NFC AIDED MOBILE ENGLISH LEARING

Mobile Systems

University Of Amsterdam

December 2011

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ABSTRACT

Starting early with learning a foreign language is important for variety of reasons. This makes it important, to expose children to the foreign language as often as possible. The "Mobile English Earning" project researches if a mobile application can contribute to learning English at an early age. The University of Amsterdam collaborates with EarlyBird to create mobile applications for young children. In this iteration of the project we have created a mobile application running the Android operating system, making use of Near Field Computing (NFC), testing the enjoyableness of such an application. We ran a field test with young participants and from our observation we can conclude that the interaction with the environment was enjoyable and worth exploring further.

1   INTRODUCTION

For the course Mobile Systems we have been asked to create a mobile system which could potentially be used to assist young children (about 10 years of age) in learning English in an informal manner. In this report we give an overview of the development and implementation of such a system. The developed system is a location-based mobile game for children. The current implementation uses the zoo as its context. The remainder of this report is structured as follows: the next section gives an overview of the given assignment, as well as the prerequisites of the project. Section 3 describes related literature. In section 4 we describe the game by providing a scenario and several use cases. Section 5 describes the implementation of the game, from conceptual model to working prototype on a mobile phone. Hereafter we describe in section 6 the field test held in the Blijdorp Zoo. Section 7 provides the user evaluation of our system. The planning of the project is found in appendix A.

2   ASSIGNMENT OVERVIEW

The purpose of this course is to produce a mobile interactive system for younger children, which supports them in learning English words. We first describe a typical user in order to deduce the prerequisites.

2.1   TYPICAL USER
Wendy is an 8 year old child residing in Rotterdam, the Netherlands. She goes to an elementary school in Rotterdam as well. Her parents gave her a mobile phone, so that she can call her parents when she needs them. Her parents have been using mobile phones for years, and generally when there is a new and improved model, they want to buy it. When they gave their daughter the mobile phone, they taught her how to use it. This is why she knows how to use the phone pretty well. She often installs new games on her mobile phone and regularly plays them. At school she has recently been given lessons in the English language, 1 hour per week. She already knows a bit of small English words, because she watches movies in English sometimes. She understands the lessons at school pretty well and is really interested in learning more English when she is not at school. She thinks that the English lessons of 1 hour per week are too few. She and her parents have been searching for an educative and fun way to learn English. They found some interesting software about learning English in a games shop. Most of the software was for personal computer use. This might be a problem for Wendy, because there are not many computers at home and most of the time they are being used by her family. Furthermore she wants to learn English wherever she is, at any moment when she feels like it. When she is traveling to school, she is often plays with her mobile phone and that would be an excellent time for her to learn some English as well. Her mother suggested to buy an English learning book, but she doesn't like it, because it would be the same as the boring school books at school. According to her, "learning should be made more fun and not just from boring books. And books are way too big to carry around everywhere."

2.2   TYPICAL USER PREQUISITES
From the description in 2.1 we can deduce the following prerequisites:

- *The system has to be mobile.*
- *The system has to be location based, i.e. the interaction should involve physical objects.*
- *The system should be designed for children of 8 to 10 years of age*
- *The content in the system should come from the MEL-project*
- *The main interaction should revolve around a game*

2.3 GENERAL PREREQUISITES

The purpose of this course is to produce a mobile interactive system. In order to create a system which is enjoyable for users to interact with one has to follow a set of design rules (Preece *et al*, 2002). In the design of our system we will follow these principles (Preece *et al*, 2002):

- *Should be effective, i.e. it should be doing what it is supposed to.*
- *Should be efficient, i.e. it should support users in task completion while using the least effort.*
- *Should be safe, i.e. users should be protected from dangerous situations physically and virtually (exposure or loss of personal data).*
- *Should have good utility, i.e. provide users with appropriate set of tools for performing tasks*
- *Should be easy to learn, i.e. there should be no steep learning curve.*
- *Should be easy to remember, i.e. the system should support users in remembering the interaction flow.*

2.4 QUESTIONS USED WITHIN THE MEL PROJECT

We used the some of the questions from the MEL project because it has already been shown that this set of questions does indeed improve the English knowledge of young children. Most of the questions that we used were generated by ourselves, but similar to the questions used in MEL. In the MEL project the questions were categorized in several continents. We have used the same categorization. All questions that we have used can be found in Appendix C.

2.5 IMPLEMENTED SYSTEM

Following from the previous sections is that the developed should a) let children learn informally and b) incorporate the questions which have been used in the Mobile English Learning project. Informal learning can very well be done through a game. For this reason we have decided to create a mobile location based game.

3   RELATED WORK

3.1   NEAR FIELD COMMUNICATION

Near field communication is a low frequency radio-wave field in the 13.56-MHz spectrum. In comparison to other wireless communication protocols NFC has a low bandwidth (106 to 414 kbps) and is short ranged (theoretical 10 cm, typical 1 to 4 cm). Because of the short range there is no need for discovery and pairing of devices. Discovery and pairing (set-up of the connection) is done automatically when the device is in the field of the NFC receiver / sender. All of this is nothing compare to Bluetooth or wifi. NFC is interesting for its low friction setup. Because it only works at short range, every time the user put two devices within that range they are going to setup a connection and are ready to talk to each other. The user does not need paring, typing in passwords etc, they just connect, offering the chance for improved usability and natural interaction for mobile devices (Anokwa *et al*, 2007). Another interesting feature is passive targets. These are devices that have NFC but no batteries. Examples are stickers with NFC in them. These devices pick up the power from a secondary device for powering up. The NFC Forum[1] specified a set of application functionalities in the specification of the NFC standard. Examples are stickers and posters with embedded text and URLs. NFC is not the same as RFID. RFID works in the range of meters, while with NFC the user needs to be really close to the device in order to communicate with the NFC antenna. NFC produces context-awareness capabilities for a single user interaction (Horng, 2009). In case of M-Learning applications this technology, along with other technologies like GPS, Wi-fi etc change the way people learn in both a formal as informal way (Martin *et al*, 2009).

