

# On the design of Camelot, an outdoor game for children

## ABSTRACT

This paper describes the design of Camelot, a mobile outdoor game for small groups of children aged 7-9. The game was designed with the aim to encourage social interaction between the players and to encourage physical activity. The paper extends the research literature on design methodology for children, by recording and reflecting upon the lessons learnt by applying a range of techniques for involving children in the design of interactive systems.

## Keywords

Children, pervasive gaming, social gaming.

## INTRODUCTION

There has been an increasing interest in the field of ubiquitous computing and game design regarding pervasive games; computer games played outdoors that make use of location aware computing and communications infrastructure. A simple but popular example is Geocaching (finding a virtual 'treasure' by means of a GPS device [7]) and more advanced examples are Pac-Manhattan [14] and Uncle Roy [3]. However, these games are not tailored to the skills of children. For example, the GPS device that is crucial in Geocaching, requires a number of skills for its operation. Other pervasive games raise safety issues, e.g., when played in the urban landscape, e.g. Pac-Manhattan [14] or Uncle Roy [3]. Finally, many of the games mentioned are designed for individual players. Our ambition has been to seek ways in which the game will support social interaction among children, as in [4] and [13]. Here we present Camelot, a game addressing this general problem but which targets outdoor group play for open and safe areas like playgrounds or parks.

The design focuses on 7-9 year old children; children in this age group have learnt to read and have started to engage in structured team play. In child development literature, it has been argued that social interaction plays a crucial role in child development. Vygotsky was one of the first scientists who emphasized the role of social interaction [20]. In his view, social interaction can confirm existing knowledge and

add new information to the existing knowledge structures. He believed that cognitive processes (language, thought and reasoning) develop through social interaction. With these reasons in mind, we set out to create a game that requires collaboration between players and supports competition, both resulting in social interaction.

This paper contributes to existing literature in two ways. First, it discusses how a number of methods for designing and evaluating with children were applied throughout the design of Camelot. Second, the resulting game prototype constitutes a design contribution to a novel class of games: technology enhanced outdoor games for children.

In the next section related research is described. Then the design of Camelot is outlined, describing the various techniques used to involve children and reflections upon their application in practice. The discussion goes through the initial inquiry regarding game play, conceptual design and detailed design and evaluation. Throughout the whole project we have worked with the same group of participants. These children are described in the section 'User Study'.

## Related Work

Recent research prototypes of computer games for children have experimented with using toys as logical pointers to computational artifacts related to a game, e.g., the READ-It prototype [18] is a tangible augmented reality version of the popular "memory game" for children. READ-It was designed to help children aged 5-6 learn to read. Ely the Explorer [1] was a game supporting a tangible user interface, designed with the aim of fostering social interactions between children through play. Other notable games are 'The Hunting of the Snark' [9], that supported playful learning by groups of children visiting a room, and the 'Augmented Woods' [16] that achieved a similar purpose but at a much wider geographic area. All the games mentioned have a clear educational purpose. In those cases where the game design was evaluated, participants invariably enjoyed them. However, given that the emphasis was not on entertainment per se, the standard expectations and challenges for designing a computer game do not apply. We argue that the potential of tangible interfaces for supporting gaming is still unexplored. Camelot explores the potential of such tangible interfaces outdoors.

Camelot was designed to support social interaction, within and around the game. [4] showed how careful design of game mechanics can capitalize on the opportunities offered by mixed reality to create a game

where children cooperate and socialize spontaneously around the game. A similar approach was taken with [redacted] [13] where physical and virtual entities are mixed in a high pace game, where constructive and cooperative play alternate to encourage social interaction.

In general, the interest in social gaming is quite new, with companies like Sony producing multi-media interactive technologies for their gaming platform, announcing them as “social gaming technologies”. Clearly, the move away from the desktop and into the physical space surrounding a TV screen affords the opportunity for social gaming. Understanding the types of social interaction and the relation to social mechanics is a very current question for game design literature, as evidenced by columns in webzines, e.g., the columns by S. Appelcline for the Skotos webzine discussing social gaming, or the discussion of Social Play by Salen and Zimmerman [17, chapter 28].

Research into pervasive gaming is quite new. Recent investigations into augmenting large cityscapes with mobile gaming applications have been carried out. For example, with the CitiTag game [19], mobile players are made aware of the social presence of large numbers of other players in the same city. The game turned out to be very amusing and engaging. Players spontaneously teamed up, developed team tactics in a game plot where cooperation was key to ‘survival’. As mentioned, most work on pervasive gaming focuses on adults and the domain of computer games developed for outdoor play by children is under explored.

