Research on app design based on persuasive design and behaviour change techniques

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Abstract: *The new study focus on the interaction design, behavior change techniques and persuasive design approach for weight loss purpose. A new game combining with physical activity was developed through a comprehensive user-centered research and design process which included literature review, online-questionnaire, observation, interview, usability testing and performance test. The results show the game app combining with physical activity could be an attractive way to contribute to increasing physical activity and loss weight in secondary or unintentional behavior.*

Keywords: *App, game, physical activity, persuasive design, behavior change techniques, overweight, obese, weight loss, healthy weight*

1. Background and context

1.1 The status of unhealthy weight

Overweight and obesity are regarded as unhealthy weight; they are the most significant risk factor leading to the health burden of the world (Bischoff et al., 2011). The incidence of overweight and obesity in adults worldwide is substantial and growing at an alarming rate. According to the World Health Organization, the body mass index (BMI) could help individual to identity the healthy situation of their weight on the basis of a value which is calculated by height and weight. The human weight is divided into three statuses from the consequence of that value: underweight, normal weight, overweight and obese. Only the status of normal weight could be recognized the healthy weight. The BMI offers a reference for people to measure their physical state. According to the World Health Organization, people have a BMI value between 25 to 30 is generally considered overweight, and the value of 30 or more is regarded as obese by the European standard. People has a BMI value between 24 to 28 is generally considered overweight, and the value of 28 or more is regarded as obese by the Asian standard. The amount of overweight and obese people is growing speedily in the global world. The data from the World Health Organization displays that the 62% of adults are overweight or obese in the United States. Data from National survey shows that 25% adults are at the status of obesity in British. Moreover, a research result from the Global Burden of Disease Study indicated that more than one third population was overweight or obese in 2013. Overweight and obesity not only affects individual physical health and living quality, but also increase burden on national health insurance, they become one of the greatest public health challenges in the 21st century (Bischoff et al., 2011).

1.2 The cause of overweight and obesity

There are extremely complex answers for the reason of obesity. According to Wright and Aronne (2012), a lot of different elements of genetic, physiologic, psychological, environmental, social, economic, and even political might contribute to overweight or obesity. However, the top cause for them is the non-equivalence between caloric intake and energy consumption. The food environment today leads the situation of overeating (Wright and Aronne, 2012). The fast, easy, convenient, and calorie-rich food become the choice of most people. However, people have not increased their physical activity, it has decreased inversely. Because screen and sedentariness behaviors occupying more and more time in people's daily life (Wright and Aronne, 2012).

Evangelista (2006) indicated that physical activity is significant in controlling weight in overweight and obese people. There was a research of testing the validity of fitness health guidance program in increasing physical activity and weight control for overweight and obese adults be processed in 2013.

There were 133 participants took part in the randomized control experiment and be allocated in once-a-week exercise project which continued a whole year and assess trimestral. The consequence of showed more than half of participant loss their weight and the risk of cardiovascular is down-sized (Bartels et al., 2013).

1.3 Behaviour change techniques and persuasive design

Cash, Hartlev and Durazo (2017) indicated that the spring up of persuasive design and the revival of behavior change unconsciously theory express it would affect users' behavior through interventions designed into the product. The research of behavior change has contributed to a great deal of specific design projects (Thomson, Nash and Maede, 2016.). There are lots of examples been listed such as 'SitCoach', 'Unifit Garden', 'CalcuFit', 'Zombies Run', 'Fish n Step' and so on apps which are related to fitness field. This research has a detailed introduction, analysis and evaluation of each app and a mass of value information for the further research.

1.4 Interaction design

With the development of technology, smartphone and internet become basic needs in people's daily life. According to Dute, Bemelmans and Breda, a total of 58% of Europeans aged 16 to 25 years use a smartphone every day. According to Dutson (2015), considering smartphone firstly would be an effective approach to implement the design projects for the most people. Smartphone is the most used electronic equipment in nowadays, and smartphone apps are cheap and convenient to reach any independent aims and put into use easily (Banga and Weinhold, 2014). Although there are a lot of existing fitness apps, as Banga and Weinhold (2014) demonstrate that every single app could have a distinctive aspect for specialized purpose. For example, instances are not rare to have several different e-mail management apps because they have different priorities for managing customers' e-mails.

