

LEARNING THROUGH NFC-ENABLED URBAN ADVENTURE

User Experience Findings

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Abstract: This paper presents a mobile context-sensitive learning concept called the Amazing NFC, and reports the findings and results of a field study where 228 students experienced the Amazing NFC urban adventure during spring 2008. The Amazing NFC concept is an Amazing Race -style survival game for teenagers for learning skills and knowledge essential to everyday life and familiarising them with their hometown. During the Amazing NFC lessons, students were guided through an urban adventure track with the help of NFC mobile phone, site-specific NFC tags located at eleven control points and related mobile internet content. Trial aimed to analyze touch-based interaction paradigm directed to specific users in a defined context as an implementation technique for mobile learning. User experiences and added value evoked by the service concept were investigated via a variety of data collection methods. Findings revealed that students experienced the NFC technology as easy and effortless to use. However, users hoped to see more challenges and activity in the track in the future. Our analysis indicates that one main benefit of the urban adventure concept was moving the learning experience from the traditional classroom to a novel context-sensitive learning environment that includes social interaction between students.

1 INTRODUCTION

Traditional classroom learning is what we are all most familiar with. It usually awards credits based on student performance, which is measured through assignments, tests and exams. Traditional learning typically takes place in an identifiable classroom space during pre-defined hours. A classroom usually has a number of specific features, including a teacher who delivers information to students and a number of students who all are physically present in the classroom and regularly meet at a specific time. Many learners favour traditional learning while others find that it is more restrictive and lacks flexibility. (Learn-Source, 2008)

However, new ways of learning are emerging. New learning approaches suggest that imaginative and innovative approaches are needed to bring about improvements in learning new skills and adopting new information (Espoir Technologies, 2007). The best learning occurs in a stimulating, active, challenging, interesting and engaging environment when you move at least some part of your body and when you learn things by doing and by experience

(ibid). The best learning occurs when you are actively involved in co-constructing knowledge in your own head, not passively reading or listening or taking notes. Forcing people to sit in a chair and listen (or read) dry, formal words (with perhaps only a few token images thrown in) is often considered to be the slowest, least effective, and most painful path to learning (ibid). Yet it is the approach you see replicated in everything from K-12 to universities.

Mobile phones have now evolved into pocket-sized computers and as such have the ability to deliver learning object and provide access to online systems and services. Mobile learning is unique in that it allows truly everywhere, anytime, personalized learning, and offers opportunities to integrate learning technology into student's daily activities (Laroussi, 2004). Mobile devices belong to a learner's personal sphere, which means that the learner can take learning opportunities directly in the situation where they occur, because the learner has his learning environment always at hand (ibid). Mobile learning can also be used to enrich, enliven or add variety to conventional lessons or courses (Attewell, 2005). Thus, the educational potential of

mobile learning contents, both as learning and teaching tool, is widely acknowledged, and various initiatives have been undertaken to encourage the integration of educational mobile resources in school practice (Avellis et al., 1999).

Portable technologies have been explored in the context of m-learning to provide literacy and numeric learning experiences for young adults (aged 16-24) who are not in a full-time education environment (Attewell, 2005). The m-learning project running 2001-2004 intended to develop some of its learning materials using a gaming philosophy to make their use attractive to young adults. In the project 62% of learners reported they felt keener to take part in future learning after trying mobile learning. 82% of respondents felt the mobile learning games could help them to improve their spelling and reading, and 78% felt these could help them improve their maths. Study's evidence suggests that mobile learning can make a useful contribution to attracting young people to learning, maintaining their interest and supporting their learning and development. It was also observed that loaning equipment to young adults has resulted in other benefits not directly related to the learning experience. In particular, some of the learners were surprised and proud to be trusted with such expensive and sophisticated technology.

