using smart cards instead of mobile phones, as the parents and teachers were worried that children could lose or accidentally break more valuable mobile phones. However, none of the children lost a smart card during the trial period.

3.4 Design Procedure

The attendance supervision concept was planned and designed in close cooperation with teachers, service and technology providers, and researchers. During the design phase the ultimate goal of integrating the concept into normal practices of the school was especially emphasized, so that the trial would not remain as an effort related only to the research project. The aim was to create a viable concept that could be adopted in the school as a routine to be used also after the research trial. This required tight involvement of teachers and school administration in planning and implementing the applications, and organizing and supervising the trial. During the trial, the researchers were only involved in the data collection activities; teachers took full responsibility for organizing and supervising the actual attendance supervision trial.

4. DATA COLLECTION

Druin et al. [7] have argued that design work in school is subject to difficulty due to the school setting and the embedded power relations between adults and children. Children have few experiences in their lives where they can contribute their opinions and see that adults take them seriously [7]. When a respect is fostered, it changes how children see themselves [2]. Williams et al. [26] implemented an exploratory workshop with ten 11-12 year old children for exploring and developing the interface between children and new mobile 'wearable' ICTs, and found that the children can be valuable, adaptive and creative users in the

participative design of ubiquitous computing experiences and devices.

Druin [6] has developed a typology of roles that children may have in the design of new technologies: user, tester, informant, and design partner. For each role, she also presents three underlying dimensions: the relationship with adults, the relationship with the technology, and the goals for the inquiry. The role the children played in this study was essentially that of an informant. As the research objectives were concerned with the potential of the attendance supervision system, the actual usage of the technology was an essential prerequisite to the children's articulation of the system value and for the informant role as well. Therefore the role of children was both that of a user and an informant.

Given difficulties that need to be overcome for describing and understanding user experience, we decided to collect data during the actual use of the system and to combine a variety of data collection methods that were complementary [28] in order to increase reliability and validity of the results [15]. Data collection methods used and data collected during the field study were as follows.

4.1 Classroom Observations

Classroom observations were made to collect information about how the pupils learned to use NFC technology, what kind of routines they had established after using the system for some time, and what kind of spontaneous reactions and discussion took place in using the attendance supervision system. Children in the first grade class were observed two times over the course of the research (see Figure 2). The first visit happened in a very early phase of the trial: the attendance supervision system had been taken in use only a day before the visit. At the time of the second observation the attendance supervision system had been in use for two weeks.



Figure 2. Children log in the school in the morning by touching the reader device with their contactless smart cards.

The special-need class was observed when they had used the attendance supervision system for two weeks. Observations with both classes were conducted during a normal school day by attending the first lesson in the morning. The login process was

observed from the back of the classroom to minimize the disturbance caused by researchers' presence. During the observation children's behavior and actions were videotaped.

4.2 Interviews and Feedback Questionnaires

All the children participating in the trial as well as their teachers were interviewed in order to investigate their thoughts and experiences about the technology and service concept under evaluation. The interviews took place on same days as the classroom observations. After login was done and children started their school work, interviews were conducted very informally by chatting with a few pupils at a time either in the classroom or in a separate place. Children in the first grade class were interviewed twice over the course of the research. The teachers were interviewed informally partly in the midst of teaching, partly during breaks between classes.

Since it is feasible to conduct one-to-one interviews with a small user group, parents of six (out of seven) participating children (two fathers and four mothers) in the special-need class were decided to be interviewed via a telephone. Parents of one child did not give their contact information for the interview. Interviews lasted from fifteen minutes to half an hour and they were conducted after one and half months from the beginning of the experiment.

In addition, as the parents of the first grade class formed a bigger user group and their interviewing via a telephone would have been more cumbersome, we decided to create two separate short paper questionnaires, one for the first-graders' parents whose children participated in the trial and the other for parents who chose not to allow their children to participate in the trial. Questionnaires were delivered to parents after one and half months from the beginning of the trial. Total of 17 parents (out of 19) answered the questionnaires.

The data collection methods and number of stakeholders for each method are listed in Table 1.

Table 1. Summary of the data collection methods and a number of valid cases for each method

Data collection method	Number of valid cases
First classroom observation and interviews with first grade class	16 pupils 1 teacher
Second classroom observation and interviews with first grade class	16 pupils 1 teacher
Classroom observation and interviews with special-need class	7 pupils 1 teacher 1 special needs assistant
Phone interviews with parents of special-need class	6 parents
Paper questionnaires for 16 first-graders' parents whose children participated in the trial	14 parents
Paper questionnaires for 3 first-graders' parents whose children did not participate in the trial	3 parents

The aim of the phone interviews and feedback questionnaires was to collect parents' thoughts on the service concept, opinions about possible added value the attendance supervision service brought to the families, and whether the service could be developed further to have a positive impact on their lives.

