Context

# Introduction

The following chapter presents a critical review of the State-of-the-Art currently available within the combined fields of video gaming and exercise. The aim of this review was to identify an area where a gap was present in the State-of-the-Art of the scientific community, which would then be developed upon eventually resulting in the solution presented in this report.

# Design Requirements for Technologies that Encourage Physical Activities (Consolvo et al., 2006)

A study conducted in 2006 designed to test various design principles for creating applications that would encourage opportunistic physical activities by users. Participants were split into three groups based on the users’ friendships, each participant was grouped with at least two members who they would consider friends, the justification for this was to allow for the testing of the impact social interaction may have on the results. Three phone based applications were designed for the study;

* A baseline application in order to collect enough data to set a fitness goal
* A personal application that one group would use throughout the study, it contained all the functionality of the baseline version as well as;
* functionality to view the daily goal as well as progress towards that goal
* recognition for meeting daily goals
* view the user’s average daily steps based on the count of the last 7 days
* add optional comments
* functionality to view previous comments
* A social application used by the remaining two groups during the main study, that had all the features of the personal version as well as functionality to;
* Send step counts and comments to any/ all members of their group
* see the progress other group members had made toward their fitness goal
* request a step count from other members of their group

Using a pedometer, the user’s step totals would be recorded each day, at any point in a day a user could access the phone application and record their data.

Results from the study concluded that users who participated in the social testing group were more likely to achieve their fitness goal (t=2.60, p<0.05), and all users who took part in some way improved upon their daily average step total with results ranging from 5% to 61%, the authors of the study however admit that the testing period of the experiment was low so these results may be misleading. In addition to the quantitative results of the experiment four design principles have been put forward to future developers of systems designed to encourage exercise, these are;

* Give users proper credit for their activity
* Provide personal awareness of activity level
* Support social influence
* Consider the practical constraints of user’ lifestyle

The design principles put forward in this paper are all well-conceived and will be used during the development of this project. The report also talks about the decision process behind setting the step goal for the users, instead of using a one size fits all approach (i.e. each user has a goal of 10,000 steps per day) the decision was made to use the baseline application to generate a fitness goal based off the first week’s results. Feedback from participants was mixed, most were unhappy with the goal the baseline application had set for them due to the way it had been calculated, others felt unhappy that they had different goals to their friends and wanted something standardised to allow for more competition. Another consideration discussed within the paper is around the choice to use active data tracking, this being the physical logging of steps from participants, compared to automatic tracking which would automatically log steps. No definitive answer is given to which is better as active input provides the user with constant feedback which is a key to goal achievability, whilst the other allows for ease of use which is a key consideration in software design.

Finally, whist the testing time of the application was low the results it produced do suggest that social engagement can play a large role in user participation, this result should inform upon the future design of this project with social interaction being made a key feature of any application design.

# Fish ‘n’ steps: Encouraging Physical Activity with an Interactive Computer Game (Lin et al., 2006)

In 2006 researchers at Siemens Corporate Research conducted a study to discover whether a socially engaging computer game could be used as a method of changing participant’s behaviour to be more likely to engage in opportunistic physical activity. 19 employees participated in the study, each member had different characteristics aside from the fact they were all highly educated, participants wore a pedometer during waking hours to track their daily steps and each day travelled to a central location to log their results. These results were then fed into a computer game and used to calculate the growth and emotional state of a fish in a fish tank. If participants met their daily goal the fish would be happy and grow a little, if their target was missed the fish would be unhappy or crying depending on by how far the target was missed. Some participants were assigned to groups with each group member being able to see the state of the others virtual pet, if a member of a group failed to reach their daily step target on a regular basis decoration from the groups tank would slowly be taken away, similarly if goals were consistently reached the tank would be adorned by more decoration, anonymous chatting was enabled to allow for social interaction in the group.

The experiment was split into three phases;

1. Pre-intervention (4 weeks): During this phase participants were given a pedometer but no goals or access to the fish ‘n’ steps application. They were encouraged to wear the pedometer and keep to as regular a schedule as possible. The pre-intervention phase was used as a way to gain enough data to set a realistic step goal for participants, as well as a time to discover at what point on Prochaska's Transtheoretical Model of Behaviour Change (TTM) each participant was with regards to improving their fitness, this being a six point scale to measure how engrained a person’s behaviour is, ranging from pre-contemplation (not recognising the need for change) to termination (the behaviour is habitual there is no danger of relapse). The pre-intervention phase determined four participants were already at the termination level on the TTM with the remaining participants having an even split among the remaining levels.
2. Intervention (6 weeks): Participants were given a step goal to reach daily and had to visit a public kiosk to log their result and check on the state of their fish, aside than this, participants were free to engage with the application with as much or as little effort as they desired.
3. Post-intervention (4 weeks): At the end of the intervention phase the participants were no longer given access to the Fish ‘n’ Steps application, they were however still encouraged to wear their pedometers and log daily results, this allowed researchers to test for any persistent effects as a result of the trial.

