
Investigating the Impact of Feedback on Gaming Performance on Motivation to Interact with Public Displays

Jiamin Shi, Daniel Buschek, Florian Alt
Media Informatics Group
University of Munich (LMU)
{firstname.lastname}@ifi.lmu.de

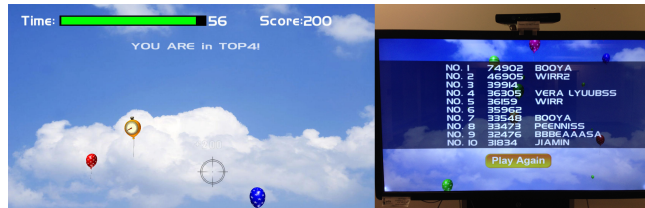


Figure 1: We present different UI modifications with the goal to motivate users to interact with playful display applications in public space. In particular we investigate whether providing feedback on gaming performance in the form of a real-time score / rank during the game (left) or a high-score list at the end of each game (right) leads to extended or repeated gameplay.

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Abstract

This paper investigates the influence of feedback about users' performance on their motivation as they interact with games on displays in public space. Our research is motivated by the fact that games are popular among both researchers and practitioners, due to their ability to attract many users. However, it is widely unclear, which factors impact on how much people play and whether they leave personal information on the display. We investigate different forms of feedback (highscore, real-time score and real-time rank during gameplay) and report on how they influence the behavior of users. Our results are based on data from the deployment of an interactive game in a public space.

Author Keywords

Public Displays; Motivation; User Performance; Competition;

ACM Classification Keywords

H.5.2 [User Interfaces]: Screen design (e.g., text, graphics, color); K.8 [Personal Computing]: Games

Introduction

As prices for hardware and sensors drop, an ever-increasing number of research on public displays is being conducted in the real world [8]. In this way, researchers can test the performance and experience of users as they try out novel

interaction techniques [1, 2, 6, 11], study the social impact of display interventions [15, 16, 17, 20], and investigate privacy concerns as users are asked to provide sensitive data [2]. All the aforementioned aspects are difficult or impossible to investigate in the lab [5].

At the same time, researchers face the challenge of attracting people to their displays due to the need to provide a tangible benefit for the user [3]. Looking at prior research it becomes apparent, that in many cases, interactive games are a good choice due to their entertaining nature [7], in particular if encountering users in a waiting situation [2, 18]. To just name a few examples, games have been used to investigate how to communicate interactivity of displays [20], how to teach gestures to passersby [21], how people interact in groups [19], how people socialize around displays [13, 14] or how interactivity impacts on cognition [4].

While prior work employed leaderboards [10], there has been little research on how mechanisms that provide feedback on user performance impact on players' motivation and behavior. This information is useful in situations, in which researchers want to control for how long people interact. While researchers often aim to make people interact for as long as possible, there is also cases where it is desirable to have short interaction times. For example, in Looking Glass [20] the authors deliberately designed a very simple game that users would abandon soon, since they were primarily interested in how users approached the display and thus aimed to maximize the number of different players rather than interaction times.

As of today, it is unclear how the aforementioned challenges could be addressed. Most closely related to our work is research on motivation in traditional games, which however mainly focuses on how to optimize the time people engage with a game. For example, Garris et al. found that users

are challenged by activities that are neither too easy nor too difficult to perform, and performance feedback allows users to track progress towards desired goals [9]. Malouf found that clear goals, immediate feedback, and scores which reflect improvement have motivational characteristics. Furthermore, games with increased task enjoyment or self-perceived competence pose fewer risks to subsequent motivation than those with no such outcomes [12]. Much of the literature in these fields is not empirically based and while this paper does not attempt to explain its results in any theoretical framework, it tends to serve as a useful counterpoint to other more theoretical work. Beyond research, it could also be relevant to people designing public terminals and arcade games. Besides, findings from traditional games are difficult to apply to public displays. Interaction times are very short, situations are manifold, users neither physically own the game nor display, and it is unclear who has access to data and where they are stored.

To bridge this gap, our research investigates different ways to motivate users to interact with public displays. In particular, we are interested in how feedback on performance in comparison to other users impact on how long people play, on whether they come back, and on whether there is any influence on their willingness to leave name or email address.

To do so, we implemented an interactive BalloonShooter game that provides feedback in different ways. In a deployment in a university setting users played more than 1200 games. Results indicate that the type of feedback provided to users indeed influences whether they leave information on the display and that there is an influence on the user's playing behavior. Our findings are valuable both for researchers and practitioners, since it provides hints as to how interactive games should be designed to trigger a certain user behavior.

Approach

To understand which factors influence a users' motivation to (a) play a game for an extended period of time, (b) come back regularly to play the game, and (c) leave personal information on the display, in a first step we implemented a simple display game.

