Evaluation of the Game Exermon – a Strength Exergame Inspired by Pokémon Go

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Abstract. Sedentary lifestyle has become a major concern across the world as a result of an increasing number of desk jobs, and a steady increase in digital media consumption. This type of lifestyle can cause major health issues. The immensely popular game Pokémon Go has proven that it is possible to develop games that will motivate people of all ages to be physical active. Our exergame, Exermon, got its inspiration from Pokémon games as well as the Tamagotchi games, where our goal was to motivate the player to do strength exercises to evolve a fantasy character. This paper describes the Exermon game concept, and presents the results from an evaluation of the game where the focus was on the physical, motivational, enjoyment, and engagement effects of playing the game, as well as evaluating the game control, progression and social interaction.

Keywords: Exergame, exertion game, computer game, physical activity, strength training, Pokémon Go.

1 Introduction

Physical activity has many positive effects on quality of life, and thus an increasing sedentary lifestyle has become a major concern across the world. Physical activity promoted through exergames has many benefits such as lower risk of early death, coronary heart disease, stroke, high blood pressure, type-2 diabetes, metabolic syndrome, colon cancer, breast cancer and reduced symptoms of depression. Most existing exergames can classified into the two categories of games to stimulate to general physical movement of the player [1-9] and games for elderly or patients to improve physical strength and balance [10-13]. Further there are exergames that explores the borders of the physical and virtual world [14-22]. Exergames focusing on muscle strengthening in general, which are not used for physical treatment are underrepresented in the literature on exergames, although there are some examples [23-26].

According to the U.S. Department of Health and Human Services, muscle-strengthening physical activity should be included at least 3 days of the week as part of 60 or more minutes of daily physical activity [27]. Adults should also do muscle-strengthening activities that are moderate or high intensity and involve all major muscle groups two or more days a week, as these activities provide additional health benefits. The challenge both for children and adults is to have the motivation to do muscle strengthening activities. Our proposed solution to address this problem is to create a motivating, enjoyable and engaging game that can provide health benefits from strength training.

In terms of numbers, Pokémon Go can be considered to be the most successful commercial exergame to promote physical activity with more than 650 million downloads worldwide [28]. To be able to succeed in the game, the player must move around in the physical world to capture pokémons appearing on specific locations, and walk to PokéStops and Pokémon gyms that can be found at predefined physical locations. Although similar games have been developed before, Pokémon Go is the first to become a major success in terms of number of users and income. The Pokémon Go phenomena that surprised media and researchers the most was the fact that this game was able to get typical gamers who previously stayed in-door and were not physically active, to walk long distances for many hours [29, 30]. The Pokémon Go game has demonstrated the power of motivation an exergame can have on physical activity, and that a game can potentially change behavior related to physical activity.

Our Exermon game with the goal to promote physical strength training was inspired by games like Pokémon and Tamagotchi. The target audience for this game is young adults unlike many games for physical strength which focus on rehabilitation of elderly [11-13, 31, 32]. Another difference with our approach is that our Exermon game was designed as a real game containing real gameplay, unlike many research prototypes that only uses game technology such as Wii Fit, Wii balance board, Kinect, PlayStation Move or Wii mote to support tracking of body movements [33]. Similarly, many research prototypes focus on motor skill learning [34] and not actual building muscles. We believe that an exergame like Exermon has a great potential both in terms of engagement, gameplay and motivation for strength training. This paper presents the concept of the Exermon game as well as an evaluation of the game.

2 Background

This section presents related work, some basic principles for strength training, and the theoretical framework used for the game design of the Exermon game.

2.1 Related Work

There are several examples of exergames on the mobile platform similar to our Exermon game, but most of these games focus on motivating the player to walk or just physically move. In [33], Wylie and Coulton describe the heart rate and movement controlled mobile exergame Health Defender inspired by the arcade classic Space Invaders. The objective of this game is to encourage players to exercise during gameplay through triggered bonuses, and to improve both gaming experience and personal health. To trigger a bonus, the player must actively work out during gameplay to raise the heart rate to match the target exertation rate. Player experiences show that such games have the potential for both improving health as well as wellbeing [35]. Other similar approaches are Fish'n'Steps that links a player's daily foot step count to the growth and activity of an animated virtual character (a fish in a fish tank) [8], LocoSnake that is a location-based version of the classic Snake mobile game in which users can control the snake by walking [36], SmartRabbit that is a mobile running game where players compete against other players using a smartphone with GPS [35], Lutfen that is a multiplayer game designed to be played at the campus of University College Dublin (UCD) where the players are encouraged to move between different zones [37], and iFitQuest that is a location-aware mobile exergame designed to target adolescent children consisting of a number of mini-games including interacting with Non Player Characters (NPCs), visit landmarks and collect items [9]. There are also several similar games that combine learning and physical movement [38-40], where the exertiation is just a side-effect of the game being location-aware. A common characteristic of the games above is that they all have a simple game mechanism to stimulate the player to physically move to achieve an award or complete a task in the game.

In addition to mobile exergames, other platforms are used including the Nintendo Wii, the PlayStation Move, special-purpose controllers, and a combination of exercise equipment and games [41]. One example of a combination of the use of exercise equipment and gaming is the PedalTanks game, where an exercise bike is used to control a multiplayer tank game [42]. A user study where the PedalTanks game was played 132 times over three days by 8 participants showed that the game scored better on both subjective enjoyment and degree of physical activity compared to moderately paced walk [7]. There are also other similar exercise bike games made such as PaperDude [43] and a game combining an exercise bike, VR and Kinect [44]. An alternative approach is to use interactive ski-poles, a mini stepper in combination with a heart-beat monitor to control a biathlon game (combination of skiing and shooting) [45].