5. FINDINGS

Interesting findings were achieved through a variety of data collection methods. In the following the findings about the adoption of attendance supervision system are introduced and analyzed together with results that can be seen as important guidelines for design processes in home-school interaction systems.

5.1 Participation

Children, teachers and parents were able to participate in the design process in various ways. Here, we analyze the impact and experiences from participation.

5.1.1 Participation of Children

Three kinds of participatory aspects were identified: (1) Children were able to participate in the visual design of the smart card used for attendance control, (2) children participated in daily use by operating the reader devices and being responsible for logging in and out of school, and (3) children were able to express their opinions throughout the research process through various data collection methods.

Interaction systems for children are usually designed by adults who often have very little idea about children's needs and desires [20]. Several authors [2, 20] have identified that involving children in product development is beneficial. Our findings revealed that children valued that they were able to participate and be active in the design, use and evaluation processes. By participating, they could have their voices heard and influence the decisions that affected their school days. Also, our experiences indicate that by participating in the design and use processes the children became aware and internalized the functionalities and goals of the system, which can lower the barriers for adoption and use.

Before the beginning of the field trial, one of the pupils in the special-need class had invented the name "Robo" for the contactless smart card. His idea was used in designing the visual outlook of the card. Receiving the card had been especially important for the boy who came up with the "Robo" name: the boy had been very pleased that his own idea had been implemented. According to the teacher, for the same boy the start of the school had been especially difficult and for him the opportunity to influence the smart card design had been a very important boost for his self-esteem. Even though children's role in designing the card was not very big, the other children clearly valued as well that one of them was behind the idea for the smart card name and appearance.

The teacher of the first grade class had shown and taught two pupils how to operate the reader device and what to do when the pupils needed to log out the school at the end of the school day (how to turn the device on etc.) when the teacher was not present. Every Wednesday operating the reader device was on their responsibility. This was also valued by the children, as they saw

this as a sign of trust towards their skills, and a source of special pride for the whole class, not just for those two children in question. Other children commented this by saying that "...they were chosen because they use computer also for other things as just playing", so the two pupils were regarded to be knowing and skilful with the use of computers.

In general, pupils in both classes seemed to understand pretty well why they had received their "Robo" cards and what the reason behind the use of the attendance supervision system was, which is illustrated in the following excerpts gained from children's interviews: *"It writes names to the Internet to show are you at school or where"*, *"The reason for doing the login in the morning is that the thing starts to transmit information to somewhere, and in the afternoon when leaving from school you need to log out so that the thing won't anymore send information and so that the information would not proceed anymore"*, *"You do the login because you need to touch the phone"*. They also seemed to understand how the system created value for parents and school: *"Mom and Dad know at what time you have arrived at school and left home, and if you have stayed in detention"*, *"You need this at new school, so that they know whether you are late or not"*, *"Parents check at their work place have you arrived at school"*.

Specifics of the technical details and operation of the system were not very clear for children, even though they had a reasonable understanding about technical components involved: *"It sends an email or a message and Dad opens his phone and sees a text message"*, *"Message leaves when card and phone touch"*, *"A light appears in the machine telling that you are late. Green flashes when you have arrived at right time"*.

5.1.2 Participation of Teachers

Participation of teachers was seen to be especially valuable in integrating the application and processes into the daily routines of a school day. The teachers took the responsibility of integrating and supervising the adoption of the new practice. Our experiences indicate that this is essential for the success of adoption.

Classroom observations revealed that the login and logout with the smart card reader device was faster when compared to the NFC phone as children did not need to queue for the reader device. In addition, with the reader device children did not need the teacher practically at all for the login, contrary to the NFC phone. As the teacher of the first grade class said: *"It worked as an assembly line"* with the reader device.

The teachers were able to observe the use and the user experiences evoked in children daily. This knowledge was very valuable for interpreting the data collected by interviews and observations.