Wyeth et al. (2008) have used mobile technology as a mediator within science learning activities in a trial where 11-year-old children completed in pairs an outdoor treasure hunt activity using a combination of two mobile phones and a video camera. During the trial was discovered that all the children treated the treasure hunt as a competitive activity and were highly motivated to make discoveries based on the clues. However, the side effect of the racing nature of the treasure hunt was that it detracted from more focused learning and considered reflections on what had been observed. Study findings also revealed the importance of context in learning: new understanding emerged as children moved through the treasure hunt environment. Productive and creative aspects included in the trial appeared also to provide an intrinsically motivating platform for learning.

Chang et al. (2006), in turn, have introduced the treasure hunting learning model that extends Computer-Aided Learning systems from web-based learning to mobile learning. In their model the system will provide students suitable instructions or quests according to students' learning results on web, students can use the mobile phone to get the guidance messages or quiz when they are moving around in the field, and what concepts students

obtained and did not understand during the mobile learning phase will be posted on the website in order to let teacher and students do further discussions.

The effective use of mobile learning resource depends to a large extent on how enjoyable students find the learning experience. Some students may be motivated by an element of competition (Becta, 2006). Also to cater the academic needs of students, the service needs to be at the appropriate intellectual level. Avellis et al. (2003) state that the effectiveness and pedagogical soundness are very important to evaluate in mobile contents. Some of the factors that encourage a positive response from students to mobile learning have been identified as (Becta, 2006):

- Attractive presentation
- Interactivity
- Feedback
- Appropriate skill level(s)
- A 'fun' element
- Clear focus
- Use of different types of media
- Versatility
- Non-threatening environment
- A feeling of progression and achievement
- Intuitive design and interface
- Challenge.

In the Amazing NFC trial, an Amazing Race - style game was created for teenagers for learning skills needed in everyday life and learning facts about the city of Oulu in Finland. An objective was to trial a context-sensitive educational service for the target group by utilising NFC technology. Our urban adventure concept acknowledged the importance of context within the learning experience by focusing on situated learning (Brown et al., 1989): enabling learning in real-life contexts, outside the confines of a conventional classroom (Tétard et al., 2008).

The aim of the trial was also to investigate user experiences evoked by the touch-based interaction paradigm and the mobile learning concept itself. In addition, the educational aspects concerning the new learning environment and the suitability of the touch-based user interface and the related interaction technique for the target group, i.e. the teenagers was explored. In the trial was also examined the added value the concept brings to learning.

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 (Rukzio et al., 2006). Väikkynen et al. (2006) state that touching is an effortless way to select objects in the environment and it is easy to learn and use.

NFC (Near Field Communication) technology is designed to make communication between two devices very intuitive, and NFC suits the requirements for physical mobile interactions very well. Objects can be augmented with NFC tags and mobile devices can be equipped with NFC readers. Tags in the environment may be used to provide fast, zero-configuration service discovery (Isomursu et al., 2008), and they can be attached to virtually any object or surface. When a tag is touched, the tag reader integrated into the mobile phone reads the information embedded by the tag and is then able to perform predefined actions. Tags are also small and inexpensive, which makes tags suitable for embedding the user interface into the everyday living environment of the user.

The main advantages of NFC are the simple and quick way of using it and the speed of connection establishment, and even though people may have to learn how to use touch-based interaction, it still offers possibilities to be much simpler and quicker than classical screen-based user interfaces on mobile devices (Falke et al., 2007; O'Neill et al., 2007). In our concept an URL to the web content was transferred from the tag to the mobile phone when the user touched the tag. The browser available in the mobile phone could then directly access the URL.

3 RESEARCH SETTING

Amazing NFC field trial was implemented in the city of Oulu in May 2008. The total of 228 students between the ages of 14 and 15 from the schools located in the Oulu district participated in the trial. The mobile learning concept used in the trial was called "Amazing NFC" after the well-known TV series called "Amazing Race". During the Amazing NFC lessons that took place in downtown Oulu, the students were guided through an urban adventure track with the help of mobile phone and related mobile internet content. Eleven locations, that we called "control points", around Oulu were marked with NFC tags.

