Analysis of the Effect of Competition on Player Immersion and Engagement in a Mobile Game

Juhong Park
Devsisters Corp.
Department of Mathematical Sciences, KAIST
Seoul, South Korea
J.Park@devsisters.com

Alice Oh
School of Computing
KAIST
Daejeon, South Korea
alice.oh@kaist.edu

Suin Kim
School of Computing
KAIST
Daejeon, South Korea
suin.kim@kaist.ac.kr

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Abstract
Competition is a major motivator for game players. In this paper, we quantify and analyze how competition affects the players' degree of immersion and engagement in the mobile social game Cookie Run. Specifically, we quantify the level of competition by the relative score difference between the player and their competitor. We measure the level of immersion by the length of game time; and we measure the level of engagement by the number of paid score-boosting items. We found that users are much more immersed and engaged as the competition increases, and the effect is greater in high-level players.

Author Keywords
Mobile game; Social game; Competition; Engagement; Immersion

ACM Classification Keywords
H.1.2 [Information interfaces and presentation (e.g., HCI)]: User/Machine Systems; K.8.0 [Personal Computing]: General; H.5.2 [Information interfaces and presentation (e.g., HCI)]: User Interfaces

Introduction
Competition is a major motivator for gamers to engage [5, 3]. When gamers recognize there is competition, they are driven to outscore their competitors, and even when

they fail, they immediately engage again to beat their competitors [4]. Such a simple, well-known mechanism greatly influences the gamers' level of immersion and engagement, and previous research showed a positive correlation between the existence of competition and the level of user's immersion [6, 2].

In this paper, we analyze the effect of competition as shown on the score leaderboard on gamers' immersion and engagement. Using the game logs from a mobile game *Cookie Run* [1], we ask two questions: (i) does competition affect the level of gamers' focus and immersion in the game, and (ii) does competition affect the level of investment and engagement in the game?

This paper aims to understand in which degree of score difference motivates the users most. We also identify the relation between score difference and the level of perceived competition with the level of user's gaming experience. As far as we are aware, this is the first work to quantitatively measure the level of competition and the relation between engagement and score difference.

Data & Methodology

Cookie Run is a mobile game launched in April 2013. About 40 million users around the world had installed the game as of April 2014 [1]. Cookie Run is a run-and-score game, where the cookie keeps running and gets points by eating the various scoring items (e.g., jellies) in its path, and the goal of the game is to get the highest score by controlling the cookie. The cookie should be controlled to avoid any obstacles, as running into an obstacle ends the game (or uses up any extra lives). See Figure 1 for a screenshot of Cookie Run. *Score Leaderboard* (Figure 2) shows the personalized list of each user's friends having the highest scores of the week. Every time a user plays, the score is

Figure 1: Cookie Run game screen. Users are required to avoid obstacles and eat the in-game items (jelly) as much as possible to obtain higher score.

uploaded to the server, and the leaderboard of the user's friends is updated accordingly. The leaderboard is located at the main landing page of the game screen, which is shown to the user every time the game starts. The score leaderboard resets every week.

We use as data the gaming logs during April 2015. During this one-month span, the total number of active users was 2,884,313 and the number of play (each running) was 156,757,073. In this study, we randomly sampled 20% of the total users, resulting in 658,547 users and 4,012,808 plays.

Cookie Run requires a special item, called *heart*, to play each game round. Each *heart* vanishes when the user starts the game round. *heart* refills periodically, or, can be sent to another friend using 'Send heart' function. Users can send hearts only to their *friends*, a set of accounts in the contact list of a linked messaging app. Because we

Figure 2: Score Leaderboard shows the list of users' friends having the weekly highest score. The score leaderboard shows each user's nickname (blurred), score, and the button to 'Send heart' function.

cannot access the complete list of friends, we construct the users' friend network using the heart interaction log.

The score leaderboard is where each user can look for a particular friend, identify their own rank in the leaderboard, or compare their own score to the scores of their friends. In this study, we concentrate on how the score leaderboard affects the user's immersion and engagement. To simplify the analysis, we assume that the user's competition is a single user, and we define that competitive friend as the user who is one rank above the user in the score leaderboard at the time the scoreboard is shown to the user prior to each game play. We note the score difference of the user and the competitive friend and we define *Score Ratio* as the relative ratio between the user and the competitor's score.