Some researchers limit the definition of exergames to only involve aerobic-type activities. Oh and Yang proposed to redefine exergames as a combination of exertion and video games including strength training, balance, and flexibility activities [46]. Most research on exergames has so far focused on aerobic-type activities, but there are some exceptions. In [23], a project where the purpose was to describe the acute exercise responses, heart rate, and rate of perceived exertion to exergaming using full-body isometric muscle resistance and to determine whether these responses are different during single- versus opponent-based play. In [24], Marshall, Linehan and Hazzard describes the design and study of two multi-player games that encourage players to use brute force directly against other players. The first game is Balance of Power, which is a tug-of-war style game implemented with the Kinect, while Bundle is a playground-inspired chasing game implemented with smartphones. Brains & Brawn is strategy card game for muscle-strengthening inspired of games like Heartstone and Pokémon [26]. Playtesting the game demonstrated that players were incented to exercise with correct form and showed favorable attitude toward the game. Another example is the Remote Impact game where two remote players are facing a sensitive playing area, on which the shadow of the remote person is projected [19]. The players can talk to and hear each other through voice connection between the two locations. Once the game starts, both players try to execute and impact on each other's shadow through punches, kicks and throws. The system recognizes when there has been a hit or a miss. Players can dodge hits by ducking or moving out of the way, just as in traditional contact sports. More points are scored by hitting the opponent harder. The player with the most points wins the game. The aim with this project was like our Exermon project: To encourage designers to make exergames that include extreme forceful behaviors, which can contribute to general fitness and weight loss while at the same time being social and entertaining.

One example of a game which is very close to our Exermon game is World of Workout, which is a mobile role-playing game where the character evolves based on the exercises the user performs in reality [25]. In this game, the accelerometer on a smartphone was used to measure activities such as jumping jacks and sit-ups without having to specify specifically the exercise being performed. The evaluation of the game showed that there was a direct

connection between exercise, in-game progress and motivation, that the sensors worked for the most part recognizing the physical activities, and the ability to automatically differentiate particular activities proved difficult.

Although the goal of the game Pokémon Go is not strength training, there are several similarities with our Exermon game as well as differences [28]. The core goal with both games is the same: training a monster that can be used to fight other monsters. The main difference is that in Pokémon Go, much of the gameplay evolves around walking around and catching pokémons, not performing strength exercises. Another noticeable difference is that Pokémon Go is a location-aware and augmented reality game. A possible extension to our Exermon game could be to also include location-aware gameplay to encourage the player to both walk and do strength exercises. Another difference is that the exercise is explicit in Exermon (you are directly encouraged to do strength exercises), while the physical movement in Pokémon Go is more a side effect of playing the game (implicit). The main positive physical effect with Pokémon Go reported is how the game has increased the players' physical activity level and socialization [29]. Some have also been worried about children safety in playing the Pokémon Go game, focusing on protecting against injuries, predators, and inappropriate situations [47].

2.2 Strength Training

Our motivation to make an exergame based on strength training was based on the fact that there are very few exergames with such focus, and there are many benefits from strength training, including reduced risk of injuries, reduced pain in muscles and joints, better body posture, increased muscular endurance, and increased muscular power [48, 49]. A strength exercise is doing a controlled movement to the degree such that micro tears are made in the muscle tissue. These tears are then continuously repaired by the muscle fibers, which expands to cover the gap. This in turn makes the muscle larger and able to exert more power. The American College of Sports Medicine recommends exercising strength training at least two times per week, doing ten to twelve repetitions of eight to ten different exercises, which covers all major muscle groups[1]. Feigen-baum found that between four and ten repetitions will progress a person's strength, and between twelve and twenty will work on the muscles endurance [50].

There are mainly two main approaches for strength training: Free weight training and body weight training. In *free weight training*, the person exercising uses weight such as dumbbells, barbells and kettlebells as resistance. It is essential to find weights that fit your own fitness level. The main challenge with free weight training is that the steep learning curve for inexperienced persons and the need for some expertise and training to perform the exercises correctly. In *body weight training*, a person uses his or her own body as resistance by countering the force that gravity exerts on it. The learning curve of body weight training is minimal, and most people learn these exercises during physical education in school. Also since your own weight is used, the risk for injuries is less than for free weight training.

2.3 The Theoretical Framework for the Game Design

The game design of the Exermon game is based on the focus areas to make a game fun to play: Challenge, fantasy and curiosity [51]. It is crucial for an immersive game to provide the appropriate level of *challenge*. If the game is too easy, the player will get bored and if it is too hard the player will get frustrated. To provide a challenge, a game must present the player with goals to be achieved, it must provide feedback to notify the player if she or he is getting closer or farther away from reaching the goal, and it must provide some kind of randomness to give the game some unpredictability. The goal of the challenge is to boost the player's self-esteem when overcoming a challenge. *Fantasy* is used in a game to make it more appealing and interesting. Malone distinguishes between extrinsic and intrinsic fantasy, where the former means that the fantasy objects or situations are influenced by the skill of the player but not the other way around. For the latter, the player's skill affects the fantasy, and the skill also depends on the fantasy. The use of fantasy is important to create player emotions, which will improve the player's attachment to the game. *Curiosity* can mainly be divided into two sub-categories: Sensory curiosity - which involves the use of graphics and audio to enhance the player experience, and cognitive curiosity – which mean that the player does not get the complete picture of the game in the beginning, but the game will open as the player progresses.

The *gameflow framework* is based on the concept of flow, which is defined as a state is reached where a person will have an intense and focused concentration on what he/she is doing, merged action and awareness, loss of self-consciousness, in control of their actions, reduced sense of time, and experiences the activity as rewarding [52].