3.2   MOBILE ENGLISH LEARNING

The Mobile English Learning[2] (MEL) project focuses on learning English to children on primary Dutch schools (Sandberg *et al*, 2011). The idea of this project is that children can also learn outside of the classroom. According to Brown *et al* (2010) it is indeed so that most of general knowledge acquisition happens outside of an area designated for learning or teaching. The focus of the project is to create education methods that are used in addition to classroom rather than replacing classroom learning. The MEL project uses material from the Early Bird program[3]. The Early Bird program develops education programs which can be used at elementary schools to teach children English at an early age. The educational programs of the Early Bird project also have a strong focus on learning outside of the classroom.

In order to test whether children would indeed improve their English skills when using a mobile (smart) phone, a mobile game was developed (Sandberg *et al*, 2011). The developed game was a so called serious

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[1]   http://www.nfc-forum.org

[2]   http://www.mobielengelsleren.nl

[3]   http://www.earlybirdie.nl

game (Susi *et al*, 2007). The idea of serious games is that playful elements can be used in a game setting in order to reach serious goals. The game consisted of questions about 25 different animals. The set of animals was categorized by continent. The game was set in a zoo (Blijdorp in Rotterdam). Children were led by GPS to the different animals. For each animal children had to answer questions posed in English. Each questions was either a multiple choice quiz, spelling quiz, memory game, True or False game or a jigsaw puzzle (Sandberg, 2011).

Three groups of children could use the mobile application. All groups had classroom teaching. One group could used the application at the location in Blijdorp. The third group could also use the application at home since they were allowed to take the mobile phone with them for a period of two weeks. Results show that all three groups improved their English skills. Improvement was stronger, however, for the groups which also played the game. Children who were allowed to bring the smartphone home played the game for another six minutes per day on average. The extra time spend also resulted in stronger improvement.

Since the game content as well as the game structure has proofed to be successful we decided to use the same content in the game we developed. We did, however, add a theme to the game to make it more engaging to the students.

4   GAME OVERVIEW

4.1   THEME
The game has a theme in order to be more engaging. The narrative in this game is that there is a battle going in on the animal world between the good and bad spirits. The bad spirits try to take over the minds of the animals in order to use them for evil purposes. When the game starts the evil spirits have taken over most of the animal kingdoms. Kingdoms can be freed of the evil spirits by fulfilling assignments (i.e. answering questions) at location. If assignments are left unfulfilled (wrong answer given) than the freedom battlers can ask for a hint at the spiritual leader of the kingdom (i.e. the wise baboon, or the mighty lion). After completion of the assignment, students receive their next assignment.

4.2   SCENARIO
Students gather at the central place. Here the game starts. Each group is given a unique kingdom to start with. Students (in groups) go to the different kingdoms (i.e. the reptiles or the canines). Students check in at the kingdom and receive information about the kingdom. After finishing reading the information, students receive the animal which they have start off with. Assignments are questions about the animals at location. Sometimes the answer can be found in the information received at the check-in. For each fulfilled assignment students receive the badge of the animals they have freed. The whole kingdom is freed when four badges are collected.

Each kingdom has a leader or spiritual creature which can be asked for help (when the assignment is answered wrong). But asking the leader for help drains its spiritual power which he needs in order to fight the evil spirits. So asking for help costs points. The collected kingdom (i.e. set of four cards) will be worth

less if the spiritual leader has been questioned. Students can also choose for another question if they do not want to drain the spiritual power of the leader. They can always go back to the check-in post to view the kingdom information once more. When the kingdom is freed, students ask the leader which kingdom they have to free now. Students are send to next kingdom and start by checking in at that kingdom.

5   IMPLEMENTATION

In this chapter we provide an overview of the different model and diagram techniques we have used in order to implement our application. We first use the GOMS model for user modeling (5.1). Then we provide the interaction model which formalizes the earlier described scenario (5.2). The interface model shows the different interfaces the user has to interact with (5.3). The sequence diagram describes how user interactions are reflected in the call hierarchy in the system (5.4). Finally we provide an overview of the class diagram (5.5).

5.1   USER MODELING

One of the most validated methods for user modeling in Human Computer Interaction (HCI) is the GOMS model. The GOMS Model is a human information processing model that gives insight in which tasks, and in which order, there are involved in order to reach a certain goal. GOMS assumes ideal situations in which users do not make mistakes (Preece *et al*, 2002). Therefore GOMS is particular useful when we compare different interactions leading to the same goal (e.g. creating a text document on Windows or Mac). Although we do not compare different interfaces in this project we use GOMS to provide an overview of the different tasks involved in order to reach the main goal of our application: learning English words. See table 1.