## **USER STUDY**

Apart from consulting related literature, a user study was set up to gain a first hand impression and understanding of how children play games outdoors, and what makes such play fun for them. Following some first informal interviews and naturalistic observations conducted in a play ground, it was decided to apply the Mission from Mars (MfM) method to obtain early input from children for the design of interactive systems.

This MfM method was introduced by Dindler et al. [6]; it is an interview technique, combined with role-play, where children are interviewed through an audio-link by a ‘Martian’ (whom they do not see). The Martian presents himself as completely ignorant with regard to the topic discussed, so the children are put in the position of the expert. This setup aims to trigger children to explain things in great detail and avoids the pitfall that the adult asking the question may be assumed by young children to know the ‘right’ answer or to be expecting a specific response. In Dindler’s study, the method provided useful input for the design of a virtual schoolbag. Given the novelty and obvious interest of this technique it was decided to apply it, in order also to assess its utility in practice.

An immediate difference to the design project of Dindler et al. [6] was that play is a more abstract and less tangible subject than a schoolbag. It was found difficult to plan an interview over such an abstract topic. To resolve this

difficulty, the MfM method was combined with asking children to create a collage which would provide the subject and focus of the discussion with the Martian. As has been argued by Brewster [5], making collages is a useful technique for 6-8 year old children to share personal experiences and to communicate ideas. The instructions for the collage were also inspired by the KidReporter [2] technique, where children are asked to create a newspaper by contributing interviews, pictures and drawings that describe daily experiences / activities.

Readers are referred to Dindler et al. [6] for an extensive description and motivation of the method. Below, sufficient detail is provided to document the experience of its application in the present design context.

## **Informants**

Eight girls aged eight to ten and two eight year old boys participated in the study. They were all pupils of a small Dutch primary school. These same children participated at all stages of the design where involvement of children was judged useful and feasible. The rationale for relying on the same children at all these points was based on earlier experiences (see [redacted] [13]) that children, who are involved throughout the design process, become more attuned to the needs of the design team, the nature of user testing and more capable of providing critical input.

## **Set-up of the Mission from Mars interview**

The MfM session lasted 2 days. During the first day, the children were introduced to the Martian story and translated a letter supposedly from Mars. The second day was spent on making the collages and meeting with the Martian.

Children were told that the researchers had received a signal from space that after translation by a supercomputer turned out to be a request for help. The first part of the message recounted that Martians only knew how to work, which was boring to them and for this reason they wanted to know more about fun games and how they are played. Children were asked to translate the second part of the message using a specially developed “Martian translator”; children could paste an unreadable sentence into a text window and this would be directly turned into Dutch text. After the children had translated the letter, we discussed the content of the letter and introduced the making of the collages.

On the second day, the children chose their own group mates in making 4 groups of children, so that they could work with a friend, as was also advised in [6]. Children took pictures of game play on the playground and created a collage with the pictures of their favorite games.

For the encounter with the Martian, two adjacent rooms were used: the interview room for the children and the ‘Martian room’. In the interview room children sat facing a video camera through which they could be observed by the Martian and facing a loudspeaker from which they heard the Martian.

The Martian was acted out by one of the researchers as in [6]. The Martian's voice was distorted so the children would not recognize it and to make it more convincing. Before the start of the interview, the children were told that they could only hear the Martian, but that the Martian could both hear and see them by means of a camera, so that they could show their collages and explain its content. The groups each had fifteen minutes to talk with the Martian. During this conversation one of the researchers sat with them in the room, in case they would need help. The Martian was assisted by a "prompt", who helped her choose the questions to ask. After finishing the conversation, the children returned to their classroom. At the end of the day, there was a small debriefing in which the children could ask questions about the test. At this point it was revealed to them that the Martian was not 'real' and they were shown the Martian room.

### Results

From the MfM interview, the following aspects of play were identified as most important:

*Physical activity.* Most favored games are rich in physical activity, e.g., running and chasing in Tag.

*Excitement, suspense, e.g., waiting while hiding in Hide and Seek.*

*Role-play, pretend play.* As one child explained, the nice thing about pretend play is pretending to be somebody else or somewhere else, which allows one to act silly.