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[1] ACSM Information on Resistance Training for Health and Fitness: http://www.acsm.org/docs/brochures/resistance-training.pdf

Specifically, in the gameflow framework, Sweetser and Wyeth specify eight elements to increase the flow in games. These eight elements are that the game must require *concentration* to play, it must provide an appropriate *challenge* and match the player's skill level, it must support development and mastery of *player skills*, it must provide the player with a sense of *control* over their actions in the game, it should have *clear goals* on what to do and when to do them, it should provide the player with appropriate and timely *feedback*, it must yield *immersion* where the player experience deep but effortless involvement in the game, and it should support and create opportunities for *social interaction*.

Dual flow is a concept used in relation to exergames [53]. When the dual flow state is reached, the player gets an effect from the exercising, and finds the game attractive at the same time. The main difference between dual flow and gameflow is that the effect of exercise is also measured. It is crucial that the intensity of the workout matches the player's fitness level. When the player gets in better shape, it is important that the intensity also increases [54].

There is an overlap of three theoretical frameworks presented above, they individually have nuances that improve game design. The game design of the Exermon game was founded on the theory on intrinsic motivation, gameflow and dual flow. We wanted to design a highly enjoyable, engaging and immersive exergame, which would directly affect the player's motivation to do strength exercises. The next section will describe the game design more in detail.

3 Exermon – Exergame for Strength Training

This section describes the game concept and gameplay.

3.1 Introduction to the Exermon Game

The name of our exergame is Exermon, a combination of the words exercise and monster. The player chooses a personal monster to train called an "exermon". The appearance of the exermon depends on the player doing body weight exercises to grow and keep it being alive. When the player is exercising, the exermon will gain stats based on the exercise and repetitions. The player will see the monster get stronger by raising the stats, but can also risk death of the monster if the player is not exercising over a period of time. The caring and growth of the exermon was inspired by the Tamagotchi game where a player needs to take care of their digital alien pet. The more the player will exercise, the more the monster will evolve as shown in Figure 1.

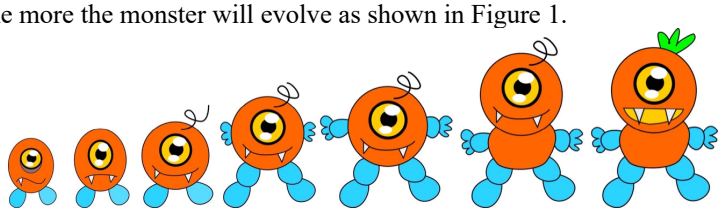

Fig. 1. Evolution of an exermon avatar

The exermons live on an island where they can fight other monsters or fight bosses in an arena. The player can connect with friends to compare their monsters and fight them. To get a monster that fights well, the player needs to keep exercising to boost the monster's health points, power, and speed.

3.2 Gameplay

Strength training demands great concentration and a focus on the exercise being performed. This means that the person exercising will not be able to interact with the game during the workout. The game consists of three main parts: Training, Planning, and Fighting. The physical activity will take place in the *training part*, where the game tracks the player's exercises using a smart phone's proximity and accelerometer sensors. The proximity sensor is used to count push-ups and handstand push-ups by monitoring the change of distance between the phone laying on the floor and the chest or the head of the player. For sit-ups, squats, hang-ups, dips, table-ups, Bulgarian squats, glute bridge, hanging leg-raises and pistol squats, the player's motion is captured by the accelerometer. The accelerometer captures acceleration on all three axes (x, y, and z). If the sensor output value exceeds the threshold value in one direction, the game knows the player is halfway through a repetition, and waits for a movement in the other direction to detect a completion of a repetition. In the training phase, the game will also stimulate the player through sound and graphics. After completing an exercise, the player will be able to see that the stats of her or his exermon have increased. The visual appearance of the exermon will also evolve over time as the player carry out more strength exercises.

The *planning part* of the game is where the player gets an overview, the progress, and the status of the game. The player is presented with the actions available, an overview of accomplishments, and an overview of the player's social network. The planning part is the hub of the game. Fig 2. shows screenshots from training and planning modes.

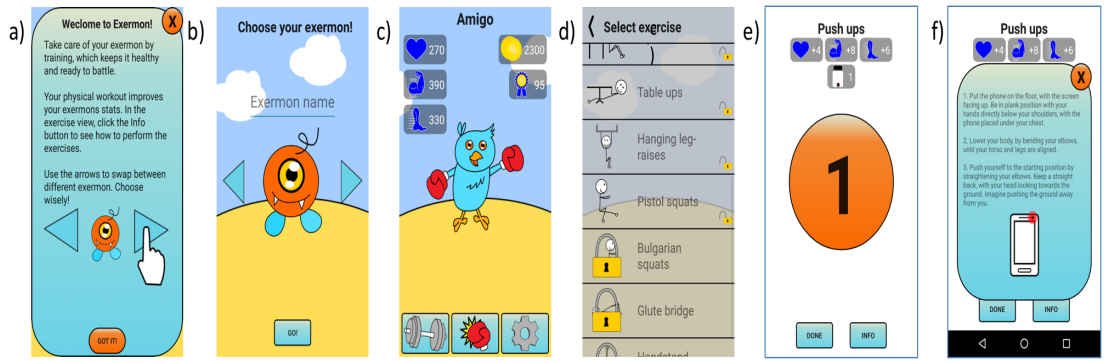

Fig. 2. Screenshots from a) the welcome screen, b) initial choosing an exermon, c) the planning and status screen, d) choose exercise screen, e) execute exercise screen, and f) exercise information screen

