Touching Nametags with NFC Phones: a Playful Approach to Learning to Read

Jukka Riekki, Marta Cortés, Marja Hytönen, Iván Sánchez, Riitta-Liisa Korkeamäki

University of Oulu, 90014 Oulu, Finland
firstname.familyname@oulu.fi

Abstract: Near Field Communication (NFC) technology was developed for mobile devices from RFID technology. It enables new kinds of learning applications that are based on touching objects with phones. When an object is touched, a phone reads data from the object's NFC tag. An application interprets the data and acts consequently. We report our first pilot study of an NFC-based learning application that supports children in their efforts in learning to read. We tested the application in one kindergarten with 23 three-to-five-year-old children with their two teachers. The results suggest that NFC is a suitable technology for learning applications and that the tested application had an effect on the children's emergent letter knowledge although the activity period lasted only for two weeks.

1 Introduction

Near Field Communication (NFC) technology is based on RFID and mainly targeted at mobile phones [1]. Phones are equipped with NFC readers and NFC tags are placed in the environment. NFC tags are stickers containing an antenna and a chip with writable memory. When a user places a phone near a tag, the phone reads the data stored in the tag and processes it. A phone application can, for example, store the data, present the data to the user, or perform some other operation the application designer specified for that type of data. Many applications suggested by researchers read just an identification number from a tag and use it as a keyword to fetch data from the network. Easy to use user interfaces can be built by placing each NFC tag under a graphical symbol advertising the action that a user can trigger by touching that point [2]. NFC technology is now mature for large scale usage.

NFC technology enables new kinds of learning applications based on touching objects with phones. For example, a language learning application can ask a user in a foreign language to touch a certain object. The applications can be brought to the everyday environment, that is, NFC enables location and context aware learning applications. This technology offers great potential, specifically for children, as it enables more natural learning by exploring and creating direct links between physical world and digital data [3]. Therefore, NFC could be a key technology in edutainment, as it facilitates the implementation of gamelike learning applications.

However, to find out how NFC technology should be used in learning applications – to achieve good learning results and a good user experience – this new technology has to be studied in the context of learning. Specifically, concrete prototypes have to be implemented and tested in real environments, as an unfamiliar and artificial laboratory environment could cause unusual behaviors which would not apply to other settings. The environment should have social relevance for the users and offer opportunities for exploration in a playful way with the applications. Moreover, we agree with the statement given at the 2005 UbiApp Workshop: "Real-world deployment is the only way to investigate fully the complex three-way interactions between [ubiquitous computing] applications, their users, and the environment" [4].

In this paper, we report our first pilot study of an NFC-based learning application that supports children in their efforts in learning to recognize words. We tested the application in one kindergarten with 23 three-to-five-year-old children with their two teachers. This application was selected due to the importance of learning digital literacy in modern society [5]. With the application, children can practice associating the written names of their peers in a kindergarten with the pronunciation of the names – by touching nametags with NFC phones.

2 Background

2.1 NFC technology and physical browsing

RFID tags are small and slim electronic components made of an antenna and a microchip. The microchip makes use of non-volatile memory to store data permanently. RFID technology has been used for several years in the field of pervasive computing since it permits creating links between the real world (the world surrounding us) and the digital world (applications and computer devices) [6]. Objects in the environment can be associated with a webpage, with online documentation, or with a data record. The necessary data to create those links, for example an identifier that uniquely determines a certain object, can be stored in an RFID tag attached to that object. An RFID reader can access this information and communicate it to an application.

NFC is a short range wireless technology for data transfer between two devices within five to ten centimeter distance from each other. NFC operates in the 13.56 MHz band and permits a data rate between 106 and 424 kbps. This technology is fully compatible with existing RFID tags working in the high frequency (HF) band. Actually, NFC technology can be viewed as an extension to RFID since it allows half-duplex communication between two NFC readers. NFC supports three different communication modes, namely, Reader/Writer mode, Peer-to-Peer mode and Card Emulation mode. In the Reader/Writer mode an NFC reader can read data stored in an NFC tag and write data to it. The Peer-to-Peer mode permits a bidirectional communication between two active NFC devices (i.e. readers, not NFC tags). This NFC mode is quite similar to Bluetooth technology. The main advantage over Bluetooth is that the handshake (initialization) process is much faster and easier, while the main disadvantage is the lower speed. Finally, the Card Emulation mode permits using an NFC device as a contactless card (e.g. a credit card). This mode enables payment and ticketing applications. For the experiments reported in this paper, we have used the Reader/Writer mode.