1.5 Need

Due to the sharply increasing issue of overweight and obesity, and the known issues mentioned above, an innovative and effective solution needed. Due to the effectiveness of behavior change techniques and persuasive design in design work and growing close relationship between adults and smartphone apps (Lepp et al., 2013). Furthermore, WHO suggests that people between 18 to 64 should have at least 150 minutes of moderate-intensity aerobic physical activity every week or at least 75 minutes of vigorous-intensity aerobic physical activity every week or a commixture of both. Therefore, a new app could be conducted to deal with the issues and up to the physical activity criterion and the purpose of weight control.

1.6 Aim

To create a new smartphone app combining game play with physical activity based on behavior change techniques and persuasive design for 18-30 years old college students and office workers who are overweight (BMI≥24) and obese (BMI≥30) or lake of physical exercise (less than 150-minutes moderate-intensity aerobic physical activity every week) to achieve lose weight and to keep healthy weight.

1.7 Objective

Research the background and existing studies which are in relevant area of the project. To find out the status and cause of overweight and obese and less physical activity adults, the behavior change techniques and persuasive design, interactive design, fitness and psychology, fitness and motivation, walking for fitness and weight loss, and research methods. Seeking good and bad practices which are in the relevant area. Compare and analyze them.

2. Problem identification

The whole observation just monitored and recorded participants' walking step data (Figure 1), not do any intervention. The observation started from February 19th to April 19th. Due to each participant use smartphone, their daily walking steps would be recorded in their phones or trackers through Apple health

app, WeChat app, and MI app. The observation required each participant to send their walking step report screenshot per week. The whole data would be recorded and collated by the times in increasing order for each person. It also asked about when the participant downloads the Pokémon Go app. Through comparing the walking step data change before and after, it would draw some conclusions about the effects of Pokémon Go in physical activity.
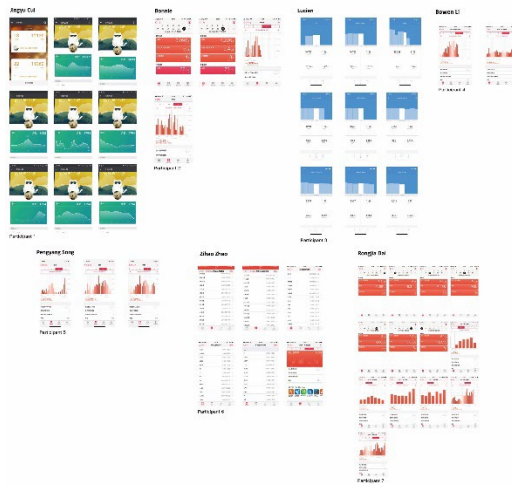

Figure 1: The data of 7 participants' walking steps

2.1 Results

According to the walking step data and the date of each participant started play the Pokémon Go, there are some results produced. At the first several days after downloaded the Pokémon Go app, all the participants' walking step increased rapidly. For examples, participant 1 started playing Pokémon Go at February 22nd and his walking step hit the highest point at the same day, in the next 10 days, his walking step keep the level of more than 10000 steps. As participant 2, her walking steps increased to more than 8000 steps and keep more than 10 days. In terms of participant 3, his average walking steps more than 8000 steps after playing Pokémon Go. For 42.8% participants, there was a period of downturn after several days of playing the app, such as participant 2, after 10 days of playing, there were 4 days which the walking step less than 5000 or even less, and participant 5, he had 3 days which decrease his walking steps 5000 steps with usual, and participant 6, there were three days which the walking step only 100 to 300 steps. However, after the downturn period, 90% participants' walking step is gradually reaching a relatively steady state, participant 7's average walking step was 7500 steps, participant 6's average walking step was 4600 steps, participant 5's was 8000 steps, participant 4's was 5000 steps, participant 3's was 8600 steps, participant 2's was 9000 steps. They were all more 2000 to 5000 steps per day than before they played the Pokémon Go. The conclusions show that Pokémon Go app would provide motivation for people to go outside and increase their daily physical activity.

