

## Experiences from NFC Supported School Attendance Supervision for Children

Mari Ervasti, Minna Isomursu

Context-awareness and Service Interaction  
VTT Technical Research Centre of Finland  
Kaitoväylä 1, 90571 Oulu, Finland  
mari.ervasti@vtt.fi, minna.isomursu@vtt.fi

Marianne Kinnula

Dept. of Information Processing Sciences  
University of Oulu  
90014 University of Oulu, Finland  
marianne.kinnula@oulu.fi

**Abstract** - Our paper presents a field study arranged at a Finnish primary school where two classes and a total of 23 pupils between the ages of 6 and 8 trialed an attendance supervision system supported by Near Field Communication technology in 2008. In the trial the pupils marked their arrival at and departure from the school by touching a reader device or NFC-enabled mobile phone with a smart contactless card. The system simplified attendance monitoring by replacing manual roll calls leaving thus more time for teaching. Parents were able to receive real-time information on children's attendance, which reduced their concerns about whether their child had arrived at school safely. Information about user experience was obtained by using a variety of data collection methods. Children, as well as their teachers, became fast familiar with the touch-based interaction, 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 but it seems that the system will serve primarily the teachers and the parents.

**Keywords** – *Near Field Communication; attendance supervision; school; children; user experience*

### I. INTRODUCTION

This paper introduces a Near Field Communication (NFC) supported 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, which is taken away from teaching. In addition, children beginning school in Finland travel to school largely independently, either on foot, by bicycle, or by bus. Therefore, parents of young pupils regularly call to their child's or teachers' cell 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 information of their children's real-time attendance.

Related work is described in the next section. Then the research setting is outlined describing the NFC technology and the developed attendance supervision system. This is followed by the procedures used in the system design with a description of research objectives. The paper continues by

introducing methodology used in user experience data collection and representing and analyzing the field study results. The paper finishes with discussion and conclusion.

### II. 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 [1]. For example locational systems can be used to make sure that children are safe on their way to school [2]. Jernström [2] 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 the child is engaged in something hazardous.

In a study by Fraser et al. [1], 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. While parents were worried about their children, they suggested that technologies that monitored children's activities, such as the mobile phone tracker and sensors, moved from expressing concern to expressing distrust as children aged. In consequence, Fraser et al. identified as one core issue for future research the discussion of children's privacy in technological design. 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 it. For example, how do we justify increasing links between home and school, when children are often active in resisting such information transfer [3]?

Denmark is traditionally presented as a country where children are able to freely move around and have independent mobility to schools and leisure facilities [9], and Finland can be considered similar to Denmark when it comes to children's mobility. Children beginning school in Finland travel to school largely independently, either on foot, by bicycle, or by bus. A Danish survey by Fotel and Thomsen [9] states that parents' supervision of children's mobility is bound up with different aspects of their travel conditions, such as the choice of mode of transport. Automobility, for instance, clearly supports the physical supervision of

children's mobility, whereas bicycling or walking can be performed by the child on its 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 [10]. 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 [9]. New technology has made it possible to monitor children by e.g. their cellular phones, and some parents use that deliberately in situations where the children are testing the boundaries of where they can go independently. Monitoring children's movements 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 [9]. Fotel and Thomsen [9] state that even though the 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.

In a small town in the United States the public school kids' whereabouts on campus were monitored by a system that used RFID (Radio Frequency Identification) technology. Children wore badges around their necks that contained a photo, grade level and name of the pupil. Within a badge was a chip with an antenna attached. As the chip passed underneath a reader mounted above the classroom door, it transmitted a 15-digit number, which then was translated into the student's name by software contained in a handheld device used by teachers to check attendance. Several parents complained that their children's privacy rights were being violated; while the school board defended the system by saying it would keep kids in school, free up more time for teachers to teach and increase security for pupils and teachers. The proposal died after protests by parents and privacy and civil-liberties advocates, including the American Civil Liberties Union (ACLU). [4]

Also a Rhode Island school district has announced a pilot program to monitor student movements by means of RFID chips implanted into the schoolbags of 80 children. Each chip would be programmed with a student identification number, and would be read by an external device installed in two school buses. The buses would also be fitted with GPS (Global Positioning System) devices. Parents or 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 bus's current location as provided by the GPS device. The RFID tag would contain only an ID number, not a name, address, or other personal information, so unauthorized individuals are prevented from gaining an access to pupils' private information. ACLU has criticized the plan as an invasion of children's privacy and a potential risk to their safety. [5][6]

Qvortrup [7] and Rasmussen [8] argue that the increased protection of children by monitoring them is a central characteristic of modern childhood and we do not yet know all the consequences. According to Rasmussen [8], 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. Williams et al. [11] have presented that society could now perhaps openly question whether (urban) parents are good parents if they don't know where their children are and what they are doing at all times and don't have control over them. Aitken [12] shows how some parents employ a policy of constant supervision of children even up to early teenage years while in any outdoor space. Furedi [13] and Rayner [14] 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.