Although RFID has been available for several decades it has been mainly used either for research or for industrial applications; mainly for tracking of goods. RFID has not been integrated into daily use. One possible explanation is that there has not yet been any right technology catalyst to boost deployment of the technology. NFC might be such a technology [7]. Moreover, NFC readers can be integrated into mobile phones which have become everyday objects. A mobile phone has both computational and communication capabilities as well as a user interface – all that is required to build both stand alone and networked NFC applications. Thus, mobile phones have the potential to bring RFID and NFC to daily use, specifically as several phone manufacturers such as Samsung and Nokia already have NFC phones on the market and NFC phones are expected to mushroom in the next couple of years.

Classical graphical user interfaces (GUIs) present interactive elements such as icons and menus on a screen. Users utilize a keypad, a pointing device (mouse, joystick) or more recently their own fingers (to touch screens) to activate those interactive elements. Physical browsing [8], in contrast to classical GUIs, offers a different approach to user interfaces. Users interact with applications by pointing or touching objects in the environment instead of icons or menus on a screen. NFC is an enabler technology for building this kind of interfaces. NFC tags are attached to objects placed in the user environment. A phone with an NFC reader reads the data on a tag when brought near that tag. A user interacts with an application running on the phone by touching tagged objects. Touching an object triggers an action in the same way tapping an icon on the phone's touch screen does. Touching might start a specific application, open a web page, make a phone call, play a sound, or show a picture on the phone's display, for example. We advertise NFC tags to potential users by graphical symbols placed on top of the NFC tags. These symbols have two tasks. Firstly, they announce to users that they can interact with those objects using NFC technology. Secondly, they give information on the actions that are triggered when the tags are touched. Thus, an NFC tag and the corresponding symbol form a two-sided interface between the real and virtual worlds: the graphical symbol communicates an action to a user and the data in the tag defines a command triggering the application to perform that action.

Summarizing, NFC technology can be used to create user interfaces for mobile phone applications which are embedded in the user environment. Instead of interacting with a GUI on the mobile phone, a user interacts with objects in the environment.

2.2 The theoretical background for learning to decode words

The theoretical background comes from the theory proposed by Ehri [9] that children progress in their reading development through phases. Children start their development by recognizing words by their visual characteristics instead of using letter-sound relationships. Often these words are logos which the children learn to recognize in their environment such as the names of the shops or labels of toys and food baggage. This type of reading is limited to the context where these words appear and children often don't recognize these words in standard print. Therefore, it is necessary for them to learn the symbol system of letters and their sounds required for conventional reading in alphabetic writing systems [9],[10]. The process of learning the alphabetic system is gradual. After the logographic phase described above the children reach the rudimentary alphabetic phase when they learn to recognize a few letters. Most often recognition is based on familiar letters either as an initial or final position in the word [9]. Because children's word recognition is rather random, they end up with faulty results in their recognition. For example, they may recognize the word house as home. However, the rudimentary alphabetic phase is useful for learning more letters and their sounds. In fact, Ehri [9] suggested that letter knowledge is the key for alphabetic coding and entering into the full alphabetic phase which is one of the main goals in reading instruction.

Similarly with commercial logos children learn to recognize their own names, as well as siblings', parents' and peers' names [11]. Indeed, children are able to recognize names although they don't know the letter names of the names. In doing so, they recognize the names as logos but they may pay attention to the initial letters which they often call my letter, mummy's letter, dad's letter etc. to demonstrate ownership. However, names may offer a pathway for children to learn letters and may help in learning the alphabetic principle especially when recognition is connected to printing the names [10], [11], [12].

Research and theory support the idea that names are useful in the process of learning the letter names and moving from the logographic phase to the alphabetic phase. In addition, activities with the names can be naturally integrated into daily routines in kindergarten. Furthermore, children seem to be motivated to use technology and play with it while learning to read [5]. Therefore, in this study NFC technology was used to afford opportunities for young children to use their names for their logographic reading and learning the letters.