GOALS: 1. **GOAL:** Learn English words

      1.1. **GOAL:** Play Game

         1.1.1. **GOAL**: Read instruction

            1.1.1.1. **GOAL:** Go to next Kingdom

               1.1.1.1.1. **GOAL:** Determine kingdom

                  1.1.1.1.1.1. Go to overview

                     1.1.1.1.1.1.1. Press "show collection button"

                  1.1.1.1.1.2. Recall that empty cards need to be done

                     1.1.1.1.1.2.1. Find empty slot

                  1.1.1.1.1.3. Remember which kingdom

               1.1.1.1.2. Walk to kingdom

            1.1.1.2. **GOAL:** Check-in at Kingdom

            1.1.1.3. **GOAL:** Determine next animal of kingdom

               1.1.1.3.1. Press overview button

               1.1.1.3.2. See which animals there in this kingdom

            1.1.1.4. **GOAL:** Go to animal

               1.1.1.4.1. Walk to animal

            1.1.1.5. **GOAL:** View question

               1.1.1.5.1. Scan Tag

            1.1.1.6. **GOAL:** Answer question

               1.1.1.6.1. Read question

               1.1.1.6.2. Search environment for information

               1.1.1.6.3. Give answer

            1.1.1.7. IF Kingdom not complete DO 1.1.1.3 ELSE 1.1.1.1

            1.1.1.8. **GOAL:** Return to starting point

               1.1.1.8.1. Recall starting point

                  1.1.1.8.1.1. Walk to starting point

      1.2. **GOAL:** Determine winner of game

OPERATORS: **Walking**

                Button click

                Touch Radio Button

                Scroll text

                Tag Scan

Table 1: the GOMS model for the application

5.2 INTERACTION OVERVIEW

The scenario from the previous section is formalized in the interaction diagram, see figure 1. This model depicts in which cycles the user interacts with the system. This a high level model in order to provide an overview.
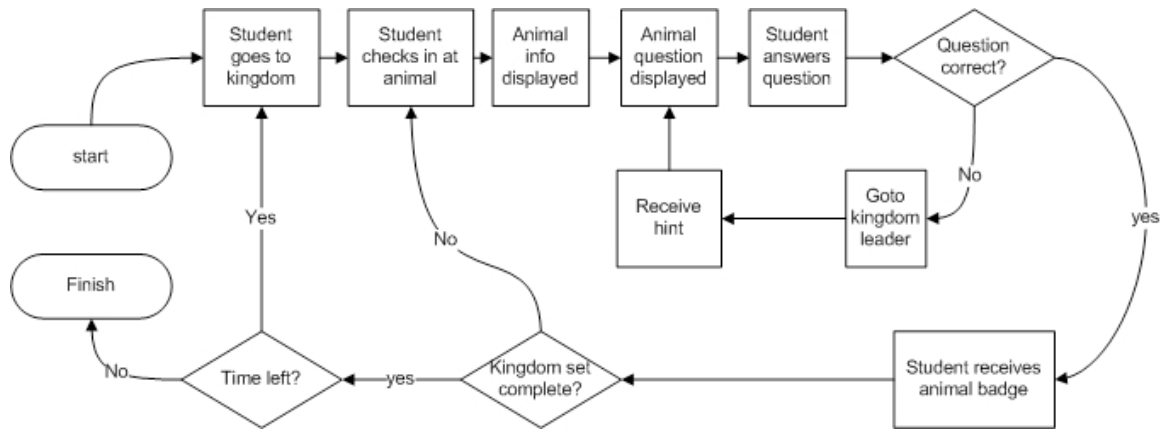
Figure 1: interaction overview

5.3 INTERFACE DIAGRAM

The interface diagram shows the different interfaces within the interaction with the minimal required elements to function. In this diagram the blue arrows represent the general flow of the application as where green arrows represent right answers, red arrows wrong answers and the purple arrow represents the end of the game cycle. The interface diagram is shown in figure 2.
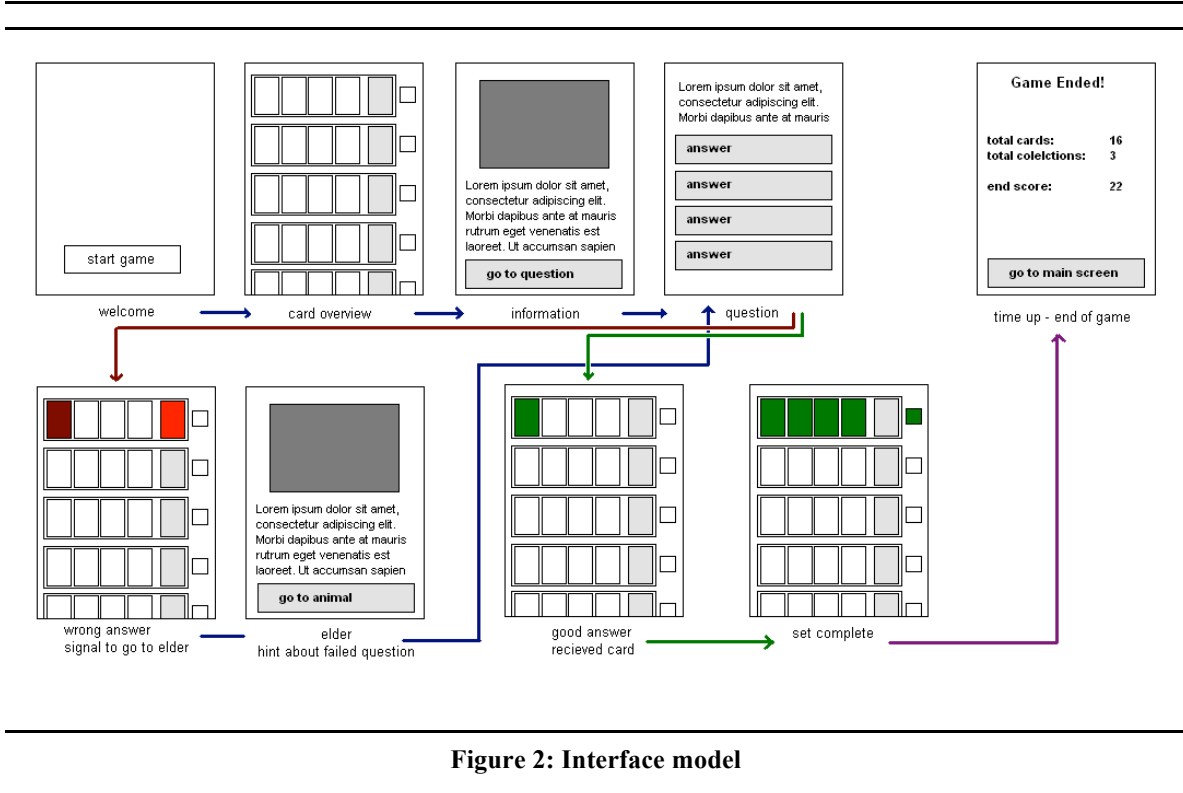
Figure 2: Interface model

5.4   SEQUENCE DIAGRAM

The sequence diagram shows the flow of data between user and system as well as interactions between separate classes within the system, see figure 3.

