Chase and Catch – Simple as That? Old-fashioned Fun of Traditional Playground Games Revitalized with Location-aware Mobile Phones

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ABSTRACT

Fun in gaming is a difficult, however paramount, topic. Some games are fun, some are not. Some games are ancient and common to both man and animals, for instance *Chase-and-Catch* (*C&C*). These games are physically intensive, short in duration, and confined to a specific area. In our research we explore transitions from traditional playground *C&C* games to their digital counterparts. The rationale is simple; modest augmentations of old-fashioned gaming concepts might prove to be a rewarding avenue for designing successful location-based games. We present a straightforward *C&C* game, *FoxHunt*, where location-aware mobile phones are used for hunting virtual foxes. Based on field studies with a total of 220 players, we present and discuss evidence of a very high fun factor, independent of age, gender, playing conditions, and inclination towards sports and physical exercise. We argue that *C&C* games deserve to be treated as a separate genre within mobile, location-aware gaming.

Categories and Subject Descriptors

H.1.2 [**User/Machine Systems**]: Human factors; I.6.8 [**Types of Simulation**]: Gaming

General Terms

Human Factors, Experimentation, Design

Keywords

Location-based gaming, Fun, User experience, Player awareness, FoxHunt, Mobile, GPS

1. CHASE AND CATCH

A kitten is lurking, wagging its tail excitedly, locking on the target, the piece of cloth, preparing to attack, then leaps, grabbing the "mouse", dragging it into a corner, satisfied, making sure the potential spectator has noticed the victory.

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A girl is standing in field, staring intently on the display of a mobile phone, then, suddenly, starts running, then stops abruptly, consulting the display once more, then setting off in another direction, and, after a few meters, throwing her arms in the air with a triumphant scream, *"Yes, I got one!"*, then shouting at a friend on the other side of the field: *"Did* you *get one?"* (Figure 1).

Figure 1: Kitten and girl playing *Chase-and-Catch*

The kitten and the girl are playing the most basic game there is: *Chase-and-Catch* (hereafter referred to as *C&C*). The kitten is hunting a piece of cloth on a string, which the cat owner thinks of as a toy mouse. The kid is chasing an icon moving on a map displayed on the mobile phone, which the game designer thinks of as a virtual fox. Both are completely absorbed by the activity, within the *Magic Circle* of play. The girl obviously has a good time, seemingly also the kitten.

Why are they playing? Huizinga might have an answer:

> We can safely assert [...] that human civilization has added no essential feature to the general idea of play. Animals play just like men [...][Nature] gave us play, with its tension, its mirth, and its fun [...] the *fun* of playing resists all analysis, all logical interpretation [8].

In short, animals, including humans, play, because it is *fun*.

Nevertheless, how futile it may seem, we have poked the matter of fun of play, more precisely limited to *Chase and Catch* gaming with location-aware mobile phones. In our opinion, this is a slightly neglected domain of mobile gaming, both research- and deployment-wise. Most of all, we will shed light on the potentially high fun factor of these kinds

of games. First, we give a brief description of the *FoxHunt* game, a *C&C* game where the players hunt virtual foxes on a map displayed on their location-aware mobile phone. Then we present, analyze, and discuss data harvested from a series of field tests with a total of 220 participants. We briefly review work on related topics, and argue why *C&C* might be an interesting genre of location-aware mobile gaming, both in commercial and educational settings. Finally, we conclude and indicate directions for future research.

2. THE FOXHUNT GAME

FoxHunt is a location-based *C&C* game where the participants hunt virtual foxes on an outdoor playground. On the surface, the primary goal of the game is to catch as many foxes as possible. As we will see later, observations and data analysis reveals that the fun of playing is not correlated with the of number of foxes caught.

The bridge between the virtual and physical space is a GPS-enabled mobile phone displaying a map with player avatars and fictional foxes. When the hunter physically moves close to the position of a fox, it will automatically be caught. Then the fox cries out loudly, a red circle is flashing on the map, and the device vibrates frantically.