3 Related work

In the last decade, there has been an increasing interest in research named as m-education or m-learning. In most work, 'm' stands for "mobile" but the definitions of the complete terms vary [13], [14]. Laouris & Eteokoeous compiled and analyzed the definitions related to m-education [13]. From a simple expansion of e-learning towards mobile technologies to considering the mobile device as a pervasive tool, almost all the approaches agreed that this term involved the use of mobile devices. Lam et al. define m-learning as "a new type of learning which allows people to learn across context and without restriction of location", and studies its evolution jointly to mobile technologies [14]. Mobile phones are utilized in many projects in learning context. For example, [15] emphasizes the use of mobile phones over other mobile devices (PDA's) because of the price. In this work, mobile phones are utilized in teaching technical English vocabulary to first-year undergraduate students.

We are not aware of the use of NFC phones for learning literacy. However, there is a related research from the United States where three- and four-year-old children learnt letters and alphabet songs with cell phones [16]. In the application children had video clips where letters were introduced in alphabetical order, 3-4 letters a week for eight weeks. The application was drawn from Ready to Learn content, Sesame workshop, where a puppet introduced a letter of the day and several words beginning with that letter. The application also included music and alphabet songs. According to the parents' pre-post-test survey, the children's letter knowledge grew. However, statistically significant differences were found only with children living above the poverty line. The authors concluded that cell phones are a potential medium for delivering the program; similar programs have been seen earlier in TV programs in the United States. The survey also revealed that children liked the program and requested to view the video. But some parents found difficulties in using the phones according to the instructions. Therefore, it is important to test in this study how children learn to use the phones and how names work as a context in learning emerging literacy knowledge.

Applications utilizing the same interaction paradigm, touching, and NFC technology have been suggested for attendance supervision [17] and content collection [18]. Learning applications and toys presenting content about a topic related to a RFID tag's or 2D barcode's location have been suggested as well. All these applications are for older users.

The prototype built in the LAMBERT project [3] and the ShadowBox [19] are targeted to the same age group, three-to-five-year-old children. Both these systems consist of toys equipped with RFID tags and a computer equipped with an RFID reader. ShadowBox teaches children the representational relationship between words and their meanings. The toys are wooden blocks that children put in a box; the task is to find matches between shapes of items and written word equivalents. A correct pairing is rewarded with an animated video; an incorrect one triggers an audio feedback presenting the pronunciation and the spelling of the word. The LAMBERT project focused on helping deaf children acquire language and expand their scaffolding of concepts. When a child placed a toy near the reader, a short multimedia presentation about that object was shown on the computer display. The main differences from our work are the application area and our use of mobile phones that allows integrating the application to the children's environment using common devices instead of usage in a single place where a computer and an RFID reader are installed. Our application uses NFC technology for faster paced interaction more intertwined with the real environment and requiring less focusing on the devices' user interfaces.

4 Application

The application supports three-to-five-year-old children in their efforts to learn to read. The application is installed on NFC phones (Fig. 1). Children use the application by touching NFC tags with phones – a phone instructs a child about the tag to touch and gives feedback after a tag has been touched. As the application is based on touching objects with a handheld device, visual and audio capabilities of the device (screen size and resolution, audio quality) were not the primary concerns when we were selecting the handheld device. Individual words and simple animations are shown on the display and audio clips are played. We selected the Nokia 6131 NFC phone because it has sufficient capabilities to offer this functionality - and the phone fits in small children's hands.

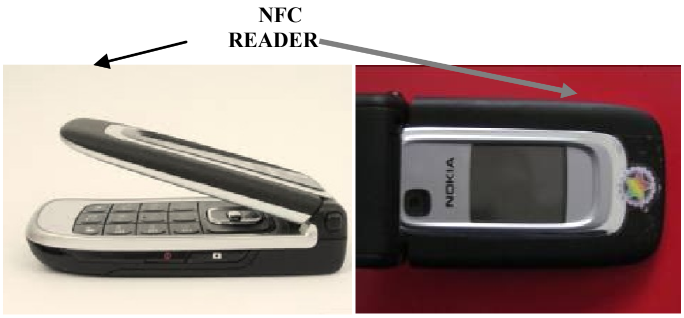

Fig. 1. The NFC phone used in the testing.

Fig. 2. A nametag "JARNO" equipped with an NFC tag and a star icon. The tag is placed behind the star icon.