User : person	Game : class	NFC : class	Question : class	NFCTag : tag

start Game

drawMainScreen()

onClick(buttonNext)

drawInstructions()

onClick(buttonNext)

initNFC()

drawGame()

getTag(tagId)

getQuestion(tagId)

drawQuestion(question)   question

answerQuestion(answer)   checkAnswer(answer)

drawQuestion(answerCorrect)   answer Correct

resetGame(gotoStart)

drawWizard(wizard)   showWizard(wizard)   getTag(wizard tagId)

getQuestionHint()

drawQuestion(question Hint)   question Hint

answerQuestion(answer)   checkAnswer(answer)

drawQuestion(answerCorrect)   answer Correct

onClick(aboutButton)

drawAbout()

resetGame()

drawEndScreen(scores)   stopNFC()

Figure 3: sequence diagram

5.5 CLASS DIAGRAM

The class diagram shows the classes and their methods of our application, see figure 4. This class diagram was generated from the final code of the application. The original design class diagram can be found in Appendix D.
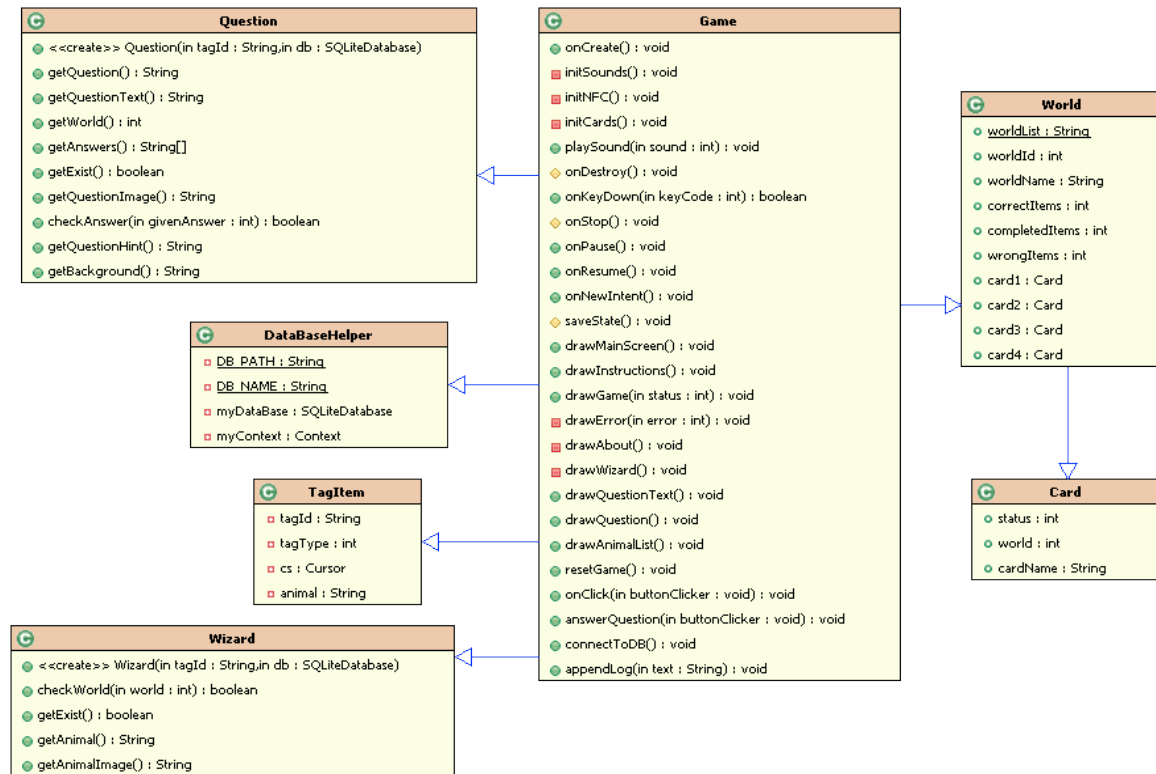
Figure 4: Class diagram

6 EVALUATION

In this section we provide an overview of the evaluation process we performed. We conducted a field test (6.1) and describe our observations along the design heuristics of Nielsen (6.2). Hereafter we give a summary of the filled out evaluation forms (6.3). General findings and possible improvements are listed (6.4).

6.1 FIELD TEST

In order to evaluate the application, we performed a field test at the Blijdorp Zoo in Rotterdam. Due to time and resource constraints we could only test the application with 3 participants. We selected the 3

participants from an elementary school that would fit our user case description. The participants were 11 - 12 years old and have had English lessons for 1 year or less. They did have some experience in using mobile phones and mobile phone applications. We used a qualitative method to evaluate the use of the application, enjoyableness, docility and improvements for the game. The evaluation was performed by observing the participants' behaviour, asking questions to the participants while they were playing the game, video recording their actions, and by using evaluation forms.

