

World of Workout: Towards pervasive, intrinsically motivated, mobile exergaming

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ABSTRACT

World of Workout is a mobile pervasive exergame to motivate players to walk and help them track their daily exercise activities. We present our pilot study on the effectiveness of World of Workout in terms of user heart rate, game playability, and user feedback from our pilot playtesting conducted on an initial prototype featuring the core game play elements expected in the fully implemented game. Results gathered from play testing are promising and indicate that our game design and concept have significant merit, although fine tuning of the system as well as development of game play are both necessary to have a truly successful game.

Categories and Subject Descriptors

L.7 [Ubiquitous/Pervasive/Mobile]: Wireless/Pervasive Computing

General Terms

Measurement, Design, Experimentation, Human Factors, Verification.

Keywords

Mobile gaming, pervasive gaming, exergaming, pervasive health, heart rate, phones

1. INTRODUCTION

Complications from sedentary lifestyles, such as depression, obesity, and anxiety disorders have been increasing steadily in recent years [1]. The prevalence of technology and modern conveniences, while making many aspects of daily life significantly easier, have also lead to significant declines in true social interaction and physical activity. Video games often taken the brunt of the blame for physical inactivity, but games are evolving. Gaming is no longer restricted to the domain of a desk chair or living room; mobile games are accessible while travelling, running errands, and even while working out. Exergaming has also changed the way people interact with video games by creating game play that utilizes physical activity as a core game play mechanic. Mobile exergames combine the benefits of exergames with pervasive, always on elements that make them easy to play on the go.

In this paper, we present a novel, pervasive, mobile exergame, World of Workout. This game was created to track and verify a user's daily physical activity while also providing intrinsic motivation through game elements. The application is intended to serve a dual purpose as both a tool and a game. World of Workout can be, in the simplest sense, viewed as a quest-based pedometer. Like a pedometer, World of Workout tracks and verifies the distance travelled by the user in a given day. However, unlike a pedometer, World of Workout has intrinsic motivation through the incorporation of a quest system modeled after popular role playing games (RPGs) and massively multiplayer online RPGs (MMORPGs). World of Workout seeks to inspire gamers to participate in a different kind of role playing game than they may be used to, while making them more aware of their physical activity level. In addition, we hope that World of Workout will provide the motivation for players to set and achieve their own in-game goals that will result in increased physical activity in their daily lives.

1.1 Motivation for World of Workout

An estimated 17.6 million children worldwide under the age of five are overweight. Furthermore, researchers have found that, among persons aged 12-19, lack of physical activity rather than increased energy consumption is the cause of obesity [5]. The CDC recommends getting 150 minutes of moderate-intensity aerobic activity (i.e. brisk walking) every week [5]. One hundred and fifty minutes may seem like a lot in today's hectic lifestyles; however this amount can be achieved by taking a 10-minute brisk walk, 3 times a day, 5 days a week. This amount can easily be achieved, even with a busy schedule. For high-risk younger populations, 10-minute breaks between classes and outside the schoolday are easy times that students could achieve their recommended workout, given the proper motivation

With the increasing appeal of gaming, particularly on mobile platforms, games can now reach millions of consumers very quickly and easily, giving them a high potential to create significant societal impact. Centralized mobile distribution platforms, such as Apple's App Store or the Android Market, make it very simple for mobile users to quickly and easily download and install games on their device. In addition, mobile games are typically much cheaper than their computer-based counterparts, with a majority of games being under \$1.00. This

ease of access removes the complication of going to a store to purchase a game, as well as the potentially high up front cost for a player just to try a new game. We feel that the mobile device arena could be a much more effective distribution method for creation of a pervasive exergame than the traditional computer-based platform. A properly designed and implemented mobile exergame, distributed on the popular iPhone and Android platforms, could help to reduce the sedentary lifestyles which have resulted in deteriorating health for society, particularly among youth.

1.2 Related Research

In his paper, Laikari points out that with an aging population and decreasing health amongst players, exergaming definitely has a place in the gaming world [1]. By using exercise games to focus more on the prevention of illness, we could use fewer medical resources on treating illnesses. Since there are so many successful games based on a social model, an exercising game that capitalizes on the same notion will likely evoke the same addictive qualities that RPG and massively multiplayer online RPG players have come to expect [1]. Furthermore, sports and athletic interaction have advantages beyond simply a player's health. Combining sports and games can both help users become healthier while also promoting social bonding. Social bonding can be achieved through social networking games that give players rewards for meeting one another, or any games that give users a set goal that they all work towards. This helps to break the ice easily in otherwise uncomfortable social situations while also motivating players to work towards a mutual goal [2].