The study concluded with 14 out of the 19 participants seeing some improvement with their daily step count average (for 4 participants) advancement of their TTM level (for 3 participants) or both (for 7 participants), despite having two test conditions no apparent difference in results were observed with the two test groups. Some participants felt the experiment incorporated too much competition and felt penalising a group for one members lack of goal reaching was unfair and stigmatised that member of the group, other participants however felt the competition within the experiment was what encouraged them to work as hard as they did. The biggest criticism for the experiment from participants was the use of bulky pedometers that were difficult to wear with some outfits leading the researchers to suggest an alternative method of data capture would be useful for future work.

Fish ‘n’ steps: Encouraging Physical Activity with an Interactive Computer Game, was a well conducted experiment using established methods to measure participants behavioural change. Many participants saw some improvement to their behaviour towards opportunistic physical activity, this was including some who were already at the highest level of TTM. Due to the amount of conditions used in this experiment however it is difficult to pinpoint the root cause of the improvements, indeed it could be the result of a singular or multiple factors. Due to the potential significance of these results the experiment could be conducted again with modern technology to reduce the annoyance of participants with regards to wearing pedometers, additionally some elements of the experiment could be stripped out to narrow down what caused these initial results.

# Physiological and Perceptual Responses to Nintendo Wii Fit in Young and Older Adults (Mullins et al., 2017)

Published in 2015 this study looked to analyse the physical and mental effects from the usage of Nintendo’s active video game; Wii Fit from the perspective of both young and older adults. Conducted with the help of twenty participants split into two groups, young adults with a mean age of 21.4 ± 2.27 older adults with a mean age of 58.0 ± 6.85 the study took place at Youngstown State University. Resting measurements of the participant’s heartrate and V02 requirements were taken for fifteen minutes before the start of the trial after which participants took part in four fifteen minute bouts each using a different Wii Fit activity category the order of which was randomised. In addition to the digital monitoring equipment used throughout the activity participants were asked to describe their current feeling of exertion at the half way point of each bout as well as their enjoyment level of the activity at the end of the bout through the use of Kendzierski and DeCarlo’s Physical Activity Enjoyment scale where the players verbal responses are correlated to the activity scale, for example an answer of “This is not fun” would receive the lowest possible rating on the scale of 1 and “I love it” or “this is a lot of fun” would receive the highest numerical value of 10 on the scale (Kendzierski and DeCarlo, 1991).

Analysis of the results indicated in all four bouts every participant showed an increase in heart rate, VO2 consumption and energy exertion over their recorded rest levels, participants also reported an above average enjoyment for all activities within the study ranging from 5.9-7.6 on the Physical Activity Enjoyment scale. However, one of the key findings to take away from this study was the amount of energy exerted of the two test groups. In the young adult test group the average energy exertion fell into the low intensity category of the American College of Sports Medicine recommended levels of exercise intensity, whereas the older adult group fell into the medium intensity category, this is significant as a low intensity energy exertion is only going to be of benefit to individuals who participate in no to very little habitual physical activity.

In conclusion, this study provided evidence for the validity that active video games can be used as an enjoyable way to provide low to medium intensity physical activity for participants. The findings also lend weight to the fact that older adults receive greater benefit from the use of active video games, this coupled with the fact that all participants within the older adult category enjoyed taking part in the trail suggests that active video games could be greatly beneficial to the physical health and wellbeing of the older population.

# The health benefits of interactive video game exercise (Warburton et al., 2007)

Conducted in 2007 this study looks at the effects of adding video game interaction into traditional exercising methods. In the study exercise bikes that were connected to the input of a video game console were used to test the following hypotheses;

* “That an interactive video game played during stationary cycling results in significantly greater improvements in multiple risk factors for chronic disease (i.e., aerobic fitness, body composition, blood pressure and musculoskeletal fitness. “
* “That the interactive video game exercise training program would result in greater attendance rates, leading to concomitantly greater changes in health-related physical fitness. “

The study took fourteen relatively inactive 18-24-year-old males split them into a control (N=7) and test group (N=7). During a six-week testing program individuals were encouraged to exercise for 30 minutes 3 times per week but had the option of exercising however often they wanted. Attendance and heart rate were monitored during the study by attending lab assistants with which there was always at least one present.

