
Wind Runners: Designing a Game to Encourage Medical Adherence for Children with Asthma

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Abstract

In this paper, we present *Wind Runners*, which is a game designed for children with asthma. The goal of *Wind Runners* is to increase the likelihood of asthmatic children adhering to the NIH's recommendation of measuring their peak expiratory flow (PEF) on a daily basis. We aim to accomplish this by incorporating both social gaming features and the actual medical regimen of measuring PEF into a mobile game.

Author Keywords

Asthma; compliance; health games; social games; game design

ACM Classification Keywords

H.5.m [Information Interfaces and Presentation]:
Miscellaneous

Introduction

In this paper, we report on our current work with *Wind Runners*, a game playable on Android smartphones and tablets for children who have been diagnosed with asthma and are between the ages of 8 – 14 with basic reading comprehension skills. According to the World Health Organization, asthma is the most frequently

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encountered chronic disease among children and afflicts approximately 235 million children worldwide [15]. Asthma is not a lethal disease, and the prognosis is generally positive as long as the patient undertakes preventative care as directed by a physician. However, not adhering to correct medical regimens is a major hurdle impeding optimal care for patients with asthma. Measurement of peak expiratory flow (PEF) via a spirometer is a particularly important regimen for asthma patients as the measurement allows them to monitor the state of their lungs with poor values being indicative of future complications including asthma attacks. The absence of patient adherence has been well documented in the case of children and adolescents [4,11].

Our continuing work on *Wind Runners* specifically addresses the issue of PEF adherence for children and adolescents. The game is designed to encourage children and adolescents with asthma to measure their PEF on a daily basis. *Wind Runners* incorporates two important innovations for increasing adherence: the completion of the medical regimen (measuring PEF via a spirometer) is integral to the gameplay, and the incorporation of a social support structure into the game. Our work is inspired by social behavioral health theory [1] and grounded in empirical research on the benefits of social support structures with regards to adherence [6]. The game is designed to be used in conjunction with a custom-built, small spirometer. To play the game, a patient blows into the spirometer thus filling an in-game air reservoir tank based on their performance of the exercise.

Wind Runners incorporates physics based, puzzle-lite gameplay where players guide a circular object past

obstacles to a goal either by pushing it with their player character or using the air stored in their reservoir tank. Players navigate past physical obstacles by blowing them away using air collected in their reservoir tank when measuring their PEF. We incorporate social media features using *OpenFeint*, a 3rd party social networking platform for mobile games. Using this game feature, players can discover and interact with others who share their health condition, thus forming a social support structure.

Related Work

There is significant research focused on educational health games for a wide variety of medical conditions including diabetes [9,13], cancer [8], and mental health issues [5]. A majority of these games aim to educate individuals and increase adherence to medical regimens through the use of well-established game design principles. With regards to asthma games, *Bronkie the Bronchiasaurus* is an educational game geared towards children with asthma. *Quest for the Code* [16], developed by Starlight Children's Foundation, and *Air Academy: The Quest for Airtopia* [14] are games that focus on teaching children about asthma through educational videos interspersed with gameplay. *Watch, Discover, Think, and Act* is another asthma education game targeted towards inner-city children whose families may not have the resources available to them for proper care [2].

Several studies and surveys conducted on these and other health games show that they have favorable outcomes in a number of areas. They have shown that these types of games can result in fewer urgent care visits [2,9], improved knowledge about personal health conditions [2,8,9,12,14], increased self-efficacy

regarding health care [2,9,12,14], and increased openness in discussing personal health conditions with others [9,14].

However, many health games have overlooked two features which may have an additional positive effect in increasing adherence. The first is the inclusion of social gaming features, and the second is including the medical regimen itself as a core component of the gameplay. We have incorporated both of these features into *Wind Runners*, described more fully in the next section.

Design Principles

There are four primary design goals in *Wind Runners* that we believe are fundamental to the success of the game. The first two of these goals have been incorporated into the game while the remainder will be added in future versions.

