Social Player Analytics in a Facebook Health Game

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ABSTRACT

Social health games can drive healthy behaviour. To track social behaviour change in social network games (SNGs), gameplay metrics should quantify socially-engaging gameplay behaviour based on player interactions. We developed social player metrics in a quantitative study of player behaviour in a social health game called Healthseeker (developed by Ayogo Health Inc.). This Facebook game targets people with diabetes to help them manage health goals in real life. Our metrics identify which game mechanics led to more gameplay success, connectedness and virality. We also identified how the behaviour of successful players differs from unsuccessful players in the game. Our results support that game mechanics aiming at social interactions can motivate players to solve more missions, to fulfill more healthy goals and to play the game longer. We conclude that having a well-connected social network can improve player success in solving game missions.

Author Keywords

Game Design; Social Games; Game Metrics; Facebook Games; Sociability; Health Games; Game Analytics.

ACM Classification Keywords

K.8.0 [Personal Computing]: General - Games; J.4 [Social and Behavioral Sciences] – Psychology.

INTRODUCTION

Games (especially the activity of play) have long been discussed as form of social interaction and human cultural development. The idea that we can use games to better ourselves (e.g., change our perceptions or behaviours and improve our health or fitness) has become widespread. This is because serious games and gamification have risen in popularity, not only within the public discussion, but also within empirical research. Serious games are entertaining, but they are real-world simulations at their core that educate, train or inform their players [1]. Gamification is the idea that you can use game design in non-game systems to engage the users of such systems [8]. Integrating serious games with online social networks has the potential to customise and personalise the gameplay experience [14]. In addition, this integration leverages the online social connections of an individuals. Existing social network games (SNGs) are played primarily in web-browsers, typically in multiplayer settings (with social connections) and with asynchronous gameplay mechanics. Thus, SNGs have been described as casual activities on online social networks that have "contextual rules permitting user engagement" [20]. We think SNGs can become drivers of personal health, because SNGs can sustain engagement with players for a long time [16]. In this context, we define a *persuasive SNG* as an SNG that fuses the idea of serious games, gamifying health monitoring and social gaming.

However, a large problem with serious games (including persuasive SNGs) is the successful evaluation of their effectiveness in terms of learning or behaviour change. We do not know how effective these games are with respect to positively modifying player habits and behaviour. Defining metrics for studying persuasive SNGs will allow us to constructively discuss their efficacy in this regard. We are especially interested in learning about the social effectiveness of gameplay in SNGs. Past studies have questioned that people play SNGs for social reason at all [25]. In the following we present a persuasive SNG for social health, Healthseeker, and develop metrics that allow us to evaluate different aspects of the game.

The Social Health Game: Healthseeker

Healthseeker[1] is a social health Facebook game developed by the company Ayogo Health. The game motivates better lifestyle choices for people living with diabetes, so that they can improve both their nutritional and physical health habits. The game rewards healthy behavior. Within the game, players solve healthy missions in daily life and become part of the social community of the game. They report the outcome of their missions back into the game. For each mission, a player then earns experience and achievements. These badges and experience points accumulate over time and help the player advance to different levels. Each mission has a different life goal and involves the player or his friends and family. The game also provides a support system called

Kudos with which players can show support to one another's missions.

In the game, there are *goals*, *missions* and simple *action steps* that a player completes helping them get started on the road to better health. The first step is to review a list of goals the game provides and identify the ones they would like to achieve by playing. Then, they choose from a list of possible missions that are designed to help complete their goals. Once they select a mission, they must choose three specific, but simple action steps from a menu to complete the mission. The action steps are activities players can do on their own or with family and friends. These activities can be incorporated into everyday life. When a player completes action steps and returns to the game to report their achievements, they receive experience points. Each mission has 4–5 levels. Players are rewarded for their achievements, such as badges or trophies, and by receiving kudos from their friends.

RELATED WORK

Game Metrics and Game Analytics

The analysis of recorded data or events for analysing player behaviour is a common Games User Research (GUR) method [19]. The use of automated systems to track player behaviour in complex entertainment environments is still in its infancy. Tychsen et al. [21] define *game metrics* as numerical data obtained from the user's interaction with the game software itself; that data can be recorded at different degrees of temporal and spatial resolution. The limitation of this data is that it only contains information provided by the game itself, not from the player or their environment [21]. Researchers and companies have developed methods to collect and use automated events for different purposes. For example, Microsoft Game Studios used automated recorded metrics to evaluate game design and user experience for the game *Halo 3* by visualizing player behaviour [9]. In addition, user behaviour metrics are also used as a basis for data visualization [22]. Whitson and Dormann [23] note, for example, that the "collection of metrics heavily influences the design of social games." Log files are often used to analyse user chat logs via statistical analysis or data mining.