*Continuous involvement.* Children need to be engaged by the game continuously to make it fun. This was most clearly indicated by a boy who did not like tag once tagged, as he would be no longer allowed to participate in the game.

### Reflection on using Mission from Mars

The technique was applied following Dindler et al. [6], though the children of Dindler's study were slightly older (10-11 years). We anticipated that the MfM method should work even better for younger children, since they might be more prone to believe the Martian story.

There were quite large individual differences in the ability of children to read and write. Some children were very fast and translated the letter within 30 minutes. Others were quite distracted and did not complete the task. The translation was stopped after 45 minutes and the researchers discussed the session with the children. Notably, the idea to make a collage came spontaneously from one of the children during this discussion.

Most children took pictures of games they liked as instructed. Some took pictures of less relevant topics.

A researcher guided each group while they were making the collage. This was necessary, as some children found it difficult to stay focused. Bekker et al. [2] did not experience this difficulty; in contrast, they report that the children were not distracted and that they were very punctual in finishing their tasks. This difference may be related to the fact that

their project took place in a zoo, which is an exciting environment to most children, and the collage making for this study was carried out in the classroom.



Figure 1: Taking pictures for the collage

Two groups of children (7-8 years) tended to include as many pictures as possible, regardless of their relevance, which again contrasts the experiences of Bekker et al. This may be due to the age of the children, since the KidReporter study involved children aged 9-10. Indeed the oldest children in the present study were very conscious about what to display, describing several games, the rules of the games and the objects needed.

At this time, the children were familiar with the researchers and they were quite talkative during the collage making. Unexpectedly, the collage making turned out to be a good moment to ask questions about playing games in general.

Some children were intimidated at first by the Martian voice, but after while, they answered all the questions by the Martian, also the obvious 'stupid' questions, e.g. 'What is a ball?'. This has been suggested by Dindler et al. [6] as one of the main advantages of the method. Questions like 'Why is that game fun?' turned out to be too hard for the children to answer. Common answers to this question were: 'Just because' or 'I don't know why, I think it just is'.

A week after the MfM session children were interviewed regarding the credibility of the Martian story. Consistent with Dindler's findings, the MfM was found successful regardless of whether children believed the story about the Martian or not. The children enjoyed all related activities and said that they would like to talk with the Martian again, even after being told that there was no real Martian. When asked how she felt about explaining details to the Martian, one girl answered: 'you already know a lot about games, so I don't have to explain everything to you. But for the Martian it is different'. This statement confirms the core rationale for the MfM method.

### CONCEPT DESIGN

Based on the user study three game concepts were developed: *Cato*, *Quattro*, and *Wizards and Witches*.

In *Cato*, the participants play in teams of two, and have to gather virtual resources to build houses and castles. Resources are distributed in zones in the play area, and to acquire a resource a player has to stay in the zone for a certain amount of time. Play involves running between zones, trading resources and applying team tactics to obtain the right resource in time.

*Quattro* is an individual game in which players have to gather sets of four identical items that are spread around the play field.

*Wizards and Witches* is played in two teams. Each team has a glass ball that is carried by one player who hides it from the other team. The game ends when the player bearing the ball is tagged. Players can tag each other, and subsequently have to show their ranks. The player with the highest rank wins and the other player is temporarily out of the game.



**Figure 2: Concept testing of Wizards and Witches: deciding team tactics followed by a mad rush**

### Testing the game concepts

Paper prototypes of the three games were made and taken back to the children for testing. The game was introduced to the children in the classroom, after which they played the game outside. For each game, one of the researchers was the game leader, resolving questions or uncertainties throughout the game. Children were observed during the play and were interviewed after each game in groups of 2 or 3. All three games were tested on the same day.

Having noted previously that the children had trouble staying focused on interview questions, picture cards were used to prompt and structure this interview (see Figure 4). Questions were divided into five categories: *My input*, *Playing together*, *Collecting*, *End*, and *Other*, and each category was represented by a card. The cards were placed faced down on the table; children were asked to turn a card around, and the researcher would ask the corresponding questions. It was expected that this would help children stay focused and to provide them with a visual cue on the progress of the interview.

### Results

The children enjoyed running and tagging in *Wizards and Witches* (see Figure 2), possessing the highest rank, and carrying the glass ball. Although not part of the game rules, children would switch ranks, to give the highest rank to the team member that could run fastest. It was observed that during the game there was no time for the children to discuss game tactics. This was mainly done before the start of the game.