In the beginning of the Amazing NFC lesson, the students were grouped into small groups of two. Each student was provided with Nokia 6131 NFC-enabled mobile phone for the duration of the lesson

and each student pair received an individual route with a designated departure point. Upon arrival at a control point, the student touched the NFC tag and a web-page concerning information about the place where the control point was located (e.g. a museum) was sent to the student's phone. First the student read the text relating to the control point, watched a video or listened to an audio file, and then answered to a question related to the site. In some locations, the question required the user to do some tasks to acquire the information needed to answer the question. After completing the assignment, students received instructions and a map guiding them to the next NFC control point. The control points, with the exception of zoological museum, were located in the city centre within a couple of kilometres distance, and the students were expected to travel from one control point to another with bikes (although some used mopeds against instructions).

During the lesson, the teachers were able to follow in real time via a web-based user interface how the pairs of students proceeded through the adventure track. Also, the students were advised to use the mobile phone to call the teacher in case of problems or questions. In Figure 1 is described the overall view of the urban adventure concept.

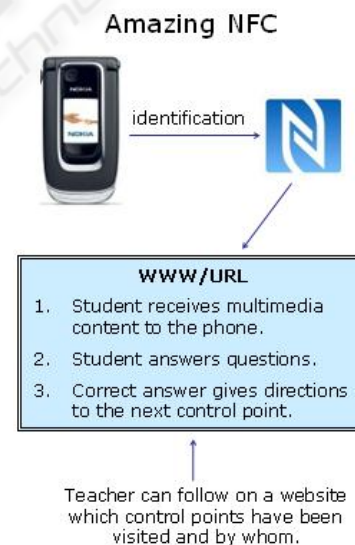


Figure 1: Overall view of the trial.

The educational goals of the Amazing NFC lesson were to provide the students with knowledge related to landmarks, public buildings and offices in their hometown, and practical skills related to dealing with public authorities in mundane everyday tasks. The locations chosen as control points were city information centre, fire station, swimming hall,

police station, museum, city hall, youth and culture centre, zoological museum at University of Oulu (requiring a bus journey to the museum and back, and ticketing was done with an NFC phone), city library, theatre and the social insurance institution. During the bus journey to zoological museum, the students became familiar with, among other items, the “Initiative for Oulu” service, i.e. sending an electronic initiative to city authorities by touching information tags in the bus. In Figure 2 the student is touching the Amazing NFC tag at the control point inside the social insurance institution.



Figure 2: Student visiting the Amazing NFC control point located at the social insurance institution.

The Amazing NFC lesson was planned and designed in close cooperation of teachers, service and technology providers, and researchers. During the design phase was especially emphasised the ultimate goal of integrating the concept into the normal practices of the schools, so that the trial would not to remain as a single occasion related to the research project. The aim was to create a viable concept that could be adopted as a learning instrument 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 trials. During the trial, the researchers were only involved in the data collection activities; teachers took full responsibility for organizing and supervising the actual Amazing NFC lessons.

4 DATA COLLECTION

Dutton and Aron (1974) have stated that humans are not very good at analysing what actually caused an experience, so it can be difficult for users to identify if the experience was caused by the technology under evaluation or the user experience evaluation

method (or any other event in the life of the user). Human memory about experiences is also unreliable thus affecting our ability to recall past experiences so that we could compare them with other experiences (Schooler and Engstler-Schooler, 1990), or to describe them reliably after time has passed. Also, our ability to predict our own experiences in a hypothetical or future setting is very limited (Wilson et al., 2000; Gilbert and Wilson, 2000). Therefore, in order to achieve the most reliable understanding of user experience, the data during the Amazing NFC lessons was collected in three phases: before use, during use and after the use.