No buttons have to be pressed, no menu options have to be selected. The one and only user-device interaction is implicit, that is, by physically moving, the hunter's avatar moves accordingly based on GPS positions provided by the mobile device. The players only have to watch the map display, correlate it with their surroundings, and *run*.

Figure 2: High school students playing *FoxHunt*

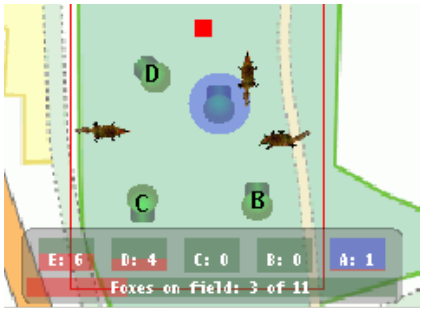
Selected user interface elements like avatars of other hunters and their game scores can be turned on and off by the game coordinator (Figure 3). Likewise, it is possible to choose appropriate values of parameters governing key aspects of the game-play, like *catch radius* and fox behavior.

The game engine keeps track of the positions of the hunters, and calculates position, speed, and direction of the foxes. Fox behavior is governed by a semi-intelligent simulation module. The foxes will naturally flock together, but disperse when a hunter approaches. This behavior enables various types of interaction between the hunters, for instance, a hunter may chase foxes towards another player. As foxes are caught, new foxes will be released, according to the current game configuration.

The game is typically played in groups of four or five, with a duration of approximately four minutes; playing longer has proved to be quite exhausting. Players may compete individually or team-wise, this is left to the players to decide.

We use two variants of visualizations, one without co-player information, and one showing the other hunters, symbolized with green caps, along with their scores at the bottom of the display (Figure 3).

(a) Stripped interface



(b) Co-player visualization

Figure 3: Cropped screen-shots of the *FoxHunt* mobile client

The system is developed with open-source tools, and the majority of the code, both server and client side, is written in Java. The background map is compiled and served by tools and infrastructure from OpenStreetMap [7]. The core component in the *FoxHunt* system is a simulation and coordination server. There are three types of clients: 1) the mobile phone client for the hunters, 2) the web client for the spectators, and 3) the orchestration client for the administrators.

The bottleneck in the system is the mobile client. Only high-end devices[1] were able to perform satisfactory, due to frequent server requests and rapid display refreshment. The game is fast-paced; hunters and foxes typically move between one and three meters per second. Ideally, to obtain a fluid experience, the mobile display should be refreshed approximately 12 times per second. In practice, we obtain around 5 frames a second, which, in our case, yields a satisfactory user experience.

The mobile client issues an update request over EDGE or 3G, tagged with the player's current location approximately each second. When the response is received, the message is parsed, and core parameters, such as current positions of foxes and hunters, and scores, are updated. In addition, a separate thread keeps track of the player's position, and download map content on demand. In the display refresh

[1]We used Nokia N-70s and N-82s in the experiments.

loop, the background map, the fox and hunter avatars, and score information, are redrawn.

The system is an academic implementation with a non-optimized graphics pipe-line. Despite this, it performs remarkably well with contemporary smart-phones. We anticipated that the relatively low and varying accuracy of the GPS technology, in worst cases up to 15 meters, would become a major obstacle. We designed the system to reduce this problem as much as possible, by ensuring that the *relative accuracy* between players and foxes is high. On a map, a typical playing ground is an open space with few features. In fact, we observed that the players used the invisible foxes as the prime landmarks for navigation, and not roads, parking lots, or other physical elements. Due to this, the GPS inaccuracy becomes relatively unproblematic.

3. METHOD

3.1 Experiments

We ran a series of experiments, where visiting pupils and students played in groups of 20+. Each game lasted for four minutes, and were played by four or five participants at a time, the rest of the group being spectators. The playgrounds were open fields, typically 100 by 200 meters. The games were played in both winter, spring and summer, with varying conditions, including 30 cm of snow, sub-zero temperature, rain, and bright sunshine.

All in all, 220 players were involved in the experiments; 23 from 4th grade (around 10 years old), 44 from 5th grade, 23 from grade 8 (14 years old), and 130 from high school (age 16 to 18). The data from the high school experiments constitutes the base of the analysis and discussion, while results from the younger players are used to validate the findings across a wider age span.