2.2 Research method 2- Online questionnaire

An online questionnaire (Figure 2) was created using Google forms, to collect quantitative data on people's usage and views of existing fitness apps and combining game and physical activity apps.

Figure 2: Online-questionnaire

2.3 Participants

The online questionnaire was distributed to college students and office workers through social media. There are total 28 responses received from: 21 female, 7 male; 20 postgraduate students, 6 full-time job workers, 2 self-employed. Respondents average age was 23.7.

2.4 Procedure

There were total 14 questions be set to collect the required information from participants. The first four question is about the personal information of participants, such as age, gender, nationality, and employment status. They are used to make sure the result of this questionnaire is suitable for the target group and could analyze the result of fractionize crowds. The fifth question asks if participant reaches the World Health Organization recommendation in physical activity, it is used to investigate the situation of participant's physical activity. The next two questions ask if there are any fitness apps in the participant's smartphone and the frequency of use. The following 6 questions ask about the usage situation, and views of the advantages and disadvantages of Pokémon Go app. The final question is about the preference elements of a new fitness app combining game play with physical activity. There are four pictures of the corresponding options; they would give help to understand the mode of each game.

2.5 Results

The results (Figure 3) of the questionnaire were as follows. Regarding physical activity, half of the participants have not reached the World Health Organization recommendation by self-assessment. There are 35.7% participants reach the recommendation, and the rest of the 14.5% participants could not evaluate it by themselves. In terms of fitness apps and the frequency of the usage, 82.1% participants have fitness apps in their smartphone, but only 10.7% of them use fitness apps every day, 7.2% over five times a week, 39.3% once or twice a week, and 21.4% even never use fitness apps after downloading them. Regarding the Pokémon Go app, 96.4% participants have heard or downloaded the Pokémon Go app and the majority reason they download it is they are Pokémon fan (selected 19 times), they like video games (selected 11 times) and to walk more (for exercise). 28.6% participants play Pokémon Go every day, 21.4% play over five times a week, 10.7% play three or four times a week. 42.9% participants consider that Pokémon Go increase their physical activity and 57.1% approve that increasing consumption in daily activities such as walking could help them to lose weight. When asked about the frustrating thing of Pokémon Go app, 50% participants to select the option of lack of in-game chat, 39.3% select the option of raise risks, and only 14.3% complain the too much physical activity. For the preference elements for a new fitness app, the most popular elements are augmented reality game (selected 19 times), located-based game (selected 18 times), video game (selected 16 times), and virtual pet game (selected 10 times).
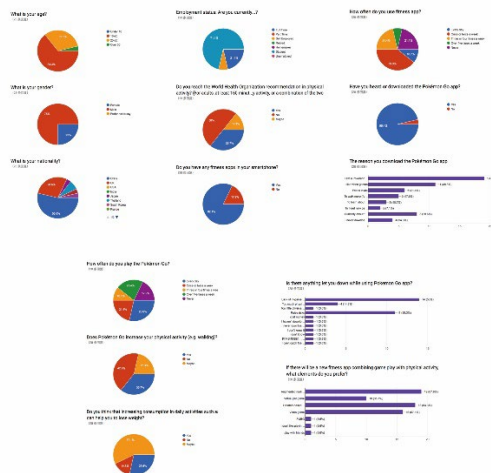