The *fighting part* of the game is where the player directly will interact with the game and reap the fruits of her or his physical training. The fighting is carried out in a first-person boxing style where you are boxing a computer-generated opponent. The player fights by swiping on the screen trying to hit the opponent's avatar that is constantly moving. Fighting against computer-generated opponents can be done in three different modes: Arena, Boss fight, and Friend fight. In the *Arena mode*, the player is given a rank and moved up and down in rank according to how well the player fights. The player will face harder and harder opponents as she or he climbs the ranking. The goal of this mode is to be ranked as number one. In the *Boss fight mode*, the player faces an extremely hard opponent with a lot of health points, power and speed. The player is awarded greater rewards from beating a boss than winning a battle in the Arena mode. At the beginning of a week, a boss is generated according to the player's stats to motivate the player to exercise an appropriate amount through the week to conquer the boss. In the *Friend fight mode*, the player can fight a friend's exermon. The exermon is controlled by the computer, but has the characteristics of your friend's exermon. The more a friend has exercised and evolved her or his exermon, the harder it is to defeat it in a fight because of the higher stats. It is also possible to earn badges in the Exermon game to promote side goals. Whenever a player earns a badge, the game presents this achievement through a cool visual effect triggering sensory curiosity. Fig. 3. shows screenshots from the fighting mode.

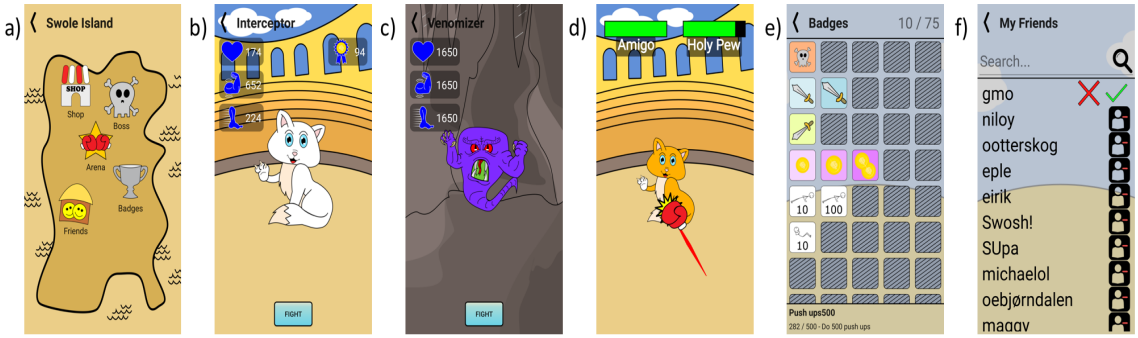

Fig. 3. Screenshots from a) the Exermon island, b) an opponent in arena mode, c) boss fight, d) fighting an opponent, e) the badges screen, and f) search for friends' screen

In addition to the elements described above, the Exermon game includes a store where the player can buy exercise boost that gives double number of stats gained from exercising. The player can also buy boosters that will increase health points, power or speed stats. The gold coins used in the store can be won from battling opponents. Finally, the Exermon game offers the player to choose from a total of nine exermons, which varies in terms of color and race as shown in Figure 4.

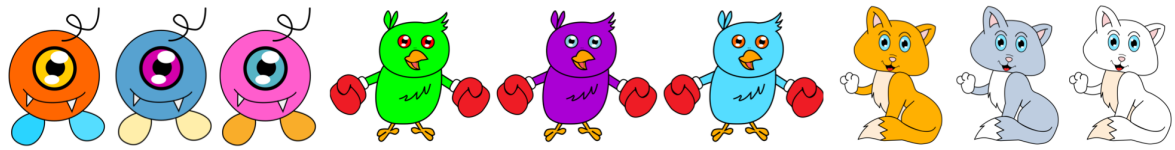

Fig. 4. Available exermons

4 Research Questions and Research Approach

The research goal of the evaluation presented in this article was to investigate the effect of an exergame for strength training. The research approach used for in this evaluation was the Goal/Question/Metrics (GQM) paradigm [55], where first the research goal is defined at the conceptual level. The next step is to define a set of research questions at the operational level, and finally describe a set of metrics to answer the research questions (quantitative level). Our research goal was defined according to the GQM template to be:

> The purpose of this study was to *evaluate the effect of using a game as a motivation for strength training* from the point of view of *an adult* in the context of *everyday life*.

The following research questions (RQs) were defined by decomposing the research goal:

- RQ1 *What is the physical effect from playing the Exermon game?* This research question investigates if the player increase the amount of exercise from playing the game, whether the player get physically stronger, and if the game can match the individual player's fitness level.
- RQ2 *What is the motivation effect of playing the Exermon game?* This research question investigates if the game can motivate the player and how the various aspects of the game affect the players' motivation.
- RQ3 *What is the enjoyment effect of playing the Exermon game?* This research question investigates the enjoyment of the game and what aspects of the game produce enjoyment.
- RQ4 *What is the engagement effect of playing the Exermon game?* This research question investigates to what extent the player gets engaged in the game and what elements of the game that engages.
- RQ5 *How does the control, progression and social interaction affect the Exermon game experience?* This research question investigates the users control of the game, the progression of the game, and how social interaction is stimulated in the game.

To answer the five research questions above, data from four data sources (both qualitative and quantitative) are analyzed:

- A *questionnaire* (quantitative) consisting of 19 statements that reflects theory on intrinsically motivating instruction [56], the gameflow framework [57], and the dual flow model, as well as questions related to demographics. The statements are answered with a non-standard 4-level Likert Scale from strongly disagree to strongly agree to avoid neutral responses.
- *Observation* (qualitative) of a limited set of the test-subjects with focus on the research questions above.
- *Interviews* (qualitative) of a limited set of the test-subjects with focus on the research questions above.
- *Logs* of the player data from the game (quantitative) including exercise events, fight events, and friend (social) events.

