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Utilizing a Modular Approach to Gamification to Improve Nutrition and Fitness in Children

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Utilizing a Modular Approach to Gamification
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of the requirements for the degree of
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by

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ABSTRACT

Obesity is a worldwide epidemic that affects adults and children, impacts over 30% of the population in several states of the U.S., damages national economies, and is a factor in four out of the six of the leading causes of death, including diabetes and heart disease. Obesity is preventable: solution approaches include better education, more exercise, better nutrition, and changing eating habits. Still, it is difficult for many people to remain interested enough to educate themselves and to learn new behaviors to change their eating and exercise habits.

Gamification is a relatively new research area that involves using video game mechanisms to make applications such as work, education, and behavior change seem less like a job and more like entertainment.

The objective of this thesis is to develop a system for gamifying the process of education and behavior change aimed at reducing obesity in children. The approach involved identifying requirements, developing a methodology, implementing a suite of games, developing a common application program interface and integration framework so that metrics from the games could form a user progress model that is securely sharable with parents, educators, and health professionals. The idea is that as users get better at playing the game, they will get healthier. We specified the following requirements for the framework and suite of games: large domain coverage in the areas of nutrition and fitness; extensibility and scalability; user diversity; measurability and metrics; and security and privacy. A working prototype at *http://www.edufitment.com* demonstrates the framework and the games developed so far. Future work will involve refining the game content coverage with the help of domain experts, adding more games, and deploying and testing the framework on the Internet.

ACKNOWLEDGMENTS

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CHAPTER 1 - INTRODUCTION

1.1 PROBLEM

Typically, when people think of games, they immediately think of video games, but games are all around us in ways that most people do not even notice. Businesses have started to utilize game mechanics to increase profitability; employees have turned work into a game in order to reduce monotony; and fitness buffs use FitBits and other health monitors to measure their progress. In short, serious applications like work and education are being tackled using mechanisms borrowed from game design. *Gamification* and *serious games* are relatively new terms used to describe the application of game mechanics to engage users and solve problems. As a new research area, gamification is still being explored.

In the summer of 2012, my adviser, Dr. Craig Thompson, and our computer science team were approached by an interdisciplinary group of faculty (with backgrounds in nursing, education, and kinesiology - see the list in the *Acknowledgments* section of this thesis) to join a project that targeted the serious objective of reducing obesity in grade school children. Dr. Thompson and his computer science students develop 3D virtual worlds and games, focusing on the architecture and artificial intelligence elements. The initial idea for the new project was to develop a video game that would interest children to learn more about nutrition and fitness and then measure if this had an effect on their eating and exercise habits. This project provided our computing group with an opportunity to address a serious social health issue using game design, but more than that, it also offered us a chance to introspect on the architecture and methodology for gamifying a serious application domain.

There is significant reason to focus upon this domain. Obesity has become a worldwide epidemic and contributes significantly to four of the six leading causes of death: heart disease,

stroke, cancer, and diabetes [1]. Energy imbalance between Calories consumed and expended is the primary cause of obesity; therefore, obesity is largely preventable by making healthier eating choices and exercising regularly [2]. This problem is not isolated to adults. In 2011, more than 40 million children worldwide under the age of five were considered obese [2]. Most studies in obesity have focused on adults; thus, there is much room for research into methods of improving the exercise and eating habits of children.

1.2 OBJECTIVE

The objective of this project is to identify and describe the requirements and then develop a methodology and architectural framework for gamifying a specific serious domain: obesity reduction in children.

1.3 APPROACH: ITERATIVE DESIGN

Initially, the interdisciplinary faculty team began with the hypothesis that gamification was an interesting approach to childhood obesity reduction. The initial concept for testing this hypothesis was to use a video game to interest students to learn more and change their eating and exercise behaviors. Students would go to computer lab a few times a week to play the game and their progress would be monitored periodically.

Rapidly, the team realized that this narrow conception was unlikely to work. Obesity reduction is part of a larger set of concerns related to nutrition and fitness. It involves knowledge acquisition of many types: knowledge of food types, an understanding of how food is processed, the relationship between food intake and exercise, and many other factors. More than knowledge acquisition, it involves behavior change.

No one video game played for such short bursts during the week would be likely to have sustained impact on a child's knowledge and behavior. No one video game was likely to cover

all aspects of the knowledge and behavior changes needed to "cover" the complex topics of nutrition and fitness. No one video game might meet the needs of a diverse population of children who vary in age, gender, reading or mathematics ability, computer ability, race, language, socio-economic background, and health or fitness. Also, no one video game might keep a child's interest over a long period of time and appeal to all children.

Our overall approach changed to identifying these requirements and then to providing a framework that could contain an open-ended variety of plug-in games, each targeting different objectives. To achieve the objective, plugin mini-games must appeal to some segment of elementary school age children which might vary by sex, race, ethnicity, or grade point average. Because there are many types of students and many kinds of knowledge sets within the domains of exercise and nutrition, creating a suite of mini-games is preferable to one large game. With one large game, there is little room for improvement once the initial version is complete. However, mini-games are modular. Those that are not well-received could be revised or removed. If a standard API defined how to add a new game, then new mini-games could easily be added in the future, including games created by third parties. Also, due to the various ethnic backgrounds students may have, there needs to be a focus on internationalization, extending the games to multiple languages. Ideally, there will initially be a reasonable amount of knowledge coverage. In order to achieve this, each mini-game focuses on different though possibly overlapping sets of nutrition and fitness knowledge areas. For instance, some games focus on determining which food groups various foods belong to while other games may lean toward the number of Calories a food contains. Finally, not all games are passive play games: the framework can also support mini-games that involve recording activity, which might just be a record of how fast someone runs the 50 yard dash or how many sit-ups they do that day.

To make the games more compelling and progress measurable, a metrics scheme common to all the individual mini-games is managed by the game framework. Metrics provide a way for a student (or their parent, teacher, or healthcare professional) to monitor progress. Points are awarded during game play, and these points are converted to a dual currency in an in-game economy. In order to keep students exercising as opposed to focusing only on nutrition, two currency types are currently awarded for different activities: ExerCoins for exercise games and NutriCoins for nutrition-based games. The coins can be spent on sending messages in a chat room students may join, on in-game collectibles for games that implement this feature, and on additions to the child's chat avatar. Items require different types of coins so that exercise will be required to purchase some items and knowledge of nutrition will be required to purchase others. In the future, some items will require both types of coins in order to prevents students from focusing on one knowledge set.

1.4 POTENTIAL IMPACT

Thus far in the project, we have developed the gaming framework and a suite of mini-games, but we have not iterated with domain experts to ensure the content of the games covers age or background appropriate knowledge. We have also not yet deployed the games for testing with children. Thus, there is considerable work ahead. Still, the approach meets our extended understanding of the requirements we have identified and documented. With these caveats, we described the potential impact of our project.

If this project is successful, it has the potential to make an impact in both the new area of gamification and on the worldwide epidemic of childhood obesity. The area of childhood obesity is a serious problem, and our project contributes one potentially beneficial and measurable approach to reducing the problem, namely, the application of gaming techniques to

interest children toward gaining knowledge and changing behaviors. At the same time, gamification as a research area is still in its infancy. By providing a structured way to use game mechanics to teach new knowledge or modify behavior, this project is contributing toward an architecture and methodology for gamifying a serious application. It seems likely that the same or a similar framework can be reused in other domain-specific applications as well.

1.5 ORGANIZATION OF THIS THESIS

Chapter 1 introduced the thesis problem, objective, and approach. Chapter 2 describes background concepts and references related work in the area. Chapter 3 describes iterative design and identifying requirements that led us to develop the architectural framework of a suite of games and also describes plug-in games developed so far. Chapter 4 provides an analysis of the gamification framework to determine whether the framework and plug-in games meet the requirements specified in Chapter 3. Chapter 5 concludes with a summary of what was learned in this project and what can be expanded with future work.

CHAPTER 2 - BACKGROUND

This chapter provides the reader with background on the obesity epidemic and suggests gamification as a solution approach that can complement other approaches. The use of games, serious games, and gamification is described. Related work on incorporating entertainment into education ("edutainment") and into healthcare is described. Finally, game mechanics useful in gamifying an application are described.

2.1 THE OBESITY EPIDEMIC

Obesity is a complex and serious worldwide problem that needs a solution.

2.1.1 OBESITY STATISTICS

The Mayo Foundation for Medical Education and Research defines obesity as having an excessive amount of body fat [20]. During the past 20 years, there has been a dramatic increase in obesity in the United States, and rates remain high. More than 72 million adults in America are obese, and 2.4 million more people were obese in 2009 compared to 2007 [25]. According to the Center for Disease Control and Prevention, in 2010, no state had a prevalence of obesity less than 20% [26]. In fact, thirty-six states had a prevalence of 25% or more and 12 of these states (Alabama, Arkansas, Kentucky, Louisiana, Michigan, Mississippi, Missouri, Oklahoma, South Carolina, Tennessee, Texas, and West Virginia) had a prevalence of 30% or more [26]. More than doubling since 1980, obesity has become a worldwide epidemic [2, 23]. The World Health Organization reported in 2008 that 200 million men and nearly 300 million women were obese worldwide [2]. It is predicted that by 2030, half of Americans will be obese [28].

2.1.2 RELATIONSHIP OF OBESITY TO OTHER DISEASES

Eating an unhealthy diet and physical inactivity can lead to many diseases such as coronary heart disease, stroke, diabetes, and high blood pressure, and diabetes and contributes significantly to four of the six leading causes of death [1,20].   Over 100,000 Americans die each year from obesity-related deaths [1], and the medical care costs of obesity in the United States, alone, are staggering.   In 2008, these costs totaled about $147 billion dollars [25].

Obesity and physical inactivity increases the risk of stroke and cancers of the breast (postmenopausal), endometrium (the lining of the uterus), colon, kidney, and esophagus [21]. According to The Associated Press, the leading cause of cancer is obesity, with about one in twelve new cases of the disease due to excess weight [22].