Results from the study indicated a significant increase to the aerobic fitness of the interactive video game group with members V02 maximproving 11.0 ± 5.1%, improvements were also made to the resting blood pressure, leg power and maximal power cardiorespiratory output in the interactive video game test group.

These results have been attributed almost entirely to the attendance figures of the two groups the interactive video game test group attended on average 30% more than the control group with a progressive decline in attendance from the control group.

The health benefits of interactive video game exercise, was a well conducted study with interesting statistical results, the group responsible for the study even went as far as to prove the exercise bike used for the control group was more comfortable than the bike used for the interactive video game test group. However, there are a couple of factors within the experiment that could be improved upon in future work these are;

* A larger more diverse test group; the group tested within the experiment were all young adult males aged between 18 & 24, all considered inactive and overweight when their BMI was considered. Adding additional test subjects that meet different criteria such as gender, age and fitness could lead to new noteworthy results.
* Extending experiment time; with modern technologies, it could make it easier to autonomously monitor the activity of the individuals taking part in the experiment. This could be used to extend the duration of the study to see if an extension to the duration has any effect on the results.

In conclusion, the results from this experiment lend weight to the notion that video games can be used as a method of effectively engaging young adult males in extended planned exercise and could be used in future as a method to combat the rising level of health risks due to inactivity.

# Conclusion

The literature review presented in this chapter paints a picture that when taking part in exercise activities, user enjoyment plays a significant role, in The health benefits of interactive video games (Warburton et al., 2007), physical activities that incorporated video game usage was proven to be more enjoyable than activities where video games were not involved. Other studies (Consolvo et al., 2006; Lin et al., 2006) have proven a link between exercise commitment with social interaction between participants of the same activity. Finally (Mullins et al., 2017) present evidence to suggest older adults receive greater benefits when taking part in low to medium intensity activity.

# Bibliography

Britain: ‘The fat man of Europe’ (2016) Available at: http://www.nhs.uk/Livewell/loseweight/Pages/statistics-and-causes-of-the-obesity-epidemic-in-the-UK.aspx (Accessed: 4 December 2016).

# References

The State of Food and Agriculture. Rome: Food and agriculture organization of the United Nations, 2013. Web. 4 Dec. 2016.

2016 GLOBAL GAMES MARKET REPORT (2016) Available at: https://newzoo.com/solutions/revenues-projections/global-games-market-report/ (Accessed: 25 October 2016).

Consolvo, S., Everitt, K., Smith, I. and Landay, J. (2006). Design requirements for technologies that encourage physical activity. Proceedings of the SIGCHI conference on Human Factors in computing systems - CHI '06.

Stephenson, T. (2013) Measuring Up The medical profession’s prescription for the nation’s obesity crisis. Available at: http://www.aomrc.org.uk/wp-content/uploads/2016/05/Measuring\_Up\_0213.pdf (Accessed: 04 December 2016).

Thompson, D., Baranowski, T., Buday, R., Baranowski, J., Thompson, V., Jago, R. and Griffith, M. (2008). Serious Video Games for Health: How Behavioral Science Guided the Development of a Serious Video Game. Simulation & Gaming, 41(4), pp.587-606.

Lin, J., Mamykina, L., Lindtner, S., Delajoux, G. and Strub, H. (2006). Fish’n’Steps: Encouraging Physical Activity with an Interactive Computer Game. Lecture Notes in Computer Science, pp.261-278.

Preacher, K.J. and Hayes, A.F. (2008) ‘Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models’, Behavior Research Methods, 40(3), pp. 879–891. doi: 10.3758/brm.40.3.879.

Kendzierski, D. and DeCarlo, K. (1991). Physical Activity Enjoyment Scale: Two Validation Studies. Journal of Sport and Exercise Psychology, 13(1), pp.50-64.

Pate RR. Physically active video gaming: an effective strategy for obesity prevention? Arch Pediatr Adolesc Med. 2008;162(9):895–896

Purnell, JQ, Knopp, RH, Brunzell, JD, Willett, WC, Bray, GA & Popkin, BM 1999, 'Dietary fat and obesity [4] (multiple letters)' American Journal of Clinical Nutrition, vol 70, no. 1, pp. 108-110.

Mullins, N., Tessmer, K., McCarrol, M. and Peppel, B. (2012). Physiological and Perceptual Responses to Nintendo® Wii Fit™ in Young and Older Adults.

Warburton, D., Bredin, S., Horita, L. and Rhodes, R. (2007). The health benefits of interactive video game exercise.