The staff in a kindergarten usually attach children's nametags to chairs, coat racks, beds, drawers, and so on. We equip these nametags with NFC tags; star icons identify tag locations. A tag and the corresponding star icon are placed at the right edge of each nametag (Figure 2). A small star icon is also attached to the position of the NFC reader (Figure 1, right), so the children can be instructed to touch the stars on the nametags with the stars on their phones.

Fig. 3. The poster for starting the application in the two modes, exploring and practicing.

The application is started by touching a star icon on a small poster placed on a wall in the kindergarten. The poster shows an animal touching a star with a mobile phone similar to the one used by the children. In other words, the animal instructs the children on how to start the application. The poster is shown in Figure 3.

The application has two modes. The first, exploring mode, is started by touching the star icon next to the fox character (Figure 3, left). Therefore, we also call it the "Fox game". In this mode, a simple animation is repeated on the phone display: a hand holding a phone touches a star icon (Figure 4). When a nametag is touched, the phone says the name aloud and also shows the name on the display for a while; then, it returns to the animation. The state diagram for the application in the exploring mode is shown in figure 5.

Fig. 4. The animation shown on the mobile phone's display.

The second, practicing mode, is started by touching the star icon next to the rabbit character (Figure 3, right). Consequently, it is also called the "Rabbit game". In this mode, the phone shows a name and waits for a child to touch the corresponding nametag (i.e. the star icon on that nametag). If no nametag is touched within a period of time, the phone says the name aloud. If the correct nametag is touched, the phone says "Great" (in Finnish) and says and shows the next name. If a wrong nametag is touched, the phone says "Please try again" (in Finnish) and says and shows the same name again. The state diagram for the application in the practicing mode is shown in figure 6.

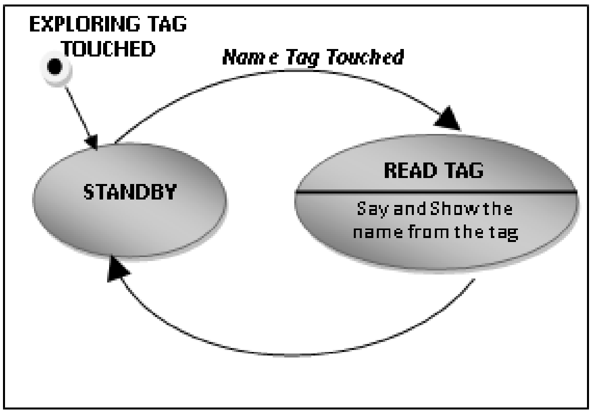

Fig. 5. State diagram for the mobile phone in the exploring mode

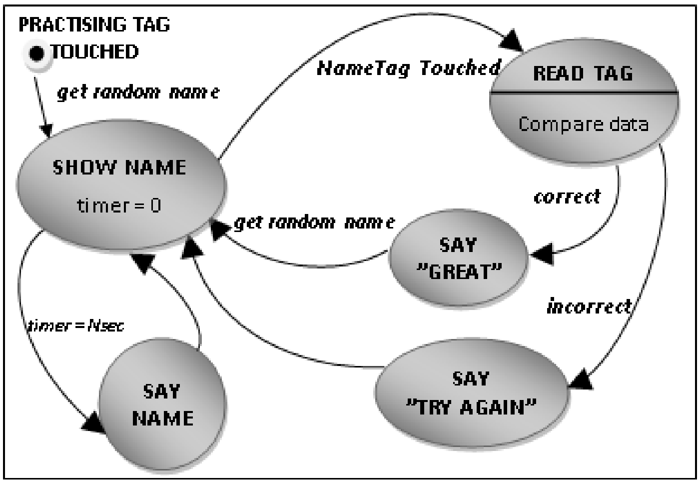

Fig. 6. State diagram for the phone in the practicing mode.

5 Procedures in the study

We selected one kindergarten for the pilot study. We tested the application with 23 three-to-five-year-old children with their two kindergarten teachers. The main objective was to study how the application worked in children's natural environment as described above. In other words, we investigated (a) how children learned to use the technology and how interested they were in using it, (b) how the names worked as a learning context in using their emergent literacy knowledge such as their letter knowledge and their ability to recognize familiar names and (c) how the children progressed in their emergent knowledge. This pilot study lasted for two weeks in the spring of 2010. Parents were informed about the project by the kindergarten teachers. Both the parents and the teachers discussed the project with the participating children.

All the parents gave a written consent which included permission to use the children's pictures for research purposes.