6.2   OBSERVATION
We evaluated our system to the design heuristics of Nielsen, as described Dix *et al* (2004).

6.2.1 Visibility of system status
This heuristic is more applicable in example for systems which have to perform long lasting tasks in the background. But we could have provided a score update after each question. This would have made the game more engaging. In the same line we could have provided other statistics such as elapsed time. By logging events like getting the question actual answering it, it is possible to measure the timespan for each question and therefor also check if some questions were harder to answer than others.

6.2.2 Match between system and the real world
The game type is "happy four". This is a well-known game so the participants could easily understand what was expected of them. As with the real-world "happy four" game participants had to collect cards. Cards where represented as such in the application. The real-world metaphor broke at the point that it was not possible in our application to trade cards with other participants. Since our game is location based there is strong link between questions and the real world. This link could have been made more explicit. In order to do this the team should have gone to Diergaarde Blijdorp while brainstorming about the questions. This was however, beyond the scope of this project. Another link between system and the real world was reflected in the retrieving question by scanning NFC tags. This seemed very natural for users. After explaining this once the users had no problems doing this again.

6.2.3 User control and freedom of use
When reading the introductory text users are allowed to jump to the question and back. Users should be allowed to jump back to the collection overview. The different participants would like to been able to compare their scores. When implemented as a real world application, the application should also allow users to switch between applications. Also the application should handle incoming phone calls appropriately.

6.2.4 Consistency and standards / guidelines
The button to navigate backwards from question to introductory text uses a left directed arrow. This is consistent with internet browsers. Going from introduction to question is done by touching the screen. Users often touched the screen by accident. Retrieving, answering, confirming of questions and results is done is consistent ways. For correct answers the user receives a green screen with a happy monkey face. For incorrect answers the user receives a red screen with an unhappy monkey face. The application is

compliant to the android user interface guidelines[4]. These guidelines describe how certain interactions must be performed on android phones to enhance sustainability between applications.

6.2.5 Error prevention and recovery
In the first evaluation round we noticed that the application can crash when NFC tags are scanned to fast in sequence. While we have not been able to fix this problem we did implement an autosave. This let users re-launce the app after a crash with their last saved results. It seemed that the application also crashed when the spiritual leader of some kingdoms where scanned. At one point one team lost all of its results. The authors had to redo the questions in order to bring the team at its last state. When users answered a question incorrect we did provide the user with dialog box advising the user to go to the spiritual leader. The spiritual leader would give them a clue about the question and would than ask the question a second time.

6.2.6 Recognition rather than recall
At no points in our application users needed to remember crucial information in order to complete a certain task at another point in the application.

6.2.7 Flexibility and efficiency of use
Our system does not cater for different users in terms inexpert vs. expert.

6.2.8 Aesthetic and Minimalistic aspects
Collected in the collection overview have consistent (within set) and different colours (between sets). This makes it clear to the user which cards (animals) still have to be collected.

6.2.9 Help and documentation
No help is provided. While the team was always present to help users when they needed it became clear that the game was not totally self-explanatory. For example, after answering a question correct, we should give a user a map on which they could see where the next animal would be located. In the current version the team had to lead the users to next animal.

6.3 EVALUATION FORM
The evaluation form consisted of 10 short questions. For an overview of the form, see Appendix C. The participants were asked questions about what they learned, what aspects of the game they liked and what they found difficult. According to them the application taught them new things, such as new English words and about animals, their habits and their environments. The participants liked the interaction between environment and mobile, to actively search for NFC tags with each animal and scan it with their mobile to receive a question. Before each question was shown, an introduction text was displayed with information about the animal. The answer to the question could often be found in this text. According to the participants, in order to find answers they often first checked the introduction text. If they didn't find the answer they would check the animal information display in the zoo or the animals themselves. If they could already find the answer, they sometimes did not look at the animal at all. The game principles to search for

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[4] http://developer.android.com/guide/practices/ui_guidelines/index.html

tags in the zoo, answer questions and complete a set was "well liked". All 3 participants preferred learning with this application over learning with books, because it was "less boring", and "it was easier to get interested about the subject". The participants did have some experience in using mobile phones and mobile phone applications, so operating of the mobile phone itself or operating the game did not pose any problems. They had the most difficulties with some of the questions in the game. Some of the questions and answers had more difficult English words. They attempted to answer these questions by consulting with other participants or after they received hints from the observers.

6.4   GENERAL FINDINGS AND FUTURE IMPROVEMENTS

The application used by the participants during the first trial run, lacked instructions to get the users going. We solved this by providing a physical tutorial. After the collection of a card, the game flow came to a stop and the children had to be ushered to the next animal. The game did not invoke a sense of urgency to proceed to collect the next card. Nor did it provide game flow driving elements to push the game forward. By design the game mechanics are as frictionless as possible, demonstrated by the effortless handling of the application. The children noticeably enjoyed playing the game. In this built, most of the enjoyableness can be attributed to the learning of the new affordance created by the NFC sensor. This enjoyableness quickly disappeared during application hang-ups when the participants held the mobile phones in front of an NFC tag and the expected feedback did not occur.

6.4.1 Docility

The docility decreased as the competitiveness rose. The two groups raced to get to the next tag first. And there was noticeable disappointment when the participants reached the tag second. This decrease in docility could consequently lead to an increase of reckless behavior and endangerment of the used equipment (i.e. the cell phone).

6.4.2 Improvements

The application in this form would benefit from additional interaction design work. It would benefit from additional screens to move the game forward. As noted above, the purpose of the game should be apparent when started, especially if this game would actually be the deployed. Supervision should not be necessary. The game would benefit from state robustness: in case of a system-failure, the user should be able to resume without loss of progress. The game should be more competitive. By including competitive elements the application could be used without supervision. Also we should improve the robustness of the interaction flow. This could be done by providing more explanations (e.g. where to go, which animal is next) and confirmation dialog boxes.