Figure 3: The result of online questionnaire

2.6 Research method 3- Interview

An interview was conducted at the University of Leeds with 7 participants (Figure 4). The purpose of the interview was to understand participants' lifestyle, needs and goals, challenges, and pain points in exercise, and to select app concept.
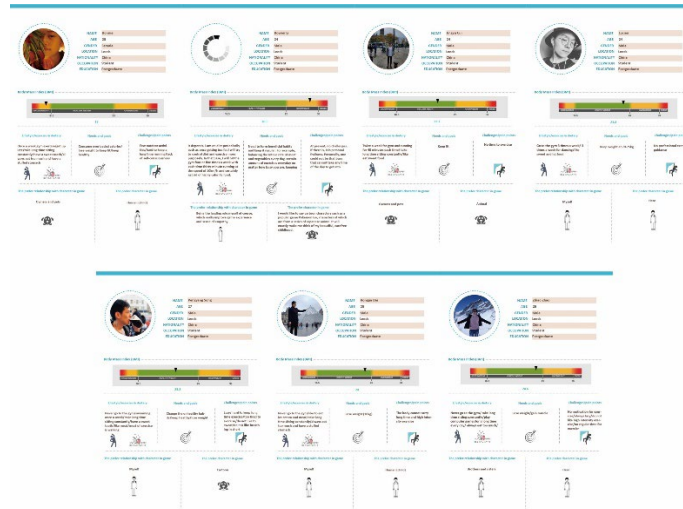

Figure 4: Persona of the 7 participants in interview

2.7 Participants

There were 7 participants who had completed the observation previously joined in the interview: 1 female, 6 male; all Chinese and postgraduate students. Their average age was 25.

2.8 Procedure

In the interview, participants were asked to calculate their body mass index through height and weight, and answer questions about their exercise and dietary habits, needs and goals of exercise and the challenges or pain points in exercise, and their preference of the relationship with a character in game and the character in game. Furthermore, there were three different concepts ask participants to make a choice and give some advice. Then, all information of the interview is recorded and sorted for each participant.

2.9 Results

According to Asian standard, it drew a conclusion (Figure 5) that 28.57% participants were in the overweight category (BMI≥24), 42.85% participants were close to the overweight category (BMI>23), 14.28% participants were in obese category and 14.28% participants in the underweight category. When asked about exercise behavior, 5 participants said they never or rarely go to the gym and they generally take a long time sitting, 2 participants have 3 and 5 times a week gym exercise. In terms of dietary habit, 3 participants demonstrated that they always eat too much, and 6 participants said that they have a sweet tooth and like to eat fast food. As for needs and goals, 5 participants expressed they want to lose weight, keep fit, the rest two participants have more detailed goals such as lose 10kg weight and keep weight at 70-75kg. In terms of challenges and pain points, participants pointed out different views from themselves: few outdoor activities, hard to keep a long-time or high-intensity exercise, lack of self-consciousness, do not like breathing in short and sweating, no professional exercise guidance, no motivation and so on. When asked about the prefer relationship between player and the character in game, 4 participants would like to become themselves, 2 participants prefer the relationship of owners and pets, 1 participant prefer brothers and sisters. As for the selection of character in game, 3 participants would like to be human, 2 prefer cartoon, 2 like a hero and 1 like an animal. In terms of game concept selection (Figure 6-8), most of the participants choose the third concept of the location-based walking game which could find treasure boxes.
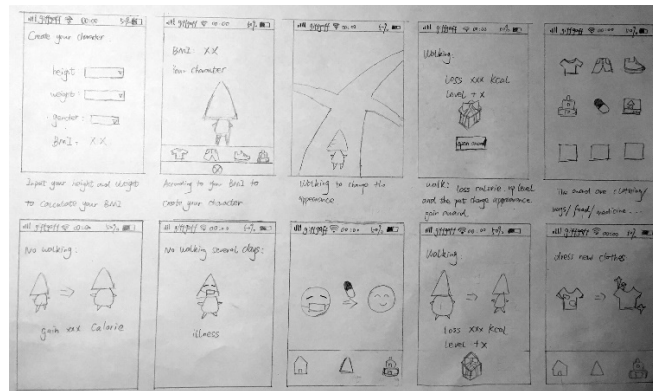
Figure 5: The result of interview