As of 2009, diabetes affects more than 230 million people, almost 6% of the world's adult population [23].   Obesity and a lack of physical activity are the leading causes of type-2 diabetes, responsible for 95% of the total diabetes cases in the United States [1, 23, 24]. Without drastic changes in worldwide diet and exercise habits, the International Diabetes Federation predicts that at least one in ten adults could have diabetes by 2030 [27].

2.1.3 OBESITY IN CHILDREN AND SOLUTION APPROACHES

The obesity epidemic extends to children.   In children in the U.S., one-third are currently affected by obesity or excess weight [7].   There are many ways to approach this problem. Probably a best approach is to use a hybrid of all of the following approaches.

Incorporating healthier meals in school is one method to improve a child's nutrition. However, there are regulatory problems with including healthier meals in school.   Schools must meet a weekly budget, which may be exhausted by including healthier meals.   Also, many children are on free lunch programs, which has restrictions on what foods are received.

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Requiring more physical education classes per week and starting physical education classes at a younger age are related methods for improving the amount of exercise a child receives. Budget issues as well as time issues may occur if attempting to incorporate more physical education classes. In most physical education classes, no measurements are regularly taken of body mass, weight, or waist size, all potential indicators of obesity. By taking regular measurements, the instructor can focus individual attention on those students who are indicated to be overweight or obese, perhaps developing an exercise program for those students in class. Realistically, however, bureaucracy may hold back dramatic improvements in this area.

A third approach is education. After all, "You can give a man a fish, but that only feeds him for a day; teach a man to fish and you feed him for a lifetime [29]." Education for adults on obesity, health, nutrition, and exercise will likely influence children's health and exercise behaviors. At the same time, providing education to children can raise awareness in parents and families. Education can take the form of literature or discussion groups and can lead to better shopping habits, better behaviors related to snacking and food choices, and more overall awareness. Still, traditional information dissemination and education alone often do not result in actionable behavior change.

This thesis explores how a gamification approach can provide obesity, health, nutrition, and exercise education and behavior change.

2.2 GAMES, GAMIFICATION, AND SERIOUS GAMES

2.2.1 VIEWPOINTS ON GAMES

The term *game* is used in many contexts and has many connotations. For children, it might mean playground activity games like bombardment or board games like checkers. For many, it

connotes sports. In entertainment, games may refer to video games or games of chance. Often, games are associated with the concept of entertainment, that is, having fun.

Games are big business. The video game industry made over $56 billion dollars in 2012, and is predicted to be worth $82 billion by 2015 [3]. In comparison, the movie industry made $62.4 billion dollars globally in 2012 [4], and the video game industry is predicted to overtake the film industry to become the fastest growing form of media by 2015 [3].

Games may have negative connotations and stigma attached. Game addiction is seen as wasting excessive time on activities that do not matter at the expense of alternative worthwhile pursuits, like work or education. Your boss might take a dim view of you playing games at work because fun is usually not associated with getting the job done.

2.2.2 GAMIFICATION TO THE RESCUE

Games, historically, can also have serious connotations including military war games and mathematical or economic game theory. Serious games are games that try to solve real-world problems. Gamification is a relatively new term highly related to serious games. The basic idea of gamification is to engage players and solve real-world problems using game mechanics [5]. Researchers in gamification are attempting to overcome the stigma that games, or at the very least, game mechanics, and work cannot overlap. Not only can they overlap, but the interplay between games and work can lead to more productive workers, more profitable businesses, and even be applied to solving large-scale problems such as the obesity epidemic.

In fact, gamification has been around for centuries and is ever-present in society today. Consider a common problem that parents face when attempting to feed an unwilling child vegetables. A typical solution to this problem is to pretend a spoonful of vegetables is actually an airplane coming in for a landing in the airstrip, which in this case is actually the child's mouth.

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By turning this real-world problem into a game, the child is actively engaged and enjoying the experience. To be truly effective, the child should also receive a small reward for accomplishing the task of eating vegetables. In that way, the child has been an active player in the vegetable eating game. He or she has acted as the landing strip, allowing the airplane safe passage, and for accomplishing this mission, the child is rewarded. In fact, the child not only learns to eat his or her vegetables, but this mixture of challenge, achievement, and reward has been shown to release dopamine in the brain, causing the child to want to play again in the future [5].

In another example, psychologist Mihaly Csikszentmihalyi describes a factory worker who turned his work into a game [6].

> "The task he has to perform on each unit that passes in front of his station should take forty-three seconds to perform -- the same exact operation almost six hundred times in a working day. Most people would grow tired of such work very soon. But Rico has been at his job for over five years, and he still enjoys it. The reason is that he approaches his task in the same way an Olympic athlete approaches his event: How can I beat my record?"

In doing this, Rico changes his attitude from work to play. This transformation of work into a game improved his performance as a worker; after five years of work, his time was down to twenty-eight seconds per unit [6].

Large-scale businesses also utilize gamification. One of the most prevalent examples of gamification in action in society comes in the form of loyalty programs. Common loyalty programs include buy-ten-get-one-free cards found in many retail stores and the frequent flier programs offered by many airlines.

Besides solving everyday problems and increasing business productivity, gamification is being used to solve serious scientific and world issues. For example, Foldit is an online puzzle game that allows players to fold proteins [8]. The solutions with the highest scores are analyzed

by researchers, which can lead to biological innovations and possibly targeting and eradicating diseases [8]. Already, there have been significant advances in science using Foldit [8]. As another example related to the theme of this thesis, as part of First Lady Michelle Obama's *Let's Move!* campaign to end childhood obesity, in the *Apps for Healthy Kids* competition, the USDA has challenged developers to create fun software tools to help children eat better and become more physically active [7].

2.2.3 WHAT IS A GAME?

These examples introduce a couple of important concepts. First, games are present everywhere in society. Also, games can take many forms; they are not always in the familiar form of video games. None of the examples are what one would think of when thinking of the term *game*; however, each of the examples presented utilize game mechanics. To give these examples context in how they relate to games, it is prudent to define the term *game* and understand what game mechanics are typically used in serious games.

In "The Art of Game Design: A Book of Lenses", Jesse Schell discusses the complexity and importance of defining the term *game* [6]. Schell defines game as, "A game is a problem-solving activity, approached with a playful attitude [6]." Now, it becomes apparent how the buy-ten-get-one-free-cards act as a game for a business. Businesses want to solve the problem of keeping and attaining new customers. By releasing a card that can be redeemed after the tenth purchase, the business is turning the customer into a player and the loyalty program becomes a system of rewards offered as part of the game.

To separate the term *serious game* from *game*, we note that the term *serious* typically refers to products used by industries such as defense, education, healthcare, politics, religion, and research [9]. Gamification can be applied to education or work to make the serious business of

acquiring knowledge or getting more things done better, faster, and/or cheaper seem more entertaining. Since gamification can be applied to almost any business model, serious or not, for this thesis, we restrict our concern of gamification to the solving of serious issues. In particular, we are focused on gamification of education and behavior change related to the serious world issue of childhood obesity.

2.2.4 GAMIFICATION OF EDUCATION

Using computing to deliver education has a long history. The computer aided instruction (CAI) programs on the 1970s and 1980s pioneered rote learning and record keeping but were not arguably entertaining.

Edutainment games, games that mix entertainment and education, including *The Oregon Trail*, *Reader Rabbit*, *Math Blaster*, and *Where in the World Is Carmen Sandiego?*, were introduced into classrooms in the 1980s and reached their height of popularity in the 1990s. *Carmen Sandiego* was the last great edutainment blockbuster game [5]. It has been two decades since that time. What happened to the edutainment industry? At the time these games were being developed, the budget for edutainment games was nearly the same as entertainment games, which is why blockbuster games could be created [17]. But a chain reaction in price slashing resulted in educational software selling for prices only 10% of what it had originally cost, devastating the industry [17].

Since that time, games like *SimCity* and *Civilization* have successfully mixed education and gaming but with the emphasis on fun. In *SimCity* players are tasked with creating and managing a city, including placing residential, commercial, and industrial buildings, placing roads and railways, managing an electrical grid, and dealing with natural disasters. *Civilization* has players develop empires throughout different ages, from an ancient era to future times; the

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primary tasks in the game involve exploration, diplomacy, and warfare [18]. The lesson to learn is that gamification must be approached with a fun-first attitude where education is merely a byproduct of fun.

Mixing education and fun can work. Third grade elementary teacher Ananth Pai recently introduced games in the classroom as a way of individualizing learning [19]. Pai focuses on helping students understand broad concepts, while he uses games to provide a method of learning skills that adhere to an individual student's needs [19]. According to researcher David Heistad, Pai's students are earning scores that show very high growth [19].

2.2.5 EDUCATION INTEGRATION FRAMEWORKS

As far as extensible education frameworks are concerned, Khan Academy contributes an interesting case study. Available free of charge, Khan Academy is a not-for-profit organization "with the goal of changing education for the better by providing a free world-class education for anyone anywhere [30]." The Khan Academy framework is interesting because it provides an organized way to cover a curriculum with more additions all the time [32]. Khan Academy organized learning modules in areas like mathematics, starting with elementary concepts and moving through calculus. Students learn at their own pace. Third parties can develop and contribute new modules.

Many universities use Blackboard as a Learning Management System (LMS) for homework submissions, delivering notes, and grade tracking. Unlike Khan Academy, though, Blackboard does not provide content. In a similar way, the Sharable Content Object Reference Model (SCORM) is an e-learning framework [33]. It is a group of technical standards used to help programmers communicate between different e-learning programs. Explicitly, SCORM manages communication between online learning content and Learning Management Systems

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(LMS), including the popular Blackboard environment.   Because it is the "de facto industry standard for e-learning interoperability," in our future work, we will be well-advised to take advantage of SCORM's protocols [33].   For instance, since schools can use SCORM for grade management, scores from a physical education teacher would only have to be entered once, in the online grade book, instead of twice, one in the grade book and once in the game.