Prior to playing, the groups were given short introductions to the purpose of the game and how it was played. Those interested in playing (almost everyone) had to fill out a pre-game questionnaire, and a second form after the game (see Section 3.2).

Each player was equipped with a GPS-enabled mobile phone, a step counter, and a yellow vest with hunter ID clearly visible. Many of the games were video taped, and we secured oral and written observations both from the field and from conversations between the spectators. In addition, log files were automatically produced server side, recording positions and time and place when foxes where caught.

The nature of the study was exploratory and relatively open. In general, we wanted to learn more about the game we had created, and how it was received by the players. In particular, we wanted to gain a deeper understanding of the the fun factor in *C&C* games. In the following, we explain in more detail how we collected and analyzed the data.

3.2 Data

The two variations of the game, with and without visualizations of co-players and scores, was our main independent variable. 56% of the players in the high school experiments played *FoxHunt* with this information rendered on the screen, the rest without it. We used the values of eight variables, collected as explained in the following (names of main variables in parenthesis).

The values of three variables were distilled from server-side game logs:

- Game variation (`visual`)
- Total distance covered during the game, calculated from the GPS tracks. There is some margin of error in this variable due to GPS inaccuracy (`dist`).
- Number of foxes caught by the player (`score`).

In the pre-game questionnaire we included three questions:

- *Gender?* (`gender`)
- *Do you like sports classes?* Choices: "1: Not at all" to "5: Very much" (`gym`)
- *How often do you exercise?* Choices: "1: Never" to "5: Several days a week" (`exer`)

The last two questions were hypothesized to predict the participants' playing performances, how much fun they had, and how they rated their own effort. Preliminary testing in a school setting indicated that these traits did matter less than expected. Teachers observing the game were surprised by the effort put in by some students who they had never seen running before.

The answers to the following six questions where captured with a post-game questionnaire:

- *How much fun was it?* Choices: "1: Boring" to "5: Great fun" (`fun`)
- *How much effort did you put into the game?* Choices: "1: Not much" to "5: A lot" (`effort`)

The motivation for these questions was to get subjective measures of performance in addition to distance covered and game score.

The remaining questions were designed to analyze the effects of visualizing co-player information and not. All four questions were answered by *yes* or *no*.

- *Did you compete with the other players?*
- *Did you cooperate with other players to catch foxes?*
- *Did you look at the other hunters around you?*
- *Did you see how the other players moved on screen?*

3.3 Analysis

First of all, the data from all experiments ($N = 220$) were summarized by computing average values for the reported level of fun, distributed on gender and age groups.

Further, the data produced in the high school experiments ($N = 130$) were subject to a more thorough statistical analysis. Our primary goal was to illuminate aspects of the fun of the game. Secondarily, we were interested in the effects of visualizing co-players and their scores on a set of variables.

We used multivariate linear regression analysis to assess the effects of the predictor variables (related to gym, exercise, and gender) to the response variables (fun and score). The response variables were investigated separately. In addition, we used Pearson's product-moment correlation to measure the linear correlation between distance run, score, and gender, and between fun, effort, and co-player visualization. The main results are reported in the next section.

4. FINDINGS

4.1 Fun factor

Our main and most significant finding is the over-all *high fun factor* reported by the players. In Figure 4 we see that the average value for all participants is approximately 4.3 on the scale from one to five. The total number of players is 220, of them 94 girls. Regarding age, the players were distributed like this: 10 years - 23, 11 years - 44, 14 years -

23, 17 years - 130. We further notice that the fun factor is quite even, regardless of age and gender (neglecting a slight bias towards a higher value among the younger players).