Figure 6: Concept selection: The sketch of the concept 1

The game flow of concept 1: (1) Input height and weight to calculate BMI. (2) According to BMI to create pet's character. (3) Walking to change the appearance of character. (4) Walk to loss calorie, up level, the pet change appearance, and gain awards. (5) The awards are clothing, bag, food, medicine, etc. (6) If no walking, gain calorie. (7) Several days no walking, get illness. (8) Use medicine to cure.
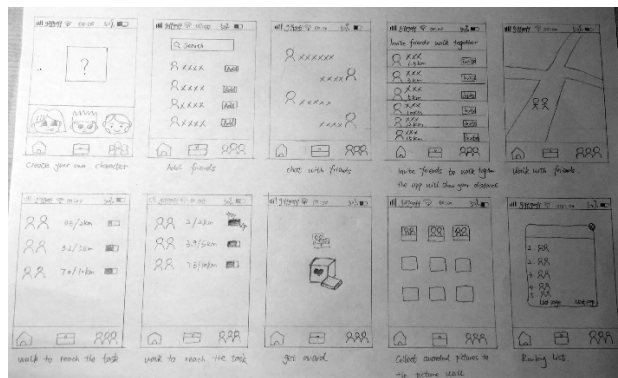

Figure 7: Concept selection: The sketch of the concept 2

The game flow of concept 2: (1) Create character. (2) Add friends. (3) Chat with friends. (4) Invite friends to walk together (the app will show the distance). (5) Walk with friends. (6) Walk to reach the task. (7) Get award. (8) Collect awarded pictures to the picture wall. (9) Raking list.
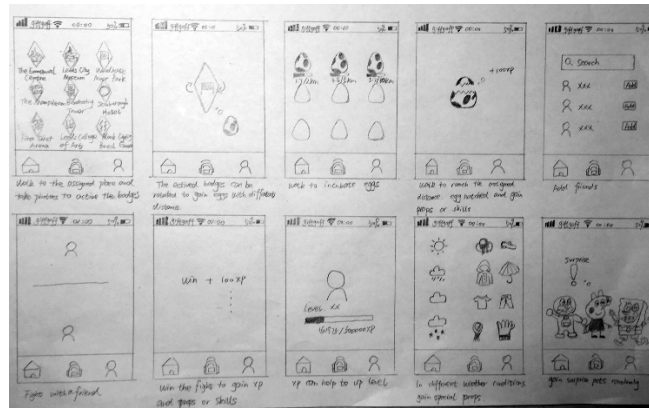
Figure 8: Concept selection: The sketch of the concept 3

The game flow of concept 3: (1) Walk to the assigned place and take photos to active the badges. (2) The activated badges can be rotated to gain eggs with different distance. (3) Walk to incubate eggs. (4) Walk to reach the assigned distance. The egg hatched and gain props or skills. (5) Add friends. (6) Fight with a friend. (7) Win the fight to gain XP and props or skills. (8) In different weather conditions gain special props. (9) Gain surprise pets randomly.

3. Design solution and development

Once the problem had been identified and analyzed, the next step was to come up with a new and innovative solution to overcome the issues and to achieve weight loss and keep fit for 18-30 college students and office workers.

3.1 Rationale for design solution

The first factor influencing the choice to use a smartphone app as the tool was students and office workers' easy and portable to use smartphone and apps. It was common practice for students and office worker to use their smartphone app anytime in anywhere. The second factor considered was the effectiveness. In the stage of an online questionnaire, it was found that most people have fitness apps in their smartphone, but the frequency of app's use was very low. In such a case, fitness apps could not work effectively as expected. However, in the same stage, it was identified that the Pokémon Go app has many users and a high frequency. It is a game app combine with physical activity, and it has a different situation compared with a fitness app. In the online questionnaire, most people indicated that it could help them to increase daily physical activity. This was further confirmed by the observation. When people started to play the Pokémon Go, their daily walking steps was increased. Through Pokémon Go is not an app focus on fitness, it helps people to reach the aim of more physical activity. With these two factors in mind, and based on good design practice and research, a new smartphone app combine game play with physical activity was selected as an alternative and innovative design solution to solve the design problem.