2.2.6 GAMIFICATION OF HEALTH AND FITNESS

Another form of education would be to incorporate reminders and knowledge into everyday activities, in short, to gamify knowledge acquisition and behavior change.   Incorporating exercise in a fun manner is an excellent way of enticing a child into participating (physical games).   Adding monitors to measure progress, like scales that measure weight and Fitbits that measure physical activity, provide ways to measure progress over time.   Many software and hardware developers are taking advantage of new technologies such as motion detection, GPS, smart phones, and tablets to provide fun and innovative ways for people to exercise and new ways of both tracking what they eat and giving advice on what to eat in order to live a healthy lifestyle.

Appendix A provides an extensive list of health monitors, applications, and health and fitness games.   As an example, Fitbit health monitors [31] are physical devices worn by users that allow activity such as steps, distance, Calories, and sleep patterns to be tracked.   Along with these abilities, Fitbit claims to make fitness fun by encouraging users to set daily goals, earn badges, and challenge friends to get involved [31].   As a part of the Fitbit suite, the devices also combine with mobile and online applications that feature the ability to log food intake to help improve nutrition and the ability to see real-time progress on charts and graphs [31].   There is also a separate Wi-Fi scale available that automatically uploads weight, body fat

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percentage, and body mass index (BMI) to a user's account [31].   Fitbit employs gamification through the use of badges.   Some badges that can be earned are -25 lbs. for losing twenty-five pounds of weight, Astronaut for climbing 28,000 floors, and 25,000 steps for walking 25,000 steps in a day [31].

Gamification is being used successfully to manage serious health problems.   For example, the work of Nicholas Graham involves a topic coined as exergames, which are games that require the player to exercise [30].   Children with cerebral palsy have shown a significant loss of motor function as they age due to poor physical fitness and disuse of muscles [30].   Traditional guidelines when it comes to developing games for people with motor disabilities include the recommendation to keep game pace slow [30].   However, Graham's research has shown that high-paced action games can be both playable and enjoyable to children with cerebral palsy [30]. Like our project, Graham has created a suite of mini-games that also contain a central hub for communication [30].

2.3 GAME MECHANICS

As stated before, gamification uses game mechanics to solve real-world problems.   The identification of game mechanics typically used in games provides a path to understanding how to gamify serious applications like work and education.

A game consists of four primary elements: story, aesthetics, technology and mechanics [6]. Profitable games tend to have an intricate story woven with beautiful landscapes for the player to enjoy.   To add to the experience, which is geared only toward entertaining the player, the latest technologically advanced graphics, game, and physics engines are employed.   Serious games have more goals than just entertaining the player, including solving real-world problems. Though serious games may utilize the same complex stories, beautiful scenes, and

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technologically advanced engines as entertainment games, in general there is less budget to do so. To make use of the aesthetics and stories of large games, hundreds of artists and writers would have to be employed. This would mean that splitting a budget between research in solving a serious issue and providing an aesthetically pleasing game would be heavily weighted toward aesthetics, which is not a desirable outcome when attempting to solve a serious issue. Thus, serious games tend to use a simpler, if not non-existent, story along with a different set of aesthetics. In addition, they may utilize the same game engine as entertainment games but do not require the latest advancements in graphics. Serious games primarily borrow mechanics from games. Game mechanics are the rules of the game and the procedures involved in the game [6]. The most common game mechanic elements used in gamification are reward systems, points, levels, leaderboards, badges, quests, social engagement loops, customization, and dashboards [5].

2.3.1 REWARD SYSTEMS

Reward systems make use of multiple game mechanics in order to entice players to continue playing a game. We shall examine the most popular reward system used in gamification, SAPS. SAPS is a reward system made popular by Gabe Zichermann, author and chair of the Gamification Summit. SAPS stands for status, access, power, and stuff [12]. It is used to summarize what motivates people in game-like circumstances in the order that they value these rewards. According to Zichermann, status is the most important of these rewards, and stuff is the least important. Status is the position of a player versus other players within a gamified system. For instance, a player achieving the rank of Master Commentator would have a higher status than that of a New Commentator. Access can be distributed in many ways, but it usually describes earlier access to items or admittance to parts of a system that not everyone can access.

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Lunch with a CEO is a way of granting access, for example [5]. First-class seating in an airplane is another example of granting access. Power can be awarded in the form of forum or chat room moderators. Counterintuitively, giving stuff to players is considered the least valuable reward. There are several drawback to giving away merchandise: It can be expensive; it may look cheap to players; and virtual items can motivate just as well as small dollar rewards [13].

2.3.2 POINTS

There are many types of point systems used in gamification. Some important point systems described below are experience points, redeemable points, skill points, karma points, and reputation points [5].

Experience points (XP) are arguably the most important of these systems [5]. These are points that only accumulate; they should not go down and are typically not redeemable. In some systems, they can, however, expire. In Best Buy's Reward Zone© program, customers that earn a certain number of points are moved up in level to a Premiere Silver account [10]. Points can expire, and to reach Premiere Silver status again, users will have to accumulate points again each calendar year. Premiere Silver accounts provide better Reward Zone© benefits, earns more points per purchase, grant free expedited shipping, and a better return policy [10]. In a well-gamified system, experience points will be gained for everything done in the system, and activities that are more important should be weighted more heavily to earn more XP.

Redeemable points are also known as a virtual economy. As the name implies, these points can be redeemed for goods, either virtual items or real. eBay uses a virtual currency known as eBay Bucks. Most purchases on eBay earn eBay Bucks, and these are distributed electronically in the form of an online coupon code every calendar quarter [11]. eBay Bucks can then be

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redeemed for any item on the auction site.   Virtual economies typically fluctuate much like a real economy.   The price of items go down when supply increases and demand is unchanged; down when supply is unchanged and demand decreases; up when supply remains the same and demand increases; and up when supply decreases and demand remains the same.

Skill points are typically found in video games, especially role playing games (RPGs).   In a role playing game, skills could include statistics such as strength, dexterity, and intelligence. These are points earned over time, much like experience and redeemable points, but they are typically linked to certain activities within a gamified system.   In gamification, for instance, skill points could be used to denote players more experienced at a certain activity, like a player who comments well and often.   Each level of the skill could be given a name, such as Master Commenter, and this would preferably be shown publically so that the player is shown to have attained a high status within the system, the most valuable of the SAPS rewards.

Karma points cannot be spent by the player who obtains them.   They can only be given away to other players.   These types of points can be good to enhance the social network and player connectivity aspects of the system, giving players a sense of closeness to other players within the system when, in the real world, they may be thousands of miles away.

Reputation points are points usually granted to players by other players in order to establish how well trusted that player is within the system.   For instance, eBay uses reputation points to allow users to rate how well sellers match items to their descriptions, how fast they shipped the item, how much they charged for shipping, and how well they communicated to the buyer if there was any communication.   Other eBay users see these numbers and decide, based on the seller's reputation points, whether they want to purchase from this seller.

2.3.3 LEVELS

Aside from point systems, levels are another game mechanic typically used by gamification. Levels indicate progress in the game. In the university game, students may progress from Bachelor's to Master's and on to PhD level. Military rank, business salary or position in an organization chart, and credit card gold or platinum memberships are other examples.

2.3.4 LEADERBOARDS

Leaderboards are both a way of awarding status to a player and a way to incorporate competition into a gamification system. A leaderboard is an ordered list containing names and scores arranged from highest to lowest score. Leaderboards have been popular since arcade games of the 1980s, but they have undergone many improvements since those days. Arcade games would simply show a small list of the top three, five, or ten players along with their scores. However, this means that only a few of the many players could ever be on the leaderboard at any given time. Advances in leaderboards have allowed all players of a game to be on a leaderboard. For instance, when viewing a leaderboard, a player could see themself directly in the middle of the board, seeing players with slightly higher scores directly above the player's score and players with slightly lower scores directly below [5]. There are still options to view the top ranking players, but the default view is often to place the player in the middle. Other leaderboard advancements include multiple views, grouping players by geographical location, by the groups in which they belong, or by their friends within the game [5]. Despite their simplicity, leaderboards are an essential part of a game because they grant an important reward to players, status.

2.3.5 BADGES

Status can also be granted to players through the use of badges. Badges consist of an image along with a name of the badge. They can be given as rewards for accomplishing missions, challenges, or quests within a game. These can be straight-forward, given out for simple quests as logging in daily or purchasing an item. However, to add a sense of surprise and pleasure, badges can be more obscure. The highly popular location-based social network, Foursquare, uses unique badges that are not always obvious to the player. For instance, checking into a gym ten or more times within thirty days will earn a user the Gym Rat badge, and checking into a venue after 3am on a Monday, Tuesday, or Wednesday will earn players the School Night badge [14]. Some people may already have experienced the concept of badges in early life. Members of the Boy Scouts of America, for instance, can earn merit badges for over 130 different accomplishments [14].

2.3.6 QUESTS AND CHALLENGES

Another commonly utilized game mechanic, quests and challenges, are synonyms, but because both terms are used frequently in gamification, the mechanic is presented here with both common names. Quests and challenges give players direction within a gamified system [5]. Quests are tasks that players must undertake in order to receive a reward. Without quests, a gamification system may lack structure. Players could be presented with a large gamification system but have no real direction for what goals to accomplish or what to do within it. Granting badges for accomplishing tasks is a way of integrating challenges in a gamification system, as is incorporating a system of levels for completing tasks. Quests may be single-player or cooperative, but cooperative quests are difficult to implement because they require many players to be in one place within the system simultaneously. The advantage of incorporating

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cooperative challenges is a notable improvement in the social network, keeping players connected within the game and increasing pressure to return to the system so as to not disappoint other players. Creating a diverse quest creation system that allows for creating single-player or cooperative challenges would be ideal because a gamification system could focus on single-player tasks in the beginning, and as the system becomes more popular, cooperative quests could then be easily added.