In keeping with the advent of mobile gaming, it's not surprising that the trend of exergames has moved to mobile devices as well. Vasudevan examined the possible future of games on cell phones and their impact for industry personnel [3]. With the concurrent trend of exergaming, it is quite obvious that these two will eventually converge [3]. Our game seeks to fill that niche. Like Wylie and Coulton's Heart Defender, which is a computer-based arcade-style game with intermittent exercise sessions [4], we seek to use a game to motivate players to exercise. However, we believe our game can be more fun, effective, and accessible since it incorporates physical activity as a core game play mechanic, and does not require peripheral devices.

2. Game Architecture/Implementation

Game design is a complex activity that seeks to balance player experiences to obtain an optimal flow experience, somewhere between what a player can and cannot achieve. Promoting this flow experience while also incorporating physical activity as a core game mechanic is even more of a challenge. There was by no means a guarantee that walking or working out would be considered fun by our target audience. In addition to these challenges, our team of four undergraduate computer science students developed the game on a platform that was new to us, while we also learned to design and implement a user study and conduct research in the context of a fourth-year computer science class.

2.1 Quests and Player Goals:

The World of Workout prototype game incorporates a linear quest-based story in this initial prototype. Ultimately, we believe a broader and more complex storyline can be used to promote a variety of exercise goals. However, our game is designed to

motivate people to play during their everyday lives, for short periods of time. The intention is to help people stay aware that they need to be physically active while also having some fun. Since physical fitness doesn't have an "end" we felt a non-linear story with options for quests would be most appropriate.

Quests are tiered so certain quests must be completed before others can be unlocked. This way, while quests might be very different, they are still linked. Our prototype has two quests. In the first quest, "Special Shoe-prize!" shown in Figure 1, the non-player character (NPC) guide, Old Man Jenkins, prompts players to walk to the river and back. In the second quest, "Are you experienced?," the player investigates the rumor that Jimi Hendrix's ghost is haunting the local waterfalls. Humor, popular culture references, and common MMORPG jokes, rather than an expansive story line, make the game fun, engaging, and relevant to players. Familiar RPG elements, such as "farming" for items, collection mechanics, leveling structures and experience points are also make World of Workout easy to play and understand.



Figure 1: Image of the first quest, "Special Shoe-Prize!" beginning and completion screens

In addition to the quests built into the game, players can set their own personal goals. World of Workout tracks overall steps during play and per day. Using these values, the player can set daily, weekly, or monthly goals that the game will help them track. The game helps keep the player motivated by tracking their goal progress and informing them of the remaining distance needed to achieve their goal. If a player does not choose to set their own goals, the game will create goals for them. Goal setting enables multiple types of quests: single occurrence, daily, and lifetime quests. The player levels up by working towards their goals and achieving quests in the game.

2.2 Gameplay:

Upon first loading the game, new players enter their player name, gender, age, height, and weight. Gender and height are used to calculate the player's stride length, while height and weight are

used to determine player Body-Mass Index (BMI). Age is used to calculate a target heart rate. Upon starting the game again, players can begin playing right away. As shown in Figure 2, our game uses question marks and exclamation points like other RPGs to show the location and status of each quest (! means complete). By tapping on quests, players can see the quest name, purpose, and the distance to be traveled. When the quest is accepted, the View Controller class stores the quest number and the number of steps needed to complete the quest (calculated based on the distance of the quest and the player stride length) in the user state data. The player is instructed to place the phone in their pocket without turning it off or locking it, and begin walking.



Figure 2: Welcome and World Map with quest indicators

With the phone in their pocket, the user begins walking to complete the quest. Every time the phone detects a shake event (a method built into the iPhone SDK), an event handler is called. This event handler invokes a method that increases the variable storing the users step count and checks it against the number of steps needed. Depending on the result, the method either exits and activity continues, or a second method is called which will end the quest. As the user takes steps towards completing the quest, a progress bar located beneath the world map displays the steps they have taken out of the total number necessary.

Upon completion of a quest, players can turn in the quest and receive any items they might have earned. Then, the world map is shown, updated with any newly unlocked quests, and the player repeats a similar process with the next quest. Players are only allowed to participate in one single occurrence, one daily and one lifetime quest at a time.

Several features can change the typical flow of game play. Game items can alter the way the player interacts with the world and completes quests. For example, the player earns shoes for completing the “Special Shoe-prize!” quest. These shoes, when worn in game, increase player speed (via stride length) in the game, making it faster to complete quests. However, the shoes are also subject to wear and cannot be used indefinitely. Other

items, such as the “Backpack of Burden,” can increase difficulty for players who appreciate more challenge in the game, by slowing down the rate at which they complete quests.