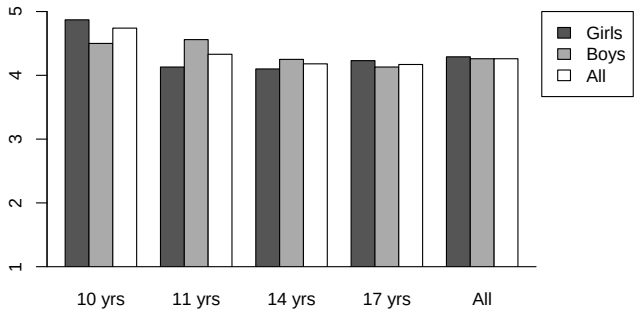


Figure 4: Reported average fun factor

The high level of player enjoyment is confirmed by the observations. When the game is over they often convene on the field and walk together back to the starting area. The conversations are mostly about who did best, and incidents like people falling or crashing, and how the foxes behaved. They finish the game happy, but exhausted. When they hand over their equipment to the next team and join the spectator group, there is a rush of conversations: *"I was the best girl!"*, *"Exhausting! I'm really dizzy, now!"*, *"Lots of fun - you really have to join the game!"*, *"Second place, yes! And me being in really bad shape..."*, *"Don't run with high heels!"*, *"How many steps did you get? I got over 800!"*, and *"You really looked silly out there, running around like fools!"*.

A typical game session involved 20-25 hunters, comprised of four or five games, and lasted about 40 minutes. Both players and spectators obviously had a good time. There were constant laughter, friendly mocking and encouraging shouting.

Very few participants were observed to drop out of the social context, and almost all were eager to play. In fact, one of the girls in 4th grade started to cry because she did not manage to join the first team, but had to wait until the next round. Consistent with the high fun factor reported in Section 4.1, there were numerous comments like *"Hilariously funny!"*, *"Good exercise - and in addition, it is fun!"*, *"This must be the new family game!"*, and *"Can I play it again, please?"*.

Interestingly, the spectators seemed to enjoy the game as much as the players (Figure 5). The web page showing the position of the hunters and their scores was projected on a large screen, and the spectators frequently checked the game development, both on the field and on the screen: *"Running around like idiots...after something that's not there!"*, *"C is a real winner, who is she?"*, *"Look how he's running!"*, *"There she gets one more!"*, and *"Poor D, he hasn't got any [foxes] yet"*.

In the next sections, we investigate in more detail various aspects of fun, based on analysis of data from 120 high school students.

4.1.1 Preference for sports and exercise

Regression analysis shows that the level of enjoyment does not seem to be predicted by gender or preference for sports and physical exercise. The estimates for this model are very small and not significant (Table 1). The game seems to appeal to users with diverse physical interests and abilities.

Figure 5: Spectators watching a game starting

Table 1: Estimation results: `fun`

	Coefficient	(Std. Err.)
`gym`	0.059	(0.090)
`excer`	-0.013	(0.067)
`gender`	0.123	(0.156)
Intercept	3.900^{**}	(0.426)

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table 2: Estimation results: `score`

	Coefficient	(Std. Err.)
`gym`	0.216	(0.505)
`excer`	0.548	(0.389)
`gender`	-4.964^{**}	(0.867)
Intercept	9.865^{**}	(2.396)

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

The next question is then, does gender, or preference for sports and exercise, predict player score? When looking at preferences for sport and exercise individually we get small but significant estimates. However, when we include gender, this relationship disappears (Table 2). The same applies to the distance measure which is highly correlated with the score (Table 3).

Many of the spectators commented on unexpected good performance by some of the players: *"I'm really surprised, I have never seen the boy move!"*, and *"Didn't believe she would run like that!"*. This is also consistent with the finding that fun and score were independent of inclination towards physical activities.

4.2 Co-player visualization

It was expected that the players who could see the other hunters represented on the screen would benefit from this extra information, and develop more efficient strategies for catching foxes. However, the results show that additional display information had no significant impact on their performance. They did not catch more foxes, and they did not run more than the players without this information.

As previously pointed out, the level of enjoyment is high, with a reported average of 4.1 on a scale from one to five. An important finding is that visualization of co-players seems to play a role in this context.