2.3.7 SOCIAL ENGAGEMENT LOOPS

Points, levels, leaderboards, badges, and quests all give players fun things to do while in a gamification system, but what keeps players coming back? A social-engagement loop can make use of these mechanics to keep players engaged, enticing them to come back and play again, and encouraging new players to join the game. The social-engagement loop consists of four elements: a motivating emotion leads to a social call to action, which leads to player re-engagement, which leads to visible progress and rewards, which, in turn, leads back to a motivating emotion [5]. For a general example of a social-engagement loop, consider the following. A player notices there are unlockable items in the game. The player wishes to obtain these items; this becomes the motivating emotion. To unlock the items, it is required that the user perform some sort of social task, such as completing a cooperative quest, sharing a request or status on a social networking website such as Facebook or Twitter, or competing against other players. This re-engages the player to use the system to complete the task in order to obtain the unlockable items. It has the added benefit of bringing other players into the game, either re-engaging players that have used the system before or adding new players to the game. By completing the task, the player receives a visible reward, in the form of the unlockable item that the player was originally motivated to obtain. Once the item has been obtained, the player

may notice there are more unlockable items, leading back to the motivating emotion to keep playing the game. The social engagement loop is an important mechanic when developing a gamification system because a well-designed social engagement loop can keep players active and bring more players into the game.

2.3.8 CUSTOMIZATION

There are two contrasting philosophies concerning customization. Some businesses believe that simple customization is all that is necessary because too many options can lead to customer dissatisfaction; other businesses believe the opposite. For instance, Apple products tend to have limited options, e.g., the iPod has only a few color options. In contrast, Dell offers the user many ways to customize their products. Research by psychologist Barry Schwartz in his paper "The Tyranny of Choice" reports that people feel satisfied the higher the number of choices, but only up to a point [16]. When that point is reached, satisfaction quickly declines as the number choices presented increases. Dr. Schwartz does not quantify that point, but the key idea to keep in mind when creating a gamification system is that customization is necessary for player satisfaction, but do not overwhelm players with too many options.

2.3.9 DASHBOARDS

Unlike the rest of the game mechanics used in a gamification system, dashboards are for the designer instead of the player. They are tools that provide an analysis of everything players do within the system. It is important for designers to know how the players are using the system in order to make improvements to the system, and dashboards provide designers with a central location to view this data. Dashboards can be used to analyze the economy to find out if some players are buying more of certain items than others or if some items are never being bought. They can be used to determine at what level most players reside, whether there are some levels

that have not been obtained, and how difficult it is to reach each level. In the same way, dashboards can be used to examine the system of badges. Quests can also be analyzed using dashboards by determining which tasks players prefer completing and if some tasks are being skipped completely by most players. By analyzing dashboard data, designers can take appropriate measures to improve each aspect of the system.

CHAPTER 3 - DESIGN

3.1 ITERATIVE DESIGN PROCESS

3.1.1 INITIAL CONCEPT AND DEFECTS IDENTIFIED

As briefly described in Chapter 1, our computing team was initially approached by an interdisciplinary group of faculty nursing, education, and kinesiology with the idea of creating a single game in the area of nutrition or fitness for elementary school students. The set of requirements we were presented was small: create a fun game in those areas; target elementary school students; make the game available in both Spanish and English; and ensure that the game could played in a school-based computer lab. After several weekly brainstorming and discussion meetings, we realized several defects with the original set of requirements.

The first issue was with the word "fun". Is one single genre is fun to every player: an action-adventure game, a role-playing game, or a puzzle game, for instance? If every person liked to play the same type of game, there would only be a need to create one game to please the entire world, which is not the case. Furthermore, games that appeal to females may not appeal to males. Games that appeal to one ethnic group might not appeal to another, and of course, even students who belong to the same sex, race, or ethnic group will not all like the same types of games. How could we create one game that could please all the children expected to play the game? The simple answer is that we could not.

A single game has further issues. Once a single game is created, there is little room for improvement. Though there can be some additions and modifications made to the game post-production, the core of a game remains primarily concrete once it has been created. Therefore, if the core of the game was disliked by either the interdisciplinary team or the students, there would be no way to fix the issues other than to start over from the beginning, which is not a

desirable outcome after several years of work have been put into developing the game.

Another issue with the creation of a single game is that the area of domain-knowledge coverage will be small in one game. The areas of nutrition and fitness are very broad. There is much that students can learn in these areas. With a single game, however, there is a good chance that only a sliver of knowledge from these areas will be covered. Which pieces of information should be chosen if that is the case? It can be argued that every part of nutrition and fitness knowledge is important to provide a complete picture to those wanting to improve their health. Not only that, but nutrition and fitness, though highly important to combine, are distinct areas. If we could not create a single game that would promote good nutrition while also encouraging exercise, the game would be considered a failure.

3.1.2 IMPROVED APPROACH AND REQUIREMENTS IDENTIFIED

After further consideration, it made more sense to create a suite of mini-games rather than one large game. A suite of games is not a binary all-or-nothing approach; individual games can be added, removed, or improved without affecting the overall gamification architecture. In addition, because games must appeal to all children in the age group regardless of sex, race, ethnicity, or grade point average, having a variety of types of mini-games is a better approach than creating one game that belongs in one genre which may only appeal to a select few students. This modular approach to the project also allows for a much larger coverage of nutrition and fitness since individual games cover just a part of the domain, and also modular games allow the possibility for easily expanding to include more games in the future, including those from third-party developers.

Once we had decided to create a suite of modular mini-games, we identified other requirements. For instance, the games should all utilize the same architectural framework.

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This has the advantage of using common functions for logging in users, internationalization, and tracking user progress. Also, since this is a suite of games, a gamification framework seemed ideal to connect the games. In that way, children could earn coins for playing games, which could then be spent in a central location that allows children to connect with one another, creating the possibility of a social network of gamers, which might be used to reinforce learning through support by various kinds of groups (e.g., family, peers, teachers, health professionals). As exemplified in Chapter 2, this system of learning from a game while earning rewards can entice players to keep playing the games, as does the variety of games itself.

While developing our more extensive, explicit list of requirements, more issues arose. For instance, we were initially under the assumption that games would be played at school. Then, there was talk of including parents at home to play alongside their children so that entire families could change their behaviors, and students could play longer than a few times a week. Also, due to regulatory issues, a time limit of fifteen minutes of game play was imposed, which lent even more credence to the idea of a suite of smaller games. This brought up the consideration of what type of delivery device would be best for students, such as iPod, personal computer, or Android smart phone, or a combination of the above.

After much deliberation, we had broadened our final list of requirements to the following. There would be a central cloud-based gamification framework for which all first and third-party games could connect. In addition to the game mechanics discussed, such as leaderboards and points, the gamification framework must be capable of internationalization. Also, the framework must contain a dashboard that allows the addition, modification, and removal of players and a way of viewing player progress. Because data provided by this dashboard can potentially expose user information, roles need to be defined that grant access only to data that is

necessary for the defined roles.   Indeed, security and privacy must be of primary concern; malicious parties should not be able to connect to the framework, and games should not unnecessarily have access to private user information such as user passwords.   To facilitate connection to the framework, the creation of a common, secure plugin game API is needed.

In addition to the gamification framework, an initial set of games must be developed.   Each game comes with their own set of requirements.   Taken as a whole, the games should provide a large coverage of nutrition and exercise knowledge.   There should also be metrics added to each game to provide a way to track player progress.   Because each game is unique, there may be different ways of viewing progress for each game, and so, each game may provide its own set of measurable progress.   Finally, each game should be extensible, providing the capability of further additions to the games or possible removals from the games.

There was one final requirement in addition to the gamification framework and games. Since players earn coins when playing the games, there should be a way to spend this currency. There are many unique ways of fulfilling this requirement.   Therefore, the requirement was left opaque, allowing for one of a multitude of methods to meet it.

The requirements are summarized below:

- *Domain coverage* – Each mini-game covers a portion of the knowledge or behavior of the target domain.   The covered knowledge is explicitly identified so game developers design for coverage.

- *Extensibility/scalability* – Mini-games can be replaced, removed, or improved with the possibility of third-party contributions.

- *User diversity* – The mini-games can meet the needs of a diverse population including students with varied capabilities, education, age, culture, and language.

- *Measurability/metrics* – The mini-games can measure progress.

- *Security/privacy* – The framework provides a way for games to securely connect to the framework, transmit data to the framework, and access user credentials from the framework. In addition, metrics visibility are kept private, giving access only to defined roles with privileges granted.

- *Social networking* – Students can cooperate or compete individually or on teams toward goals.

With our more complete list of requirements, it was now time to create the gamification framework, plug-in game API, and an initial set of mini-games.

3.2 EDUFITMENT ARCHITECTURAL FRAMEWORK

3.2.1 EDUFITMENT WEBSITE

A server-based website is used to host the game framework, which is available online at *www.edufitment.com*. The name "edufitment" was chosen for the framework as a combination of education, fitness, and entertainment. The interested reader may want to login with username "demo" for English language content, "demode" for German, "demoes" for Spanish, or "demofr" for French along with password "demopass". The website contains a short description of purpose and then a sequence of frames, one per game, as shown in Figure 1 below.

The website is cloud-based in that information for a given user is stored on the web server's database. This makes the information available to the same user logging in from different devices and also to other parties who may have access to the users' shared data.

Figure 1 - Edufitment Homepage

3.2.2 EDUFITMENT FRAMEWORK IMPLEMENTATION

The edufitment framework is complex. For instance, each initial mini-game involves different architectures, or, at the very least, different ways of utilizing the architectures involved. Connecting the mini-games, the overarching framework model also employs a separate set of technologies.

The edufitment framework is comprised of several technologies, including HTML5, CSS, PHP, JavaScript, and MySQL. The website, edufitment.com, was developed using HTML5 for displaying content and CSS for styling content. PHP was used for many purposes, including defining role permissions, allowing dynamic content to be displayed, interacting with the MySQL database, maintaining user login status, internationalization of the website and games, developing the plugin game API, and managing user accounts. JavaScript was used to display the games on the home page and to facilitate closing game windows when a player quits the game.

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3.2.3 EDUFITMENT FRAMEWORK DATABASE DESIGN

The MySQL database consists of five primary tables and several tables specific to first-party games.   The five primary tables are currency, users, ISO639, game_statistics, and games.