Social Gaming Features

Using social gaming features to encourage adherence to medical regimens is an underexplored area within the domain of health related gaming. Social support structures can have a positive benefit towards a patient's adherence to certain medical regimens [6]. However, many of the current health games remain solitary experiences. Social gaming features can provide an avenue for individuals to find, connect, and share their experiences with others who have the same medical condition. A community formed under the auspices of a game can provide a basis of encouragement and support as an individual copes with their illness. This can be especially important for children and/or adolescents who may be embarrassed

of or in denial of their condition [3] and/or may not have ready access to outside social support groups.

Integration of Medical Regimen into Gameplay

Few existing health games directly integrate the medical regimen itself into the gameplay. Having an individual performing the regimen as part of the game can provide additional incentive and positive reinforcement thus increasing the likelihood of adherence.

Detailed Reports/Statistics

Prior studies have shown that a significant number of asthma patients tend to exaggerate their adherence to recommended care regimens [4,11]. Therefore, it is important for a game in this domain to provide detailed reports and statistics regarding the completion of the medical regimen by the player/patient. In this way, the physician is better informed of the patient's progress. In addition, reports can easily show improvements in a patient's condition providing further motivation to complete the regimen. While this is not a new phenomenon in health games [9,10,12], we believe it is a fundamental game feature for inclusion.

Added Value through Expansions

Many health games end when there are no more lessons to be taught about the illness in question. However, this is not ideal when the medical regimen itself is integrated into the gameplay as the individual needs to repeatedly perform it for a long period of time. Therefore, the game needs to be regularly updated with new content to keep the player engaged as forcing him/her to repetitively complete the same scenarios will result in the player becoming bored quickly. This added



Figure 1 - mobileSpiro sensor and laminar flow tube



Figure 2 - Two screenshots showing the spirometer input step. Players are prompted to blow into the spirometer.

content can be in the form of new scenarios, rules, and game objects or content generated by the player.

mobileSpiro Hardware

The medical regimen promoted by our game is the daily measurement of PEF as recommended by the National Institute of Health [17]. Commercially available spirometers use proprietary interfaces which prohibit the access of raw sensor data. As a result, we are using a custom-built spirometer dubbed *mobileSpiro* [7] shown in Figure 1. *mobileSpiro* is functionally comparable to commercially available spirometers such as the *Thor PC FlowMeter*. However, using *mobileSpiro* allows us to customize the *Wind Runners* game based on raw sensor data.

The *mobileSpiro* architecture is divided into two major components. The first component is a MSP430 microcontroller-based pressure sensor, which samples raw data from a spirometer maneuver and transmits it to an Android client via Bluetooth. The second component is the Android API on the client device, which converts the pressure data into flow data based on a calibration step. The spirometer can run up to 80 days on two standard AA batteries if used sparingly.

Wind Runners

Wind Runners is a mobile game aimed at encouraging children with asthma to measure their PEF on a daily basis and is developed for use on Android devices in conjunction with the *mobileSpiro* hardware¹. Android was chosen due to its wide adoption and its ability to

freely interface with external Bluetooth devices such as *mobileSpiro*.

mobileSpiro Integration

When starting *Wind Runners*, the game first prompts the player to measure their PEF with the spirometer, as shown in Figure 2. An in-game air reservoir tank fills up based on the player's performance during this spirometer maneuver. This air tank is essential for the gameplay as it enables the player to successfully complete game levels. It also fulfills one of our core design principles by incorporating the medical regimen as an essential gameplay feature. This creates an incentive for children to perform the measurement as advancement in the game is dictated by successful completion of it.

