

# CHILDREN'S GAME EXPERIENCES IN DIFFERENT SETTINGS

*Satu Jumisko-Pyykkö\*, Satu-Maria Hellsten\*, Mandy Weitzel\*, Ismo Rakkolainen+*

\*Tampere University of Technology, Department of Software Systems, Human-Centered Technology, PO Box 553, 33101 Tampere, Finland

+FogScreen Inc., Tammasaarenkatu 1, 00180 Helsinki, Finland

## ABSTRACT

Games provide enjoyment and positive experiences for players. Goal of this paper is to examine children's game experiences between physical gaming on the immaterial FogScreen and a mouse-based PC gaming. The systematic game evaluation experiment was conducted with 20 children. Game experiences were measured quantitatively using a children-friendly flow questionnaire and a qualitative interview for gathering playing impressions. The results showed that FogScreen provided novel gaming experience, was funnier and children enjoyed about its naturalness and possibilities to move compared to PC set-up. However, the interaction with the FogScreen set-up was harder, providing a lower level of playability and controllability than the PC set-up.

**Index Terms**— game experience, enjoyment, children game, immaterial screen, PC, physical gaming

## 1. INTRODUCTION

An important criterion for a successful computer game is player's enjoyment and game experience. Game experience is a complex and holistic construct of player's characteristics, content and context of a game. During the last 15 years there has been an increasing interest to study game experience from different perspectives. Besides, numerous platforms from dance carpets to other physical multiplayer systems and mobile gaming exists nowadays [5]. The immaterial FogScreen provides a novel environment for a physical game, but its impact on player's game experience has not been studied. The aim of this study is to examine children's game experience between two different settings: physical gaming on the immaterial FogScreen and a typical PC set-up.

## 2. GAME EXPERIENCE

In the literature, game enjoyment and experiences is approached using the theory of flow [1,2]. According to Csikszentmihalyi [1] flow is a state of complete absorption or engagement in an activity that refers to the optimal sensory experience. He implicates several antecedents to conceive the multidimensional construct flow. Below, these

flow antecedents (1-5) and its indicators (6-9) are listed with a short description [4]:

1. Challenge-skill balance: User's skills and the challenges of the game have to match to achieve flow.
2. Action-awareness merging: This antecedent involves the playability of a game and assumes that the activity has to become spontaneous and automatic.
3. Goals of an activity: Clearly defined goals are essential to reach the experience of flow.
4. Unambiguous feedback: Feedback conveys the user of his/her success of achieving the defined goals of a game.
5. Control: The sense of control appears in the possibility to develop skills that reduce errors and makes the game enjoyable.
6. Concentration: The user concentrates totally on the game and there are no resources for information beyond the game.
7. Loss of self-consciousness: In flow the user has no mental resources for self-scrutiny.
8. Transformation of time: During the flow experience users lose track of the actual time, either the time flies or drags.
9. Autotelic experience is an activity that is "done, not with the expectation of some future benefit, but simply because the doing itself is the reward" [1].

When individuals identify a number of these dimensions or their combinations during an activity they experience a sense of deep enjoyment. Previous research has shown that computer games which enhance experiencing flow have a positive impact on learning, exploratory behavior and the attitude of players [4].

Game developers have used the theory of flow to evaluate and design games. Different models and heuristics for assessing the experience of flow in computer games have been proposed in the literature. Among the most notable work Sweetser and Wyeth [1] integrated these heuristics into a GameFlow model that was validated in two real-time strategy games. Desurvire et al. [2] introduced a Heuristic Evaluation for Playability (HEP) to evaluate video, computer, and board games. Kiili [4] has proposed

an experiential gaming model to be used as a base for game experience evaluations.

### 3. GAME RESEARCH WITH CHILDREN

As children are consumers of various entertainment technologies, nowadays their participation to game development and evaluation is a key factor. Children represent a heterogeneous user group having varying cognitive, emotional and social skills and require extremely careful design for experiments. Different research methods have been adapted to involve children in computer product design of new children's technologies [3]. When conducting user research with children, it is especially important to minimize the power structures and authority between adult and child and provide supportive natural and social environment to decrease impact of pleasing and scaring [3].

### 4. RESEARCH METHOD AND SET-UP

**Participants** - A school class of 20 children participated to the experiment. The number of girls corresponded to the number of boys which were all in the age of 11 to 12 years. 50% of the children reported to play regularly computer games, 45% play at least once a week and 5% play at least once within half a year. Participants reported to play approximately 1.6h at the time.