Social Network Games (SNGs)

SNGs have become a subject of increasing interest in the HCI community and were discussed in a dedicated workshop at CHI 2011 [10]. The workshop organizers lauded the integration of SNGs with online social networks that "allows these games to be intertwined with existing real-world social ties." The mainstay of studies regarding SNGs is the examination of social games that are created specifically to be played within a social networking site [20]. A user's decision to engage with an SNG is based on two central factors: perceiving (1) the social network as private and safe and (2) the SNG as fun to play [20]. In addition, perceived enjoyment and ease of use can predict the intention of players to use an SNG. However, player culture plays only a small role in explaining what SNGs people play [15]. A feeling of vertical collectivism[2] in an SNG predicted the likelihood of players to spend real money on virtual goods [see also 26]. This is seconded by Doughty et al. [3], who see the investment element of *Farmville* (Zynga, 2009) as a motivator for players, where players exchange or invest real-life elements to advance in the game.

In another study, Wohn and Lee [25] found that in their sample, most players engaged with SNGs as coping mechanisms or ways to pass time and were not playing them for social purposes. This supports findings from their earlier work, where they demonstrated that social outcomes from SNGs might not have been anticipated, but can still result from selfish behaviour in SNGs [24].

On a more positive note, Whitson and Dormann [23] discuss the potential of Facebook SNGs and social games that have been built to elicit behaviour change or educate their players. The success of many SNGs hinges on the ability of players to maintain real-world socials connections. In a similar way, persuasive SNGs leverage the real-life social support network to drive behavioural change.

SNGs can create communities in which players and their information are represented within a social graph which represents social entities and their relationships [2]. However, SNGs that are built on social graphs (and those that are not) feature similar social properties [12]. The social graph allows developers to reach a large player base and provides automatic usage exposure within the social network (an implicit recommendation within a circle of friends). In addition, the social graph allows the exposure of players to socio-contextual information, which is more likely to spur their involvement in an SNG [11].

Kirman and Lawson [13] studied the influence of a player's play style on the social environment of a game. They found that hardcore players can "bind together the social fabric of the game community" in an SNG [13].

Games for Health

Games for health have recently emerged as a separate field with a journal dedicated to their study [4] and a strong community within human-computer interaction [5]. Games for health often refer to studies where games are examined in a clinical setting, or the development of exertion games for fitness and nutrition [17], sometimes developed for special populations [7]. Digital games usually have a high level of interactivity, and are possibly able to close the gap between applications such as wellness diaries and motivation trainers.

[2] This can be defined as hierarchical cultural values that stress group goals and interdependence [15].

One area of health games the support of personal fitness goals through the encouragement of behaviours consistent with a healthy lifestyle. The game *OrderUp*, for example, is a mobile game that teaches adults how to make better meal choices [6]. Playing the game encouraged the participants to think more about their ordering behaviour and to choose healthier meals based on the knowledge they had gained [6].

Another contributing factor of behavioural change is often the social context provided by support groups, family and friends, or other people in the same condition [18]. The specific manner in which game interactivity and social context influence the success of behavioural changes within social health games is not yet fully understood.

The game Healthseeker was developed to use the social support and 'friend' functionality of Facebook as a motivational tool. Besides posting results on Facebook walls, players can interact with other Healthseeker players, and show direct support for each other by using the 'kudos' mechanic. In this study, we had access to player data subsets, but did not influence data collection. We defined metrics and developed definitions for player behaviour in the game.

METHOD

Measurements

In working with the game development company Ayogo, our goal was to identify and create metrics that would be useful in analyzing the social behaviours present in the game. The Healthseeker data set had no behavioural metrics pre-defined. It contained user data and mission information only. We needed customized interfaces to make this data workable for the statistical analysis we wanted to perform. Data mining and statistics programs and methods need normalized structures and distinct fields to interpret such data. Finding the right filter definitions, for example, for separating active players from inactive players was imperative to define the set of players on which we should focus our analysis.