Since describing and understanding user experience are complex as user experience is always multifaceted and difficult to verbalise and describe, the combining of different data collection methods increases the reliability and validity of the results (Isomursu et al., 2007). Therefore, we decided to utilise a variety of data collection methods that were highly complementary (Yin, 2003). The methods used and data collected in different phases of the experiment were as follows.

Before the start of the trial, two teachers were interviewed in order to investigate their expectations, doubts, thoughts and attitudes towards the evaluated technology and learning concept. Before the Amazing NFC lesson we also observed how the students learned to use NFC technology, and what kind of spontaneous reactions and discussion took place in introduction of the concept. A mobile questionnaire was used to capture information about the expectations and attitudes towards the mobile learning experience before the lesson. Unfortunately, there were some technical problems with the mobile questionnaire during the very first trial lessons. Additionally, some teachers forgot to provide the NFC tag used for accessing the mobile questionnaire for their students. Therefore, not all students were able to report their experiences through the mobile questionnaire (we received 133 valid responses from 228 participants).

User experiences during the Amazing NFC lesson were collected through video recordings, and through automatic creation of log data about how the pairs of students progressed on the track. Video recordings were made by placing video cameras at fixed spots to record students while they were visiting the NFC control points, and by providing students video cameras that they could use to record their experiences during the lesson.

After use, the students filled out a second mobile questionnaire collecting data about the user experience immediately after use. The data received

from both mobile questionnaires was used to survey how students' expectations and attitudes changed during the trial; whether their expectations were met and attitudes altered. The students and teachers were also requested to fill out a web questionnaire within two weeks after the trial. For this purpose we created two separate questionnaires (resulting in a total of 81 responses from students and 8 from teachers). In addition, we arranged a workshop with twelve students to explore the experiences with the Amazing NFC. The workshop included participatory features, i.e. the students participated in designing how to iterate the concept for future use.

5 FINDINGS

5.1 Before Use

Evaluation before use was done for gaining insights into the attitudes, expectations and doubts of the user groups regarding the upcoming Amazing NFC lesson. Technology training situation was observed to see how the students coped with learning to use new touch-based interaction technique.

5.1.1 Interviews with Teachers

In general, teachers had a positive attitude toward the learning concept. They found the trial trustworthy; students could not get lost or get into trouble as the teachers could follow their progress on the track in real time through a web interface and contact them if needed. Teachers felt it was good that learning could be taken out from the traditional classroom and 45-minute teaching style. They saw the concept as an excellent way to familiarise the students with their hometown and for students to learn life-skills and to gain more courage to visit different public buildings and offices in the city. However, teachers thought that urban adventure track needs to provide students a sufficient amount of challenge in order to maintain their interest and motivation during the Amazing NFC lesson. Thus, in order to make a concept to succeed and to create real experiences students must be offered more activities, such as competitions and tasks. Teachers expressed a doubt of NFC technology having the taint of decoration; that in practice NFC would not bring any added value for the learning concept. Teachers' stressed that the technology itself is not enough to surprise and amaze students; it is the content and activities that need to generate real experiences.

5.1.2 Observation of the Training

Before the Amazing NFC lesson, students were given an introduction to NFC technology and they had their first visual and physical encounter with the learning concept and their first hands-on experience on using the novel interaction paradigm. Therefore, it is not surprising that learning touch-based interaction required some practicing. Students needed some practice to find the comfortable personal reading distance between the tag and the phone. Also, finding the right touching spot both from the phone and from the tag, and learning the response times required some practice. However, as teenagers are nowadays very technological-savvy and familiar with mobile technology, they adopted the new technology and touch-based interaction fast: all students were able to learn to use touch-based interaction with a few repetitions.

5.1.3 Mobile Questionnaire

Students' preliminary feelings were explored with a mobile questionnaire just before the Amazing NFC lesson: general attitudes toward the lesson, the biggest expectations of and the major doubts about the lesson. We received 133 responses from 74 boys and 59 girls. A three-point Likert scale ranging from 1 (positive) to 3 (negative) was used to measure the question concerning the attitude. 54.1% of students had positive feelings about participating in the lesson, and only 10.5% of students expressed negative attitudes towards the lesson (see Figure 4).