5 Results

The Exermon game was tested on 24 subjects, and the demographics of the subjects are shown in Figure 5. The gender distribution was 71% male vs. 29% female. The majority of subjects were between 21-30 years old. Before the evaluation started, half of the subjects exercised 3-4 times per week, 33% 1-2 times per week, and 13% did not exercise at all. One of the subjects exercised 7 or more times per week before testing the Exermon game.

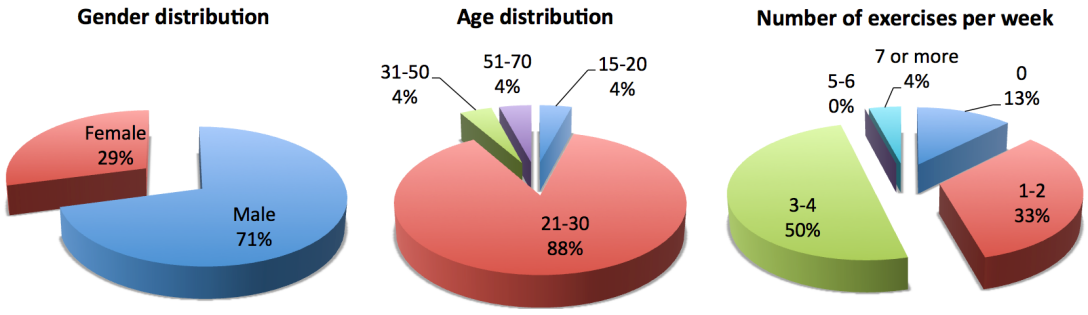

Fig. 5. Demographics of test-subjects

All 24 subjects tested the Exermon game over a two-week period, and answered a questionnaire after the test period was over. For observation and interviews, we used stratified sampling where you define your samples (strata) based on population characteristics such as age and gender. The strata defined were young adults between 18 and 25 years old of both genders. From the 24 test-subjects, four female and four males in the age 18 to 25 years old were picked for observation and interview.

The results reported in this section are based on results from the questionnaire, the observations, the interviews, and logs from the game server.

5.1 Physical Results (RQ1)

An important part of this experiment was to investigate whether a game like Exermon could increase motivation for doing strength exercises. In our survey, the subjects were asked to report how often they worked out before testing the game, and how often they worked out during the test period. Figure 6 shows that around 60% of the test-subjects exercised the same amount in the test period, while around 40% increased the amount of physical exercise. Out of the ten test-subjects who increased the amount of exercise, eight did 1-2 extra exercises per week, while two did 3-4 extra exercises a week during the test period. Also among those who increased their exercise per week while playing, 30% of them did not exercise at all before playing the game, 50% exercised 1-2 times per week, and the remaining 20% exercised 3-4 times per week.

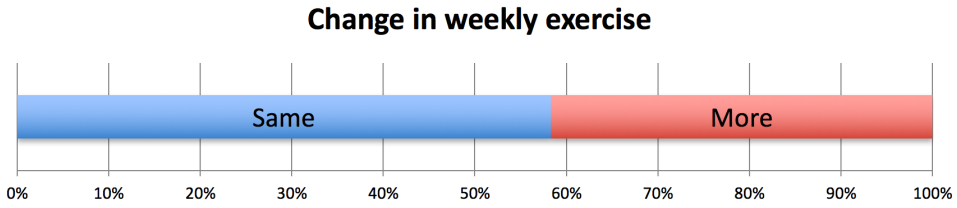

Fig. 6. Change of amount of exercise after playing the game

Table 1 shows the results of two statements in the questionnaire related to physical strength[2]. The results revealed that about 40% of the test-subjects agreed to the statement that they felt their strength had improved due to the game. On the statement whether the exercises in the game matched their fitness level over 80% agreed.

Table 1. Results from statements related to physical strength

ID	Statement	Disagree	Agree
S1	I have improved my strength because of the game	62%	38%
S2	The exercises matched my fitness level	17%	83%

Our evaluation lasted 14 days, and we recorded every time someone had finished an exercise in the game. Figure 7 shows the day-to-day records of exercise events in the game over the two weeks the test lasted. The figure shows that most exercise events occurred the first four days where the peak was day two with 150 events. At day five, the event count stabilized around 25-50 events per day, with another peak at the end of the period (day 12). The

[2] In the presentation of the data, the results from the questionnaire grouped in to the two responses disagree and agree. This means that strongly disagree and disagree are put into one group, and strongly agree and agree are put into another group.

average exercise event count for the period was 65.2 per day, which computes to 2.7 exercise events per subject per day.

Fig. 7. Exercise events registered during the test period

Our data also recorded the number of unique users executing exercise events during the test period. These results are shown in Figure 8. Also here, the number of unique users peaked at the beginning of the test period and varied during the test period. It is interesting to note that only 8 unique users were responsible for 147 exercise events on day 12. This contrasts with day 2 where 17 different users performed 150 exercises. The average number of unique users per day for the test period was 8.1.

An observation of eight test-subjects showed that they all did the exercises correctly. By correctly, we mean that they performed the exercises to the best of their abilities, not cheating or doing it halfway. The majority pushed themselves to do as many repetitions as possible. The observations exposed the exercises to be physically demanding shown by heavy breathing and verbal confirmation about getting tired. The exercises the participants chose were pistol squats, push-ups, squats, sit-ups, dips, and glute bridge.