We needed to identify metrics that could be created from the available database information (by developing a parser) and that were important for the social analysis of the game. This also ruled out using standard metrics such as churn rate or k-factor virality. We created three different groups of metrics: *success*, *social* and *virality*. We used the information from the Healthseeker database to create variables for these three groups. All of these metrics were created by our software and are based on the parsing and filtering of the Healthseeker data set. We chose to define different actions as separate activities, each with a time and any necessary information about the activity (e.g., writing a message, commenting on a post, starting/finishing a mission).

The SNG metrics that our parser measured were:

1. **Number of Missions** (started | completed). The successful completion of missions is a direct way to monitor player progress and the only way to directly observe changed behaviour.
2. **Number of Challenges** (accepted | received | dropped | completed | sent). Challenges are a direct way for players to motivate one another to complete missions or goals. The number of challenges sent and received indicates player interest in the SNG, both on the part of the sender and the recipient.
3. **Number of Wall Posts**. A player can post messages on a game 'wall', referred to as the 'fridge door'. The player's motivation to share game-related information with their friends is an indicator of their interest in the game.
4. **Number of Kudos** (sent | received). Giving kudos is another direct way for players to interact with one another by showing support for healthy missions or activities in the game. We identified the number of sent and received kudos as a suitable variable for measuring social support within the SNG.
5. **Invitations** (sent | accepted | pending | dropped). Invitations are sent from one Facebook user to another to invite them into the game (similar to an infection rate). However, the receiving user is not yet part of the game data base, and cannot be identified. Even if an invited user accepts an invitation (acceptance rate equating with conversion rate), the database is not able to connect the user with the sent invitation. Therefore, we used the number of sent invitations and the status of the invitation (accepted, pending, dropped) to measure player *virality*.
6. **Number of Friends**. Ayogo already had previous results indicating that the number of friends could influence success variables, such as completed missions. Therefore, we used the friends of a player as a predictive indicator of their activity` and social awareness within the game. For this, we visualized the network of the game by creating a social network graph and by directly counting the number of friends to work toward a quantitative statistical analysis.
7. **Number of actions**. We defined actions as every action that a player can take in the SNG and that is represented in the database. For example, sending a message, writing a comment, accepting/finishing a mission/action and sending invites or challenges are all actions. We used this variable as an indicator of user activity, because our data did not have detailed user logs.

We wanted to determine which players in the data set could be considered valid players for our analysis. Certain accounts, despite having been created, were completely inactive. Test accounts, which are only created to "just take a look at the game," can then be excluded. We created a definition together with the developers and game designers of Healthseeker: *"A valid player is a player who has done at least two different actions in the game on at least two different days."* Our next step was to divide the parsed metrics into four groups after discussion with the game designers: success metrics, social metrics, viral metrics and other metrics. We settled on these groupings after visually exploring the data set together with the game's designers in our social network graph tool. We used the social metrics to

find correlations with the success metrics, to determine which values can be used to explain or even predict player behavior in Healthseeker.

Social Metrics

We defined social metrics as measures of player actions that lead to interactions with other players. Since the game itself does not include direct behaviour values, such as a player action log, these values are interpreted and created based on the games database. Our social metrics are:

- Number of friends
- Number of challenges (accepted | received | dropped | completed | sent)
- Number of kudos
- Number of wall posts

Success Metrics

The success category includes all actions a player makes during gameplay that we associated with success in the game. The success of a mission is directly linked to a player's healthy behaviour in real life, because every mission can only be solved by accomplishing real life health goals (e.g., eating more vegetables). We assume for this study that all accomplished missions in the game are honestly completed by players, because the game is based on self-reporting. Our success metrics are:

- Missions (started | completed)
- Invitations (sent)

Viral Metric

The game offers the possibility to invite other people to the game. Unfortunately, our data set did not connect players outside of the game who had received invitations, which prevented us from calculating conversion rates (and the k-factor virality). The number of sent invitations is already defined in our success metrics, but is also an interesting value on its own. Our viral metric for players is therefore:

- Invitations (sent)

Other Metrics

We also identified descriptive variables, which represent the player and player behaviour within the game in general. They are used to define and filter valid players for our analysis and to describe the player population:

- User Information (e.g., gender)
- Actions

Research Questions

We formulated the following research questions toward predicting player success when analyzing the data from the persuasive SNG Healthseeker.