BalloonShooter Game

We implemented a game called BalloonShooter. To attract passers-by. A call to action ('Start Game') is shown in idle mode. After tapping this button, users are allowed to play for 60 seconds. During the game, balloons of different sizes and moving at different speeds are floating across the screen. The task of the players is to destroy the balloons by hitting them with their finger on the touch screen. For each destroyed balloon, users receive points. Occasionally, clocks appear on the screen, touching which gives players some extra 5 seconds.

At the end of the game users can enter their name which is then shown together with their points in the high score list. Additionally they can enter their email address, to receive information as new games are deployed on the screen. The email is not publicly displayed but only stored in the system. Then, the game returns to the start screen (cf. Figure 3).

Pre-Study

To gather early insights, the game was deployed during an Open Lab Day for about 3 hours in a large room of our lab with several exhibits. No researcher was present at the display but we observed passersby and their interactions from the corner of the room. After users finished playing and turned away, we approached them and conducted a short interview. In addition, we logged quantitative data: the score, the time people played, and the name (if provided).

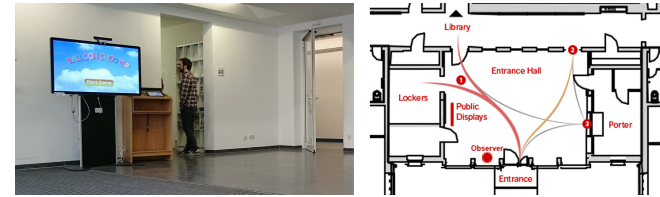


Figure 2: For the main study we deployed the display in the entrance area of a University building.

In the pre-study, the game was played 75 times by 47 different users. We post-hoc grouped the players based on their scores into beginners and experts. We found that the vast majority of expert players (89%) left their name while only 45% of beginners did so. This suggested to us that the own performance in comparison to others seems to be a strong motivating factor.

As a result, we decided to more in-depth investigate feedback on performance. In particular we were interested in the influence of three different types of feedback.

- The *high score* provides users information after the game on how well they performed with regard to other players.
- The *real-time score* provides users information while they are still playing on how well they are doing.
- The *real-time rank* tells people their current rank in the high score list as they are playing the game.

We then designed a study where we investigated the influence of these three feedback types on whether users leave their name or email address on the display, for how long they play and whether they come back.

SHr(Cnd1)	shr(Cnd2)	Shr(Cnd3)	sHr(Cnd4)
SHR(Cnd5)	shR	ShR	sHR(Cnd6)

Table 1: Six Conditions: (S=real-time score shown, H=high score shown, R=rank shown; s=real-time score not shown, h=high score not shown, r=rank not shown) We omitted the conditions where a rank but no high-score would be shown.

Main Study

We extended the balloon shooter game to support three modes: showing a high score at the end of the game, providing a real-time score during playing the game, and providing a real-time rank during the game.

We then deployed the game over 90 working days in a University building that hosts about 300 researchers from different disciplines (politics, sociology, communication science, computer science), a cafeteria, and several lecture theaters (cf. Figure 2). The display was deployed in the main foyer at a 90° angle to the normal walking direction of passers-by.

Study Design

We combined the three aforementioned independent variables (high score, real-time score, real-time rank) into 6 conditions (cf. Table 1). Conditions changed every 40 sessions. In all conditions, users were shown their final score and provided the opportunity to leave their name (associated with their high score) and email address (to receive updates on new games).

Data Collection

Our quantitative data stem from log files, where we recorded condition, time stamp, user score, user name, email address, and when users left the game (during the game, after the game, after entering name/email).

Factors	Repeated Gameplay (RG)(%)	Email(%)
Show Real Time Score	39.81	26.96
Hide Real Time Score	40.50	35.12
Show Final Score	40.00	30.70
Hide Final Score	40.46	29.77
Show Rank	45.12	40.24
Hide Rank	38.04	26.45

Table 2: Percentage of first-time players that played again (RG) and entered a valid email address.

Furthermore, on three days we ran observations where we, similar to the open lab day, hid in the vicinity of the display [?] and only approached users after they stopped interacting to conduct semi-structured interviews with them.

Data Analysis

After the deployment we analyzed our data. In particular, we (1) counted how many users returned (based on names entered in the highscore list), (2) the duration of continuous gameplay (timestamp), and (3) the number of consecutive games being played.

Results

During the deployment, 1235 sessions were played. After removing consecutive games (timestamp) and games of users with the same name, 561 entries remained, which gives an estimate on the number of users. For analyses we only considered sessions where users played until the end so that users had the chance to see the feedback forms.

Quantitative Findings

First, we were interested in how many people entered a valid name in each condition (Table 2). We found that showing users their rank during the game encouraged more than 40% to enter a valid name. The difference is statistically significant ($df=1$, $Std.Error=0.2405$, $p=0.003$). Real-time score and high score did not have a significant influence on whether or not people left their name.