In order to investigate the correlations that stemmed from the student's gender, data was also analysed by doing the dependency tests between the questionnaire parameters. Between the student's gender and attitude towards the Amazing NFC concept was found a direct correlation (see Figure 4). 16.2% of boys had negative attitudes towards the lesson, whereas only 3.4% of girls expressed the same opinion. In contrast, 72.9% of girls thought it was nice to attend the lesson, the corresponding proportion of boys counting only to 39.2%.

Students were expecting most eagerly (see Figure 3) to spend time with their friend (21.8%), to try out new technology (21.8%) and to get out of the school (19.5%). They were least expecting to learn new information at the control points (9.8%) and to get to know new places (8.3%). Correlation was also discovered between the gender and expectations (Figure 3). 32.2% of girls were most expecting spending time with their friend while only 13.5% of boys were expecting that. Whereas 29.7% of boys and only 6.8% of girls were expecting getting away

from school the most. Quite surprisingly, more boys (13.5%) than girls (5.1%) were waiting “learning new information”, whereas girls (15.3%) were more waiting “getting to know new places” when compared to boys (2.7%).

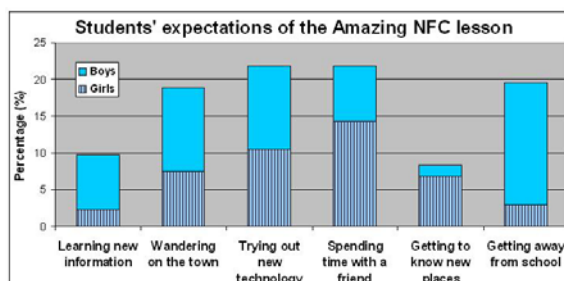


Figure 3: Students' expectations of the Amazing NFC before the lesson (n=133; 74 boys and 59 girls).

Over half of the students (66.2%) reported having no doubts regarding the Amazing NFC lesson. Of those 33.8% students that reported having some doubts, 16.5% identified the most important reason to be the anticipated problems with new technology, 7.5% considered it to be the difficulty of finding the control points and moving around the city and 3.8% feared bad weather during the day. Student's gender had also effect on whether or not something daunted him or her before the lesson: 41.9% of boys had some doubts whereas the figure with girls was lower (23.7%).

5.2 During Use

Collecting information about user experiences at the time they happen requires in situ data collection methods which can be applied during the use of technology (Consolvo et al., 2007). This means that the tools and methods used for collecting user experience data need to be integrated into the everyday practices of the trial users, just as the technology under evaluation. Experiences show that the user experience evaluation method may actually “steal the show” (Isomursu et al., 2007) if it is more visible and needs more attention and cognitive processing from the user than the actual technology under evaluation.

5.2.1 Video Recording

Video cameras were set at fixed spots to record students while they visited NFC control points. This solution was chosen in order to minimise the interruption of the videotaping, and to prevent it from having an influence on the user's behaviour

and user experience formation (Yin, 2003). However, when the student's head was down while he was watching the mobile device, it was difficult to see all the facial expressions. Students also often turned their backs to the camera or even moved out of the reach. Thus, videos recorded by students themselves proved to be a better information source. Videos showed, for example, that students commonly asked for help from passers-by if they had trouble finding the control points. During the lesson they also called and send text-messages to their classmates to find out how they were doing and how many control points they still had to go.

5.2.2 Log Data

User experiences were also collected by monitoring the log data that was automatically recorded from the control points by the Amazing NFC backend system. For example, from the log data could be seen that some pairs coincided with each other at some control point and continued their way from then on together, which resulted in some students going through part of the track in bigger groups.

5.3 After Use

After-use evaluation was utilised to investigate user experiences after the lesson and to identify possible changes in students' attitudes by comparing situations before and after use. Also the future use of the concept was inquired of students and teachers.