Assumption: The received sample size represents players, who are well-connected within the game.

RQ1: *Are players with more friends more successful, and do they show more engagement in the game than players with fewer friends?*

Success is measured as the number of started/completed missions and the virality of the player. This research question was formulated based on previous research conducted by Ayogo Health.

RQ2: *Do players who are socially active solve more missions in the SNG?*

Again, based on the previous observations of Ayogo, a player solves more missions when they are socially active. This indicates that they are more successful at achieving their health goals. We wanted to know whether our metrics could confirm this.

Exploration: Besides these research questions stemming from prior observations of the game developer, our analysis examined player behaviour and tried to find relationships between social and success variables. These relationships could have important implications for the company's future persuasive SNGs.

RESULTS

Population

To define our sample, we attempted to exclude 'test' and other 'non-real' accounts by separating active and inactive player account. Facebook provides developers with a definition of active users, which they use in the statistics overview for Facebook applications. Individuals are considered 'active' if they interact with the app in any way or if they have the webpage with the Facebook app in focus.

The structure and concept of Healthseeker is different from other SNGs on Facebook. Facebook games encourage players to come online every day (or more often), but Healthseeker missions require actions only once every couple of days. A highly active user might be online less than once every other day. In total, the game has 11182 (N=11182, 6941 female, 3214 male, 1027 without gender information) registered user accounts. Peak account creation occurred between May 2010 and September 2011.

For this study, we obtained a random subsample of valid players in the game, which we could use for analysis. The data was collected by the company as a part of the Healthseeker game. In total, our subsample size of valid players is 803 (N = 803, 532 female, 202 male, 69 without gender information) registered user accounts. An average valid player spends 62 days playing the game and does a total of 37 different actions. Included in these actions are: wall posts, commenting on wall posts, accepting a challenge, completing a challenge, dropping a challenge, starting a mission, completing a mission, sending invitations and sending kudos. Thirty-eight percent of the actions are done within the first week (M=38.26, SD=39.17). After the first three months, 72% of all user actions are completed (M=71.88, SD=34.52). This means that half of all user actions take place within the first week after registration,

while the average active lifetime of a user is 62 days. The decreasing percentage in user actions over the first three months indicates that players, who play more in the first week, stay longer in the game, and it becomes more probable that the players take more actions within the game. Within the game, a total of 9358 missions were started and 3423 missions were completed. Players sent 1012 wall posts. 1000 kudos were sent, and players challenged one another to complete missions 94 times.

Statistical Analysis

In our statistical analysis of the user base, we focused on the social measurements conducted. Besides the two hypotheses based on the company's previous internal research, we used an exploratory approach to analyze the data set step by step to find important relationships between social behaviours and successful lifestyle change.

We developed a tool that displays the social graph of the game based user identifiers. This was important to see if the game meets our first assumption for a social game: having a well-connected user base. The tool is based on the library *Graph#* and modifies it to display a network of players. The social graph then displays each player as a node and their connection to another player (a friend) as an edge. Each edge contains information about the type of connection and can contain weights based on the interactions between two players. This can be used to find more intense connections between players, which can indicate stronger bonds. Each node (user) can contain any information that is stored within the game. The social graph can be explored by simple drag & drop functions and a zooming tool. We built this tool to visually explore a user's social connections early in our project. Exploring the network graph showed us that the game consists out of one large network of "core players" and many smaller islands with small player groups out of 1–3 people. With this in mind, we decided to investigate other social values (besides the number of friends) like sent invitations and wall posts. We assume that the well-connected core players are, in general, more successful and engaged within the game than players who are not as socially connected.

According to our first hypothesis, the connectedness of a player has a strong influence on their motivation or behaviour in the game. We conducted a correlation analysis to investigate the connection between having friends and being successful in the game (see Figure 1 to compare completed missions and number of friends). The correlation is more evident when looking at the number of friends instead of merely asking whether a player has friends in general. Both effects are highly significant, but moderate strongly. Furthermore, the number of successful accomplished missions increases positively with the number of friends (F (27,775) = 3.20; $p < .001$; $\eta^2 = .10$; $\omega = .26$). This could indicate that friends may support the motivation to seek success in the game. Our data supports the assertion that an active player with friends solves twice as many missions as a player without friends (with friends: $N = 458$; $M = 3.15$, $SD = .329$ | without friends: $N = 345$; $M = 1.74$; $SD = .294$). When we look at the number of friends, we found that people with more than ten friends solve even more missions (more than ten friends: $N = 47$; $M = 6.32$; $SD = 1.512$) and stay longer in the game than other players (fewer than ten friends: $M = 2.3$; $SD = .2$; more than ten friends: $M = 100.2$; $SD = 21.1$).