We then analyze how the *score ratio* affects the user's degree of immersion and engagement. To quantify the degree of immersion and engagement, we use two measures: play time and usage of booster. In Cookie Run, users are required to minimize the mistake (e.g. falling into the trap, missing the jellies, ...) in order to get the higher score. Thus, play time is strongly, negatively correlated to the amount of mistakes made in the game, which can effectively measure the user's level of concentration and immersion.

Users can extend the play time by using special item to rectify their play. Booster is a paid item that can undo the mistake (i.e. falling in the pit or hitting to an obstacle). The cost of booster items surpass the amount of in-game money that user earns for each game round, thus they are infrequently used. We analyze how ratio affects the amount of booster items used, which we define as booster probability. We define *Booster Prob* as the the probability of booster item used for every play rounds in each bin (size=0.01). *Booster prob* is the number of plays with booster item divided by the number of all plays.

Result

Measuring Immersion: Play Time with Score Ratio
For each play, we calculated the *score ratio* and the play time of the respective play round. We then plotted the *score ratio* and the play time in the figure 3. Due to the large amount of play rounds, we binned each *score ratio* with size=0.01 and calculated the averate play time that belongs to the respective bin.

As shown in the figure 3, users on average played higher amount of time per each play round as *score ratio* becomes smaller, that, the *score ratio* negatively correlates to the user's average play time per each round. This suggests that users on average make less mistake and feel more immersive when the score gap between the users and their

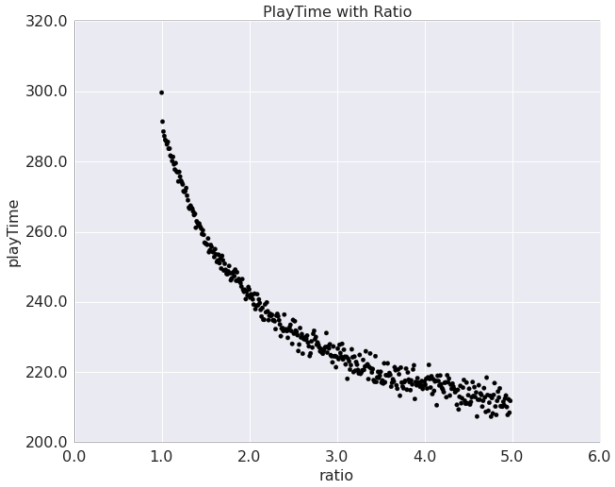

Figure 3: Graph of playTime (in seconds) and ratio.

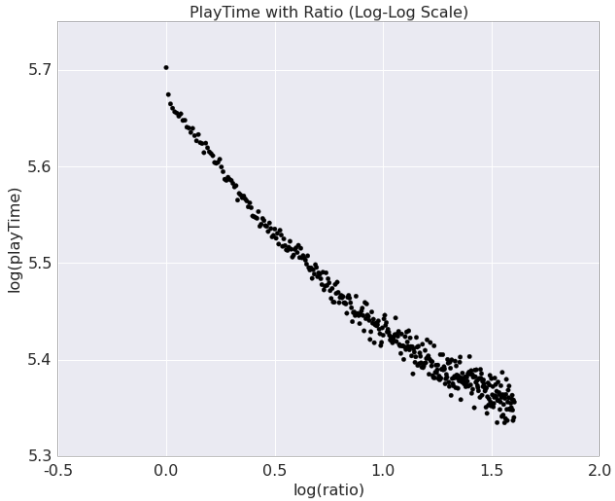

Figure 4: Graph of playTime and ratio, Log-Log scale.

competitors become smaller. When setting both ratio and play time axes in log scale, we observe that play time is linearly, negatively correlated with *score ratio* until $\log(\textit{score ratio}) < 0.5$ and the slope slowly flattens as the *score ratio* increases (Figure 4).

PlayTime with Episode (Difficulty level)
In Cookie Run, there are multiple levels with differing difficulties, called as Episode. New user starts at the episode 1, and remaining becomes available as user progresses and unlocks predefined conditions. Usually the users having higher experience point reaches the upper episode, and the level of difficulty also increases.

We then examine if the relation between play time and ratio with repect to the different episodes. Figure 6 shows the distribution of play time and *score ratio* for each episode.

Figure 5: Episode map. Users start at episode 1, and remaining becomes available as they progress.