### III. RESEARCH SETTING

Attendance supervision trial supported by Near Field Communication (NFC) technology began in Oulu, 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 special-need 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.

#### A. 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 [15]. Vällkynen et al. [16] state that touching is an effortless way to select objects in the environment and easy to learn and use. Near Field Communication (NFC) technology is designed to make communication between two devices very intuitive. NFC is a very short-range wireless technology that allows electronic devices to be used in interaction with other devices simply by touch. The main advantages of NFC are the simple and quick way of using it and the speed of connection establishment

NFC is based on existing radio frequency communication standards, so it is a special case of implementation of RFID technology. The touch-paradigm also 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. However, in this paper, we assume that NFC is used through touch-based interaction paradigm. In our 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.

## B. System Description

Designed to simplify attendance monitoring and replace manual roll calls, the NFC attendance supervision system does not require teachers to mark 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 ‘logged in’ by touching with an NFC smart card an active card reader device and pupils in the special-need class logged in by touching a NFC-enabled mobile phone. The reader devices recorded the card ID (the child’s name), the direction (arrival in school) and a time stamp in the backend system. The active reader device was chosen for the first grade class because it works faster than an NFC-enabled mobile phone for large groups. The application in both the reader device and the mobile phone recorded the time of the log-in; it was possible to choose the ‘direction’ of the pupil registration (in or out) through both devices. At the end of the school day pupils touched the reader devices again to mark their departure. Attendance supervision system (through NFC phone) was also used in extended day-care programs where some children went after school.

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

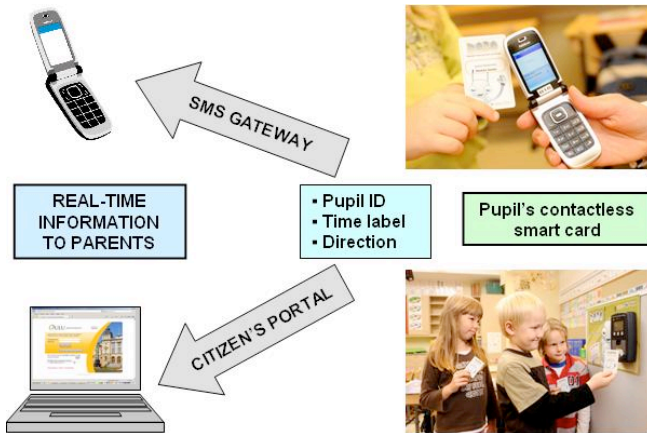


Figure 1. Overview of the attendance supervision system.

The log of arrivals and departures was automatically compiled by a backend 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 text messages sent to their mobile phones. The system prevented truancy by informing tutors, administrators, and parents of absences in real time, enabling instant intervention.

## C. Design Procedure and Research Goals

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 the normal practices of the school was especially emphasized, so that the trial would not remain as an effort related 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. Participating teachers volunteered for the trial, and it was on their responsibility to adopt the attendance supervision system in everyday use at their class. Teachers explored new working practices brought by the system and were expected to report their experiences and observations regarding the system.

The goal of the concept was to (1) enhance and secure children’s independent mobility in home-school transition and (2) increase rationalization of home-school communication. Objectives of the field study were to test attendance supervision system for school children and their parents and teachers, and to examine the value the attendance supervision concept brings to these stakeholders. The extent to which the service supports enhancement of school routines and practices and improves information sharing between school and home was also examined in the study.

## IV. USER EXPERIENCE DATA COLLECTION

Druin et al. [19] 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 so few experiences in their lives where they can contribute their opinions and see that adults take them seriously [19]. When a respect is fostered, it changes how children see themselves [22]. Williams et al. [20] 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 are valuable, adaptive and creative users in the participative design of ubiquitous computing experiences and devices that might enable them.

Druin [21] 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 to adults, the relationship to the technology and the goals for inquiry. The role we sought from the children was essentially that of an informant. As the trial objective was 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 potential use and for the informant role as well. Therefore in the case of this trial the children’s role was both that of a user and 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 [17] in order to increase reliability and

validity of the results [18]. The user experience data collection methods and number of stakeholders for each method are listed in Table 1.