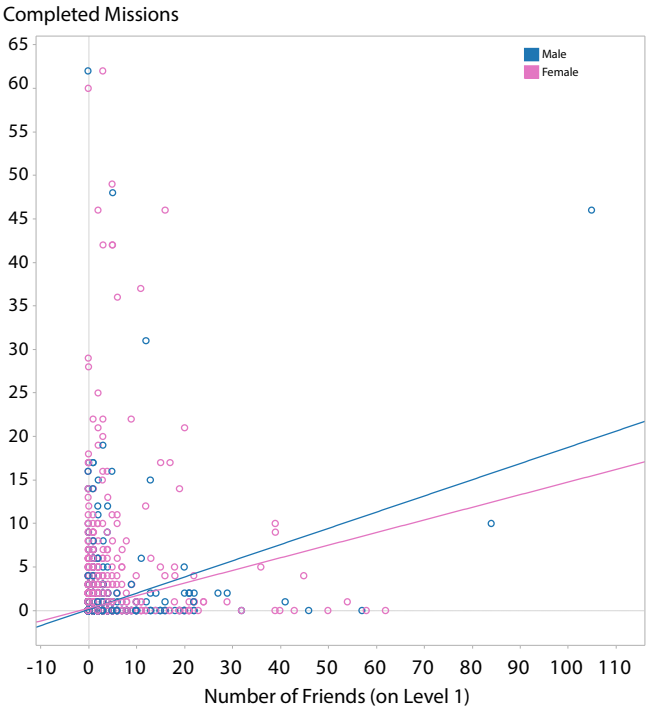

Figure 1. Completed missions compared to number of friends (on the first player level).

Social Interactions—Success in the Game

N = 803	Compl. Missions	Compl. Rate (in %)	Days Spent in Game	Sent Invitations
Has Friends	p = .001; r = .108	p = .000; r = .161	p = .000; r = .149	p = .000; r = .165
Number of Friends	p = .000; r = .157	p = .000; r = .181	p = .002; r = .195	p = .000; r = .133
Number of Wall	p = .000; r = .325	p = .000; r = .169	p > .005	p = .000; r = .156
Send Challenge	p = .000; r = .374	p = .000; r = .155	p > .005	p = .001; r = .113
Send Kudos	p = .000; r = .381	p = .000; r = .183	p = .002; r = .110	p = .000; r = .200
Received Kudos	p = .000; r = .287	p = .000; r = .159	p = .000; r = .015	p = .000; r = .098
Receive Challenge	p = .000; r = .007	p = .000; r = .035	p > .005	p = .000; r = .002

Table 1. Correlation Table for Social Metrics (N = cases; r = effect strength).

Our second hypothesis connects social activity with motivation to succeed in the game, and Table 1 above shows that this assumption has stronger effects (larger r) than the number of friends.

While the social activities for sending challenges, kudos, or wall posts have strong effects, the receiving social actions seem to have a strong positive correlation with the success metrics (i.e., completed missions). A one-way analysis of variance (ANOVA) shows highly significant results for sending challenges (F (1, 775) = 152,043; $p < 0.001$; $\eta^2 = .14$; $\omega = .372$) and sending kudos (F (27,780) = 13.799; $p < .001$; $\eta^2 = .283$; $\omega = .456$) for *active* social actions. This shows that players who use the social mechanics of the game actively are more motivated than players who do not. The receiving actions, for example kudos, show a significant positive effect on the motivation to be successful in the game.

The effects of both active and passive social interactions on the motivation to be successful in the game underline the importance of social interactions in a game and their power to support the goal to incite healthy behavioural changes. We concluded that the following variables had the strongest effects: send/receive challenges; send/receive Kudos; wall-posts; comments.