Figure 3: When the game is over (1), users' are asked for their name (2), email address(3) and are finally shown the highscore list (4).

Cnd	Score(M)	RG(%)	Name(%)	Email(N)
SHr	52000.16	38.54	20.98	2
shr	37488.54	39.13	26.47	5
Shr	27609.6	41.94	30.65	0
sHr	33904.65	31.15	37.70	1
SHR	36571.05	42.31	44.23	3
sHR	54110.51	46.43	34.82	4

Table 3: Comparison of the different conditions based on score, percentage of players that interacted again, percentage of users that left a valid name, and number of people that left a valid email address. Only the first game people played was considered.

With regard to the email address, 15 valid email addresses were left during the 561 sessions. This number was too low to run any statistical tests and suggests, that players either considered it too cumbersome to enter the email address or that they refrained from doing so due to privacy concerns.

Table 3 provides a comparison of the different conditions. In particular, it summarizes the users' scores (Score), how many played again (RG), how many left their name (Name), and how many left their email address (Email). We found in the condition where we showed the high score list as well as the real-time rank, people scored best and the largest percentage of people played again.

One aspect we were particularly interested in was when users decided to leave the display. As can be seen from Figure 4, the vast majority of users left only after they saw

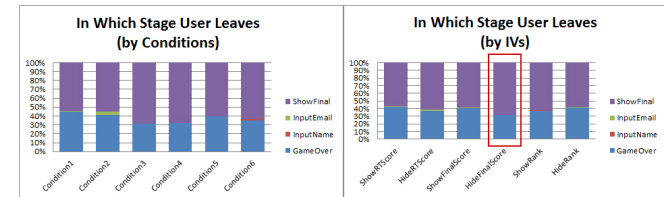


Figure 4: Comparison of stages and conditions in which users left. Most users left after they saw the high score (appr. 60%), about one third left immediately after the game.

the highscore screen, while only about one third of users left during the game over screen. Very few user left the screen where they could enter name or email address. This was similar for all conditions. From this we learn that the highscore indeed motivates people to stay at least until they saw how they performed. This can be exploited by display owners to present further information or other motivating elements to the user.

Finally, we were interested in frequent players. Overall there were 11 players that played more than 7 times. Inspecting the score we were not able to find any obvious learning effects. The difference in score of the last game compared to the first game was, in almost any case, smaller than the standard deviation of all scores. From this we conclude that at some point, people did not expect their performance to further increase, and hence left the display.

Qualitative Findings

We discovered not only forms of indirect competition through the highscore but also direct competition. For example, there was one student frequently using the display during breaks as he prepared for an exam. On this occasion he often took pictures of the display with his phone and sent it to a friend. We discovered that as a result, also the friend started playing extensively, resulting in 56 games played.

We also received some feedback on how the game could be enhanced. For example, one student from the Japanese institute suggested to add a Japanese keyboard to motivate more people from this institute to leave their name. He himself did not leave the name because he found adding the Japanese name with Latin letters too cumbersome.

Summary and Discussion

From our findings we conclude that feedback on performance can indeed influence a user's motivation to interact with playful applications on public displays.

- When users play for the first time, showing the rank during the game encourages them to enter valid names.
- Players that perform well (and are made aware of this) are more inclined to come back and play again.
- High score lists could serve as a stimulus for players to continue interacting after they played one game. In the condition where the highscore list was shown, experts were more inclined to leave their name.
- Findings suggest that as users do not become better anymore, their motivation to play decreases.

Since providing feedback on the real-time rank was the most vital factor on user's motivation to leave their names

and also encouraged users to interact again, this suggests that display game designers should include this information in their interface in case they strive for extended game play or would like to collect information on the number of returning users (which could be derived from their name). Showing a highscore leads to people playing repeatedly but it could also be explicitly omitted in case short interaction times are desired.

Limitations and Further Work

Our study has several limitations. First, we have conducted our experiments with one application only – a first-person-shooting game. Future work could investigate different playful applications. Second, the studies were carried out in a University environment, leading to that participants were mainly students and academic staff.

In the future we plan to investigate further aspects that potentially impact on users' motivation. On one hand, this includes incentives. For example, people could be provided a coupon or bonus points as they return. On the other hand we expect privacy to play a major role. For example, users could be provided feedback on who has access to email addresses as well as information about what data about them is being logged.

Conclusion

Our work contributes to the understanding of how feedback on performance in playful public display applications impacts on the behavior of users (for example, extended and repeated gameplay) and whether they are up to leave personal information at the display. Our findings can aid designers of interactive display applications to create gaming concepts that fit the display owners' needs, i.e., applications that optimize interaction times or user numbers.

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