Visualization of other hunters is positively co-related with the perceived level of fun and the reported level of effort put into the game (Table 4). In other words, although visualization plays no significant role in the success of a hunter, it

Table 3: Cross-correlation `score`, `dist`, and `gender`

Variables	`score`	`dist`
`dist`	0.712	
	(0.000)	
`gender`	-0.492	-0.553
	(0.000)	(0.000)

Table 4: Cross-correlation `fun`, `visual` and `effort`

	`fun`	`visual`
`visual`	0.236	
	(0.007)	
`effort`	0.368	0.152
	(0.000)	(0.083)

does seem to play a significant role in how much the players are having fun during the game. Regarding how visualization of co-players and score is used by the players, it is difficult to see any pattern in the data.

These results are consistent with the observations. It was difficult to notice differences between the games where the players saw each-other represented on the screen and the games where they did not. Correspondingly, it was not clear if the hunters used the screen or the surroundings as the main source of information. Preliminary analysis suggests that players are more attentive to their surroundings when they only see themselves on the screen. Their heads were bobbing up and down more often, and they seemed more prone to interact with other players.

4.3 Gameplay

Based on the observations, it is possible to describe a general game-play development. When the players recognize that the game has started they run onto the field laughing and talking loudly to each-other for 5-15 seconds; *"In what direction should I hold this thing?"*, *"Where are the foxes?"*, *"Where am I?"*, and *"I'm going to beat you!"*. After this brief togetherness the players go silent and disperse. Often they choose very different directions and keep a good pace.

Moreover, the hunters demonstrate different *playing styles*. Some study the display, moving slowly or standing still, conferring with their surroundings, then suddenly charges in a certain direction, stop, checking their display again, and take another course.

Others are constantly on the move, running fast and determined, checking their display all the time. Some do not relate much to the device, but rather run around in a seemingly random pattern.

Based on how the players talk about the game afterwards, it is clear that some followed more or less consistent *strategies*:

- Run towards places where they see many foxes gathered on the map.
- Run towards places where they see other players on the map.
- Run towards places where they don't see other players on the map.
- Neglect the map and run after other players.
- Loitering close to the midpoint of the field and let the foxes do the running.

However, not everyone seemed to develop strategies, there were numerous comments like *"I just ran around, and suddenly I caught a fox..."*.

After a short while the players often start meeting on the field. Sometimes the display takes all the attention so that hunters almost crash into each-other. Most of the time the players do not interact at all. They throw a brief glimpse at each-other and run in opposite directions. When a meeting triggers a communication pattern, this is often a shout without reciprocation. Sometimes a meeting leads to proper two-way communication, mostly about being lost or the game standing. It seems that this behavior is more frequent towards the end of the game when they grow tired.

5. DISCUSSION

FoxHunt was initially developed as a showcase application to be used in a workshop teaching programming of location-aware mobile devices. Since then, it has been used as entertainment on various occasions, most often in connection with high-school classes visiting our department.

After a while, a pattern emerged: The players enjoyed the game immensely, even if rain was pouring down, or they had to skid around on a snowy field. Interestingly, the girls, including the fashion oriented ones with elaborate haircuts, designer jeans, and high heels(!), expressed as much fun, sometimes more, than the boys. Another counter-intuitive observation was that players with relatively low interest in physical exercising performed very well. Even more surprising; hunters with low scores were happy, too.

Then we designed and ran a series of experiments to learn more about *how*, and ultimately, *why*, such a simple *C&C* game could be so fun. As we documented in Section 4, the experiments confirmed our initial observations; *FoxHunt* is fun for all, all the time. Neither gender, age (at least in the interval 9 to 18), playing conditions, nor inclination towards physical exercise affect perceived fun.

We start our discussion with examining the familiarity of the game components in order to understand the efforts to master the game. We describe how *FoxHunt*, as an *open* game, accommodates different *playing styles*, which in our opinion is one of the keys to understand the fun of *FoxHunt*. Further, we comment of how inclination towards traditional playground gaming might affect (or not) the user experience. Finally, we make some remarks about how, and if, the novelty of the *FoxHunt* concept could help explain our findings.