TABLE I. SUMMARY OF DATA COLLECTION METHODS AND 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 three first-graders' parents whose children did not participate in the trial	3 parents

## V. RESEARCH FINDINGS

In next sections we will present and analyze the field study findings obtained by using the variety of data collection methods described in the previous section.

### A. 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. 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. 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. They seemed not to get disturbed or bothered about researchers' presence.

1) *First grade class*: At the time of the first visit to first grade class, routine for the login had not yet had time to develop and the login had not yet integrated into the children's everyday school routines. As the pupils arrived at a classroom, teacher had to remind most of them about the login. Children had quite different ways for doing the login procedure; some merely touched with their card the reader device while some carefully placed the card on an exact position on top of the device. All the pupils had already allocated some specific place for their card where they always put the card so that it remained safe. Most of the

pupils said they kept their cards in their backpacks, and many even had one particular pocket in the bag where they put their cards.

At the time of the second observation, the attendance supervision system had been in use for two weeks and the login had now become a natural part of children's school routines. As the children arrived in a classroom, they remembered without a separate notification to take their cards from their backpacks and to log in the school. According to the teacher there usually emerged a small line behind the reader device from where the children at the latest remembered the login: *"It went as in an assembly line"*. In Figure 2 are shown pupils logging in the school.



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

2) *Special-need Class*: At the time of observation, the special-need class had used the attendance supervision system for two weeks. Teacher told that before the experiment started pupils had eagerly been asking "when do we get the cards, when will the device arrive". Similar to the first grade class, the login appeared to have well integrated in to the school routines after only a two weeks use. Teacher did not need to separately remind children about login, since children remembered on their own initiative to log in the school, which happened by touching the card with the NFC phone (see Figure 3).

Login seemed to happen quite smoothly, only with some slight bustle and elbowing: *"It's my turn now!"*, *"Wait for your turn!"* Similar to the first-graders, all the pupils told they kept their cards in their backpacks, and most had one specific pocket in the bag in which they always put their card after login.





Figure 3. Pupils log in by touching the NFC-enabled mobile phone with their cards.

Classroom observations revealed that the login 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 but they were able to handle it independently, contrary to the login done with NFC phone.

#### B. Interviews with Children and Teachers

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. Children seemed to be proud and excited that adults outside their school had come to their class for just to chat with them and ask about their thoughts. The children were very happy with answering the questions and told freely and frankly about their own thoughts and opinions.

The teachers were interviewed informally partly in the midst of teaching, partly during breaks between classes.

1) *First grade class:* 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 the teacher: "Nowadays children have seen so many kinds of things that they don't marvel at things like this." Teacher told that for pupils the attendance supervision system is pretty exciting and nice thing, and the children had been very pleased when they received their cards. Pupils themselves reported that using the card and reader device was "nice" and "quite easy". Login with the reader device at classroom seemed to be easier than login with NFC phone in the day care: "Cell phone needs to be moved back and forth in a way", "It takes more time".

Pupils seemed to understand pretty well why they had received their "Robo" cards and what the purpose behind the use of the attendance supervision system was, which is shown in the following excerpts gained from first-graders' interviews: "Mom and Dad will know that I have arrived at school and at home", "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".

The teacher 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 their responsibility. This was also valued by the children, as they saw this as a sign of trust towards their skills. 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.

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.

2) *Special-need Class:* Children in the special-need class understood also the reason behind the use of attendance supervision system. However, it is possible that children's answers partly repeated the same words the teacher and their parents had told them about the attendance monitoring: "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", "You do the login because you need to touch the phone", "Parents check at their work place that you have 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: "Writes names to the Internet, are you at school or where", "It sends an e-mail 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."

Teacher told that the children had been extremely excited when they had heard they could participate in the experiment. Pupils had very much waited for receiving their own cards, and after a few weeks' use had only positive thoughts about the attendance supervision: "This is easy to use, login has worked well", even "awfully nice, giant-sized!" and "really great!". According to the teacher,

children had easily learned how to use the card, and the login had soon become an integral part of their school routines.

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 (see Figure 4); on the other side of both the special-need and first grade classes’ cards read “Robo” along with a funny robot image and pupil’s name and school name. 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 very important.



Figure 4. The visual outlook of the “Robo” card and the reader device.

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 [23]. Children were very proud and excited that they were shown trust by giving them their very own smart contactless 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.”*

### C. Phone Interviews with Parents

Parents of six (out of seven) participating children (two fathers and four mothers) in the special-need class were interviewed via a phone. Parents of one child did not give their contact information for the interview. Interviews lasted from fifteen minutes to half an hour. In order to gain real hands-on experiences by the parents, interviews were conducted after one and half months from the beginning of the field study when the parents had had time to experiment a longer period of time with the attendance supervision system. The aim of the phone interviews was to investigate 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.