5.1.3 Participation of Parents

Parents gave many ideas for the system development and improvement in the phone interviews and questionnaires, and they were identified as important partners for the design and evaluation processes, which is also supported by previous studies [11]. Parents reported that following the children's logins and logouts was not very practical and did not integrate well with their daily routines. Parents needed to separately log in to an online 'citizen's portal' and that took way too long time during a busy workday, in their opinion. The information of children's logins

and logouts should be received on the device that is nearly always at hand. Therefore, the text-message service appeared to be more usable solution in children's attendance monitoring: "We do not always have an opportunity to be by the computer, so a message to a mobile phone would bring lots of additional value". One parent told that she would preferably receive the attendance data on an email account, while another parent did the majority of his work on a PC so he was able to follow his child's attendance information regularly during his work days. He found the text-message service more harmful than useful because a parent could "be bombarded with text-messages" during the work days, which could disturb and interrupt working.

In the parents' opinion it would be much better if the children could log in the school immediately when they arrive on the school grounds, for example at the school gate or by the school's front door, as opposed to the login done inside the classroom. Then the parents could get the attendance information as soon as the child arrives on school area. One parent reported that for their family it would be much more useful to get a message indicating whether or not their child has locked the front door when leaving for school. A hope was also expressed that it were possible to send a message from home when the child leaves for school and the device would then react if the child does not log in the school within a time limitation.

In several families one of the parents was at home when the child left for and arrived from school, enabling the parent to follow child's comings and goings. Also some families lived so near the school that the child had only a short way to school. Thus, for these families the attendance supervision system did not bring real added value.

One interesting finding was related to situations where the parents were separated. The system could provide a parent not living with the child (at the moment) with a way to know more about the daily activities of the child. This could provide a better feeling of involvement in the life of a child. In our trial, one father not living with her daughter would have liked her to participate in the trial so that he could get more information about his child, but the mother who lived with the child refused the child's participation.

Several parents mentioned that they hoped to see the attendance supervision service to be developed further to include more features. For example, in one parent's opinion the paper notebook for home-school communication was already outdated and behind the times, so a web-based counterpart would be much better. An idea was raised that more services could be added in the card (card functioning also as a library card, for example) as well as important daily information about school. That information could also be checked from the web portal.

5.2 Attitudes towards Privacy

When planning and designing the system for children's attendance supervision we were aware of the potential of such technology for increasing the debate in the issue of surveillance and privacy invasion. Concerns were expressed even before the actual system was taken into use when the Finnish media published the plans for implementing and testing the NFC-enabled school attendance supervision concept in the city of Oulu. On the web site of the local newspaper many readers expressed their biases towards and opinions about the system. The following

excerpts are from the discussion on the web site (translated from Finnish): "For real, big brother will monitor also in this case [19]", "Personally, I would certainly not accept stalking through access control at our school, the old, traditional control of non-attendance made by the teacher is enough...we need to genuinely take care that the high technology of the future will be used to help people, not to stalk them [19]", "Next phase is a microchip planted on the back of the hand, the mark of the beast from the Apocalypse of John...[18]"

However, during the study itself the privacy concerns and negative aspects of surveillance did not play a big role, contrary to the previous studies [8, 11, 22]. Benefits of monitoring were seen larger than the negative sides by all the interest groups. For example, one parent stated in the phone interview that in her opinion it is good that you can monitor your children, since "...life changes all the time, becomes more fierce". One family reported that because of the attendance supervision system, they did not need to provide a child with a mobile phone which they would have otherwise done to monitor how the child travels between home and school.

In their interviews, children themselves did not bring out any comments regarding stalking, losing their privacy or being under surveillance. Quite contrary, and also according to the parents, the children regarded the attendance supervision as a natural part of the school routines, and did not wonder why they were given the cards and why they had to do the login every day, because, as one of the parents said: "For the child it is just part of their life". For the children, the system had been very easy to accept and adopt. Parents also told that the children had liked the system and had been very excited when they were given the cards that were their very own. Children had experienced the card and login as very important things.

NFC technology is a very short-distance technology requiring a close touch to activate reading. Based on our observations, we expect that this increases the feeling of control, and does not trigger feeling of being under surveillance. Other types of RFID technologies that can be read automatically from a distance without any explicit action from the user side can create a stronger feeling of being under surveillance by "an invisible eye", therefore triggering negative experiences towards the loss of privacy and being monitored. This has become very apparent in earlier surveillance initiatives conducted in school environments [9, 14, 24].

The contactless smart cards used in our study contained only an ID number, not any personal information (other than the printed name on the card surface), pupils' online attendance data was put under password protection and text-messages were sent only to authenticated mobile phone numbers, so unauthorized individuals were prevented from gaining an access to pupils' private information.