5.3.1 Mobile Questionnaire

Students' experiences were explored with a mobile questionnaire immediately after they had finished the Amazing NFC lesson. The questionnaire explored the general feelings after the lesson as well as the best things and the downsides experienced during the lesson. A three-point Likert scale ranging from 1 (positive) to 3 (negative) was used to measure the question concerning the emotions. 51.9% of the students reported that they had enjoyed participating in the lesson, whereas 13.5% described their feelings as negative (see Figure 4). A direct correlation between student's gender and feelings after the lesson was revealed: 20.3% of boys had negative feelings when only 5.1% of girls were in the same opinion. As much as 66.1% of girls but only 40.5% of boys had enjoyed the lesson.

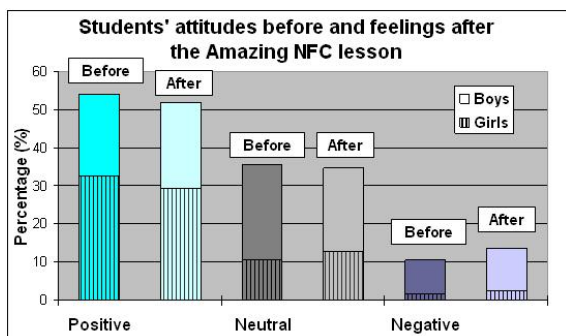


Figure 4: Students' attitudes towards Amazing NFC before the lesson and their feelings towards Amazing NFC after the lesson (n=133; 74 boys and 59 girls).

There was also discovered correlation between students' attitudes before and feelings after the lesson. 60% of the respondents who reported having negative feelings after the lesson had also had an unfavourable attitude towards the lesson. Correspondingly, as much as 72.9% of those having positive feelings after the lesson had also had a favourable, positive attitude before the lesson.

The best things in the lesson were considered to be spending time with a friend (30.8%), wandering on the town (22.6%) and trying out new technology (19.5%). Over half of the students (64.7%) stated that in their opinion there were no downsides in the Amazing NFC lesson. Those 35.3% that had experienced some negative things felt that the most important reason was related with finding the control points and moving around the city (12.8%).

5.3.2 Web Questionnaires

After the trial, students and teachers answered to the web questionnaire that aimed for evaluating their experiences about the lesson and finding improvement ideas for Amazing NFC. Unless stated otherwise, a four-point Likert scale ranging from 1 (strongly agree) to 4 (strongly disagree) was used to measure the questionnaire variables.

The total of 81 students (42 girls and 39 boys) answered to the web questionnaire. The majority of the respondents reported that they liked the urban adventure track (av. 3.741, where the scale was from 1 (boring) to 5 (nice)). Students mostly agreed that it was easy (av. 1.691) to discover the tags located at the NFC control points. The navigation from one control point to other by using the map and instructions received on the mobile phone was considered easy (av. 1.838). The usage of NFC phone and touching the tags was also experienced as effortless and natural (av. 1.457).

However, the students somewhat disagreed (av. 2.432) that the information provided at the control points was interesting. Students did not think they had learned lot of useful information during the lesson (av. 2.346) nor considered the questions presented at the control points having been challenging (av. 2.951). Nevertheless, they preferred (av. 1.704) the learning through Amazing NFC to learning in the classroom, but did not think (av. 2.346) that participating in the trial had given them more courage to visit the public buildings and offices in their hometown.

Students found it nice (av. 1.469) that they could go from one control point to other on their own and at their own pace. In the trial, the learning experience was rather social, as the students were instructed to work in pairs. Working in pairs was preferred by almost all (97.5%). In addition, many participants (59.5%) reported that they had formed bigger groups during the Amazing NFC lesson. The time it took from the students to go through the adventure track and the distances between the control points were perceived as suitable by 76.5%.