5.1 Digital natives

The *FoxHunt* concept is a novel and unfamiliar approach to physical gaming, and as such, unknown territory for all the participants in our experiments. However, the various components; the mobile phone, the map, and moving avatars, are, separately, indeed familiar concepts. Of the 44 5th graders, 39 had their own mobile phone. Moreover, 34 of them frequently used their phones for gaming. In addition, on average they had access to 3.2 dedicated gaming consoles, and of these were 38.8% portable consoles such as Nintendo DS, Nintendo Gameboy, and Sony PSP [4]. The games played on these tiny displays often utilize stylized maps of virtual worlds, with all kinds of avatars, including their own, which they control by arrow keys or more advanced input mechanisms.

Against this background, the *FoxHunt* game might not be as unfamiliar as by first glance. The component that they

are not trained in, is that of moving their avatar on the map by running. Yet, with Nintendo WII and their motion-based "wiimotes", which 39% of the 5th graders had regular access to, most of them are quite accustomed to user interfaces based on body movement.

Surely, the 5th graders are *digital natives* [14]. Still, the *FoxHunt* concept in total requires a certain degree of learning, in the sense of grasping the gist of it, at least. In the next section we follow up the learning aspect by introducing the notion of *playing styles*.

5.2 Playing styles

During the experiments, we observed a variety of different *playing styles* (Section 4.3), and we now discuss this finding in the perspective of *learning styles*.

We start by assuming that all play carries aspects of learning. First of all, the game has to be learned, to the degree that the player is able to take part in the game. There might be rules to adhere to, and there might be a story-line to follow. In *FoxHunt* there are few rules, and the story-line is simple: Virtual foxes run around within a limited geographic area, and get caught when a hunter moves close enough. The score of each player is recorded and broadcasted to other hunters and the audience.

The superfluous goal is simply to catch as many foxes as possible. However, the underlying objective might be to have fun, by using your body and your brain, together with friends, classmates, or colleagues. Further, the players also provide an experience for the spectators. Our findings do indeed support this disguised, but perhaps most important goal; the game is fun, no matter how it is played and how many foxes are caught.

Playing games can help the player learn new things, or increase existing abilities. In *FoxHunt* the players are subject to a short but intensive exercise session, which (slightly) increases their fitness. Moreover, and perhaps more significant, they train their spatial perception and abilities, relating a virtual representation of the reality, the map with its moving foxes and players, to the physical surroundings, mediated by the relatively inaccurate GPS technology. Finally, at the inter-personal level, they may get a better and more positive understanding of fellow students, since the results of the game seem to contradict prejudiced assumptions about physical abilities.

5.2.1 Learning styles

The concept of *learning styles* is based on the idea that learners have different preferences towards learning. We briefly introduce the work of Kolb [9], as an example of one of many approaches to the field. Kolb states that "it is the combination of how people perceive and how people process that forms the uniqueness of 'learning style' - the most comfortable way to learn". According to Kolb, effective learning is a four-stage cyclic process that includes concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE). He argues further that people have different strengths and weaknesses regarding the stages in the learning circle, and he ends up with four types of learners:

Accommodator The activist who favors AE and CE
Diverger The reflector who favors CE and RO
Assimilator The theorizer who favors RO and AC
Converger The pragmatist who favors AC and CE

Aspects of different learning styles can be observed in the FoxHunt game in the different ways that the players approach and carry out the game. There is no generic playing style. The players demonstrate a variety of strategies and behaviors.

The core of learning style research is that teaching- and learning-material should accommodate for all kinds of learning styles. For instance, in *digital learning*, much effort is put into making tools configurable to support various styles of learning. Ideally, learning tools should intrinsically support all styles (see e.g., [11]).

From a pedagogical point of view such *open systems* are important for the reason that they do not exclude users. The challenges in games and sports are quite parallel; to design activities that engage all users independent of individual qualifications. Regarding *playing style*, *FoxHunt* is such a game where everyone seems to fit in and define their own playing experience. For instance, you may stand still and accidentally catch a fox now and then. You may play like you want, but fortunately, your playing style will not have significant effects on other players' experiences.

As the hunters run around on the field they show little interest in the other players. Although they share the same goal of catching as many foxes as possible, there is little competition amongst the players. Once in a while it seems as the players coordinate their efforts, but suddenly they spread out in different directions. In a certain aspect, *FoxHunt* is a solitary game, hunters play alone, but still, they do it in good company (Figure 6). In particular, when playing without co-player information, the player (that is, the position on the map and the score) is anonymous, still physically present.