The currency table provides for inflation and deflation of the in-game economy.   In it is stored the current global game score-to-coin conversion.   Games in the edufitment framework award scores to players.   These are then converted to coins by determining both the global score-to-coin conversion stored in the currency table and calculating the local game score-to-coin conversion stored in the games table.   The currency table is primarily used for inflation and deflation of the economy; however, each game has the potential to earn wildly different scores. For instance, one game may have an average score for one round of play of 10000, whereas another game may have an average score per game play of 100.   To help balance the games so that each produces roughly the same amount of coins based on the difficulty level of the game and how easily points are awarded, an extra column exists in the games table that determines the local game score-to-coin conversion.   This, used in conjunction with the currency table allows for fluctuation in the economy and helps to balance the amount of coins earned from playing games.

The users table stores all user account information.   This information consists of a first name, family name, nickname, gender, role, language preference, system of units preference, username, password, and the group to which the user belongs, if any.   Usernames must be unique, but two users may share the same nickname.   Seven roles were built into the system, which will be detailed later in this section.   The system of units currently accepted are the International System of Units (SI) and Imperial Units.   Language preference can be set to any of the currently supported languages, which shall also be explained later in this section.

The ISO639 table is tied to internationalization of the framework. ISO 639 defines a list of language codes and the English name of the language. For instance, the language Spanish has the two-digit language code "es" as defined by ISO 639-1. Unfortunately, there was not a readily available standard list of two-digit language codes along with their native language name. Had this list existed, instead of Spanish, Español would have the two-digit language code "es". It is unfortunate that this list either could not be located or does not exist because a user seeing his or her native language would be more clear for users of non-English languages than seeing an English translation of their language name. For example, there is an option to set user language preference on the edufitment.com website. However, every language name in the selection box is in English, and this is the only internationalization not provided on the website.

Besides the currency, users, and ISO639 tables, the games and game_statistics tables are used for first and third-party games. The games table is used to store player game scores, and it also contains information about a game. Information about the games stored in the games table includes the name of the game, the game's password, the type of coin that playing the game will award players, and the maximum daily coins allowed.

The game_statistics table is very generic in order to allow a large variety of options. It merely contains the name of the game, an entry date, an entry, an amount, an optional unit, and the id of the user that played the game. An example usage of this--taken from the Quiz Show game which will be described in section 3.3 of this chapter--is to store the number of questions answered correctly in a single play-through. Sample data for that entry in the game_statistics table may resemble the following: entryDate: 2013-05-27, entry: Questions_Answered_Correctly, amount: 26.

3.2.4 GAME MECHANICS

Customized Settings

The above technologies all describe how edufitment was implemented. However, it is also important to note how the website can be used from a high-level standpoint. Because there are several different roles within the system, all with different sets of permissions, we shall take a simple example and describe how the lowest level of granted permissions, the Player role, may use the website. Before a player logs in, the homepage displays a header containing navigation, body content, and a footer containing a copyright notice and the current date. If the player's web browser language settings are set to one of the four currently translated languages, the player will see all of this information in that language. For instance, if the player's web browser is set to Spanish, the player will automatically see web content in Spanish. The navigation contained in the header includes a small dot icon that, when clicked, takes the user back to the home page, a list of approved third-party games, and a login button. The body content of the website displays general information about the website and information about each mini-game included in the website, along with screen shots of each game.

Once the player has logged in, the language of the website changes to the player's current language preference. This can be set from the settings section of the website, which now becomes accessible from a link contained in the footer of the homepage. Other features of the settings section include the ability to change the player's first name, family name, nickname, gender, or system of units preference. The player may also change his or her password from a link located on the footer of the settings page. Aside from the settings link on the footer of the home page, the player's current NutriCoins and ExerCoins are prominently displayed prominently alongside the player's nickname and role. The content of the website has also

changed since logging into the site.   The main body of the website contains, in addition to information about the games, leaderboards displaying game statistics and links to play the games. The header navigation has also changed to contain additional links to the games and a link to a chat room where the player may spend coins to chat with other players in the framework.

Economy, Metrics, and Points

Aside from describing the technologies used in developing edufitment and exemplifying a high-level view of the website, a detailed examination of the gamification framework would not be complete without explaining how edufitment utilizes the game mechanics commonly employed by gamification systems, as described in Chapter 2.   Edufitment makes use of several game mechanics.   The first and most pronounced of these mechanics is the use of an in-game economy.   Each game awards points which are then converted to one of two currencies: ExerCoins or NutriCoins.   NutriCoins are granted by playing games with a focus on nutrition knowledge; however, there may also be a focus on exercise knowledge in these games.   More precisely, ExerCoins are granted only by games that require the player to physically exercise. This dual currency opens the possibility of creating unlockable items which require either of ExerCoins or NutriCoins to purchase.   Purchased items may also require a combination of both currencies, meaning that the player would have had to participated in both nutrition games and exergames in order to purchase these items.   Because there was only a single initial game that required exercise, the use of ExerCoins was left to future work but would be a simple matter to implement when additional exercise games have been added to the framework.   The initial method developed in which NutriCoins may be spent is on sending messages in a chat room where members of edufitment may connect.   This meta game will be described later in this chapter, but it is important to note that there are many viable methods in which the spending of

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coins can be developed.

Besides the redeemable points in the form of a dual currency, experience points were also utilized within the gamification framework. These points also rely on the cumulative amount of ExerCoins and NutriCoins garnered by players. Currently, the experience points are used to track user progress within the games, and they form the basis of the coin statistics leaderboard, which leads to the next game mechanic implemented in the edufitment framework.

Leaderboards and Game Statistics Boards

The next mechanic edufitment takes advantage of is the use of leaderboards. These are displayed prominently on the homepage of edufitment.com after a user logs into the site, and they are also located on each game's website. Several leaderboards were created, and there is at least one leaderboard for each game developed. Because the leaderboards are displayed alongside game statistic boards, these shall be discussed in tandem. For the framework as a whole, there is a coin statistics leaderboard. This board displays the overall accumulated ExerCoins and NutriCoins and the total coins accumulated by the logged in player or student. The coin statistics leaderboard is also sliced by top students (or player, depending on the logged in role), by top students within the group in which the student belongs, and by top student groups. Thus, the top overall students are displayed, the top student groups are displayed, and the top students within the logged in student's group is displayed. By separating the top students from the top groups, competition can be fostered both within a school and between schools. This same slicing of leaderboards is used for each leaderboard in the edufitment framework. A currently logged in student's score is also displayed below each leaderboard so that a student can see how his or her score matches up to the top overall students and top students within the school.

By displaying different slices of the leaderboard, edufitment takes advantage of one of the advances made in leaderboards since 1980s arcade days. Each game also provides its own leaderboard, using the same slicing schema as the coin statistics leaderboard: top users overall, top user groups, and top users within a group. The statistics for each game also utilize the same slicing as the leaderboards. The game statistics employed by each game, however, is unique and displayed alongside the leaderboards. These will be described in the mini-games section of this chapter, but to mention an example, the Quiz Show game provides the interesting statistic "Most Difficult Category", which is calculated based on the number of questions answered incorrectly in a category. This statistic can help teachers and students alike determine which area may require the most attention in order to improve the students' knowledge sets.

Quests

Unlike the prominent dual currency and leaderboards, quests are not explicitly implemented by the gamification framework; however, there is a way of utilizing quests with edufitment. Quests may become daily or weekly assignments given out by teachers. For instance, teachers could ask students to play certain games in order to accomplish the tasks for the day or week. A quest system would not be entirely difficult to implement in the framework in the future. To give instructors more control over which tasks they feel are essential for students, in the beginning stages of this framework, it was decided that a questing system should be saved for later work.

Dashboard

The last of the game mechanics implemented, a dashboard is used to display user progress and also grants the ability to modify user accounts. In the dashboard, each role has different permissions. For instance, teachers can view every student at the school but cannot view

information about students at other schools.   The dashboard contains features for adding users, removing users, resetting user passwords, and editing user information such as the user's first name, family name, and nickname.   In addition to modifying users, progress can be seen in the form of current NutriCoins, current ExerCoins, cumulative NutriCoins, and cumulative ExerCoins.   The amount of NutriCoins and ExerCoins a user has cannot be modified by anyone other than an administrator, as this would allow the economy to be easily circumvented, and the competitive features implemented within and between groups would cease to function.

3.2.5 OTHER FEATURES

Beyond the game mechanics employed by edufitment, the gamification framework provides several additional features.   Edufitment defines several roles, each with a different set of permissions.   There were also several security measures taken in order to prevent malicious attempts to gain access to user data.   Multilingual capabilities are built into the framework, as well, so that users whose first language is not English may still use edufitment.   The edufitment framework also provides an API for use with first and third-party games in order for these games to gain access to certain aspects of user data and submit game scores, which are then converted to coins.   Finally, a chat room was created so that users in the game may spend their hard-earned coins.

<u>Roles</u>

We begin with a discussion of the roles defined by the gamification framework.   For added security, not everyone may use the edufitment framework.   Instead, edufitment utilizes seven roles: Administrators, Developers, Healthcare Administrators, School Administrators, Teachers, Students, and Players.   Administrators are the highest level role, and as such, have the most permissions.   Administrators can add, remove, and modify any type of user, regardless of the

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user's role. Administrators are also capable of adding, removing, or modifying game content, such as adding extra questions or categories to the Quiz Show game. Administrators are the only role capable of approving third-party games and adding them to the framework. Administrators are also the only role that has the ability to modify the ExerCoin and NutriCoin amount for users. This feature was added in case of emergencies such as server failures or malicious parties that have managed to gain access to a user's account.

Developers have the ability to add, remove, or modify other Developer accounts. They may also extend, modify, or remove game content. Healthcare Administrators have the ability to add, remove, or modify other Healthcare Administrators, School Administrators belonging to any group, Teachers belonging to any group, Students belonging to any group, and Players. The Healthcare Administrator accounts were added as a supervisor role for all schools and represent the multidisciplinary team that originally approached us with the idea of creating a game. Healthcare Administrators may also add, remove, or modify game content.