Children stated that they enjoyed *Quattro*, especially collecting the card sets. Some had trouble remembering where items were located. The fact that this game was played individually, instead of in teams, did not to appeal to

some. During the game, children cheated by keeping more items in their hands than was allowed by the game rules.



**Figure 3: Gathering resources in concept testing of Cato**

Children enjoyed *Cato*, playing and discussing together, gathering things and trading. Waiting for some time (counting to 15 while being in a zone) before acquiring a resource (see Figure 3), was found to take too long. Some children cheated by taking cards before counting.

From both observations and interviews, *Cato* appeared to be most fun to play and brought out the richest interaction between the children. However, it became clear that the game rules were too difficult.

### Reflection on Concept Testing

Hanna et al. [8] already noted the difficulty of obtaining feedback from children for concept testing of games. Contrary to that study, the present study concerned paper artifacts and focused on the game mechanics. Actively playing the games proved invaluable for understanding how children experienced the play, and would not have been feasible with just asking them to comment on a game description and visualization.

Making interviews semi-structured and using category cards turned out to be good decisions. After the first interview, children started to anticipate the questions associated with each category. The cards proved effective in drawing the children's attention back to the questions when they were distracted. Interviewing in groups of 2-3 proved effective; with more children, they would distract each other.



**Figure 4: Interview with cards**

## THE CAMELOT GAME

Taking into account the results of the concept tests, Camelot, the eventual game concept, was designed.

In Camelot, players collect resources to earn parts of a castle. They are divided into two teams, and the team that finishes the castle first wins. The game is divided in four phases; at the end of each phase a part of a castle is built: a moat, a drawbridge, the two towers and a wall.

During each phase, players gather virtual resources from zones that are spread around in the play field. To acquire a resource, a player has to remain in a zone for a predefined period. A player can carry a maximum of two resources at a time. Each team has its own castle construction site where acquired resources are brought. Resources that are not immediately needed for the current phase can be stored for later use at the castle construction site.

At random times in the game a virtual ghost appears who can steal resources from the teams. To avoid this, teams have to quickly get to the ghost; the team that is the last to reach the ghost loses all acquired resources of the current construction phase, though completed construction phases are untouched.

## DESIGN OF A TANGIBLE USER INTERFACE

### Prototyping with Phidgets

The interaction with the collector devices was prototyped using Phidgets [14]. Phidgets are an easy to use set of building blocks for low cost sensing and control from a PC.

The interaction for acquiring resources and dropping resources at the castle construction site could be tested within the small area of a table top. For acquiring the resources, an interaction style was implemented based on proximity: to acquire a resource the collector should be held near the zone for some time. During the acquisition, a LED on the collector flashed, and when finished the LED was switched on.

For dropping a resource, two different interaction styles were prototyped. One required holding the collector near the castle for some time and the other shaking the collector for three seconds. Feedback was provided by means of LED lights.

Using Phidgets was shown to be a fast way to test different interaction styles; the prototypes were built within 2 days.

### Evaluation with Peer tutoring

The Peer Tutoring method [10] was applied for testing the tangible interface. First, five children were given “tutor training” in which a researcher explained the protocol of tutor and tutee and demonstrated the tasks they would have to explain to their peers: picking up a resource at a zone, transferring it to the castle, both using the proximity interaction and the shake interaction. The tutor training was done in two sessions: one with 2 children and one with 3 children. Then each child tutored one peer (see Figure 5). After the session children were allowed some free

exploration with the setup and were interviewed on what interaction style they preferred.

The test showed that the children clearly understood the feedback of the collectors given by the LEDs. Most of the children concluded spontaneously that the blinking LED was analog to counting in *Cato*: “If it blinks, it means I am counting!”. They thought that the proximity based interaction style was the easiest to use, though the shake interaction style was more fun.



Figure 5: Explanation by peer tutor

### Reflection on the Peer Tutoring method

The peer tutoring method worked well for most children, making it easy to observe whether they understood the interaction. Some children forgot the tasks they were supposed to tutor and needed help from the researcher. The role of the researcher can very much influence the outcome of the test. In the first tutor training session, the researcher gave a shorter explanation of the test than during the second. This difference was reflected in the tutor sessions: the children trained in the first session, were also much briefer than children trained in the second session.

Van Kesteren et al. found that sometimes tutors tend to take over the tasks of tutees [11]. This problem was avoided by following Höysniemi’s advice [10] to seat children on opposite sides of the table. It therefore required considerable effort of the tutor to take over the task.