3.2 Guidelines from the literature

As Dute, Bemelmans and Breda indicated that due to smartphone could be used anywhere and at any time, they could potentially reach a lot of people and provide excellent opportunities to contribute to health promotion and health protection. At the same time, the growth in the development of smartphone apps has created an opportunity to use them as treating and preventing intervention tool (Dute, Bemelmans and Breda, 2016). However, many current English and Arabic apps could be described as advice-giving or self-monitoring, but they lack the behavior change aspect of the treatment of weight loss (Dute, Bemelmans and Breda, 2016). Therefore, increase behavior change into the app design is a new aspect of weight loss treatment. Researchers come from Harvard Chan in the US did research of observing physical activity among 1182 young adults using an iPhone 6 series smartphone, they found that in the first week after installation, Pokémon Go was linked with an average 955 steps increase among players per day (Corcoran, 2016). There was another similar research of influence of Pokémon Go on physical activity, researcher through a combination of signals from large-scale corpora of wearable sensor data and search engine logs for 32000 participants for 3 months. The result shows that Pokémon Go leads to significant increases in physical activity over a period of 30 days, participants increased their

activity by 1473 steps a day on average (Althoff, White and Horvita, 2016). Pokémon Go is a location-based augmented reality smartphone game; it is a popular video game, it allows players to create their virtual avatar and walk to explore their neighborhood (Marquet et al., 2017). Physical activity has been the most cited potential benefit for Pokémon Go, it attracts people through game mechanics, making physical activity a secondary, unintentional behavior (Marquet et al., 2017).

3.3 Iteration 1- Initial game flow

At the beginning of the design process, the game flow (Figure 9) was developed based on the literature review and primary research. The initial game flow then had the first user testing.
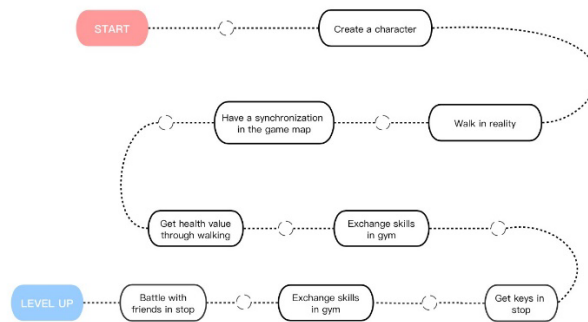

Figure 9: User testing 1- Game Flow

3.3.1 Participants

There were 5 participants took part in the user testing 1: 2 female, 3 male; all Chinese and postgraduate students. Their average age was 24.

3.3.2 Procedure and materials

After improving concept 3 which was selected in interview, the first user testing was conducted to test game flow and game character selection. The whole game flow is introduced at first to help participants to understand the game steps and functions. There were several questions asked after introduction; they were about the complexity of the game, the rationality and preference of props which appear in-game, the game functions which participant would like to add or remove, the game character selection, and other questions or advice about the game. Due to it was just designed idea at this stage, some good examples and pictures be used in the testing to help participants understand better. All the feedback be recorded and analyzed at the end of this testing.

3.3.3 Results

Figure 10: The result of user testing 1

For the initial game flow, participants had four main feedbacks (Figure 10): a) it was a little complex because it has too many functions to remember, b) the award was not enough, c) they would like to have a shop and a pet in the game, d) it should be a guide at the beginning of playing the game.

3.4 Iteration 2- Interface design

The revised final game flow was developed according to the feedback in user testing 1; then it had the second user testing of visual elements.

3.4.1 Participants

There were 5 participants joined in the user testing of interface design, game icon and color selection: 3 female, 2 male; all Chinese and postgraduate students. Their average age was 24.