2.3 Platform:

We chose to implement this prototype of World of Workout on the iOS operating system for the iPhone and iPod Touch. Utilizing the multi-touch screen, the interface is entirely touch based. The user interacts with the game by touching buttons and text fields to enter information and accept messages. The simplicity of the interface keeps the amount of time spent learning the user-interface to a minimum. The simple interface also helps keep the player focused on their physical activities. The interface does not provide any new challenges to the user, allowing them to immediately jump into simple gameplay and remain focused on their goals and quests in the game rather than learning a set of controls.

The iPhone SDK encapsulates applications into views, grouping functionality by the screens that users see. Our player data views collect minimal data including user age, weight, height, and physical activity level. We use simple formulas with these data to calculate stride length, body-mass-index, and calories burned, and save this snapshot of physical fitness with their user data. This more accurately tracks the user’s physical activity and helps us motivate the player to attempt quests and set goals in the game.

2.4 Game Structure and Data:

Since we were building a linear prototype game, we first built the game in an ad-hoc manner. However, it soon became apparent that we needed better solutions to pass data and organize the code for our four-person team. We then changed to a more modular format, separating the classes to handle different events and keeping the main class as small as possible in order to increase memory and processor efficiency. We separated out classes for the World Map, Character Information and Quests.

Data is stored in Property List files called p-lists, which are basic, String-based arrays of properties native to the iPhone SDK. P-lists make it easy to save user data, the game state, and even a database of the quests. This allows us to update quests without re-compiling the game, a much more efficient and agile implementation. Using p-lists for quest data supports scalability, making it very simple to distribute updates to player devices with a new Quest p-list, in addition to opening the door for user-created quests in the future. Using p-lists to save game state data (such as if the player was in a quest, what quest they were in, how many steps are needed vs. how many steps they have taken, etc) allows easy recovery when the game is interrupted by a phone call, text message, or putting the phone to sleep. Once the p-lists were created to hold the Quest and Character Information, they were utilized throughout the code to store needed data. The quick saving to p-lists also enabled us to pass data easily from view to view, as the application saves any changes it makes immediately.

3. Experimental Method

World of Workout was designed with college students and gamers in mind. The idea is to appeal to young adults who, although active, do not meet the recommended time spent exercising due to

a sedentary lifestyle. While we hope to appeal to gamers, our primary goal is to leverage game and social elements to attract and motivate a broader audience iPhone/iPod touch users. For our pilot study, we had ten participants. These participants were students at UNC Charlotte, range in age from 21 to 33, and all label themselves as either “hardcore” or “casual” gamers. As such, these ten participants are exactly the audience we’re hoping to reach with our game.

The main purpose of our preliminary pilot study was to gather qualitative feedback from play testers to help us refine and improve our game design and implementation. Below we list the sequence of steps for participants in the study:

1. Participant’s resting heart rate is measured and recorded using the iPhone application “Pulse Finder”.
2. Participant is provided with a device and told to complete the two quests created just for play testing.
 - a. Quest one is a total of 100 feet and is the only quest available upon starting the game.
 - b. Quest two is 1/10th of a mile and is available upon completing quest one.
3. Immediately upon completing both quests, participant’s heart rate is measured, again utilizing Pulse Finder.
4. Participants complete a demographic and post survey to gather some basic information and gauge attitudes towards the game.

The demographic survey gathers information including age and gender, attitudes towards and involvement in gaming as well as participant’s physical activity level and workout habits. Finally, the post survey includes sixteen 5-point Likert-scale questions to measure player perceptions of the game. Space was also provided to make additional comments if the participant so desired.

4. Results and Discussion

All ten of our playtesters labeled themselves as either “hard-core” or “casual” gamers, are college students aged 21-33, and play RPG games. The target heart rate based on our age range is, roughly, 97 – 170 bpm. Since the game involves only walking, we were concerned that World of Workout may not sufficiently elevate players’ heart rates to the level necessary for aerobic exercise. However, the heart rate of every participant increased upon playing our game and, for the majority of participants, this increase was enough to put them in their target heart rate range. Our average increase in heart rate was 31.5 bpm.

Table 1. Individual heart rates before and after game play

Participant	Resting Heart Rate	Post-Play Heart Rate
1	67 bpm	87 bpm
2	93 bpm	95 bpm
3	80 bpm	97 bpm
4	83 bpm	101 bpm
5	76 bpm	116 bpm
6	97 bpm	116 bpm
7	64 bpm	118 bpm
8	67 bpm	119 bpm
9	80 bpm	122 bpm
10	93 bpm	144 bpm

The Pulse Finder application used to collect heart rate data relies on each participant’s ability to find, and accurately tap out, their own heart rate. Therefore, these results should be taken as indicative of heart rate but not necessarily accurate. For future studies, we will use a heart rate monitor to measure results more precisely and accurately, before, during, and after game play.