We tested all children individually, both before and at the end of the pilot. We were careful to use unobtrusive and sensitive research methods and doing research with children – not on children. Special emphasis was put on being sensitive to the children's development stages and reactions. Each child's development stage was considered in testing individually their knowledge: testing started from uppercase letters and proceeded to lowercase letters, to the child's own name, to other children's names, and to phonological awareness when a child was considered ready for such testing. The tests were developed to be playful [11] and children looked at one letter at a time through a "magnifying glass". Children's names were printed with capital letters on cards resembling playing a memory game typical of that age. Similarly, for testing phonological awareness the context was made playful by using stories and cards.

Apart from the abovementioned data of the pre- and post-tests, we were also interested to know how each child used the application on the mobile phone. Therefore, a log system for the application was implemented. We collected all the data related to the usage of the application by each child. When any of the two starting tags was touched with the phone, it recorded the mode name. If the exploring tag was touched, the phone recorded the subsequent touches. That is, the phone recorded which name tags the child was exploring. From timestamps included in the records, we were able to calculate how long the child played with the phone. Likewise, data was recorded for the practicing mode. The name proposed by the phone and the different attempts (if any) of the child to find the correct answer were recorded.

Besides the quantitative data we also videotaped and took pictures of some of the children's activities. A research assistant also made some observational notes. These data provided an important source in evaluating the feasibility of NFC phones and names as a context for learning.

The selected kindergarten had nametags in common use: all children had their nametags in chairs, coat racks, beds, drawers, and so on. We equipped the nametags with NFC tags and star icons and attached a poster on the wall, as described in the previous section. All in all, around 50 NFC tags were placed in the kindergarten. Moreover, we delivered 13 NFC phones to the kindergarten.

At the beginning, the children were instructed to first touch a star next to an animal character in the poster. In the exploring mode, the children were instructed to touch star icons on the nametags. In the practicing mode, the children were instructed to first listen to a name and then touch the corresponding nametag (Figure 7). Teachers had participated in developing innovative literacy activities in earlier research projects; therefore, they needed only a brief introduction to the technology. This was done in the course of one morning in the kindergarten by some of the authors of this paper.

Fig. 7. A child is touching the nametag “ANNIINA”. The star icon is on the right, behind the phone.

6 Results

Although our main interest was not to investigate the progress in children’s name and letter recognition, we present this data first to provide a background to the other results. The test results before (pre-test) and after using the application (post-test) are summarized in Table 1. In the pre-test, seven children recognized all of the children’s names. But there were five children who recognized only their own name. One child did not recognize even his own name. The Finnish alphabet includes 28 letters but only 21 letters are needed to read original Finnish words. Five children were able to recognize 20 or more uppercase letters and three children recognized ten or more. Note that the playing time was recorded for the first, Fox game (i.e. the exploring mode) for reasons explained below.

Post-test results show that seven children recognized all of the children’s names, and four children’s name recognition improved by several names: one child recognized 15 names more in post-test than in the pre-test, three other children recognized about seven to nine names more after playing. But there were two children whose name recognition did not develop at all. On average, the children recognized about four names more in the post-test than in the pre-test. There were five children who recognized 20 letters or more in the pre-test, and after the two-week experiment seven children recognized 21 or more letters. Interestingly, most children’s letter knowledge improved by one to four letters although letters were not focused in the play at all. Some children who did not learn the conventional letter names mentioned in the post test letters based on whose letter it was.

Table 1. The pre- and posttest results and the playing time in the Fox game. Both the number of recognized children's names and uppercase letters and the changes in the recognition are listed. 'A' indicates that all the names or letters were recognized.

Child	**Names**		**Letters**		**Playtime**		**Child**	**Names**		**Letters**		**Playtime**
	pre/post	**+/-**	**pre/post**	**+/-**	(min.)			pre/post	+/-	pre/post	+/-	(min.)
1	23/23	A	2/3	+1	43		**13**	1/3	+2	0/0	0	11
2	23/23	A	21/23	+2	10		**14**	11/20	+9	0/0	0	16
3	0/4	+4	3/7	+4	13		**15**	9/8	-1	0/1	+1	14
4	19/23	+4	17/21	+4	64		**16**	1/1	0	5/5	0	5
5	2/17	+15	1/2	+1	22		**17**	23/23	A	28/28	A	3
6	23/23	A	28/28	A	61		**18**	23/23	A	26/26	0	51
7	23/23	A	20/23	+3	45		**19**	23/23	A	19/19	0	11
8	1/1	0	0/2	+2	13		**20**	1/4	+3	2/6	+4	19
9	15/23	+8	9/10	+1	26		**21**	7/9	+2	4/8	+4	9
10	20/23	+3	2/2	0	18		**22**	8/12	+4	19/21	+2	15
11	10/17	+7	3/4	+1	26		**23**	2/6	+4	3/6	+3	33
12	1/4	+3	0/0	0	48							