All the interviewed parents of the special-need class children told that the smart contactless cards and the attendance supervision concept had been received very well by the children. For example, one child had got really excited when he received the card that was similar to the card his father used at work. Parents told that the children had taken care that they had their cards always with them, and for some it seemed to be very important that they had their cards with them all the time.

Parents reported that following the children’s logins via an online ‘citizen’s portal’ was not very practical and did not integrate well with their daily routines. Parents needed to separately log in to the portal, which took way too long time during a busy workday. 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; being able to receive real-time information about the child’s logins on the mobile phones via text-messages. However, one 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.

The interviews also revealed a fact that for some families the attendance supervision system did not bring real added value. In these families one of the parents was always at home when the child left for and arrived from school, enabling the parent to follow child’s comings and goings, or family lived so near the school that the child had only a short way to school. 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, instead of information about their child’s arrival at and departure from school.

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.

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 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.

During the study itself the privacy concerns and negative aspects of surveillance did not play a big role, contrary to previous studies [1][3][8]. 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 had 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"*.

#### D. Feedback Questionnaires for Parents

Two separate short questionnaires were created for the first-graders' parents, one for the 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 in order to assure that the parents had already gained real experiences with the attendance supervision system. Total of 17 parents (out of 19) answered the questionnaire. In the questionnaires were explored the same things as in the phone interviews.

First-graders' 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"*.

Also these parents preferred to receive child's attendance information on their mobile phones: *"We do not always have an opportunity to be by the computer, so a message to a cell phone would bring lots of additional value."* One parent told that he/she would preferably receive the attendance data on her e-mail account. Some parents thought that the service brings the same feeling of safety as when ensuring the child's arrival at school by calling with a cell phone, so the system does not bring real value when compared to already established practice.

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. Some parents also wished to be able 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 pre-specified time limitation.

A few parents expressed concerns about 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."*

In the first grade class three children did not participate in the trial. Those parents explained that in their opinion *"the safety of the child is created through the genuine presence of an adult and not through a supervision system"*. In their opinion, what children really need is the time of the trusted adults. These parents 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 [7][8]. 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."* In addition, same parents commented that the system can sometimes cause extra worry, as the child might lose the card or forget to log in: *"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 of the parents, who had chosen not to participate in the trial, justified their decision by saying that in their opinion the teacher should have a full responsibility about the whereabouts of the children, and they felt that a computerized system would remove this responsibility from the teachers: *"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?"* 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.

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!"*

## VI. CONCLUSION AND FUTURE WORK

The attendance supervision system can reduce unnecessary doubt by allowing the parents to receive real-time information on non-attendance or if the pupil is late from school. Main benefits for the home are that parents can follow in real time their children's attendance status in school and day care, thus 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.

Children, as well as their teachers, became very fast familiar with the login 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 [15][16]. Children were very proud and excited that they were shown trust by giving them their very own smart contactless cards that were on their own responsibility and that adults trusted for them to take care of, which has also been discovered in a research by Attewell [23]. Also, children valued the responsibility they were given for logging in and out of school and even operating the reader devices by themselves.

The importance of the role of children in the research process was emphasized throughout the research to overcome the problems associated with children as research subjects [19]. Children were respected as the users of 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 [22]. 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.

Parents as well 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 [1]. In addition, 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. The teachers were also 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.

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 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 [25]", "Next phase is a microchip planted on the back of the hand, the mark of the beast from the Apocalypse of John...[24]"*. In addition, many readers had commented the attendance

supervision system also in the following way: *"Child is not anymore allowed to grow up at her own pace; she will be raised in real 'Orwell' spirit [25]", "Here the monitoring, caring and presence of a grown-up is tried to be replaced with a ridiculous cell phone [25]"*.

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 our study, privacy concerns were not raised, which seems unique when compared to previous research [1][3][8]. 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 [4][5][6]. 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 cell phone numbers, so unauthorized individuals were prevented from gaining an access to pupils' private information.

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 motivated by parental and child desires for parents to be able to contact their children when they have to go to school alone. With this new attendance supervision system children would be able to go to school alone even if they did not have their own mobile phone, since the attendance monitoring would enable the parents to check that their children had arrived at the school safely, thus making the check calls between parents and their children (or between parents and teachers) needless.

Comments by parents clearly showed 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.

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