The remaining roles are School Administrators, Teachers, Students, and Players. School Administrators, such as school principals, may add, remove, or modify other School Administrators, Teachers, and Students, so long as they are within the same group (school). They may also add, remove, or modify Players. Teachers may add, remove, or modify other Teachers and Students so long as they belong to the same group. They may also add, remove, or modify Players. Students, as well as Players and every other role, may play games, earn ExerCoins and NutriCoins, and spend their earned coins. Every role is capable of changing his or her own settings, such as the user's password, nickname, system of units, language preference, and/or gender.

Players are the last role to be discussed. Players have the same access as the Student role.

Initially, the Player role was created in order for School and Healthcare Administrators to add people that may be interested in joining in on the fun of the gamification framework but that are either older or are not a student of the administrator's school. Therefore, initially a member of the Player role was simply a Student who did not belong to a group. The Player role, however, has the most potential to expand as the system becomes more popular. When that occurs, it would be beneficial for Players to be able to join groups of friends and create their own Player groups. Then, as the framework expands, this role may be changed, potentially removing modification permissions of this role from School Administrators, Healthcare Administrators, and Teachers and treating this role as part of the general public instead of simply a Student who does not belong to a group.

Security and Access Control

The defined roles provide an aspect of security to the edufitment framework. Each of the roles has a separate and unequal set of permissions. Only certain roles can access user information, and the core roles, Students and Players, are limited to accessing only information about their own accounts. Aside from the various roles and permission sets, security measures were taken to prevent malicious parties from accessing user data. The framework model provides an external application programming interface (API) for first and third-parties to use. One of the features provided by the API, checking a user's credentials, enables the potential for malicious access to user data. Another of the API's features, inserting a user's score, could potentially circumvent the economy if no security measures were in place. For instance, if there were no security measures provided, a game could insert a score over and over again, making the ExerCoin and NutriCoin currencies worthless. More important, however, is the fact that a user's credentials could be obtained without requisite security measures to prevent malicious use.

Therefore, a security measure was implemented which requires games that connect to the API to submit a game name and password before any user data may be accessed. Each game has a unique name and password entry (stored as a one-way md5 hash) in the MySQL database. Thus, only approved games may access the API. Part of the approval process for third-party games is for this unique game name and password to be assigned and added to the games table in the database. The game password may be changed by Administrators and Developers only. Another measure that was taken was to display a list of approved third-party games on the website. This can prevent a user from being fooled by a malicious application into entering their credentials. Though these are excellent measures, there are more measures that may be taken in the future to prevent other types of attacks, such as brute force attacks or attacks by malicious users who attempt to access a high-level role that may have forgotten to log out of the system. These extra security measures will be described in Chapter 5 in the section on future work.

Internationalization

Another feature considered to be highly important during the creation process of edufitment was internationalization. The capability of translating games and the edufitment.com website to multiple languages is built directly into the framework itself. This makes the games easily expandable to a very large user base. To facilitate this feature, a file containing a list of string variables (text holders) was created. To add another language, this file would merely need to be translated and saved as the ISO 639-1 two-letter language code with a .php extension. For example, the English language file is stored as en.php. Edufitment is already available in four languages: German, English, Spanish, and French. Each role may change his or her language preference in the settings section of the website. The list of languages from which users may

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choose his or her preference is automatically updated as soon as a new language file is created. Additionally, multiple language capabilities are also available when a user is not logged in. When anyone who is not logged in visits the edufitment.com website, the framework checks to see which language the user's web browser is set to and automatically displays content in that language, so long as the Internet browser language preference is set to one of the translated languages. The user does not even need to select a country or language of origin for the translation to take place. Multilingual capabilities are available to first and third-party games as part of the plugin game API, as well. Games merely need to retrieve a list of strings used in-game from the API to enable extending to more languages.

3.2.6 SUMMARY OF THE EDUFITMENT ARCHITECTURAL FRAMEWORK

As described in the preceding paragraphs, edufitment is a complex gamification framework that utilizes many current technologies such as PHP, MySQL, and HTML5. Edufitment takes advantage of features common to gamification frameworks such as redeemable and experience points in the form of ExerCoins and NutriCoins, leaderboards, and dashboards. Additionally, edufitment includes several roles, each with its own set of permissions. Several security measures were taken to limit access to user data only when necessary and to prevent malicious parties from circumventing the gamification system. Multilingual capabilities are built directly into edufitment, easily extending games and the edufitment.com website to more languages than the initial four provided. Finally, as an extension of edufitment, a plugin game Application Programming Interface is provided for games to take advantage of the gamification framework. There has already been some discussion of the security measures, multilingual capabilities, and features provided by the game plugin API. Next, we will take a further look at the way games connect to the framework using the API.

3.3 PLUGIN GAME API

The plugin game Application Programming Interface (API) is an online extension to the edufitment framework that provides four useful features for first and third-party games.

First, it provides a method to check user credentials in order to associate a round of game play with a particular user. To use this and all other features of the API, each game is assigned a unique game name and password. In order to check for a correct user name and password provided by a player, games must submit the game's credentials, along with the player's credentials to the framework API. The game name and password are checked before the user credentials are accessed by the API. Thus, if the game name or password provided to the plugin game API is incorrect, the game would have no way of knowing if, additionally, the user's credentials were submitted incorrectly. This provides a secure manner to protect a user's private information from being access by malicious parties. Once the game's credentials and user's credentials are correctly submitted, the user's nickname is sent back to the game so that the game may refer to the user by his or her nickname instead of username when playing the game.

The next feature provided by the API is the ability to add a player's score, which is then converted to either ExerCoins or NutriCoins, to the games table in the MySQL database. As mentioned, in order to access any feature, the game's credentials must be correctly supplied to the API. Once that is submitted, the user's score and time stamp for that round of game play are added to the database.

The game plugin API also gives games the ability to insert game statistics into the database. Game statistics are unique to the game and may be anything the game wishes to track. For instance, the Food Group Match Up game tracks both the percent of correct and the percent of

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incorrect matches made by players.

The final feature granted by the API is the ability to retrieve language translations for the game. In order to work properly, these translated strings must already exist in the language file. Thus, game developers may request translations in advance to be added to the games. Any text that is not in the language file is returned to the games as a string containing "false". Again, a game's credentials are supplied to the API in order to access the language translations. Along with the credentials, a game must supply an array of text strings containing all the required translations for the game. Additionally, variables containing the ISO 639-1 two-digit language code for both the language to translate from and the language to translate to must be provided to the API. With all of this information provided, the API will send the game an array containing the converted strings for use within the game.

3.4 CATALOG OF PLUGIN MINI-GAMES

Now that the gamification framework and the supplied plugin game API have been described, the initial set of mini-games that were developed to take advantage of the framework and API are examined. Each games is described by a template that includes the game name, game creators, coin type, domain covered, game statistics, game appearance, game description, and game extensibility. Other game descriptors would be useful but would require the games to be deployed before precise measures can be developed. For instance, it would be valuable to add game metrics such as Play Time, a measure of how long users stay engaged while playing the game, and Mastery, a measure of whether players learned from the game, which would require pre- and post-testing. Ratios like Domain Covered / Play Time and Master / Play Time would provide metrics on a game's effectiveness and efficiency in transferring knowledge or behavior to students. For activity games, a more useful metric would be related to Activity

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Measure / Play Time, where Activity Measure is a measure of how active the game is, using quantifiers such as a user's average percent of maximum heart rate or average percent of VO2 max (maximal oxygen consumption).

3.4.1 QUIZ SHOW

Game Creators: Chad Richards

Domain Covered: Potentially unlimited domain coverage depending on question sets

Game Statistics: Games Played, Games Won, Percent Questions Attempted, Percent Questions Answered Correctly, Percent Questions Answered Incorrectly, Most Difficult Category

Coin Type Awarded: NutriCoins

Game Appearance:
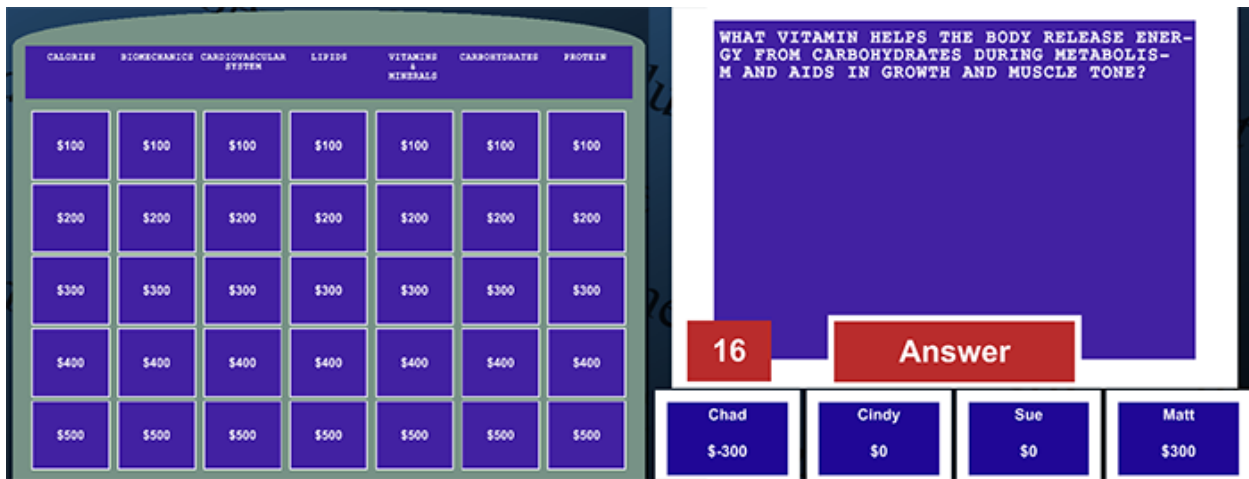
Figure 2 - Quiz Show

Game Description:

Created in Unity 3D, the Quiz Show game is a trivia game similar to Jeopardy. Players are pitted against three computer opponents in order to test their knowledge of nutrition and fitness. The Quiz Show game offers three difficulty settings, twenty-four unique opponents, and contains

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an expandable database of questions. The enemy opponents offer several features to make the players seem more realistic. Each enemy has an associated percent of time the enemy will answer a question and percent of time the enemy will answer the question correctly. Additionally, these opponents have a minimum and maximum time in which to attempt to answer the question. Each of these features are different for each opponent, and the opponents becomes more difficult at higher difficulty settings.