In the web questionnaire were also explored students' preferences between the eleven control points. Students had most liked about the control point that was situated inside the zoological museum (32.1%), next best was the bus journey to the museum (25.9%), the third best being the police station (9.9%). So, clearly the most interesting control point for Amazing NFC participants was the visit to zoological museum. The visit started with a bus journey, where the students were able to use their NFC phones for ticketing. Inside the bus the students were able to use informational NFC tags offering e.g. news from the local newspaper. For other transitions, students used bikes in all weathers. During some lessons, weather was cold, rainy and windy. Also, as the lesson lasted approximately three hours, some students started to get tired. Therefore, the bus ride was experienced as a welcome change. At the zoological museum, the students were instructed to see the animals on display, and consume content about the animals through tags attached to the displays. When compared to other control points, there was clearly required more activity and offered more interaction with the environment.

Students reported that they would be willing to participate in the Amazing NFC lesson also in the future (av. 2.123), but were not especially eager to go through the adventure track on their own outside the school (av. 2.716). In students' opinion NFC technology suited the learning concept well (av.

1.605) and they would be glad (av. 1.815) to use NFC technology also in other situations and environments. The average grade students gave to the concept was 8, on a scale from 4 to 10.

The total of eight teachers answered to the web questionnaire after the Amazing NFC lesson. Teachers experienced that the new learning concept exceeded their expectations (av. 1.5) and somewhat agreed that students had learned and received new information to expected extent (av. 1.75). All the teachers thought that the adventure track served well getting to know ones hometown, and 75% of the teachers were in the opinion that the lesson had also served students becoming independent and learning life-skills, whereas only 25% thought that the lesson had served informational learning. They also agreed that the monitoring of students' progress on the track was easy (av. 1.375) through the web-based interface and had received all the necessary information through it (av. 1.625). All the teachers were ready to exploit the learning concept in the future. The average grade the teachers gave to the concept was 8.9 on the scale from 4 to 10.

Teachers gave also many ideas for the future utilisation of Amazing NFC concept. For example, different kinds of adventure tracks could be planned based on art works, nature, history or different theme days such as Easter and Christmas, and in those occasions tags could be placed in locations that suit the theme. Teachers also hoped to see the concept to be used for teaching of different school subjects, e.g. in language learning clues and tasks at the control points could be given in English. NFC tracks could also be created for new students starting the secondary school in autumn. On their first day at new school students could go through the adventure track located on the school premises and would thus have an opportunity to familiarise themselves with the new school and its surroundings. Getting to know unfamiliar cities with the help of NFC technology would also be useful for example during school trips. Teachers were in the opinion that the adventure track should be mainly directed for a bit younger students, because students around the age of 15 already have so advanced knowledge and skill levels that they comprise a difficult target group when you want to dazzle them with new information.

5.3.3 Workshop

In the workshop twelve students were asked to give ideas on how the Amazing NFC concept could be improved and developed further. In their opinion,

tags at the control points should be hidden and located in more difficult places. Students also thought that the tasks should be longer, and more effort should be required to find answers to questions, because now all just guessed the answers. There should be someone supervising at the control points to check that all tasks would be performed correctly. Students hoped to see more physical and problem-solving tasks and activities at the control points and if they could also compete with each other on the adventure track it would bring along more motivation and excitement.

6 DISCUSSION AND CONCLUSION

The Amazing NFC learning concept provides a learning experience on a mobile phone – which many young people are comfortable using and enthusiastic about. Mobile technology was used to encourage both independent and collaborative learning experiences, to help to battle against reluctance to use ICT in learning, to help to remove some of the formality from the learning experience, to engage reluctant learners, to aid learners to remain more focused for longer periods and to help to raise learners' independence and self-esteem. In our concept an objective was to have learning content, pedagogical methods and technological tools all functioning in a harmony (Tétard et al., 2008).