To further describe the effect and analyze the impact of the single variables regarding passive and active social actions, regression analyses were used for each of the 'strong' variables listed above. Also, each variable had a strong effect on the success in the game, but the social interaction between players is hardly describable through the use of any one metric. Thus, we focused on the combination of the 'strong' variables to discover a model which explains the combined effects of social behaviour on motivation to succeed.

Models 1 and 2 show models for the combined active and passive social actions recorded for each user. Model 1 features strong indicators of socially active behaviour; particularly, the number of wall posts is a strong influence on mission completion.

Model 1 for Sent Social Activities. Influence of Socially Active Behaviour on Success in Healthseeker. *($r^2 = .282$ $p < .001$ ($\mu^2 = .145$ for step 1 ($p < .001$), $\Delta\mu^2 = .106$ (.251) ($p < .001$); $p < .001$)*

$$numberOfCompletedMissions = 1.307 + 0.511 * NumberOfSentKudos + 0.198 * NumberOfSentChallenges + 1.984 * NumberOfWallposts$$

The second model contains the combined results from recorded passive social behaviour. The act of commenting seems to prominently influence mission completion.

Model 2 for Received Social Activities. Influence of Received Social Actions on Success in Healthseeker. *($\mu^2 = .175$ $p < .001$; (Note: $\mu^2 = .078$ for step 1 ($p < .001$), $\Delta\mu^2 = .045$ (.123) ($p < .001$) ; $p < .001$)*

$$numberOfCompletedMissions = 0.206 + 0.209 * NumberOfReceivedChallenges + 0.459 * NumberOfReceivedKudos + 2.416 * NumberOfReceivedComments$$

Both models have a strong and significant effect on the dependent variable and show that these values seem to be highly connected. Again, the active social behaviour has a much stronger effect on the motivation to succeed.

This effect is also visible in Model 3, when we analyze all social actions (active and passive) together in one model.

Combined Model 3 with Relevant Social Activities. Influence of Social Activities (sent & received) on Success in Healthseeker. *($r^2 = .299$, $p < .001$; (Note: $\mu^2 = .299$ for step 1 ($p < .001$), $\Delta\mu^2 = .0$ (.299) ($p < .001$); $p < .001$)*

$$NumberOfCompletedMissions = 1.290 + 1.191 * number\ of\ comments + 0.464 * number\ of\ sent\ kudos + .186 * number\ of\ sent\ challenges + 1.709 * number\ of\ wallposts$$

Model 3 considers all variables in a stepwise backwards fashion and keeps those variables with a significant effect on the success metric: completed missions. The variables with the strongest ability to predict the success or motivation in the games according to the developed model are: *comments*, *sent kudos*, *sent challenges* and *wall posts*.

Model 3 shows the important recorded interactions with a great influence ($r^2 = .299$; $p < .001$) on the motivation to succeed in the game. Using this information, we created another filter to identify the user groups from our subsample, which can be used to describe a socially active player: *"A player that uses the social features comments, kudos, challenges and wall-posts."*

With this definition for a socially active user, based on Model 3, we are able to look at the average behaviour of a user based on his social activity status during his time as a Healthseeker player. We identified three user profiles with this definition:

- **Highly Socially Active Player (HSAP):** uses all of the identified social mechanics
- **Non-Socially Active Player (NSAP):** has never used either of these mechanics
- **Partially Socially Active Player (PSAP):** uses some mechanics but not all of them

	Completed missions		Number of actions in the		Days spent in game	
	M	SD	M	SD	M	SD
HSAP (N= 16)	19.9	4.1	870.3	506.4	125.6	46.7
NSAP (N = 457)	1.4	0.2	6.5	0.7	71.2	6.3
PSAP (N = 330)	3.3	0.4	38.9	5.0	47.9	5.1

Table 2. Average success metrics split into three discovered groups (HSAP, NSP, PSAP) based on Model 3.

Table 2 shows some of the average values for the recorded success metrics separated into the three user types. Highly

socially active players not only spend twice as many days in-game as their non-social counterparts, but complete more than five times as many missions.

Also, players who use some of the discovered social game mechanics show more motivation to complete missions and participate in healthy actions in the game. Even if this is only an overview of the average recorded behaviour for the overall active lifetime of a Healthseeker user, this shows the difference in behaviour and motivation among the three groups.