The Quiz Show game is very similar to Jeopardy in game play, but there are several differences. The player always has control of the board, and the board contains a total of seven categories and five questions per category for a total of thirty-five questions. Like the console version of the Jeopardy game, players choose from four multiple choice answers after deciding whether they wish to answer the question. However, when an opponent answers, players do not see what answers opponents give, only whether the opponent answered correctly or incorrectly. This keeps the chance of randomly answering correctly at 25% instead of varying based on what incorrect answers enemies have exposed. Questions are also in the form of questions instead of answers. There is only one level, no double or final level, and players get to keep whatever points they earn so long as the value they score is greater than zero since ExerCoins and NutriCoins are only ever meant to be subtracted by actually spending the coins.

One of the key features for enabling a potentially unlimited domain coverage is the fact that Quiz Show contains a dynamic set of questions and categories. Administrators, Developers, Healthcare Administrators, School Administrators, and Teachers can each add questions and categories to the database. The questions can be set to apply to a single group so that each school can utilize a different set of questions. Questions and categories can also be set, but only by Administrators, Developers, and Healthcare Administrators, to apply to every group. The

database of questions and categories can be easily expanded from the edufitment.com website. To facilitate the ease of adding many questions, multiple questions can be added at once by uploading a CSV file containing question information. So long as the questions and categories have been translated, these are also available in the user's preferred language.

Extensibility:

Each difficulty level in Quiz Show is represented by more intelligent opponent. However, an important extension to this game would be the use of difficulty levels when setting questions so that a different set of questions would be retrieved for easy games versus more difficult games. However, this expansion would require a method of reviewing questions in order to determine what difficult level best represents each question. One method of implementing such a feature would be to have an expert panel of nutritionists and exercise physiologists review the questions and assign difficulty levels. Another method would be to open the rating system up to the public and allow edufitment users to rate questions. Besides a difficulty setting, more realistic enemy intelligence could be implemented. Opponent could be improved by, for instance, an additional setting stored per enemy to determine which categories each enemy excels at or does not know much about. This could override the percentage of time an enemy answers a question and the percentage of time an enemy answers a question correctly. Also, if edufitment were released to the general public, questions and categories could also be expanded to feature age groups so that each age group would retrieve a different set of questions.

Another kind of extension for the Quiz Show might be to let players view and try to learn the content beforehand, e.g., by reading stories or text that covers the concepts the quiz show covers. The quiz show could monitor which questions a user answers correctly and remove them from future quizzes leaving just the material that the user has not yet mastered. In this way, the user

could build mastery of the subject matter.

3.4.2 FOOD GROUP MATCH UP

Game Creators: Taylor Yust

Domain Covered: Recognizing the food groups in which foods belong

Game Statistics: Percent Matched Correctly, Percent Matched Incorrectly

Coin Type Awarded: NutriCoins

Game Appearance:

Figure 3 - Food Group Match Up

Game Description:

Food Group Match Up was created in the Unity 3D game engine and is similar to other

matching games.   Players match three or more foods in a horizontal or vertical row in order to score points.   Unlike most matching games, the foods do not have to be identical in order to be matched.   They must, however, belong to the same food group.   The food groups implemented are Dairy, Empty Calories, Fruit, Grains, Protein Foods, and Vegetables.

This requirement of foods must belong to the same food group to successfully match is more challenging than it may seem.   It requires players to really think before attempting to match foods.   Point are taken away for incorrect matches.   After a while of game play, then, players will begin to recognize which foods belong to what group.   Because paying attention to healthy daily nutrition requires eating a certain number of portions from each food group, this adds to the goal of improving one's nutrition.   One final note on the game is that, like all the other games, this game is multilingual, displaying the name of the matched foods and food groups in the user's preferred language.

Extensibility:

Initially, twenty-eight foods were added to the game.   The game is easily extendable by adding more foods.   Eventually, this game could also extend by storing the foods in a database and retrieving them dynamically.   This would mean that adding new foods would not require recompiling the game.   Web-based functionality could also be implemented on edufitment.com to facilitate easily adding new foods to the database.   Other edufitment nutrition games could then share access to the same food database, helping to maintain consistent graphics for each game and saving on space for the compiled games.   New game rules, such as time limits, could also be employed by the game.   Like the Jeopardy game, it would be possible to give the user help tutorials on which foods came from which food groups and that learning should improve their game play.   Their percent of correct answers is a measure of their mastery of the subject

matter.

3.4.3 CALORIE METER: THE CARD GAME

Game Creators: Taylor Yust

Domain Covered: Recognizing Calorie content of foods

Game Statistics: Correct Hands, Incorrect High Hands, Incorrect Low Hands

Coin Type Awarded: NutriCoins

Game Appearance:
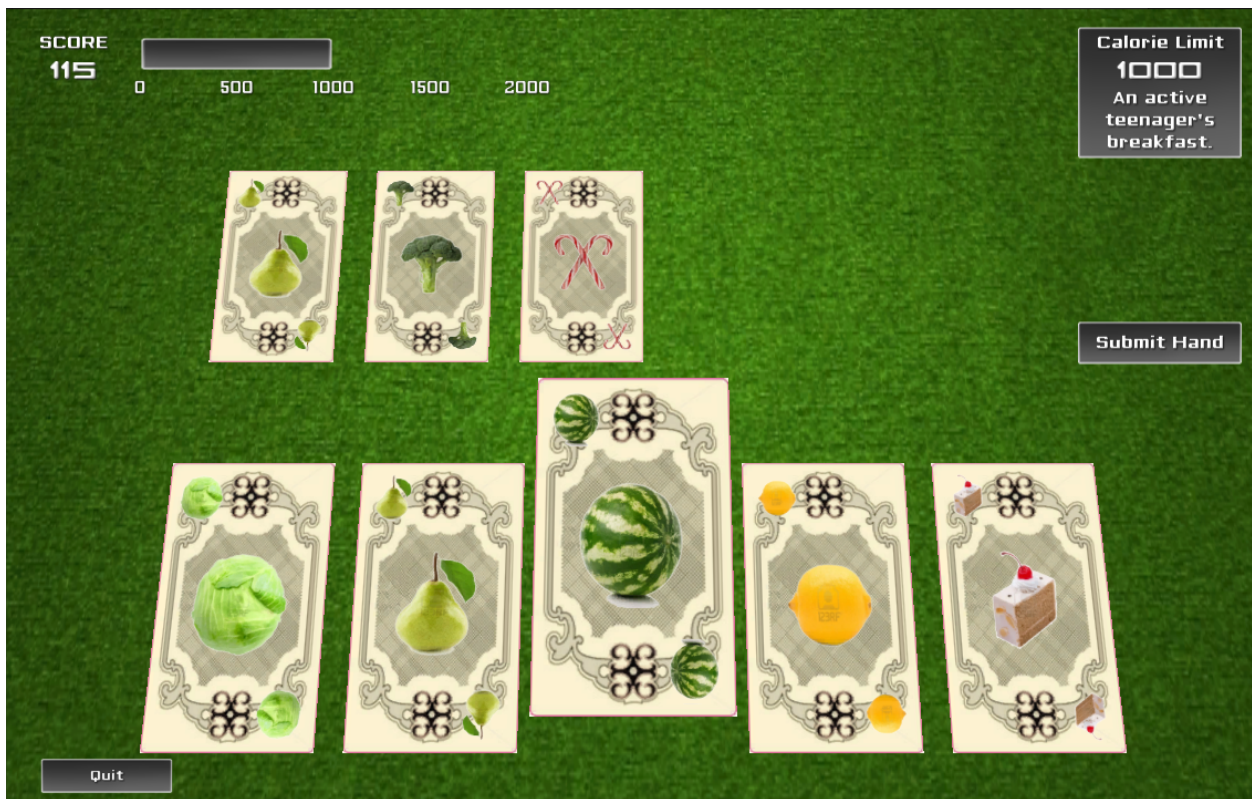
Figure 4 - Calorie Meter: The Card Game

Game Description:

Calorie Meter is a unique card game that is similar to Texas Hold'em Poker and 21. Players are presented with two hands of cards. The first hand resides in the middle of the table and represents Calories already in play. Players must select from zero to five cards from the

hand closest to them to add to the hands in play.   Each card contains a picture of a food item, and the value of the card is a single serving of the pictured food.   To win a round of play, the total value of the selected cards and the cards in play must not exceed the Calorie limit and must be at least 80% of the optimal card selection.   The Calorie limit is displayed on the top right corner of the screen and as the length of a Calorie limit bar on the top left of the player's screen. Winning a round of play earns points based on choosing the best hand from the available cards. Exceeding the limit or going under 80% of the optimal hand, however, subtracts points from this score.   Players may quit the game and submit their current score at any time.

This card game provides an opportunity for players to learn how many Calories are in a serving of each food.   The number of Calories per serving is not obvious, and it will take many rounds of play before a player starts to recognize how many Calories a single serving of each food contains.   However, once this skill is mastered, it can easily be applied to the real world when grocery shopping.   Without reading labels, long-term players will be able to recognize how many Calories a food contains.   Because energy imbalance is the primary cause of the obesity epidemic, learning the number of Calories contained in food can help prevent overeating, which will contribute to the overall goal of reducing obesity.

Extensibility:

This game is easily extendable by adding many more foods.   The USDA nutrition database is public information and contains thousands of foods, all of which could be added to the game. Also, the options of 1500 Calorie and 2000 Calorie hands were left out of the initial game because of the lack of foods.   These features would not be difficult to add to the game if additional foods were added.   Further options for the game, such as time limits, avoiding empty Calories, or enemy opponents, could be implemented, as well.