Figure 6: Hunting alone, playing together

People are different regarding abilities, preferences and backgrounds. *FoxHunt* demonstrates that it is possible to build games based on physical activity that can be enjoyed by everyone. In short, in *FoxHunt* there are no losers, only the occasional winners.

5.3 New game - old news?

The classical *C&C* playground games, like *Capture the flag*, *Tag*, *Hide and seek*, and *Kick the Can*, might seem to loose the battle against digital and sedentary spare time activities, like console gaming and chatting. However, *C&C* games are rooted deeply in childhood play in all cultures. The new generation of digital natives might in fact miss this element in their daily life, and when playing *FoxHunt* they can rediscover the joy of running around on a field, together with friends and classmates, for no purpose other than to have a good time.

Perhaps the role of the hand-held device, and the overlay of virtual foxes, is not at all significant? Would the players have as much fun, just chasing and catching, *without any technology at all?* More specifically: How, and to what extent, does the digital artifact provide added value to traditional games?

In one of the *FoxHunt* experiments, the participants were asked whether or not they *enjoyed* playing *Tag* and *Kick the Can*. Among the 5th graders, 42.7% liked *Tag*, and 79.5% had fun when playing *Kick the Can*. In 8th grade the numbers were 17.4% and 65.2%, respectively [4]. This indicates that children enjoy *C&C* games to a certain degree, however the interest seem to drop when they get older. By asking the high school students the same question, we would most likely get even lower values.

Based on these numbers, we can assert that inclination towards traditional playground games *does not* explain the high fun-factor reported by the same children playing *FoxHunt*. Further, we suggest the hypothesis that the digital device with its virtual layer is a significant component of the enjoyment in location-aware *C&C* games.

5.4 Novelty factor

As an important reflection, we ask if the fun factor depends of the the *novelty* of the concept; a fresh mix of traditional playground chasing and catching and "cool" technology. Perhaps the fun factor might drop when repeatedly playing the game over some time? We have no answer, since this would require a longitudinal study which we not yet have carried out. However, some test persons have played the game several times, and still think it is fun. Moreover, the researchers have not grown tired of being (passive) spectators to the numerous games. One could also argue that repeated exposure might *increase* player satisfaction, by getting more skilled and seasoned. One girl, in her first game, did not perform very well, and got really unhappy. However, playing the game once more, some months later, she mastered the game perfectly and caught many foxes, and exclaimed when the game was over: *"*This *time it was really cool!"*.

6. CHASE-AND-CATCH AS GENRE

Many computer games carry aspects of *C&C*. However, they tend to be more elaborate, developing along a complex story-line, and maybe lasting for days, weeks or even months. This is indeed applicable to *pervasive gaming*, which has received much attention during the last few years. Affordable location-aware mobile phones have made it possible to design, develop, and deploy mobile games using the players' positions to combine real world experience with representation of virtual artifacts. Fiction meets reality, and playing interweaves with everyday chores.

Many of the locative games have in common that they originate from traditional computer gaming. Some are direct adaptations of existing concepts, such as *PacMan* [3], others are heavily inspired by them, as in the case of *Alien Revolt* [5]. Another category of mobile games is inspired by classical board games, translating the boards to urban spaces and playgrounds, as in *Mobile Monopoly* [10].

Just as the aforementioned examples are designed for fun and entertainment, some "serious" games have been developed to explore location-based games as learning tools, in particular for children (edugames), like *Savannah* [6]. Spikol et. al., have, among others, investigated gaming as a means to engage youngsters in physical activities (exergames). They have studied a game called *Skattjakten (Treasure Hunt)*, as a combination of traditional orienteering and contemporary mobile technologies [15]. As such, their work differs from the mainstream mobile games, by augmenting existing real life concepts (orienteering) with the help of digital artifacts (mobile phones), rather than using the real world as an add-on to the computer game.