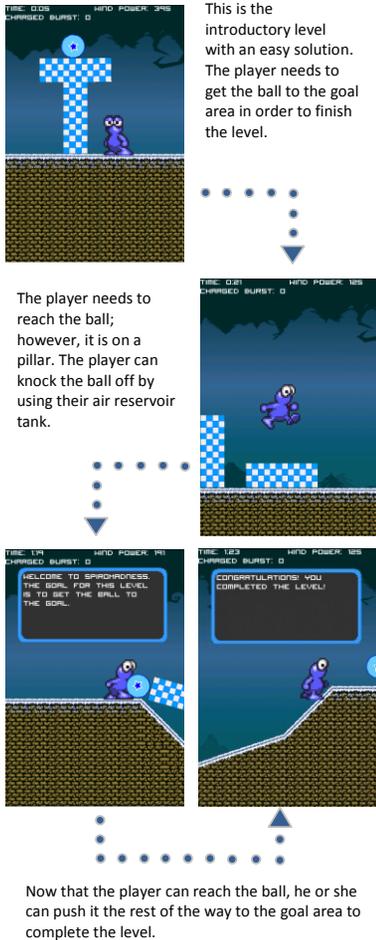
Gameplay

Wind Runners is a game belonging to the platforming genre and incorporates physics-based, puzzle-lite gameplay. This game design approach has appeal across diverse age groups and genders as has been demonstrated by the success of recent games such as *Little Big Planet*. In the game, players must guide a ball to a goal area in each level. Players do this by moving the ball either by pushing it with their player character or using the air in their reservoir tank, which was collected at the start of the game, to push it along. Physical obstacles hinder the player's progress in completing the level and are dealt with by using air from the reservoir tank to remove them. For a gameplay example, please see the *Level Walkthrough* sidebar.

¹ Artwork for *Wind Runners* is from:

<http://www.spicypixel.net/2008/01/10/gfxlib-fuzed-a-free-developer-graphic-library/>

Level Walkthrough



Social Features

To incorporate social features into *Wind Runners*, we integrated *OpenFeint* [18], a popular 3rd party social networking platform for mobile games. Features provided by *OpenFeint* include achievements, leaderboards, and friend lists. Achievements are hidden and can be unlocked upon accomplishing certain objectives in the game. The player's score is submitted to *OpenFeint* after successful completion of a level and high scores from all players can be viewed via the *OpenFeint* interface. Players can 'friend' other players of the game and leave status messages and wall posts similar to *Facebook*. Including this platform in the game satisfies a core design goal of providing social gaming features. In so doing, asthmatic players from around the world can interact with each other through a shared gaming experience. We anticipate that this will result in a social support structure that will create further community-based incentive for players to continue playing the game and thus continue measuring their PEF on a daily basis.

Current Status and Future Plans

The game currently integrates the spirometer into the gameplay and contains a social gaming component. There is one introductory level with several more near completion. We will implement detailed progress reports and statistics in a forthcoming version, which will show the player's PEF measurements over time. We will also create additional content as well as a distribution system, which will allow players to update their game with these new additions. Finally, we plan on developing a more direct cooperative and competitive play environment for players. These additions will give further incentive for individuals to

continue playing the game and performing PEF measurements over an extended period of time.

Over the next several months, we are planning on conducting preliminary studies to test the efficacy and appeal of the game. We will also conduct several participatory design studies to better gauge what children wish to see in future iterations of this game. Finally, we realize that Android devices have a limited reach due to many families not having the means to own one. Therefore, we are examining additional platforms, such as HTML5, which can reach a broader audience.

Conclusion

In this paper, we present a mobile game, which encourages children to measure their peak expiratory flow on a daily basis using a custom-built spirometer. The primary current contributions of the game are the incorporation of social gaming features and the medical regimen itself into the game, thus providing additional incentive for children and adolescents to adhere to the regimen. This has broad implications for both individuals dealing with asthma and health care providers. Measuring PEF is a good preventative care regimen, which can result in higher quality of life and reduce costly hospital visits. Moving forward, we believe that the design principles exercised in this game could prove promising in the development of health-related games for a wide variety of long-term or lifetime illnesses.

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