### FORM DESIGN

Several different shapes for the collectors were considered: a stick, an egg-like shape and a wristband (set 1). Furthermore, three different ways of visualizing the type of resource (water, wood or bricks) were created: icons, colored fabric and colored paper (set 2). Non functional mock-ups were created and tested with children.

### Paired comparison test

Children were asked to do a paired comparison test individually [12]. They were shown the two sets of shapes and within each set they did a paired comparison and chose the preferred interface. The test showed us that most children preferred the wristband, combined with an icon for information visualization.

It had been expected that this method would make it easier for children to choose and rationalize, as the items were presented two at a time. Indeed it turned out that some

children were better able to motivate their choices, compared to previous interviews.



Figure 6: Comparing two mock-ups

### PROTOTYPE IMPLEMENTATION

The devices to support the game should implement functionality for acquiring a virtual resource from a zone, display what resources have been acquired, store resources at the castle construction site, display the resources at the construction site and notify when the virtual ghost appears and display its location.

Three types of un-tethered devices were built: a device representing the castle construction site, a small portable “resource collector” device carried by each player and, finally, the zones where resources can be acquired. The three types of devices were implemented using programmable micro-controllers (Microchip 16F877). Due to time and resource constraints the current implementation does not include the ‘ghost’ and the ‘castle’ ones, which were simulated by members of the design team for user testing. A sufficient number of devices were constructed to support two teams of two players each.

Collector and zone devices in the prototype communicate with each other through IR LEDs and IR detectors. E.g., to acquire a resource the player should place their collector over the resource-zone device. Trading is also supported; by holding a full collector to an empty or half-full collector, the two units of the former collector are traded for a unit on the latter collector. Game rules such as waiting in the zone for 10 seconds, or the capacity of a collector are enforced by the embedded software. Feedback to the player was displayed through LED lights, e.g. a flashing LED while acquiring a resource.

The castle construction site has been implemented on a small box containing several drawers. When enough resources have been acquired, a drawer opens, containing a part of the castle. Players can build that part of the castle on top of the box.

### EVALUATION OF THE FINAL DESIGN

The prototype was evaluated in order to answer a range of questions. Do players find the game engaging? Is social interaction between players enhanced? Do the LEDs provide sufficient feedback? Are the waiting times appropriate? Is the technology robust enough to support the game?

Because of bad weather, the eventual test was held inside the school of the children. An empty room provided enough space for the children to run back and forth between the resource zones and their castles. The castles and the resource zones were placed at opposite corners (Figure 7).

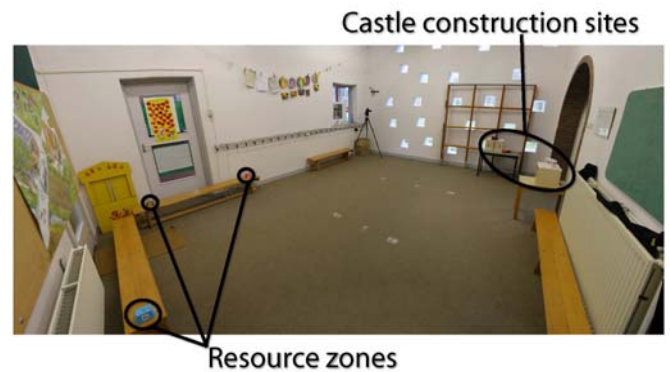


Figure 7: Test setting

The researchers introduced Camelot to the children and demonstrated how collectors work. Children were split in small groups to familiarize with the equipment.

The children were divided in teams of two for the test. The design team assembled teams of equal strength, based on the earlier experiences with these children. Every team participated in one game session of about 20 minutes that consisted of two games. A game mediator stood next to each castle to keep track of the collected items, to help players when they did not know what to do and to reset the collectors once the resources had been transferred to the castle, as this was not automatically done. The ghost was only introduced in the second game to let children first get acquainted with the game. All games were recorded on video, from two corners of the room, so that the actions of each team were captured.

After each game session both teams were interviewed separately. We applied the semi-structured interview technique using cards as described previously.

### Results

From the interviews and our observations we gathered that the children had no trouble interpreting the interactions with the collectors and several children mentioned that they liked the lights on the collectors.



Figure 8: Acquiring a resource

In contrast to Cato, none of the children thought that the acquiring time was too long (see Figure 8), even though the waiting times were equally long. This may be attributed to the technology: children could not cheat anymore, but they also knew that other players could not cheat either.