**Test procedure and data collection** - Test procedure contained three parts. In the pre-test part, demographic and psychographic data collection took place e.g. gathering information about daily media consumption.

The actual experiment contained two gaming sessions with different set-ups, one physical gaming using the immaterial FogScreen and another with traditional PC. Two different set-ups were chosen to make the evaluation task easier for children even our primary interest was in game experience of the FogScreen. The gaming started with short introduction and training and it was followed by actual playing for approximately 10 minutes. After playing on each set-up participants filled a short survey. To make the task easier for the participants, the researcher read the simple claims. The claims were constructed to represent the aspects of flow and interaction [4,8] but they were modified and tested to be understandable for children in the age of participants. Participants answered their agreement to each of the claims by coloring the face which represented a 5-point Likert-scale. They were especially encouraged to answer according to their own impressions and the researcher did not see the answers in order to reduce the children's need to please researcher. All participants played on both set-ups and the starting set-up was randomized.

The post-test session contained a questionnaire and interview about game experiences. The aim of the post-test questionnaire was to sum-up the player's experience after playing on both set-ups as well as to warm up and encourage to present their rationale behind the answers.

The questions presented by researcher were the following: If you had a chance to play once more, which set-up would you choose? Which of the set-ups you find funnier to play? Which of the set-ups you find easier to play? After each of the question participants either commented freely their answers or they were asked reasons why they chose certain set-up. This data was used to collect qualitative impressions about gaming on the immaterial screen.

**Game environment** - Two different set-ups, the immaterial FogScreen with a hand-held pointer and a tabletop PC with mouse, were used in the experiment.

The FogScreen is an immaterial projection screen that can form a projected mid-air image on a flat vertical plane of thin and dry fog [1]. The fog is made of water which is broken into tiny fog particles so that they appear to be very dry and soon evaporate to air. In contrast to ordinary screens, the user is encouraged to walk through the screen and to interact with the displayed objects by touching them [Figure 1]. Due to the fact that fog particles pass light but do not reflect back almost any light, the FogScreen enables to project different content onto each side of the screen without images interfering each other. The FogScreen has been employed for example in exhibitions, theme parks and museums. The permeability of the screen enables new imaging and interaction possibilities among other things for gaming and physical experiments. Interaction with the immaterial 2D or 3D graphics objects can be implemented by using different tracking systems such as eBeam employing hand-held pointer or a Sick laser range scanner.

For the FogScreen gaming we used a 1.4 meters wide FogScreen with an Epson EMP-74 projector (1024x768, 2000 ANSI lumen) and a modified eBeam whiteboard tracker as a mouse replacement. The FogScreen was rigged above the heads of the children so that they could reach the whole screen area. For rendering we used Lenovo ThinkCentre M55 with Intel Core 2 Duo Processor E6300 at 1.86 GHz, 1GB RAM, Windows XP, and Intel Graphics Media Accelerator 3000.

For PC gaming we used a HP LP2065 LCD display, which was set at 1024x768 resolution, and a Lenovo 44G0302 mouse.

**Interactive 3D Content** - An interactive game employing real-time 3D graphics developed by Rakkolainen et al. [1] was used. Different dynamic 3D objects of various sizes, forms, lifetimes, speeds, scores appeared and moved to random positions of the screen [Figure 1]. The goal of the game was to catch as many moving objects as possible with one hand in a given time. If an object was touched, the player score was increased and more objects appeared at the screen. A game level took less than a minute. If the player got enough points, the next more difficult level with an increased object speed and decreased object sizes or lifetimes was started. Background music and effect sounds were also added to enhance the appearance of the game.

Prior to the experiment the heuristic playability evaluation was conducted by two usability experts for game. We applied Desurvive et al's [2] heuristics. Based on the heuristic evaluation visibility of transitions between the different difficulty levels were improved.