7   CONCLUSION

As noted in section 6.4.2., there is a lot of room for improvement. However, this first release shows that NFC and the new form of interacting with the environment, provides for a compelling and engaging experience for children. The immediacy and implemented tactility of the NFC interface invokes a lot of enthusiasm in the children when using the application, something that should be further explored and

optimized. There are still many avenues to be explored using NFC, like peer-to-peer communication or bi-directional data-exchange with the tags. This first proof of concept and the initial enthusiasm displayed by our participants shows it to be a worthwhile exercise.

Additionally, the theming of the game raised the level of immersion in the game and added to enjoyableness of the game. Combined with the storyline, it imbued the children with a sense of urgency to complete the quest. Even when played in a foreign language. It seemed that the children experienced the language barrier, as just another game element adding to the difficulty; and the overall game experience was strong enough to overcome this barrier.

8   ACKNOWLEDGMENTS

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APPENDIX A: WORK OVERVIEW

Here we list all the tasks in this project and the team member who has worked on it.

Activity		Team Member
Report	Introduction	Jorrit
	Assignment Overview	Jorrit, Franklin
	Related Work	Jorrit, Jos
	Game Overview	Jorrit
	Implementation	
	- *Use-Case*	Imre
	- *User Modeling G.O.M.S*	Jorrit
	- *Interaction Model*	Jorrit
	- *Interface Model*	Imre
	- *Sequence Diagram*	Imre
	- *Class Diagram*	Jos (reverse engineered) Imre (design)
	Evaluation	Jorrit, Franklin, Jos
Application	Programming	Jos
	Introduction text	Jorrit
	Design / Graphics	Cye
	Questions, answers, hints	Franklin
Evaluation	Observation	Jos, Franklin, Cye, Jorrit
	Video recording	Cye
	Evaluation Forms	Franklin
Video	Video Editing	Cye

APPENDIX B: EVALUATION FORM

Evaluation form in Dutch language. The form was targeted at Dutch school children.

Vragen over het Blijdorp kwartetspel

- Je krijgt GEEN cijfer voor deze taak
- Wij willen vooral weten wat je moeilijk vond
- Leg uit WAAROM je iets moeilijk of makkelijk vond

1. Heb je veel van het kwartetspel geleerd?

* Maak een keuze en leg uit waarom:

[] Ja, want..

....

[] Nee, want..

....

2. Wat heb je vooral geleerd?

....

....

3. Welke nieuwe Engelse woorden heb je geleerd?

....

....

4. Hoe denk je dat je het beste Engels kan leren?

* Maak een keuze en leg uit waarom:

[] Met dit kwartetspel, want...

....

[] Met een lesboek voor Engels, want...

....

Op de achterzijde staan nog meer vragen ! → → →

5. Vond je het moeilijk om de mobiele telefoon te gebruiken?

* Maak een keuze en leg uit waarom:

[] Ja, want...

....

[] Nee, want...

....6. Wat vond je verder nog

moeilijk?

....

....

....

7. Had je het leuker gevonden om het spel op papier uit te voeren?

....

....

....

8. Vond je het leuk dat je de telefoon tegen de paal moest aanhouden?

....

....

....

9.Als je moet kiezen tussen invullen van de vragen op de telefoon of invullen op papier. Kies je dan papier of de

telefoon?

....

....

....

10. Wat zou jij nog verbeteren aan het spel?

....

....

....

APPENDIX C: LISTING OF QUESTIONS AND CORRESPONDING HINTS

In this appendix we give an overview of all the questions that were used in our application.

Questions are categorized by continent.

Kingdom of Africa
Gorilla: Kingdom of Africa's leader
Hint giraffe1=   "Giraffes look somewhat stretched."
Hint giraffe2=   "Giraffes like to eat plants."
Hint crocodile1=   "Start counting when the crocodile opens it's mouth."
Hint crocodile2=   "They are sometimes mistaken for floating wood."
Hint hippo1=   "It can be very warm where hippos live."
Hint hippo2=   "Hippos like to bathe from time to time."
Hint hyena1=   "Check the size of both animals."
Hint hyena2=   "It can be very warm and dry over there."

Giraffe
Question =   "What is quite noticeable about the giraffe?"
Correct Answer =   "The giraffe's lengthy neck and legs"
Wrong Answer1 =   "The giraffe's lengthy tail"
Wrong Answer2 =   "Giraffe's are very tiny"
Wrong Answer3 =   "The giraffe's lengthy teeth"
Question =   "Where do giraffes live?"
Correct Answer =   "on grasslands"
Wrong Answer1 =   "in trees"
Wrong Answer2 =   "in tropical rainforests"
Wrong Answer3 =   "in cold areas"

Crocodile
Question =   "How many teeth do crocodiles have?"
Correct Answer =   "more than 10 teeth"
Wrong Answer1 =   "2 teeth"
Wrong Answer2 =   "0 teeth"
Wrong Answer3 =   "200 teeth"
Question =   "Where do crocodiles live?"
Correct Answer =   "in rivers and on land"
Wrong Answer1 =   "in oceans"
Wrong Answer2 =   "underground"
Wrong Answer3 =   "under rocks and in small holes"

Hippo
Question =   "Why does the hippo like to be in the water?"
Correct Answer =   "To stay cool in the hot sun"
Wrong Answer1 =   "To catch fish"
Wrong Answer2 =   "To play with the water"
Wrong Answer3 =   "To drink it all the time"
Question =   "Where do hippos live?"
Correct Answer =   "river and land"
Wrong Answer1 =   "desert and forest"
Wrong Answer2 =   "savanna and ocean"
Wrong Answer3 =   "mountain and sea"

Hyena
Question =   "Are hyenas bigger or smaller than bears?"
Correct Answer =   "Hyenas are smaller than bears"