DISCUSSION

The following are our takeaways from this study:

- To analyze social games, metrics can be categorized into the following groups: Social Metrics, Success Metrics, Viral Metrics and Other Metrics.
- The number of friends is an important factor to motivate players to be active and successful in the game.
- Using social game mechanics increases the motivation to succeed.
- The most important socially active game mechanics are: wall posts, comments, sending kudos and sending challenges.

Based on our metrics, we demonstrated that having friends in the game is an important indicator of player success. The motivation inspired by social connections appeared to increase the completed missions and longevity of a player. Concepts like awareness or sociability could also play an important role, but could not be included in this study. Future studies could examine whether a player's knowledge of a large social community related to a particular game could have an effect on their behaviour.

We also analyzed the effects of social interaction intensity on player success. The effect of a socially active support group within the game increases a user's motivation to complete healthy missions. In particular, sharing tasks with family, friends and other players in the form of challenges or talking about success and problems seem important for players. We could show that the number of challenges explains about 14% of players' accomplished missions in the game. While the effect of challenges is already strong, the effect of direct moral support seems to have an even stronger impact on a user's behaviour in the social health game. Therefore, Healthseeker offers the kudos system, which players can use to send supporting messages for specific goals or actions to other players. The kudos system can explain more than 28% of the variance of successful missions. These two features (challenge and kudos system) show that the moral support and collaborative features are important for a social network.

Another important mechanic of the social game seems to be the possibility to discuss and share topics within the community. To describe the relationship for the different success-influencing values, we used three regression models which variously analyze the sending and receipt of social actions as well as a combined model. While the models specifically about sending or receiving actions show specifically how social behaviour influences the motivation to succeed in the game, the combined model can explain 30% of the completed missions on its own. The three models underline the previous findings that the challenge, kudos and communication mechanics seem to have a big influence on the players' behaviour and build a good support mechanism. We also conclude that more socially active players display a generally higher level of engagement. Our regression analysis showed that the most fitting metrics to describe a players' social behaviour are comments, wall-posts, kudos and challenges.

While the user base we obtained from the company was only a subsample—and the players within the subsample only spend 62 days in the game in average—a socially active user generally keeps playing the game for years. Conversely, a user who does not use social mechanics (N = 330), stops playing after the first day. If we compare missions (as the success metric) with the social activity of a user, we conclude that those players, who partly use the social mechanics, accomplish three times more missions, and those fully socially active players even 20 times more missions, than their non-social counterparts.

CONCLUSION

These results show that game mechanics are important to describe players' success or motivation to succeed in the game. The tracked metrics can be used to increase the success of a social health game by encouraging players to use social game mechanics. Many of these mechanics seem to be common social network site functionalities, such as posting messages on a user's wall or commenting on actions in the game. In particular, direct social interactions between players (challenges, kudos) seem to have great influence on user behaviour.

These findings reflect the traditional system of interventions in offline support groups. Also, direct moral support from a group of people (family and friends) seems to be important. In future studies, the differences of these influences between demographic groups could provide further insight into the development of successful persuasive social games.

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REFERENCES

1. Bellotti, F., Kapralos, B., Lee, K., Moreno-Ger, P., and Berta, R. Assessment in and of Serious Games: An Overview. *Adv. in Hum.-Comp. Int. 2013*, Article ID 136864 (2013), 1–11.