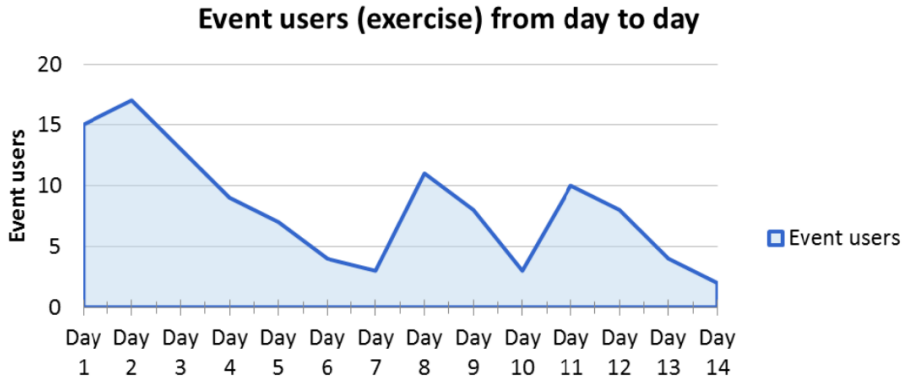

Fig. 8. The number of unique users exercising day by day during the test period

From the interviews, we found that 50% of the subjects had increased the amount of exercising because of the Exermon game. One of the interviewees elaborated: “I have exercised more because of the game, I like this kind of training”. In the interview, three subjects said that they had gotten stronger by being able to do more repetition from the game. Three other subjects said that they were already exercising a lot and did not feel that the Exermon game had contributed to improved strength, even though one of them had increased the number of workouts during the test period.

5.2 Results on Motivation (RQ2)

Table 2 shows the results from the statements related to various aspects of motivation. On the first statement over 90% of the subjects agreed that they were motivated to play the game before each session. This shows that the game itself was a motivation for the subjects. The response was rather varied on how various aspects of the game motivated the subjects. Close to 40% agreed that the character’s appearance in the game motivated the subject to work out more. Similarly, about 40% that knowing that the player’s character could die made them work out harder. However, one aspect of the game that clearly motivated the subjects was the feature to unlock all the

exercises in the game (70% of the subjects agreed to this statements). Similarly, over 80% of the subjects agreed that being able to beat an opponent who previously appeared unbeatable motivated to work out. Finally, over 60% of the subjects agreed that the feature that made it possible to compare the user's exermon with other players' exermons motivated to improve.

Table 2. Results from statements related to motivation

ID	Statement	Disagree	Agree
S3	I was motivated to play the game before each session	8%	92%
S4	My character's appearance inspired me to work out more	58%	42%
S5	Knowing that my character could die made me work out harder	62%	38%
S6	I wanted to play more to unlock all the exercises	30%	70%
S7	Beating an opponent who previously appeared unbeatable gave me great motivation to work out	17%	83%
S8	Being able to compare my exermon with my friends' exermons motivated me to improve	37%	63%

Our observations revealed some more details related to how the game design affected the motivation of the subjects. It was obvious also from the observations that beating friends was a motivation to improve the exermon's stats to be able to fight better. This again meant that the player had to exercise more to boost the exermon's stats. One of the test-subjects lost motivation when his friend did not manage to follow his progress in exermon stats, as it became too easy to defeat his friend's exermon. After the participants had exercised, some hurried back to look at the image of their exermon to see if it had improved his visual appearance. Being able to obtain badges clearly motivated two of the female test-subjects to exercise more to get a new badge. One of the test participants had bought an exercise boost item before the observation. Because if this, she really tried to maximize the amount of repetitions she could do to boost the stats as much as possible.

In the interview, the interviewees focused on different elements of the game that made it motivating. Six out of eight were clearly motivated, while two were less. Some told us that the rivalry against friends was the major motivation factor, while others focused on appearance and development of their exermon, and keeping it alive.

5.3 Results on Enjoyment (RQ3)

Table 3 describes the results on statements related to enjoyment in the questionnaire. 100% over the subjects enjoyed playing the game, while over 90% felt better at the game the more they played. Also, close to 80% found the fantasy world in the game to be appealing.

Table 3. Results from statements related to enjoyment

ID	Statement	Disagree	Agree
S9	I enjoyed playing the game	0%	100%
S10	I felt better at the game the more I played	8%	92%
S11	I found the fantasy world in the game appealing	21%	79%

The observations and interview also clearly showed that the subjects enjoyed the game. While playing in the arena, one of the test-subjects shouted, "it is fun to fight!". When we told the test-subjects to play the game, the group was divided into two. Some knew right away what they wanted to do and went in the arena or found friends to battle without any explanation. Others felt a little insecure about what to do and needed more instruction on what their next step was going to be. However, for both groups we observed that the test-subjects smiled and enjoyed different parts of the game. The observations of subjects also revealed different attitudes towards the audio in the game. Some players muted the music during gameplay, while others moved according to the music and enjoyed it. One of the test-subjects celebrated his victories, and after defeating a friend shouted out to his friend who were nearby: "Hah, I beat you!".

In the interview, all participants said they enjoyed playing the game, and especially the fighting part of the game. One of the participants exclaimed: "I was excited" about the fighting in the game. Two participants said that the exercising got more exciting because the game gave feedback when you completed a repetition in terms of increase in stats and a sound that was played. Although all subjects enjoyed the game, three players pointed out that the game gets a little boring in the long term because the lack of features and monotonous fighting.

5.4 Results on Engagement (RQ4)

Table 4 shows the results from statements on engagement. In general, it was obvious that the test-subjects got engaged by the game as over 90% felt engaged, close to 80% were completely focused on the task they were doing, and over 80% were curious on how their exermon would evolve. However, only 25% of the subjects agreed that they were so engaged in the game that they became less aware of their surroundings. We believe there are two reasons for the latter. First, games on mobile devices such as smart phones are generally less immersive than games played on larger screens, as it is easier to focus on the surroundings on a small screen. Second, the Exermon game takes the player in and out of the gameplay on purpose, as the player must carry out strength exercises.