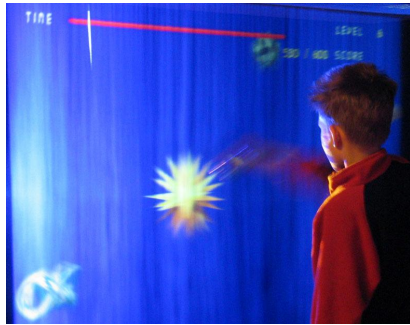


Figure 1 Gaming on the immaterial projection screen

## 5. RESULTS

**Flow experience - antecedents and indicators** - Both set-ups gave equal flow experience when evaluations of all measured attributes were averaged across ( $t=-1.85$ ,  $df=19$ ,  $p>.08$ , ns). More detailed analysis revealed differences in flow experience when separating the dimensions of flow antecedents and indicators [Figure 2]. The antecedents of flow experience (averaged across challenge, goal, feedback, control and playability) were experienced more pleasing on PC set-up than FogScreen. Within flow antecedents playability and control constructs collected higher scores on PC compared to FogScreen gaming (playability:  $t=-0.434$ ,  $df=19$   $p<.001$ , control:  $t=0.254$ ,  $df=19$   $p<.05$ ). All others were evaluated being in the same level ( $p>.05$ ). In the terms of indicators of flow experience (concentration, time distortion, autotelic experience and loss of self-consciousness) there was not significant difference between the set-ups ( $t=-.57$ ,  $df=19$ ,  $p>.571$ , ns). Reliability of flow experience was reasonable in both of the studied cases (Cronbach's alfa, FogScreen  $\geq 0.74$  and PC  $\geq 0.68$ ).

**Interaction and scores of the game** - Evaluations of interaction and scores of the games separated the different set-ups clearly. Interaction on PC using mouse was found both quicker ( $t=-4.27$ ,  $df=19$ ,  $p<.01$ ) and easier ( $t=-3.82$ ,  $df=19$ ,  $p<.01$ ) during the game than catching the objects on e-beam of the FogScreen set-up. Similarly, the collected scores were significantly higher in PC set-up ( $M=770p$ ) compared to FogScreen ( $M=290p$ ) ( $t=-12.4$ ,  $df=19$ ,  $p<.001$ ).

**Post-test questionnaire and interview** - Three post-test questions revealed that gaming on FogScreen was funnier and participants were interested to play more on it [Table 1]. In contrast, the PC set-up was experienced easier. The results also showed a weak relation between funny to play

and interests to play more ( $\chi^2 = 0.449$ ,  $p<.05$ ), while not relation between other measures ( $p>.05$ ).

Table 1 Results of interests, fun and easy to play

QUESTION:	FogScreen	PC
Interested to play more on:	63.2%	36.8%
Funnier to play on:	90 %	10 %
Easier to play:	5 %	95 %

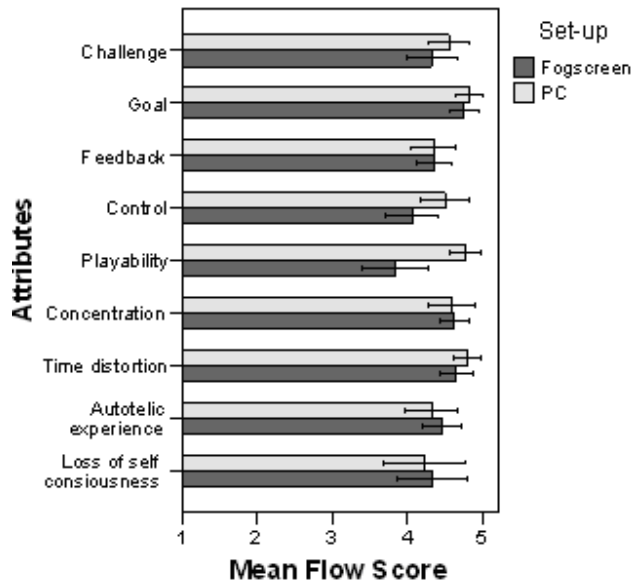


Figure 2 Mean scores for the different flow attributes on the PC and FogScreen set-ups. Error bars: 95% CI.

**Impressions of gaming on interactive FogScreen** - Analysis of qualitative experience factors was based on grounded theory principles, originally presented by Strauss & Gorbun [1]. Grounded theory represents data-driven approach to analysis and it is applicable to research areas with little a priori knowledge, and when the research aims at understanding the meaning or nature of a person's experiences. The theory or its building blocks are derived from data with systematical steps of analysis. At the beginning of analysis, all data was read through to discover the concepts and further main categories. All created concepts were organized into nine categories. In the categorization, several mentions of the same topic were recoded only once. Coding reliability was good and it was estimated with intercoder agreement between two independent researchers in all codes (Cohen's kappa  $> 0.79$ ).