The NFC application was voluntary for children. Therefore, the playing time varied from 3 to 64 minutes. If a child played on average 19 minutes or more, s/he learnt an average of 6.3 names but only about 1.8 letters. Children playing 9-18 minutes learnt 2.9 names and 1.5 letters on average. Those who played 8 minutes or less did not gain any new knowledge. The children who already knew all the names or letters are not included in the corresponding averages.

The first game, "Fox game", which we used as an *exploring mode*, was developed to be as simple as possible to test how small children are able to learn to use NFC technology in the context of their own names. The game only gave the children's names in two modes: in written and oral mode one at a time. Children learnt very quickly how to use the technology and they were excited about the names as they ran to their peers to show "my name" and "your name". Although the children were motivated to play, there were differences between girls and boys. The girls played 40.9 minutes and the boys 16.6 minutes on average (girls average 17minutes and boys 8,9minutes). The girls also knew more names at the beginning, as the context of the game was more familiar to them.

But because there were, despite the children's young age, children who knew all the names and enough letters to decode the Finnish words, we introduced another game, the "Rabbit game", which we called *practicing mode*. This game was more complicated and challenged the more advanced children. The purpose was to find out how children use their knowledge of name recognition to define their phase and strategies in name recognition.

The "Rabbit game" first gave the name on the phone in two modes (written and oral) and then the child was to move around in the three rooms to look for a nametag (in their genuine places) to correspond to the name s/he had seen and heard on the phone. At the destination the phone gave a feedback for the response. The phone data showed that some children did not play this game at all, because the choice was not entirely based on the children. Instead, the teachers may have been selective in introducing the Rabbit game to some of the children only. Therefore, Table 1 does not include the playing time for the Rabbit game.

But the data which the NFC phones recorded from the Rabbit game was very interesting, because it revealed how children recognized the names. As described above, children used strategies typical for logographic word recognition, which meant that they confused names with the same initial letter or names with the same letter combination. The most confusing names were MARKUS and MARCUS which made the children try them several times in a row. More obvious logographic reading took place, however, with names having the same letters in a different position and order but still resembling each other, such as ANIINA and HANNA (note that all the names were printed in upper case letters). Even children who had recognized these names in the pre-test confused these names. Similarly, there was confusion between names such as EEMI and TEEMU. Initial letters were used as a cue for recognizing names e.g. JARNO, JOONA JESSICA, NIKO, NIILO, SOFIA, SISU, VALTO, VILMA and VÄINÖ. Final letter position confused children only with the two names JOONA and HANNA which have the same final two letters.

Based on the data recorded by the phones it seems obvious that the children started to use their letter knowledge as a cue for recognition. In fact, children who had enough or almost enough letter knowledge first made lots of errors, but touched the correct names later. This means that the children began to use their letter knowledge more accurately, looking at their order rather than using their logographic memory.

7 Discussion

We reported our first pilot study of an NFC-based learning application. This and our earlier prototypes (e.g. [2],[18]) illustrate the potential of NFC user interfaces. As predicted, all children learnt to use the application quickly. While we were instructing the teachers to use the application, some of the children spontaneously took some phones and started using them without any direct instructions. Some of the children even learnt by themselves, without any instructions, how to use the phone's camera to take pictures and videos of their peers.

NFC technology can be integrated into the environment and no technology-specific features need to be remain visible. The users can be instructed to use natural actions of touching, actions that are one of the first ones we all learn in our early childhood. This matches well the concept of calm computing [20]: computers vanish in the background and support us in our everyday activities without demanding too much focus or disrupting our activities.