3.4.2 Procedure and materials

There were 20 single designed screens (Figure 11) which show the different steps in game. Participants were tested individually through look through the 20 screens to answer s series of questions on: a) Background of each scene, b) Icon of the function key and special props, c) Color, d) Size of pictures and font, e) other advice. All the feedback be recorded and analyzed at the end of this testing.
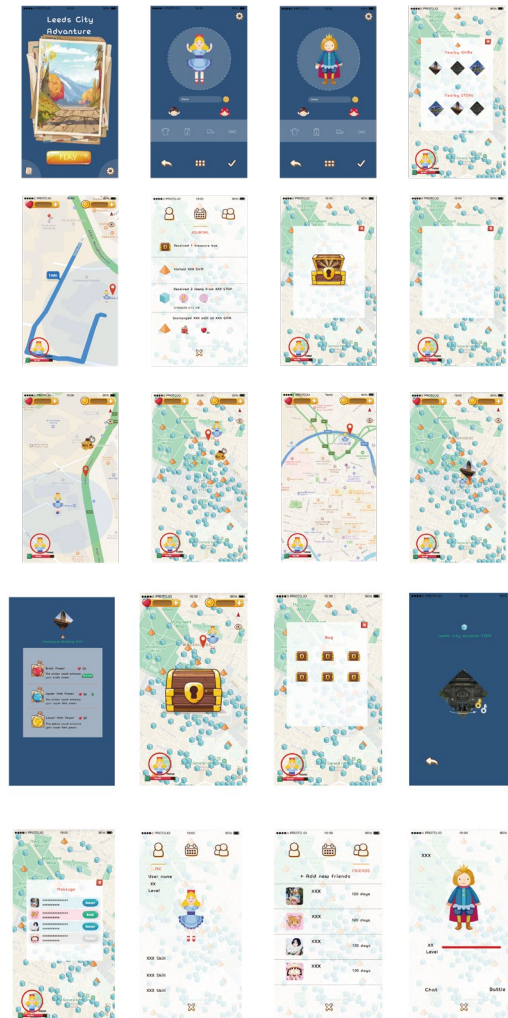

Figure 11: 20 interface design screens

3.4.3 Results

After this testing, there was some feedback from participants: a) blue of the solid background should be brighter, b) the style of icons should be more integrated, c) the font size should be bigger, d) the position of some function keys should be adjusted, e) the graphic could be more suitable for a game.

4. Evaluation

A performance test was devised to evaluate the effect of the completed app interactive design, specifically regarding: a) the fluency of the game flow, b) the connection between different functions, c) information in the app, d) experience and feeling of using this app.

4.1 Participants

There were 5 participants completed the testing: 3 female, 2 male. All participants were postgraduate students at the University of Leeds, and their average age was 23.7.

4.2 Procedure and materials

Participants were tested individually and were asked to use the app (Figure 12) though the proto.io app. The whole procedure of the test was divided into four steps. In the first step, participants would be given some tasks to finish by exploring functions by themselves; it was used to test if the information was clearly and could be found easily. The second step was to give participants more time to look through the app and test the fluency of the game flow and the connection between different functions. The third step asked participants to talk about the experience and feeling of using and give some feedback. Participants were then asked to watch the demonstration video and give the answer to the same set of questions in the last three steps.

Figure 12: Outcome of the game app

4.3 Results

Most participants could finish tasks and find the function keys accurately in step 1(80%). The rest 20% participants could finish the tasks after reading the instruction of game. The majority also agreed that the connection between different function was fluent (80%). However, there are quite a few people thought that the fluency of the game flow needed to improve (40%). When asked about the detail, it was found that because it was a game app and have a lot of functions and the action selection was unordered, participants might enter the same screen repetitively in the unfamiliar stage. When participant watched

the demonstration video, they said they understand the flow of the game (100%). As for experience and feeling of using the game app, more than half participants said that their favorite parts were the setting of unlocked time limited treasure box and the surprise of a pet.60% participants agreed that it looks like a game app with detailed well. 80% participants showed that they would like to give a chance to use this app to increase their physical activity and they also thought the way of combining game with physical activity could improve their mood for exercise. These results suggest that the game app combining with physical activity would be an attractive way to give help to increase physical activity unconsciously.