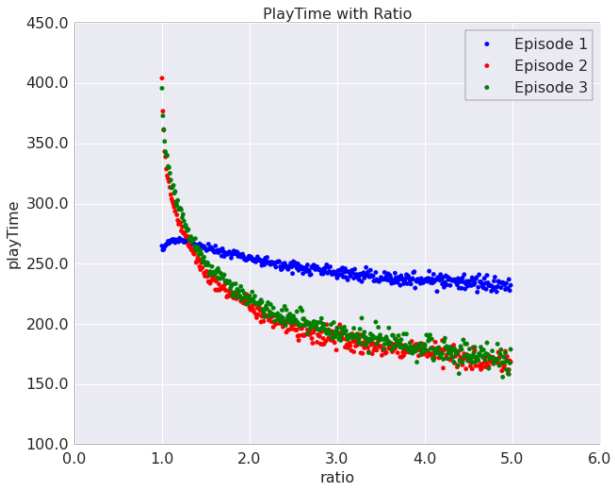

Figure 6: Graph of playTime (in seconds) and ratio with episode.

We observe that the slope is higher in episode 2 and 3 than in episode 1. The slope indicates the sensitivity of change in user's perceived competitiveness by *score ratio*. In Cookie Run, episode 1 has the lowest difficulty, and usually the most participate, whereas episode 2 and 3 are more challenging and only being played by the users having higher experience level. This suggests that the effect caused by changes in ratio appears much stronger in the levels requiring higher in-gaming expertise.

Measuring Engagement: BoosterProb with ratio
Figure 8 shows the distribution of *booster prob* and *score ratio*. The pattern in episode 1 is quite interesting because it opposses the pattern discovered in prior analysis. In episode 2 and 3, we observe that *booster prob* increases as *score ratio* decreases, which implies that competing high-level users use costly booster items more when the

Figure 7: Player can use booster item when game finishes. Booster has multiple functions, that can amend user's mistakes, but each costs substantial amount of in-game money.

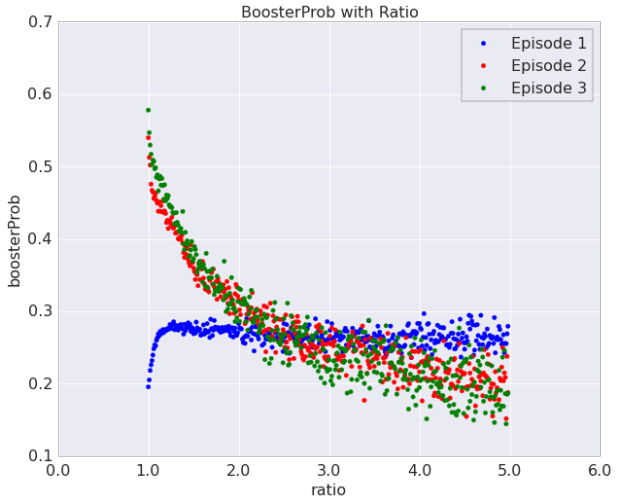

Figure 8: Graph of boosterProb and ratio with episode.

score gap between them and their competer becomse smaller. However, in episode 1, *booster prob* decreases when *score ratio* becomes smaller. This interesting phenomenon can be explained by the fact that episode 1 is played by all users, including low-level users who cannot afford booster items. When they becomes engaged, they are likely to spend booster items at the first couple of rounds, and becomes indigent quickly, but still cannot overcome their competitors. We conclude that the usage of paid item sensitively increases only for the higher-experienced, not for the low-level users.

Conclusion

In this paper, we have analyzed the massive amount of game log data from mobile game that spans for multiple countries. Using Cookie Run gaming data, we found that the ratio of score difference of user and user's competing friend are strongly correlated to the level of engagement, which we quantitatively measure in play time and amount of paid items that can boost the score. Users feel much more engaged as the score gaps between them and their competitors. This effect was exerted more in case of high-difficulty, high-level, but appeared relatively weakly in the competition that low-difficulty, low-level users participate.

This study aims to identify the relation between user's perceived score difference and the level of immetsion, and we hope our findings to be applicable in future gaming design. There can be many further directions rooted from this research. One is to analyze the user's competitiveness including the non-interacting friends, as in this study we were able to construct the friend network only from the interaction log. Another is examining the cultural difference in social-based mobile gaming, as we discovered notable difference in interaction patterns across the different cultures.

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