Wrong Answer1 =	"Bears are smaller than hyenas"
Wrong Answer2 =	"Hyenas and bears are equal in size"
Wrong Answer3 =	"Hyenas are bigger than bears"
Question =	"Where do hyenas live?"
Correct Answer =	"Africa and Asia"
Wrong Answer1 =	"Europe"
Wrong Answer2 =	"North Pole and South Pole"
Wrong Answer3 =	"South America"

Kingdom of Americas

Bison: Kingdom of the Americas' leader

Hint dog1=	"Guinea pigs also look like this animal."
Hint dog2=	"You can walk on this area."
Hint ibis1=	"The nest is usually high above the ground."
Hint ibis2=	"This continent is located below the equator."
Hint pudu1=	"The reindeer also belongs to this animal group."
Hint pudu2=	"This continent is west from Europe."
Hint wolf1=	"Check the size of the animal."
Hint wolf2=	"There are a lot of places to hide in here."

Prairie Dog

Question =	"What other animal resembles the prairie dog?"
Correct Answer =	"otters resemble the prairie dog"
Wrong Answer1 =	"whales resembles the prairie dog"
Wrong Answer2 =	"kangaroos resemble the prairie dog"
Wrong Answer3 =	"cows resemble the prairie dog"
Question =	"Where do prairie dogs live?"
Correct Answer =	"on land and in holes underground"
Wrong Answer1 =	"in large plants"
Wrong Answer2 =	"at the bottom of oceans"
Wrong Answer3 =	"in the sea"

Scarlet Ibis

Question =	"Where does the Scarlet Ibis make his nest?"
Correct Answer =	"In a tree"
Wrong Answer1 =	"At the ground"
Wrong Answer2 =	"On the water"
Wrong Answer3 =	"In a cave"
Question =	"Where does the Scarlet Ibis live?"
Correct Answer =	"In South America"
Wrong Answer1 =	"At the North Pole"
Wrong Answer2 =	"In Africa"
Wrong Answer3 =	"In the ocean"

Pudu

Question =	"In what animal group does the pudu fit?"
Correct Answer =	"The Pudu fits in the animal group of deers"
Wrong Answer1 =	"The Pudu fits in the animal group of cats"
Wrong Answer2 =	"The Pudu fits in the animal group of parrots"
Wrong Answer3 =	"The Pudu fits in the animal group of monkeys"
Question =	"Where does the pudu live?"
Correct Answer =	"In South America"
Wrong Answer1 =	"In Africa"
Wrong Answer2 =	"In Asia"
Wrong Answer3 =	"In North America"

Maned Wolf

Question =	"What animals does the wolf hunt on?"
Correct Answer =	"rabbits, and other small animals"
Wrong Answer1 =	"elephants"
Wrong Answer2 =	"animals that are larger than wolfs"
Wrong Answer3 =	"whales"
Question =	"Where does the wolf live?"
Correct Answer =	"In the forest"
Wrong Answer1 =	"In trees"
Wrong Answer2 =	"Underground"
Wrong Answer3 =	"At the beach"

Kingdom of Arctica

Steller Sea Eagle: Kingdom of the Arctica's leader

Hint fox1=	"The ears are on top of it's head."
Hint fox2=	"It is generally cold over there."
Hint bear1=	"The fur is a hairy coat of the animal."
Hint bear2=	"It should contain water."
Hint arctic1=	"You would probably think it is winter."
Hint arctic2=	"It is not warm at the surface."
Hint lemming1=	"Check the body length of the lemming."
Hint lemming2=	"You have to wear mittens over here."

Arctic Region

Question =	"What is characteristic about the Arctic region?"
Correct Answer =	"It is generally cold at the Arctic region"
Wrong Answer1 =	"It is generally hot at the Arctic region"
Wrong Answer2 =	"It is generally sunny at the Arctic region"
Wrong Answer3 =	"It is generally humid at the Arctic region"
Question =	"What does the Arctic region look like?"
Correct Answer =	"Lots of grass, rocks and some ice"
Wrong Answer1 =	"Lots of sand"
Wrong Answer2 =	"Lots of mud, lava, and rivers"
Wrong Answer3 =	"Lots of tropical trees"

Arctic Fox

Question =	"How many ears does the arctic fox have?"
Correct Answer =	"two ears"
Wrong Answer1 =	"five ears"
Wrong Answer2 =	"zero ears"
Wrong Answer3 =	"one ear"
Question =	"Where does the arctic fox live?"
Correct Answer =	"At the north pole"
Wrong Answer1 =	"In rivers"
Wrong Answer2 =	"In the oceans"
Wrong Answer3 =	"In the deserts"

Polar Bear

Question =	"What is the colour of the fur of the polar bear?
Correct Answer =	"white fur"
Wrong Answer1 =	"green fur"
Wrong Answer2 =	"red fur"
Wrong Answer3 =	"purple fur"
Question =	"Where does the polar bear often swim?

Correct Answer =	"In the sea"
Wrong Answer1 =	"In swamps"
Wrong Answer2 =	"In small pools"
Wrong Answer3 =	"In mud"

Steppe Lemming
Question =	"What is the estimated length of the steppe lemming"
Correct Answer =	"up to 14 cm"
Wrong Answer1 =	"up to 110 cm"
Wrong Answer2 =	"up to 2 cm"
Wrong Answer3 =	"smaller than 5 cm"
Question =	"What part of the world is the habitat of steppe lemmings?"
Correct Answer =	"Northern part of the world"
Wrong Answer1 =	"Western part of the world"
Wrong Answer2 =	"Eastern part of the world"
Wrong Answer3 =	"Southern part of the world"

Kingdom of Asia
Flamingo: Kingdom of the Tropics's leader
Hint panter1=	"Shapes and figures can form a pattern."
Hint panter2=	"It is very rocky over there."
Hint elephant1=	"Operate the instrument with your mouth."
Hint elephant2=	"Elephants like to eat plants."
Hint tiger1=	"Their prey can be very fast too."
Hint tiger2=	"It is the biggest continent on earth."
Hint rhino1=	"This feature makes the rhino quite dangerous."
Hint rhino2=	"Rhino's are quite heavy."