Interaction by touching is easy. The users of this application are so young that they have not even learnt to read yet – and hence cannot use conventional user interfaces presenting textual information. Moreover, the phone keypad is not needed at all. NFC user interfaces are suitable for user groups that cannot read, have difficulties to read due to poor eyesight, or have difficulties in using the keypad, for example. One could develop NFC applications for such users using mainly graphical icons, images, animations, vibration, sounds, speech, and touching for interaction with the user.

An interesting observation is that quite modest phones are sufficient for NFC applications. As the interaction is based on touching objects in the environment with a phone, advanced GUI features and sensors like high-resolution touch displays and gyroscopes are not needed. Many useful applications (like the one described in this paper) do not even need network connectivity. The 6131 NFC phone model has limited features. However, for this application – and for many other applications utilizing the NFC reader – this model has all the features needed. In fact, it has even better usability than some newer NFC phone models, as the location of the NFC reader and the slightly curved form of the phone when opened enable quite natural touching actions with surfaces at different orientations.

Based on the results of the pilot study, it seems that children who already had some prior knowledge benefited more from the activities during the two-week period. It seems that knowing ten letters or more is instrumental for rapid growth of print related knowledge. The results suggest that the activities affected children's emergent knowledge, although the activity period only lasted for two weeks. Furthermore, during this period the children played at most 64 minutes – just a bit longer than one Finnish lesson at school, where about 7 lessons per week for several months have been reserved for teaching letters and their sounds. Considering the very short time the children spent playing, it is surprising how children were able to self teach with the phones not only the technology but some emergent literacy knowledge as well.

The time spent with the learning application varied among the children, as did their motivation. However, many children were keen on playing with the mobile phones and wanted to take them home to continue with the activities. The child's own name appeared to be a very important piece of text. However, there might be space for developing the application to use children's popular culture, for example as a context for learning the literacy concepts.

Indeed, the only text our application presented were the names of the children. It is very obvious that the children recognized the names as logos as children do in their process of becoming conventional decoders [9]. However, the names provided a context for learning the letters [12], [5] although the letters were not introduced at all. The results indicate that the application can facilitate learning letters, which is a prerequisite for learning to read. Moreover, this kind of application can familiarize children with new technology, multimodality, and emerging new literacy skills [5]. It is likely that this application would support acquiring decoding skills, if it was available for a longer period. However, more research is needed before the effect of the application can be estimated in more detail.

Interestingly, the literacy activities changed from individual practice to collaborative peer interaction. The children especially liked to share their texts on mobiles by showing them to their peers, and invited others to listen to their names. In addition, children were eager to ask for help and to advise their peers in using the mobile phones for name recognition. The teachers were very motivated to continue the activities. Indeed, it was their initiative to continue developing and making small changes to the application for the next implementation. It is worth noting that the teachers as well as researchers regarded the activities as different from both computer and pen-and-pencil literacy activities, because the phones allowed children to move around instead of sitting still. The application met the children's need to move. Therefore the activities were rather playing than learning exercises.

We have added functionality to the application and are currently testing it in a kindergarten. The new version also presents individual letters and asks children to touch the starting letter of a given name. We are considering control groups as they would produce more information about this application's effects on learning.

This was the first application. NFC technology offers remarkable potential to develop new learning applications that focus on acting in groups in a real environment rather than using conventional educational material and computers in a classroom. At its best, this technology can facilitate inclusion in learning: children that do not learn as fast as others can use this kind of applications to catch up with others. We will continue to develop new learning applications utilizing NFC technology. In fact, such a study is already in progress.

Acknowledgments. Our thanks to Mikko Pyykkönen for designing the user interfaces, to Mari Pitkänen for participating in the design and testing, and to Seppo Laukka for his help in collecting data about the children's use NFC application.