5. Discussion and conclusion

This is a new research study to create an app combining game with physical activity based on behavior change techniques and persuasive design to achieve weight loss and keep fit. The target group of this research is a high-risk group of overweight and obesity with an unhealthy lifestyle, the purpose of this research is to increase their physical activity through an attractive game and reach the aim of changing their behavior of exercise and keep fit. Moreover, it offers an innovative user-centered solution developed through a thorough design and research process which involved: 1) identifying the problem through primary research and secondary research; 2) identifying the solution through literature and observing and speaking with the users (in this case a smartphone game app); 3) conducting usability testing at the different stages of design process; 4)conducting a performance test to validate the output further; and 5) involving real and suitable users in all test conducted.

The result, according to participants' performance, is a clear and accessible interaction design of increasing physical activity through game to lose weight and keep fit in an attractive way. Because when users play a game, they are more focus on the game itself and ignore the potential guide. Therefore, their physical activity would be increased unconsciously. The most important factor of the successful design outcome is attraction. The output was designed according to the result of previous research and primary research at first, it chose the most acceptable and most popular way of game app.

In this game, it encourages users to walk outside and explore their surrounding and local new spaces. As Marquet et al. (2017) indicated that it would increase location awareness and the use of public spaces, and thus increase the opportunities for social interaction within these new spaces. The capacity of increasing social capital and build new social networks through playing game and being outside is also beneficial to promote for mental health, as social engagement connected to game has been found to decrease perceived loneliness and depression. Moreover, as Althoff, White and Horvita (2016) demonstrated that the discovery of a new public place would increase the curios of users. It will contribute to enhancing interests. At the same time, there is a game chat function in the game, it is due to the result of online questionnaire, when asked about the disadvantage of Pokémon Go app, majority participants pointed out the less of game chat. According to Althoff, White and Horvita's research in 29016, it shows that playing game alongside friends is the highest-rated aspect and emphasizes the need for considering the social in future games od interventions. Furthermore, there are three surprises arrear randomly in this game, they are the locked treasure box, the time-limited unlocked treasure box, and the pet. As Ludden, Schifferstein and Hekkert (2008) pointed out that a surprise can draw attention to the product, leading to increased product recall and recognition. Surprise is an emotion designer often wish to elicit through their products (Rodriguez Ramirez, 2014). Therefore, setting surprises in the game is an effective way to attract users to explore more about the game and increase user stickiness to work. Especially in the surprise of a pet, some researchers have observed that nurturing pets holds a special attraction to human beings (Melson, 2001). As Chen et al (2007) indicated that virtual pets could encourage the ability to maintain long-term motivation, and pet could stimulate people to action (Liao et al., 2010).

Overall, this research has high impact. In academic terms, this research is a contribution to interaction design research in general, and behavior change techniques and persuasive design and game deign specifically. It presents research-based guidance and provides empirical evidence in support of interaction deign principle, and it is a user-centered design. In practical term, As Dute, Bemelmans and Breda (2016) showed that although large potential and abundant usage by young persons, limited research is available on health promotion and apps. This research provides a good solution of a new fitness game app for college students and office workers to cope with the reality problem of overweight and obesity. It could provide information of design outputs and testing materials in the relevant research area.

Finally, in terms of future research, two directions are proposed. The first is to put the app into use in practice and long-term impact. Due to the limitation of technology, the output of the research could only

stay the stage of interaction design and interface design, the app could not put into use in practice and have an observation and testing of the effect. Moreover, it should be a long-term study to test the stay power and to find out an effective way to keep attraction and customer loyalty. Therefore, a follow up use in practice and long-term study would be needed to measure this.

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