5.3 Trust and Respect

Teachers told that the children had been extremely excited when they had heard they could participate in the experiment. Before the trial started pupils had eagerly been asking "when do we get the cards, when will the device arrive". For example, one child had got really excited when he received the card that was similar to the card his father used at work. All the parents told the smart

cards and the whole attendance supervision concept had been received very well by the children.

Parents reported that their children felt that the supervision was important and took a big responsibility for keeping the card safe and carrying it to school every day. One of the parents commented *“a proud and eager pupil has remembered it well”*. For many children the possibility to participate in this trial seemed to be a boost for their self-esteem, which is also consistent with previous research [3]. Children were very proud and excited that they were shown trust by giving them their very own contactless smart cards that were on their own responsibility, and that adults trusted that children took care of the cards and the login. This is well illustrated in the following teacher’s comment: *“For children this has been an important and big thing, since not all the classes have these cards in use, so in that way children now have a chance to stand out and they have something that others do not have.”*

However, many of the pupils knew that secondary school students had received NFC mobile phones for attendance supervision and pupils seemed to be a bit jealous about it. One of the children said: *“Smart cards could have been given for secondary school students and we could have had the touch mobile phones”*. Clearly, mobile phones were valued as devices and status symbols more than smart cards.

The children clearly valued the trust they were given, but they also used this new power to mutiny against teachers and parents. One child had thrown his card away in a burst of anger towards his parents. In general, however, children accepted parents’ and teachers’ authority in protecting them [4] through attendance control without questioning. The children could have chosen not to mark their arrival to and/or departure from the school as a sign of rebellion, or could have given their card to a classmate to handle the login and logout on their behalf. However, this type of behaviour to manipulate the system did not come out in our trial group. We assume that this might be different with older children and teenagers.

5.4 Adults’ World

On the web site of the local newspaper many readers commented the attendance supervision system also in the following way (translated from Finnish): *“Child is not anymore allowed to grow up at her own pace; she will be raised in real ‘Orwell’ spirit [19]”, “Here the monitoring, caring and presence of a grown-up is tried to be replaced with a ridiculous mobile phone [19]”*.

Children did not wonder why they had to do the login and did not resist new practices; they simply regarded it as a natural part of the school routines. This is well illustrated in the following excerpt from one of the teachers: *“Nowadays children have seen so many kinds of things that they don’t marvel at things like this.”* Children themselves had only positive thoughts about the attendance supervision, it had been *“nice”* and *“easy”*, even *“awfully nice, giant-sized!”* and *“really great!”*. Classroom observations revealed that during the first few weeks’ of the trial teachers needed to separately remind most of the children about the login, otherwise the pupils would have forgotten to log in and out. Also, according to the teacher there usually emerged a small line behind the reader device from where the children at the latest remembered the login and logout: *“It worked as an assembly*

line.” But as a whole, children easily learned how to use the card, and after a few weeks’ use the cards and the login/logout process had become an integral part of their school routines (see Figure 3).



Figure 3. Pupils log in by touching the teacher’s NFC-enabled mobile phone with their “Robo” cards.

However, those parents, whose children did not participate in the field study, explained that they had considered that *“the safety of the child is created through the genuine presence of an adult and not through a supervision system”*. These parents thought that what children really need is the time of the trusted adults, and also considered the trial to be a technology-led project *“where the effect of the project on child’s everyday life had hardly been considered well enough”*, which is also argued in previous research [21, 22]. Parents stated: *“Children of this age should not need to be rushed into the world of cards and codes. They can do that later. The amount of new things in the first-graders’ world is already big enough.”*

5.5 Responsibilities

Teachers told that parents had expressed their interest towards the system for practical reasons; to be able to know where their children were. It happened often that a child had forgotten to phone Mum or Dad and the parent made a ‘check call’ to the teacher in order to make sure that the child had safely made his/her way to school. So, attendance supervision system facilitated teacher’s work eliminating the need for a teacher to answer parents’ calls during the school day.