Teenagers are a tough target group for designing mobile services. The experience and high knowledge in using mobile devices means that this user group is hard to amaze or even satisfy. NFC promises a novel and intuitive user interface to mobile devices but the novelty of the technology is not enough to ensure the success and interest of the concept. The teenagers who attended the trial had high expectations concerning the new technology and the content and quality of the service. One factor contributing to negative attitude towards the content provided and related tasks may be the association made by naming Amazing NFC after the popular TV show "Amazing Race". The naming might have set expectations and mental impressions that were not fulfilled. For example, searching and finding the tag at the control points was part of the excitement of the urban adventure. This is illustrated in the following improvement idea expressed by one of the students: *"Tags should be somehow hidden so it would be more interesting to search for them."* The

excitement and challenge level of the TV show was not obviously reached during the lesson.

Observation of students showed that none of them had problems in learning to use touching as an interaction technique within a couple of minutes of hands-on training. Intuitiveness and naturalness of this interaction technique made adopting effortless. In NFC technology survey (O'Neill et al., 2007) was discovered that users were concerned with how the use of NFC readers in public spaces made them appear to other people around them. Many participants of that survey noted that they felt awkward at first using NFC due to the very explicit public act of reaching out and touching a tag embedded in the environment. However, many participants lost their reservations about using NFC over the course of the trial. In Amazing NFC trial, none of the students reported that touching tags would make them feel uncomfortable.

Even though the students attending the Amazing NFC lessons mostly reported that context-based mobile learning experience was better than classroom learning and they enjoyed participating in the lesson, they criticized the provided content strongly. Majority of students reported that the tasks and the information provided were not interesting and challenging enough to make the urban adventure truly motivating and thrilling. Students expressed their need for getting more challenging tasks, for example by including physical and competitive activity and increasing the variety of tasks. For example, the following student comment reveals the need for improvement: *“There should be more challenge at control points. Now the maps were not actually needed and the questions were too easy.”*

Clearly the most interesting control point for Amazing NFC participants was the visit to the zoological museum. When compared to other control points, there was more activity required from the students and more interaction offered with the environment. The average time used for the visit was the longest during the lesson, and the content and related questions integrated seamlessly with the physical activities required and the context of use. In most control points, the students just quickly visited the entrance hall of a public building for reading the content and to answer the question. In these cases, the physical experience and social context of the location did not successfully integrate with the content provided, as the students did not really interact and experience the space and environment they visited.

Thus, in future development the Amazing NFC urban adventure needs to be more carefully

combined with intrinsically motivating attributes (Malone and Lepper, 1987) such as challenge, curiosity and competition. However, when adding the element of competition in learning, one has to be aware of the possible pitfalls associated with racing (Wyeth et al., 2008).

Teachers brought up an idea that in the future the students themselves could act as content creators and providers by offering them a possibility to create their very own tags and to place these tags at the control points. In general, teachers identified that the main benefit of the Amazing NFC lesson was moving the teaching situation and learning experience from the traditional classroom to real-life contexts that also included social interaction between students.

Within this mobile learning concept the threats mostly concern to ensure the safety of students while they are independently going through the urban adventure track. However, students participating in the trial were already older and more independent and used to move around the city by themselves. Also, students could not get lost in the city because teachers were able to follow in real time their progress on the track through a web interface, and the students were advised to use the NFC phone to call the teacher in case of problems or questions. Throughout the pilot, the students coped very well on their own. However, the city of Oulu is relatively small (130 000 inhabitants). In bigger cities safety could be more of a problem.

Also, in this kind of concept a password protection is a necessary requirement to gain access to the web interface that contains status information of the students (which control points have been visited, at what time and by whom) while they are on the urban adventure track. Tags at the control points need also be protected against rewriting.

After this Amazing NFC trial, the project arranged a cultural/historical track where students became familiar with the city of Oulu's culture and history. The route consisted of seven NFC control points located at the local cultural and historical sites in the Oulu, such as statues, monuments and historically meaningful buildings.

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