Panter
Question =	"What pattern does the fur of the panter have?"
Correct Answer =	"dark brown and black spots on an orange-yellow-white fur"
Wrong Answer1 =	"black and white stripes"
Wrong Answer2 =	"orange and white circles on a dark brown fur"
Wrong Answer3 =	"random colours of pink, white and green"
Question =	"Where do panters live?"
Correct Answer =	"near mountains"
Wrong Answer1 =	"near the beach"
Wrong Answer2 =	"near a large dune"
Wrong Answer3 =	"in large rivers"

Elephant
Question =	"What sound do elephants make?"
Correct Answer =	"a sound similar to a trumpet"
Wrong Answer1 =	"a sound similar to a guitar"
Wrong Answer2 =	"a sound similar to a piano"
Wrong Answer3 =	"a sound similar to a accordeon"
Question =	"Where do elephants live?"
Correct Answer =	"in grasslands"
Wrong Answer1 =	"most of them in Europe"
Wrong Answer2 =	"at the south pole"
Wrong Answer3 =	"inside caves"

Tiger
Question =	"What are tigers good at?"
Correct Answer =	"Tigers can run very fast"

Wrong Answer1 =	"Tigers can fly very high"
Wrong Answer2 =	"Tigers can swim very fast"
Wrong Answer3 =	"Tigers can gnaw on trees very fast"
Question =	"Where do tigers live?"
Correct Answer =	"In Asia"
Wrong Answer1 =	"In an icy environment"
Wrong Answer2 =	"In sandholes"
Wrong Answer3 =	"Most of them live in South America"

Rhino

Question =	"What is characteristic about the rhino?"
Correct Answer =	"Rhinos have horns on top of their nose"
Wrong Answer1 =	"Rhinos have 2 wings which use to fly"
Wrong Answer2 =	"Rhinos have 50 legs to walk with"
Wrong Answer3 =	"Rhinos have a black and white coloured pattern on their skin"
Question =	"Where do rhinos live?"
Correct Answer =	"On grasslands and open savannah"
Wrong Answer1 =	"In North America"
Wrong Answer2 =	"In caves and underground"
Wrong Answer3 =	"On small plants"

Kingdom of the Oceanium
Jelly Fish: Kingdom of the Oceans' leader

Hint turtle1=	"The legs can be found at either side of the animal."
Hint turtle2=	"Check how this animal is called."
Hint penguin1=	"The fur is the coat of the animal."
Hint penguin2=	"There is a lot of ice in this area."
Hint shark1=	"The shark favours eating sea animals."
Hint shark2=	"Sharks are surrounded by water."
Hint stingray1=	"He looks a bit like a pancake."
Hint stingray2=	"This animal generally does not walk on land."

Sea turtle

Question =	"How many legs do sea turtles have?"
Correct Answer =	"four legs"
Wrong Answer1 =	"three legs"
Wrong Answer2 =	"two legs"
Wrong Answer3 =	"eight legs"
Question =	"Where do sea turtles live?"
Correct Answer =	"In the water"
Wrong Answer1 =	"On mountains"
Wrong Answer2 =	"In trees"
Wrong Answer3 =	"On leaves of trees"

Penguin

Question =	"What is the colour of the penguins' fur?"
Correct Answer =	"black and white"
Wrong Answer1 =	"red and orange"
Wrong Answer2 =	"pink and purple"
Wrong Answer3 =	"yellow and green"
Question =	"Where do penguins live?"
Correct Answer =	"At the north pole"
Wrong Answer1 =	"In rivers"
Wrong Answer2 =	"In tropical forests"
Wrong Answer3 =	"In deserts"

Shark

Question =	"What do sharks eat?"
Correct Answer =	"Plankton, fishes and seals"
Wrong Answer1 =	"People and surfboards"
Wrong Answer2 =	"Grass"
Wrong Answer3 =	"Shells and oysters"
Question =	"Where do sharks live?"
Correct Answer =	"In the ocean"
Wrong Answer1 =	"In caves
Wrong Answer2 =	"In the tropical forest"
Wrong Answer3 =	"On land and in small pools"

Stingray

Question =	"What is the shape of the stingray?"
Correct Answer =	"Large and flat"
Wrong Answer1 =	"Round and big"
Wrong Answer2 =	"Round and very tiny"
Wrong Answer3 =	"High in length and with big ears"
Question =	"Where does the stingray live?"
Correct Answer =	"Deep in the ocean"
Wrong Answer1 =	"On mountains"
Wrong Answer2 =	"In the tropical forest"
Wrong Answer3 =	"In small lakes"

APPENDIX D: DESIGN CLASS DIAGRAM

The following diagram shows the original design of the application. The earlier shown class in chapter 5.5 diagram is a reverse engineered representation of the final product.

student
- -studentId
- -studentName
- -studentClass
- +addStudent()
- +removeStudent()

main
- -location
- -studentGroupSize
- -studentGroupId
- +appStart()

cardGame
- -gameDuration
- -totalScore
- +gameStart()
- +groupComplete()
- +goAnimal()
- +goGroupElder()

animal
- -animalID
- -elderID
- -animalCollectionID
- -animalName
- -animalInfo
- -locationCoords
- -isCollected
- +showAnimalInfo()
- +setCollectedState()

animalQuestion
- -animalID
- -question
- -answer
- +showQuestion()
- +answerQuestion()

NFC
- -animalID
- +getNFCData()