Table 4. Results from statements related to Engagement

ID	Statement	Disagree	Agree
S12	I felt engaged in the game	8%	92%
S13	I was completely focused on the task I was doing	21%	79%
S14	I was so engaged in the game that I became less aware of my surroundings	75%	25%
S15	I was curious on how my exermon would evolve	17%	83%

Our observations revealed that the majority of test-subjects concentrated hard to do their best while playing the game. The interview documented variation in the mount of engagement in the game. Some subjects were really engaged in the beginning, but lost the engagement after a while. Others were really engaged throughout the game, relating to their exermon and trying to achieve the best result possible. “I was really focused while fighting, because I really wanted to win” was the response from one participant. Two players said they were lacking engagement in the game.

5.5 Results on Control, Progression and Social Interaction (RQ5)

Table 5 shows the results from statements related to controlling the game and the progression of the game. The majority of the test-subjects felt they were in control of what they were doing in the game (close to 80%), as well as it was clear what they had to do to progress in the game (over 80%). Fewer, but the majority, said that the game presented clearly the tasks to accomplish (67%), and that the game had an appropriate difficulty level (71%).

Table 5. Results from statements related to Control and Progression

ID	Statement	Disagree	Agree
S16	I felt in control of what I was doing in the game	21%	79%
S17	It was clear that I was making progress in the game	17%	83%
S18	I was presented with clear tasks to accomplish	33%	67%
S19	The game had an appropriate difficulty level	29%	71%

Our observations showed that the subjects understood that they made progress in the game by viewing their rank and stats. Initially, some subjects had some problems understanding what to do in the game. We also noticed that everyone had challenges that matched their skill level. This was because they started by working out to improve their stats, and progressed up to the opponent’s level.

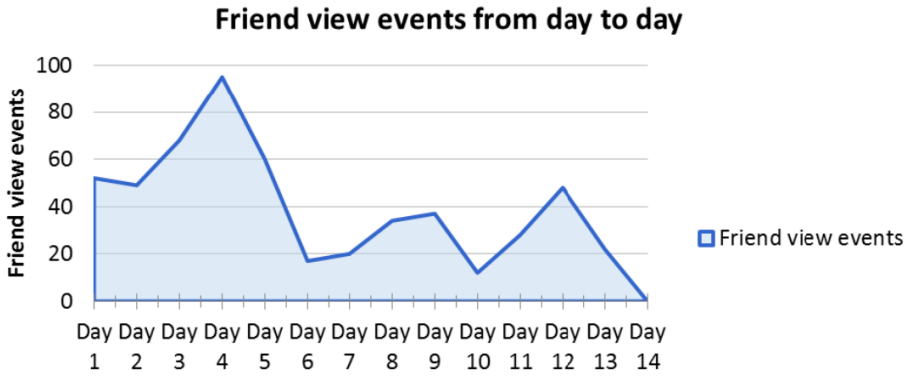

Fig. 9. Records of friend view events

During the test period, we also logged data on fighting activities in the game, what kinds of fights were fought, and friend events. Our data revealed that most fighting activity was around the first days of the test period, but there were also frequent fights around day 8-9 and day 12. The average number of fights per day in total was 129.3, which computes to 5.4 fights per test-subject per day. Further, our data showed that 83% of the fights were arena fights, 11% were fights with friends, and 6% were boss fights. Figure 9 shows number of times a player looked at a friend's game stats per day over the test period. As we can see the number of friend view events varied over time with a peak on day four with over 90 friend view events. The average amount of friend views per day was 38.7 (1.6 per player per day).

6 Discussion

This section presents and discusses some technical challenges in the Exermon game, the problem of cheating, and threats to validity of the result.

6.1 Technical Issues

From tests during the development of the Exermon game, it was found that the tracking of the various exercises using the proximity and accelerometer sensors varied among different Android smartphones. It was therefore decided to include a question about how the phone tracked the exercises in the questionnaire. The results from the survey showed that for 37.5% of the test-subject, the game counted about the correct number of repetitions. For 25% of the test-subjects, the game counted fewer repetitions than they actually did, and for 37.5% the game counted more repetitions than they actually did. This means that for 62.5% of the test-subjects, the smart phone did not count the correct repetition when exercising all the time. Our observations of the eight test-subjects showed that the majority got exactly the correct number of exercise repetitions, except for two participants who had problems with the dips exercise where it counted several repetitions while getting into position and none when actually doing the repetitions. One of the two said "I lost focus on doing the exercise physically correct, because I was more focused on getting the phone to count the number of repetitions correctly." In addition, one person did not get any repetitions counted while doing the glute bridge exercise. One person had a lower tier smartphone without a proximity sensor, which meant that no repetitions for push-ups were counted. Further, one of the persons we observed decided to do the exercise without the phone, and afterwards simulated the repetitions by shaking the phone. The main problem with exercise counting is the great variation sensor responses in various Android smartphones. A possible solution to this problem is to add a calibration or learning mechanism to the game, to teach the game what should be recognized as an exercise repetition. This problem is not unique to tracking exercises on smart phones, but are also a problem when playing commercial exergames using dedicated exercise sensors in games like EA Active, or the Kinect sensor on games like XBOX Fitness and Shape Up. Another solution to this problem suggested by one of the observed test-subjects was to add a possibility to adjust the count after an exercise, which brings us to the other challenge of the Exermon game – cheating.