2. Van de Bovenkamp, R., Shen, S., Iosup, A., and Kuipers, F. Understanding and recommending play relationships in online social gaming. *Fifth International Conference on Communication Systems and Networks (COMSNETS)*, IEEE Computer Society (2013), 1–10.
3. Doughty, M., Hopkins, L., Lawson, S., and Linehan, C. Are you the Farmer? Understanding social game player motivation and sustainability. *Proc. of the Social Game Studies Workshop at CHI 2011*, ACM (2011), 1–4.
4. Ferguson, B. The Emergence of Games for Health. *Games for Health Journal 1*, 1 (2012), 1–2.
5. Gerling, K., Fuchslocher, A., Schmidt, R., Krämer, N., and Masuch, M. Designing and Evaluating Casual Health Games for Children and Teenagers with Cancer. *Proceedings of ICEC'11*, Springer (2011), 198–209.
6. Grimes, A., Kantroo, V., and Grinter, R.E. Let's play!: mobile health games for adults. *Proceedings of Ubicomp'10*, ACM (2010), 241–250.
7. Hernandez, H.A., Ye, Z., Graham, T.C.N., Fehlings, D., and Switzer, L. Designing Action-based Exergames for Children with Cerebral Palsy. *Proceedings of CHI'13*, ACM (2013), 1261–1270.
8. Kappen, D.L. and Nacke, L.E. The kaleidoscope of effective gamification: deconstructing gamification in business applications. *Proceedings of Gamification '13*, ACM (2013), 119–122.
9. Kim, J.H., Gunn, D. V, Schuh, E., Phillips, B., Pagulayan, R.J., and Wixon, D. Tracking real-time user experience (TRUE): a comprehensive instrumentation solution for complex systems. *Proceedings of CHI 2008*, ACM (2008), 443–452.
10. Kirman, B., Björk, S., Deterding, S., Paavilainen, J., and Rao, V. Social game studies at CHI 2011. *Proceedings of CHI EA '11*, ACM (2011), 17–20.
11. Kirman, B., Lawson, S., Linehan, C., Martino, F., Gamberini, L., and Gaggioli, A. Improving Social Game Engagement on Facebook Through Enhanced Socio-contextual Information. *Proceedings of CHI '10*, ACM (2010), 1753–1756.
12. Kirman, B., Lawson, S., and Linehan, C. Gaming On and Off the Social Graph: The Social Structure of Facebook Games. *International Conference on Computational Science and Engineering, 2009. CSE '09.*, IEEE Computer Society (2009), 627–632.
13. Kirman, B. and Lawson, S. Hardcore Classification: Identifying Play Styles in Social Games Using Network Analysis. In S. Natkin and J. Dupire, eds., *Proc. of ICEC 2009*. Springer Berlin Heidelberg, Paris, France, 2009, 246–251.
14. Konert, J., Göbel, S., and Steinmetz, R. Video Game Personalization via Social Media Participation. *GameDays 2014, LNCS 8395*, Springer International Publishing (2014), 35–46.
15. Lee, Y.H. and Wohn, D.Y. Are there cultural differences in how we play? Examining cultural effects on playing social network games. *Computers in Human Behavior 28*, (2012), 1307–1314.
16. Linehan, C., Doughty, M., Lawson, S., Kirman, B., Olivier, P., and Moynihan, P. Tagliatelle: Social Tagging to Encourage Healthier Eating. *CHI '10 Extended Abstracts on Human Factors in Computing Systems*, ACM (2010), 3331–3336.
17. Mueller, F. "Floyd," Edge, D., Vetere, F., et al. Designing Sports: A Framework for Exertion Games. *Proceedings of CHI'11*, ACM (2011), 2651–2660.
18. Renders, C., Valk, G., and Griffin, S. Interventions to improve the management of diabetes in primary care, outpatient, and community settings a systematic review. *Diabetes Care 24*, 10 (2001), 1821–1833.
19. Seif El-Nasr, M., Drachen, A., and Canossa, A. *Game Analytics: Maximizing the Value of Player Data*. Springer London, 2013.
20. Shin, D.H. and Shin, Y.J. Why do people play social network games? *Computers in Human Behavior 27*, (2011), 852–861.
21. Tychsen, A. and Canossa, A. Defining personas in games using metrics. *Proceedings of the 2008 Conference on Future Play: Research, Play, Share*, ACM (2008), 73–80.
22. Wallner, G. and Kriglstein, S. PLATO: A Visual Analytics System for Gameplay Data. *Comput. Graph. 38*, (2014), 341–356.
23. Whitson, J.R. and Dormann, C. Social gaming for change: Facebook unleashed. *First Monday 16*, 10 (2011), Date accessed: 17 Jun. 2014.
24. Wohn, D.Y., Lampe, C., Wash, R., Ellison, N., and Vitak, J. The "S" in Social Network Games: Initiating, Maintaining, and Enhancing Relationships. *Proc. of 2011 44th Hawaii International Conference on System Sciences (HICSS)*, IEEE Computer Society (2011), 1–10.
25. Wohn, D.Y. and Lee, Y.H. Players of facebook games and how they play. *Entertainment Computing 4*, (2013), 171–178.
26. Wohn, D.Y. Spending Real Money: Purchasing Patterns of Virtual Goods in an Online Social Game. *Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems (CHI'14)*, ACM (2014), 3359–3368.