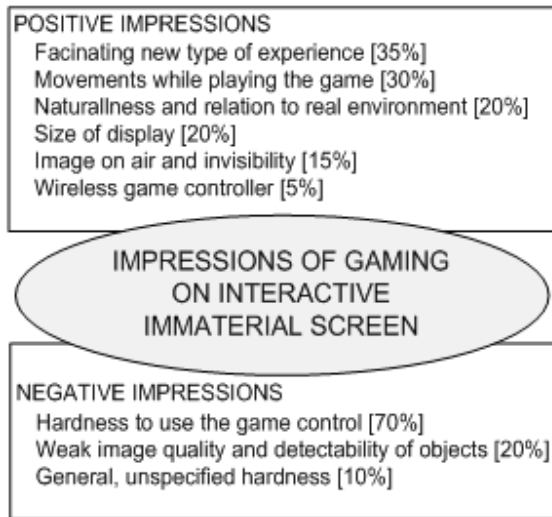
Aspects of gaming experience were divided into two affective dimensions, to positive and negative impressions [Figure 3]. Uncomfortable gaming experience was mostly formulated from hardness to use game controller. It was clearly the most mentioned category as 70% of all participants mentioned it. An 11-year-old boy summarized the inconvenient behavior of game controller as follows:

*“slow to control, -- it did not react, --it did not reach from the top of screen, and continuous pressing the button was complicated while playing”*

Other negatively experienced factors were weak image quality and detectability of the objects and general impression of hardness in gaming.

Six different aspects sketched pleasant impressions of gaming on the interactive FogScreen. It provided fascinating new type of experience. In addition, possibility to move around while playing, naturalness, wide screen size, invisible image on air and wireless game controller offered positive aspects in gaming. The words of an 11-year-old girl crystallize the positive aspects of playing on immaterial FogScreen:

*“--interesting, unusual, wide screen and walkthrough”*



**Figure 3. Impressions of gaming on interactive FogScreen**

## 6. DISCUSSION

This study investigated impact of two different set-ups on children's game experience. We measured game experience by applying a quantitative flow questionnaire and qualitative interview. In overall, there were not differences in a game flow experience between the FogScreen and PC set-ups. More detailed analysis revealed that the level of control and playability were lower with the FogScreen set-up. Similarly, results of interview described that the game controller of the FogScreen set-up was hard to use. These results reflect the problems of the specific tracking system that we used. Further development work should focus to improve shortcomings of interaction techniques with the immaterial screen. The results also highlighted gaming on the FogScreen being funnier and more interesting compared to PC. Children described impressions of the FogScreen gaming providing fascinating new type of experiences and they enjoyed its physicality in

terms of freedom of movements and its naturalness. To provide even more positive impressions, possibilities to emerge physicality and walkthrough features should be examined parallel to interaction techniques and content production with the immaterial screen.

Our results showed similarities but also differences between used data collection methods. Quantitative flow questionnaire was sensitive for negative experience factors providing partly similar results to qualitative interview whereas the qualitative part provided also more positive aspects of experience which might provide useful hints for product development. These findings emphasize that methodological triangulation should be considered when measuring game experience to capture the phenomena holistically.

## ACKNOWLEDGMENTS

This work is in part supported by EC within FP6 under Grant 511568 with the acronym 3DTV, by Academy of Finland under Grant 114006. We thank our participants and their teacher for valuable feedback.

## REFERENCES

1. Csikszentmihalyi, M. Flow: The psychology of optimal experience. Harper Perennial, New York, 1991.
2. Desurvire H., Caplan M. and Toth J.A. Using Heuristics to Evaluate the Playability of Games. In Proc. CHI 2004, ACM Press (2004), 1509-1512.
3. Höysniemi, J., Hämäläinen, P., and Turkki, L. Using Peer Tutoring in Evaluating the Usability of a Physically Interactive Computer Game with Children, *Interacting with Computers* 15, 2 (2003), 203-225.
4. Kiili, K. Evaluations of an Experimental Gaming Model. *Journal of Humans in ICT environments* 2, 2 (2006), 187-201.
5. Magerkurth, C., Cheok, A.D., Mandryk, R.L. and Nilsen, T. Pervasive Games: Bringing Computer Entertainment Back to the Real World. *ACM Computers in Entertainment* 3, 3 (2005).
6. Rakkolainen, I., Erdem, T., Utku, B., Erdem, Ç., Özkan, M. Mid-air Display for Physical Exercise and Gaming. *IEEE 3DTV Conference*, Kos, Greece, May 7-9, 2007.
7. Strauss, A., and Corbin, J., *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.), Thousand Oaks, CA: Sage, 1998.
8. Sweetser P. and Wyeth, P. GameFlow: A Model for Evaluating Player Enjoyment in Games. *ACM Computers in Entertainment* 3, 3 (2005).
9. Takatalo, J., Nyman, G. and Laaksonen, L. Components of human experience in virtual environments. *Computers in Human Behavior* 24, 1 (2008), 1-15.