However, some parents chose not to participate in the trial, as they thought that the teacher should have a full responsibility about the whereabouts of the children, and felt that a computerized system would remove this responsibility from the teachers. One of the parents said: *“If parents cannot trust that the teacher knows where the children are (ill, at school, on vacation etc.) something is really wrong.”* One parent argued that in case that a child does not arrive at school and there has not been any notice about the absence, it is teacher’s duty to contact the parents, so *“what kind of additional value does the service bring to parents?”*

In addition, parents commented that the system can sometimes cause extra worry, as the child might lose the card or forget to

log in upon arrival: *“The login is based on memory, so parents cannot be sure that the child is at school if the child has forgotten to log in or if the child has lost his card.”* Some parents expressed concerns about the increasing amount of information they need to follow: *“In this insecure world it is good to know where the child is, but the information flood and reading the messages is already now fully employing the parents and therefore it feels that the ‘traditional’ way would be enough. But naturally, if there is a fear that the child is skipping classes or thinks of leaving on his/her own ways from school, the attendance supervision service is good.”*

Most parents had also been wondering why their child’s login happened always so late in the morning, for example the child might have left from home to school at 7:30 am, but the login, however, did not happen until around 8:30 am. As the parents knew that the journey to school should not take this long, this easily caused concern and worry. The delay was caused because the reader devices were located in the classrooms, and some mornings it took some time before the children got inside or remembered to log in.

In one parent’s opinion all the resources should be directed to preventive work in regard to safety, such as traffic, school environment and social support: *“What does it help to get the information that something has happened, if something could have been done to prevent that from happening!”* And another parent thought that the supervision for older pupils would bring more benefits, since in her opinion a small pupil is already quite well controlled by the school and day care.

All these comments clearly show that when a new technology is brought into the school environment, it needs to be clear for all how the adoption of the system affects the responsibilities of school personnel, parents and children. In this case, the responsibilities of the teacher remained the same, and the technology was used only to support and enhance communication. However, many parents felt that technology would remove responsibilities from the teachers.

6. DISCUSSION AND CONCLUSIONS

Main benefits of the attendance supervision system for the home are that parents can follow in real time their children’s attendance status in school and day care, thus reducing unnecessary doubt and eliminating the need for calling the child or the teacher for inquiring about the child’s whereabouts. Service also facilitates teachers’ work by offering technology and a system for gathering the information about children’s attendance information and keeping log about their possible lateness at school.

Information about user experience was obtained by combining different data collection methods. The findings were analyzed from the viewpoint of three end-user groups, namely children, parents and teachers. Children, as well as their teachers, became very quickly familiar with the login/logout process, and the attendance supervision was soon integrated into their everyday school routines, mainly due to the intuitiveness and effortlessness of the NFC touch-based interaction technique [23, 25]. Our findings also indicate that by participating in the design and use processes the children became aware and internalized the functionalities and goals of the system, which lowered the barriers for adoption and use. In addition, the fact that the teachers took

the responsibility of integrating and supervising the adoption of the new practice appears to be essential for the success of adoption.

The importance of the role of children in the research was emphasized throughout the research process to overcome the problems associated with children as research subjects [7]. Children were respected as the users of the new technology and their contributions and ideas were sought out and valued. All communication was planned to convey a message that children could trust that adults will listen to their thoughts and ideas, and respectively adults pursued to learn to elaborate on children’s ideas, rather than merely listening passively or not listening at all [2].

For many children the possibility to participate in this trial was a boost for their self-esteem. Children were very proud and excited that they were shown trust by the adults by giving on their on responsibility the smart cards. Also, children valued the responsibility they were given for logging in and out of school and even operating the reader devices by themselves. Similar results have also been discovered in a research by Attewell [3].

Main concerns with the attendance supervision system relate to the privacy and security issues concerning the collection of pupils’ real-time attendance details and the possibility that unauthorized individuals gain access to children’s movements and location and personal data. In this study, privacy concerns were not raised, which seems unique when compared to previous research [8, 11, 22]. We expect that one reason for this is the nature of the NFC technology, which enables reading ID only upon touch.

User research revealed that for the children at this age as well as for their parents, the concept of being monitored by the technology is not something they reject, but possibly welcome. Interviews and questionnaires with parents and children revealed that mobile phone ownership among this age group is closely tied to parental purchases, and often motivated by parental and child desires for parents to be able to contact their children when children have to go to school alone. With this new attendance supervision system children would be able to go to school on their own even if they did not have their own mobile phone, since the attendance monitoring would enable the parents to check that their children have arrived at the school safely, thus making the check calls between parents and their children (or between parents and teachers) needless.

Even though the children themselves did not get direct benefit from using the system, they valued the fact that they could actively help teachers and parents by creating useful and valuable information. Perhaps surprisingly, children seemed to be the most pleased group with the system. When describing their experiences towards the system, children’s descriptions were positive and enthusiastic. Our analysis shows that a technology-supported attendance supervision system can bring value for all end-user groups but it seems that the system will serve primarily the teachers and the parents.

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