Other offsprings, perhaps more well-known, of the same design strategy, are *CatchBob!* [13] and *Can You See Me Now?* [2]. These games are building on the simple *Chase and Catch* concept, but add complex elements from video gaming.

In contrast, the *FoxHunt* game is definitely not rooted in the the console/computer/video-gaming tradition. It is merely a modest augmentation of tradition playground gaming, where the digital artifact becomes an aid in the traditional game, like a bat or a ball, rather than a central and critical component creating a hybrid reality.

However, the locative and mobile nature of *FoxHunt*, its use of ubiquitous technology, and the mixed reality approach, make it tempting to place the game in the (somewhat fuzzy) category of *pervasive gaming*. However, even if the boundary between reality and fiction becomes blurred when running after virtual foxes, the game is definitely taking place within the *magic circle* of play, as described by Huizinga [8]:

> [A] free activity standing quite consciously outside "ordinary" life as being "not serious", but at the same time absorbing the players intensely and utterly... It proceeds within its own proper boundaries of time and space according to fixed rules and in an orderly manner.

However, according to Montola et al. [12], in pervasive gaming, the magic circle is blurred and expanded:

- Spatially: In principle, all parts over physically surroundings might be part of the playing field.
- Temporally: Pervasive games typically lasts for a long time and can be dormant in periods, and intensity varies over time.
- Socially: It can be difficult to distinguish between players and citizens being present where and when a game is unfolding.

Based on this, we claim that *FoxHunt* is *not* a pervasive game.

Similar approaches are hard to be found. However, a few common design principles are used in research on *Head-Up Games*, where non-display devices are used to support the game in a natural way, for instance by "picking" virtual artifacts [1]. However, when playing *FoxHunt*, you definitely have to keep your eyes on the device.

To summarize, the novelty of our approach is the focus on a segment of applications in the intersection of elaborate *mixed reality* games and simplistic *Head-Up Games*. Due to the encouraging and, in our opinion, interesting, results regarding player enjoyment, we think it is proper to suggest a new genre of mobile location-based gaming, simply called *Chase and Catch*, or for short, *C&C*. with the following characteristics:

- Design-wise, they originate from traditional playground games.

- There are two types of participants, chasers and targets, which in any combination could be physical or virtual. The player is either chaser or target.
- Players are represented in the virtual world by the means of location-aware mobile devices.
- The player moves the avatar by physically moving the body.
- The game stays within the *magical circle*, being played in a limited and well-defined area, in a relatively short period, with a distinct beginning and end.

7. CONCLUSION AND FUTURE WORK

We have created and investigated a *Chase and Catch* (*C&C*) game called *FoxHunt*, in which players use location-aware mobile phones to hunt virtual foxes in a physical environment. Our main finding is that the fun-factor of the game is indeed high, and quite independent of gender, age, playing conditions, and preferences for physical activities. One of the keys to understand this, is to view *FoxHunt* as an *open game*, facilitating a wide variety of *playing styles*.

We also observe that it is quite feasible to implement and deploy mobile-based *C&C* games with off-the shelf devices and easily obtainable open and free software. Despite the relatively small displays, the participants did not have any problems with using the application, not even under non-optimal weather conditions such as rain or bright sunshine.

The significance of this finding is three-fold:

1. There is revenue to be harvested by marketing simple *C&C* games.
2. *C&C* games carry a potential to be used in physical education and sports, as a fun-enhancing tool in exercise.
3. By embedding learning aspects, for instance by chasing information carrying targets, *C&C* games could become efficient tools in mobile learning.

All in all, the authors firmly believe that the *C&C* genre has great potential, both in commercial and educational contexts, and a good candidate for further research.

A new series of experiments is planned, where we will investigate in more detail the player enjoyment depending on age and cultural background. In addition, we plan to design variations of the *FoxHunt* concepts, where we will be particularly concerned with how additional features and complexity will affect the fun-factor. Moreover, we would like to embark on a longitudinal study in order to cancel out the effects of novelty and validate our initial findings.

Finally, we think we have demonstrated that games do not have to be complex or elaborate to be embraced by the players. We also argue that augmenting existing game concepts, by adding a thin virtual layer, could be a sound design principle.

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