8 References

1. NFC Forum. 4.1.2011. NFC Forum Specifications. http://www.nfc-forum.org/specs/
2. Riekki, J., Salminen, T. and Alakärppä, I. Requesting Pervasive Services by Touching RFID Tags. In: IEEE Pervasive Computing, vol. 5, no. 1, pp. 40-46. (Jan.-Mar. 2006) doi: 10.1109/MPRV.2006.12
3. Parton, B.S. and Hancock, R. When Physical and Digital Worlds Collide: A Tool for Early Childhood Learners. In: Springer Boston. TechTrends: Linking Research and Practice to Improve Learning. vol. 52, no. 5, pp. 22-25. (2008) doi: 10.1007/s11528-008-0191-4
4. Sharp, R. and Rehman, K. The 2005 UbiApp Workshop: What Makes Good Application-Led Research? In: IEEE Pervasive Computing, vol.4, no. 3, pp. 80-82, (July-Sept. 2005) doi: 10.1109/MPRV.2005.69.
5. Bus, A.G & Neuman, S.B. (Eds.) Multimedia and literacy development. New York: Routledge. (2009).
6. Want, R., Fishkin, K. P., Gujar, A. and Harrison, B. L. Bridging physical and virtual worlds with electronic tags. In: Proceedings of the SIGCHI conference on Human factors in computing systems: the CHI is the limit, pp. 370-377. Pittsburgh, Pennsylvania, United States, (1999)
7. Want, R. Near Field Communication. In: IEEE Pervasive Computing vol. 10, pp. 4-7. (2011)
8. Välkkynen, P., Korhonen, I., Plomp, J., Tuomisto, T., Cluitmans, L., Ailisto, H., Seppä, H.: A user interaction paradigm for physical browsing and near-object control based on tags. In: PI 2003. Workshop on Real World User Interfaces in conjunction with Mobile HCI 2003, Udine, Italy (2003)

9. Ehri, L,C. Development of the ability to read words. In: R. Barr, M.L. Kamil, P.B.Mosenthal & P.D. Pearson (Eds.) Handbook of reading research vol. II. pp. 383-417. London: Routledge (1991)
10. Van der Kooy-Hofland, V., Kegel, C. A.T. and Bus, A. Evidence-based computer interventions targeting phonological awareness to prevent reading problems in at-risk young student. In: S. B. Neuman and D.K. Dickinson (Eds.) Handbook of Early Literacy Research, voI. III, pp: 214-227. London: The Guilford Press. (2011)
11. Korkeamäki, R-L. How first graders and kindergarten children constructed literacy knowledge in the context of story reading and meaningful writing. In: Acta Universitatis Ouluensis. E 21. University of Oulu. (1996) ISBN 951-42-4290-4.
12. Bloodgood, J.W. What's in a name? Children's name writing and literacy acquisition. Reading Research Quarterly, vol. 34, no. 3, pp. 342-367. (1999) http://www.jstor.org/pss/748067
13. Laouris, Y. & Eteokoeous, N. We need an educationally relevant definition of mobile learning. In: 4th World Conference on mLearning (pp. 1-13). Cape Town, (25-28 October 2005). http://www.mlearn.org.za/CD/papers/Laouris%20&%20Eteokleous.pdf
14. Lam, J., Yau, J., Cheung, S.K.S.: A Review of Mobile Learning in the Mobile Age. In: ICHL'10 pp. 306-315 (2010)
15. Cavus, N. and Ibrahim, D., m-Learning: An experiment in using SMS to support learning new English language words. British Journal of Educational Technology, no. 40: pp. 78–91 (2009)
16. Revelle, G., Reardon, E., Mays Green, M., Betancourt, J. and Kotler, J. The Use of Mobile Phones to Support Children's Literacy Learning. PERSUASIVE 2007, LNCS 4744, Springer-Verlag, pp. 253–258. (2007)
17. Ervasti, M., Isomursu, M. and Kinnula, M. 2009. Experiences from NFC Supported School Attendance Supervision for Children. In: Third International Conference on Mobile Ubiquitous Computing, Systems, Services and Technologies UBICOMM '09, pp. 22-30. (11-16 Oct. 2009) doi: 10.1109/UBICOMM.2009.9
18. Sanchez, I., Riekki, J., Rousu, J. and Pirttikangas, S. Touch & Share: RFID Based Ubiquitous File Containers. In: 8th International Conference on Mobile and Ubiquitous Multimedia. MUM08, pp. 57-63. Umeå, Sweden (Dec 3-5 2008)
19. Sung, J.-Y., Levisohn, A., Song, J.-W., Tomassetti, B., and Mazalek, A. In: The First IEEE International Workshop on Digital Game and Intelligent Toy Enhanced Learning,. DIGITEL '07, pp. 206-208. (2007) doi:10.1109/DIGITEL.2007.43
20. Weiser, M., Gold, R., and Brown, J.S. The origins of ubiquitous computing research at PARC in the late 1980s. In: IBM Systems Journal, vol. 38, no. 4, pp. 693 - 696, (1999) ISSN: 0018-8670, doi: 10.1147/sj.384.0693