6.2 Cheating

By using sensors in a smart phone to count exercise repetitions, it will be easy to cheat the game by simply moving the phone according to the pattern required to recognize a strength exercise. This is a challenge for almost all exergames. If the players want to cheat the physical movements, there are always ways of doing this. We were of course aware of this problem and thus included a question in the questionnaire about cheating. The results showed that 42% of the test-subjects said they had not cheated at all. Further, 29% said they cheated a few times in the game, 25% said they had cheated many times, and one person said he had cheated all the time. The subjects that cheated a few times explained their cheating that they wanted to test which movements were picked up by the phone and counted as repetitions, to avoid the death of his or her exermon, or correct the number of repetition the game did not recognize. Those who cheated many or all the times, wanted to gain stats to beat opponents in the arena, the boss and friends' exermons, or did not want to do a lot of exercising. We acknowledge that cheating is a major concern for all exergames including Exermon, and currently there are no easy solutions to prevent it. However, if the player is interested in getting stronger physically in the first place and play together with friends who agree on a code of honor about not cheating, this issue should not be a major concern. Experiences from other exergames we have worked with shows that players interested in playing exergames have an initial motivation for improving their physical health, although they might lack motivation to do the physical exercises. Their motivation for improving their physical shape is our best weapon to avoid cheating in exergames. It is always a way to trick the sensors.

6.3 Threats to Validity

The evaluation of the Exermon game cannot be classified as a controlled experiment, but rather a quasi-experiment. To counter the lack of a controlled environment and a detailed experimental design, we used four sources of data, both qualitative and quantitative. We believe that the combination of data sources provides a realistic evaluation of the game.

The Hawthorne effect states that the behavior of individuals will change as they become aware that they or their actions are under observations [58]. We did overt observations, which mean that the test-subjects were aware of our observations and that the Hawthorne effect might have influenced our results, giving us a more positive feedback and data that we otherwise might have gotten.

Generalization of the results of this quasi-experiment is limited, as the results are related to this particular game and to the length of the study. However, we believe the results are useful for other researchers working on games to motivate physical strength. Due to the limited length of the study, it is hard to say anything about the potential lasting effects of similar exergames. However, the initial results are very positive, and we believe an improved and extended version of the Exermon game with more depth in gameplay should motivate players over a longer period of time.

7 Conclusion

In this paper, we have presented the Exermon game, which is a new type of exergame combining role-playing game elements, first-person boxing, caring for a monster, and strength exercises. The goal of developing Exermon was to motivate players to do strength exercises to get their monster, their exermon, to grow and evolve. Further, our paper describes the results from the evaluation of the game where 24 subjects tested the game over two weeks, and where five research questions were answered through a survey, observations, interviews and logs from the game server.

The *first research question* investigated whether there were any physical effects from playing the Exermon game (RQ1). The survey showed that above 40% the test-subjects exercised more than they did before when playing the game, where most did 1-2 extra exercises per week, and a few 3-4 extra exercises per week. The survey also showed that 40% of the test-subjects felt their strength had improved due to the game. Our logs from the game showed that most test-subjects exercised mostly in the beginning of the test period and at the end. To conclude, we found that the game gave a positive physical effect but not on all test-subjects.

The *second research question* focused on the motivational effect of playing the Exermon game (RQ2). The survey showed that over 90% of the test-subjects were motivated to exercise by the game itself, but it was found a great variation in what parts of the game that motivated the test-subjects to perform strength exercises. About 40% were motivated by the exermon's appearance, 40% were motivated by the fact that their exermon could die in the game, 70% were motivated by feature to unlock all exercises in the game, over 80% were motivated from the goal of defeating a previously unbeatable opponent, and 60% were motivated by the feature of playing against other players' exermons. To conclude, the game has a motivational effect on the players, but there is room for improvement for making the game even more motivational.

The *third research question* investigated the enjoyment effect of playing the Exermon game (RQ3). The survey showed that all test-subjects enjoyed playing the game, that 90% felt better the more they played the game, and about 80% found the fantasy world in the game appealing. The observations of the test-subjects clearly confirmed that the test-subjects enjoyed the game, and especially the fighting part. The only challenge found was that a few subjects got less enthusiastic over time as the game was running out of content. To conclude, the game was found to be enjoyable, but more content should be provided to keep the game enjoyable over time.

The *fourth research question* focused on whether the players were engaged by the Exermon game (RQ4). In general, the game was found to be engaging of almost all test-subjects (90%), and about 80% were completely focused the task they were doing. However, we found that only 25% of the test-subjects were so engaged that they became less aware of their surroundings. One part of the game that made it engaging was the players' curiosity of their exermons evolution.

The *fifth research question* investigated the control, progression and social interaction in the game (RQ5). The survey showed that the majority of players felt control over their actions in the game, the progress was easy to follow and easy to understand what to do, and the difficulty level was appropriate. The players also found social component of the game motivational, although there is a potential to improve it through direct fights between friends.

The main challenges revealed in our evaluation of the game were found to be the possibility of cheating the strength exercises, and issues related to the game recognizing repetitions of exercises using smartphone sensors. The evaluation of the Exermon game shows that there is absolutely a great potential for exergames for strength training. The main challenges are technical as well as cheating, and the game design and inclusion of social features are essential for the success of such games.

Another challenge with exergames like Exermon, is that such games require the players to be interested in doing strength exercises in the first place. The effect of the game is to boost the motivation for doing physical training, and not to motivate those who are not interested in doing strength exercises in the first place. A weakness with the approach is that the strength exercises themselves are not directly related to the fantasy of the game, but rather have an indirect effect on the fantasy through evolving the monsters. Future research includes investigating exergame concepts where the exercises and the fantasy is tightly integrated, as well as examining the long-term effects of such exergames.

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