Every participant was able to, upon being handed the device, access the game, open it, run it, and know what to do. We as developers can only take so much credit for this, as the iPhone/iPod Touch interface is intuitive, user-friendly, and familiar. However, we felt it was important to develop a game that can be so easily picked up and played. This is especially true when the game is intended to become an addition to daily activities.

As summarized by the average Likert-scale ratings in Table 1, our survey results were positive. Players did feel that World of Workout qualifies as a game, is motivating, and could motivate them to play along with their regular walking. Players were neutral on how much fun the game was, but liked the concept.

Table 2. Survey results for World of Workout on Likert scale, from 1 (Strongly Disagree) to 5 (Strongly Agree)

Statement	Avg.
I found WoW to be fun.	3.0
I would play WoW in addition to my normal walking.	3.43
I would walk slightly out of my way in order to complete a quest in WoW.	3.57
World of Workout is a useful tool for working out.	3.71
WoW provides sufficient motivation for being more active on a day to day basis.	3.71
I would recommend WoW to my friends.	3.86
I would play WoW if made available in the App Store.	3.86
I would play WoW in correlation to my normal walking.	3.86
I consider WoW to be a game.	4.0
I like the concept of WoW.	4.57

Table 2 shows the results for the question “Please indicate how you feel the following features would affect game play.” This question measured player opinions on future changes, additions, and expansions to the game. Players felt that multiplayer competitive quests would have the most potential for making the gameplay better. Playtesters also simply wanted more quests and a leaderboard to track who was doing best in the game.

Table 3. User rankings for potential game features from 1 (Significant decline) to 5 (Significant improvement)

Feature	Average
Useful workout tips	3.71
Scoring System	4.29
Multiplayer, co-operative quests	4.43
Leaderboard	4.43
More quests	4.57
Multiplayer, competitive quests	4.71

We were happy to find a positive reception to the prototype for World of Workout, and felt that players were excited about the potential for such a mobile pervasive exergame. World of

Workout needs considerable expansion before it will be considered fun and engaging by consumers, and our pilot study indicates areas where we can focus our game development efforts. Likely, participants did not strongly agree with every Likert-scale statement because the game is currently very short. It is difficult to envision how World of Workout could be used in correlation to daily walking, let alone in addition to it, when the version played had only two quests which covered less than a mile. This is supported by “More quests” being one of the most strongly recommended features to improve game play.

5. Conclusion and Future Work

Our pilot study shows that college-age students are ready and excited to try a mobile exergame that helps them track their physical activity anytime, anywhere within a role-playing game. Based on our results, we believe that World of Workout can raise player heart rates to target rates for health benefits. Survey results indicate that players believe they will be motivated by game elements, particularly multiplayer, competitive quests. We believe this reflects the social nature of today’s youth, who wish to challenge and be challenged by one another to be better and be more involved. Games also provide today’s youth with structures to track and collect credit for their own activities – an important feature in an increasingly complex world, where events happen quickly and there is much more information available than a single person can manage.

Designing games that promote exercise and fun simultaneously is a difficult challenge. Most exergames achieve only one of these goals: either they are fun or they get heart rates up, but most of the time they don’t achieve both goals at once. For example, Heart Defender alternates classic arcade game play with in-place running [4], not a very integrated approach. The Wii Fit game sought to engage players in exercise while having fun, but many players learn to avoid exercise in the game, simply using their wrist to achieve most arm motions, and very subtle weight shifts when body actions are required. Given that exergames are challenging to develop for games and consoles, translating their benefits to mobile exergames is even more of a challenge. World of Workout seems to show that there is potential for such games, but even so players can avoid walking, just by shaking their phones to achieve quests. A combination of GPS with shake or accelerometer events would probably help to ensure that players didn’t cheat their own physical activity goals in the game.

In the future, we plan to expand World of Workout to incorporate social elements such as integration with Facebook and Twitter and a friends list to encourage competitive gameplay amongst peers. We also plan to incorporate more quests and support for player-defined goals. The recent release of iOS 4.0 for the iPhone and iPod touch has incorporated multi-tasking, which allows us to run

World of Workout in the background, even if the user has closed the application to use other parts of their device. This further enhances the pervasiveness of World of Workout, and the game will be tracking the player’s movements as long as it is running in the background. We also plan to refine our data logging system and determine how to incorporate a heart rate monitor in preparation to conduct a controlled scientific study of our expanded game.

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