The children indicated that they liked running as a part of the game and thought that it balanced well with resting, e.g. during acquisition of the resources or building the castle, see Figure 9.



**Figure 9: Building the castle and winning the game**

Cooperative social interaction took place in the form of talking or yelling to each other, which occurred frequently between players of the same team. Players would encourage each other to hurry up, or advise their teammate which resource should be collected next. Children also celebrated together when winning the game by jumping and cheering loudly (see Figure 9). During the interviews the children clearly pointed out that the game with the ghost was most fun, and they appreciated the suspense that the ghost brought to the game.

There was a clear learning effect between the two games. In the first game some children were still figuring some rules out, but in the second game it was clear that they understood the rules and knew how to apply game tactics.

#### **Reflection on the process**

Initially, it had been intended to analyze the level of engagement of children using video observation. It was assumed that passivity and temporary non-involvement in the game would indicate low levels of engagement. However, during play children would often stand still, as the child could be figuring out what to do next. Eventually, there were few observable signs of engagement (or lack thereof) that could be used as a quantitative measure of success of this game. This repeats earlier experiences, e.g., see [2], which illustrates the need to develop observation methods for evaluating engagement.

#### **DISCUSSION**

The evaluation has shown that Camelot is a promising game concept which children enjoy to play, that supports and enhances social interaction. Team members discussed and applied team tactics and showed joint commitment to the end result. An interesting incident was when two children initially asked to switch teams, as they did not want to play

together. However, during the game they interacted normally, and after the game they admitted that their cooperation had worked out quite well.

This paper has presented the process of designing Camelot, which involved a gradual refinement of the concept and an increasing realism of the implementation. Clearly, there is more to be done; more parts of the game need to be built, e.g., the castle and the ghost, which necessitate also the design of appropriate interactive elements for locating and tracking the virtual ghost. The current implementation involves small robust devices that can be operated by children outdoors. The design of the devices and the game have been tailored to the interests, needs and preferences of the children. In this respect, the game adds to existing literature on pervasive gaming with a game design for children.

Pervasive games have a lot of potential, though a lingering issue that was experienced throughout this design was what the role of technology was and whether it was necessary for the game. As it turned out, technology added to the game, by ensuring that game rules were applied. Nevertheless, the emphasis of the design has not been on impressive effects or augmenting physical world with computational game elements. The implementation of the ghost would be a move into that direction. At this stage it is not yet clear whether this would add to the experience of playing the game or divert the attention of the children from playing a game to a virtual presentation of the ghost and its position.

The project has provided an interesting case study as several techniques for involving children in the design of games have been tried out. Some of the methodological lessons learnt are summarized below:

- Throughout the design of Camelot the same children were involved, and it seems that this has been beneficial to the project. While children could not be argued to be full design partners, their sustained involvement certainly made them affiliated to the team, at ease, capable of providing appropriate input and interested in the outcome of the design process.
- Mission from Mars [6]. This method was applied, perhaps for a first time by a team other than its originators. The experience reported shows that the motivation of the method is largely confirmed. An adaptation of the method was its combination with making a collage.
- Making a collage together with the children was in itself found to be an interesting way to talk to them and to create an informal atmosphere for an interview. Because play is a fairly abstract concept, collages gave the children a concrete means to express their views.
- Structuring interviews with picture cards was effective to keep children focused on the questions and to give them a sense of progress through the interview.

- Evaluating the game concept was effectively achieved by paper prototyping and playing parts of the game, rather than by showing pictures and explaining scenarios. This contrasts Hanna et al. [8], and may be a reflection of the type of game or type of input sought by the design team.
- Prototyping dynamic behavior of the interactive toys with Phidgets was a good way to test detailed interaction design.

## CONCLUSION

This paper has presented the design of a mobile outdoor game for children. The game is designed to be played outdoors, requires running around and encourages social interaction between children.

The design of Camelot was deliberately conducted as a trial application of several techniques for involving children in the design process. Several lessons have been learnt, confirming some of the existing knowledge and challenging other parts. In general there appear to be good methods for obtaining input from children at the early phases of the design. Observation for testing fun and engagement during game play is still quite challenging, pointing to the need for relevant methods to be developed.

## ACKNOWLEDGEMENTS

We are very grateful for the cooperation of the children and their teachers. We also like to thank all persons that supported us during the tests.

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