A variation on the game might be a meal planner game to create a meal that does not exceed a given Calorie count.

As with the earlier games, the user can be provided with help screens that provide information on food groups, foods, portions, and Calories so that they can learn outside the game about Calorie counts.   This could accelerate their ability to master the game and gain higher scores than other players.

3.4.4 NUTRIHUNT

Game Creators: Taylor Yust and Andrew Johnson

Domain Covered: Recognizing vitamin, mineral, and macronutrient content of foods

Game Statistics: Levels Cleared, Shots Fired, Targets Hit

Coin Type Awarded: NutriCoins

Game Appearance:

Figure 5 - NutriHunt

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Game Description:

NutriHunt is a game similar to the iconic NES Duck Hunt game. Instead of ducks, players must shoot foods matching the current rule set for the level in order to score points. Each level has unique features, showcasing the expandability of this game. For the version produced, four levels were created. The first level gives players unlimited ammo and requires users to shoot foods until five vitamins are filled to the recommended daily allowance values: Vitamin A, Vitamin C, Vitamin D, Vitamin E, and Vitamin K. The next level has the same rule set but now there is a time limit imposed on the player and a different set of vitamins, minerals, and macronutrients. Level three has the same rule set as the first level, except now if the player hits empty Calorie foods, the player loses the level. The fourth and final level created for the game has players fill up Vitamin C, but ammo is limited so players must choose carefully which foods to shoot. Players earn points for completing levels and lose points for losing levels. After the fourth round the game is restarted from the first level, keeping the total points a player has scored. A player may quit the game and submit his or her score at any time.

NutriHunt's primary goal is to get users to recognize which vitamins, minerals, and macronutrients are contained in a serving of different foods and in what amount. Furthermore, NutriHunt aims to promote an understanding of how many servings it takes of different foods to meet the minimum recommended daily allowances (RDAs) of each vitamin and mineral. To prevent vitamin and mineral deficiencies, which can lead to sickness or disease, it is important for people to understand how to fulfill these daily requirements. This adds to the domain coverage of nutrition knowledge implemented in edufitment and helps to promote overall good health. Since limiting Calories could also be implemented as part of the rule set for winning a level, this could also aid in reversing the trend of the obesity crisis by teaching players to

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recognize how many Calories are contained in a single serving of different foods.

Extensibility:

This game was programmed to be extensible in several ways.   Levels were kept generic so that designers could easily add new levels to the game.   The rule set for winning a level is adaptable.   This allows for easily changeable time limits, ammo limits, and the ability to choose which vitamins, minerals, and macronutrients must be filled to win a round.   Additionally, winning and losing conditions can be set to allow only certain foods belonging to particular food groups (fruits, vegetables, dairy, etc.) to be hit.   As it stands, four different levels were created for demonstration of the game, but level designers can add many different types of levels to the game.   One final expansion would be the addition of extra foods in the game.

3.4.5 2D PLATFORMER

Game Creators: Chad Richards

Domain Covered: Recognizing unhealthy foods

Game Statistics: Not implemented

Coin Type Awarded: Not implemented

52

Game Appearance:

3 lives remaining

a or left arrow = go left
d or right arrow = go right
spacebar = jump.

Figure 6 - 2D Platformer

Game Description:

The 2D Platformer was initially developed as a way of becoming familiar with the Unity 3D development environment.   However, there is potential for this game to expand.   Though the health education would be minimal, the game would provide a quick way for students to learn to recognize which foods are healthy and which are not.

The premise of the game is simple; avoid the unhealthy food in order to grab a key that unlocks the door out of the level.   Currently, the game provides several enemy types -- Doughnut, Pie, Cupcake, and Twinkie -- with various abilities.   For instance, if a Pie sees the player, the Pie speeds up, heading toward the player.   The Pie enemy cannot see far above itself,

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so the player can avoid the Pie by continually jumping once seen by the Pie. The Doughnut simply rolls back and forth currently, but it could be expanded to leave a trail of jelly that would slow the user. Cupcakes are hopper enemies with the largest range of sight and will hop toward the player in an attempt to squash the player. The Twinkie is perhaps the easiest enemy currently in the game. It can see the player further than the Pie, but the Twinkie is slower than the player and will fall to its doom attempting to catch a player. The player currently has three lives, and if the player touches an enemy, the player will lose a life, flash red for a few seconds, and grow (as if the player ate the unhealthy food and is bigger now).

Extensibility:

The game is easily expandable with the addition of more enemy types, more and diverse levels, and player abilities. The abilities could be obtained by eating healthy foods. For instance, eating a strawberry could render the player invulnerable for several seconds. Levels could be diverse, including an ice level, making it hard to traverse the slipper terrain. Additionally, this is the only game not to utilize the gamification framework since it was created only as a test of the Unity 3D development environment. When complete, the game could take full advantage of the framework, awarding NutriCoins, tracking statistics, and providing leaderboards.

3.4.6 OUT-DANCE THE ELEPHANT / WIN THE FIGHT

Game Creators: Chad Richards

Domain Covered: Physical activity

Game Statistics: Not implemented

Coin Type Awarded: ExerCoins

54

Game Appearance:

Health: 100	Health: 41
Keep going! Way to go!	Boo, you slowed down! Pick up the pace!
Heart Rate: 163 117	Heart Rate: 130 108
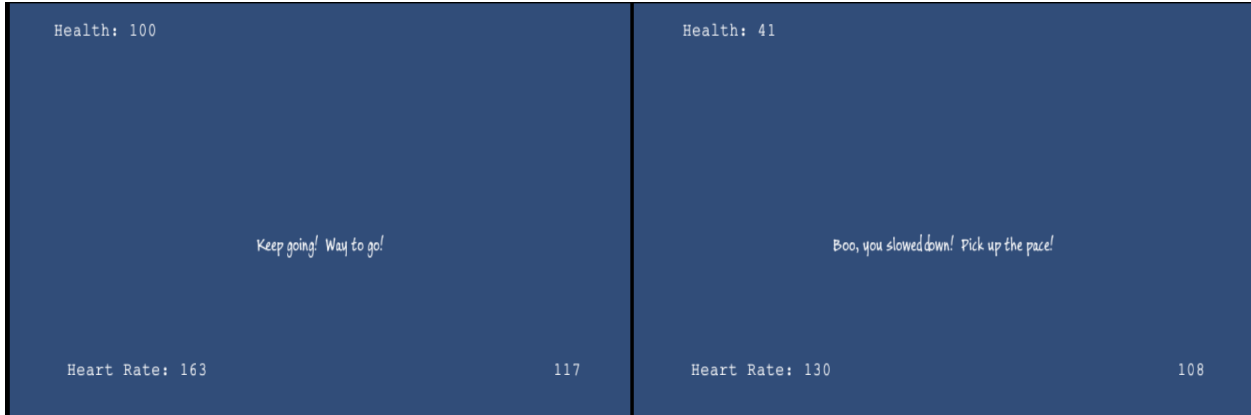
Figure 7 - Out-dance the Elephant / Win the Fight

Game Description:

Exercise is one of two components necessary for improving the obesity crisis. The other mini-games take advantage of the larger component, nutrition, but exercise is very important to improving one's health.

The Out-Dance the Elephant / Win the Fight game opens up an entire class of simulation games that can take advantage of automatically collected biometric data, in this case, heart rate data. The premise of the game is that there is a dancing elephant on the screen. The player's job is to out-dance the elephant by keeping his or her heart rate elevated. Alternatively, the player is associated with an on-screen boxer. To win the fight against the opponent, the player must keep his or her heart rate elevated.

Developed in the Unity 3D game engine, the game currently exists as a proof-of-concept version. The game works and takes advantage of the edufitment framework, but, at present, it contains no graphics and very few songs.

In the game, players wear a Zephyr Bioharness 3 BlueTooth [34]. The player logs into an application developed for the Android platform. This program pairs with the Bioharness and

continually listens for heart rate data. Once received, the data is submitted to a PHP script which updates a database entry containing the logged in user's id, current time, and heart rate. A second application, the Out-Dance the Elephant game, continually connects to another PHP script which retrieves the heart rate data. The heart rate is then used to play the game.

In order for this game to work properly, the time between sending and receiving must occur within only a few seconds. Otherwise, the heart rate data would not be updated quickly enough to be considered accurate and would not be usable by the game. In testing, the time between sending and receiving never reached two seconds.

There are several challenge modes available to the user: Beginner, Standard, H.I.I.T., and Tabata Challenge. In both Beginner and Standard modes, the user is given a set of times (10 minutes, 15 minutes, etc.) allotted until the elephant is beaten. In these modes, if users keep their heart rate high enough for the allotted time, they have out-danced the elephant. If, at any time after warming up, the player's heart rate dips below the threshold level, the player's health begins to go down. If the player's health reaches zero, the game is lost. The difference between Beginner and Standard modes is the heart rate requirement. Standard requires a higher heart rate than Beginner to win the game. In each of these modes, breaks are given to the player at regular intervals to allow the user to rest without penalty. In the H.I.I.T. Mode, the dance lasts between 15 and 30 minutes and the workout follows a 2:1 ratio. For example, if 15 minutes is selected, the user will have to keep his or her heart rate at 75% of maximum heart rate or greater for one minute, then have an active recovery for 30 seconds, keeping the heart rate between 50-75% during that time. This interval would be repeated 10 times, beating the elephant it the user's health bar lasts all ten intervals. The Tabata Challenge is similar to H.I.I.T., only the dance lasts four minutes, 20 seconds at 80%+ followed by 10 seconds of rest,

continuing in this manner until the Tabata (the entire four minutes) is complete. The user is able to select how many Tabatas they wish to accomplish to successfully out-dance the elephant. These same levels could easily be applied to the Win the Fight version of the game.

Dancing does not technically have to be done to win the game. Dance moves are not monitored, only heart rate, but it is likely that the user will want to attempt to copy the elephant. In each mode, a timer is located at the bottom telling the user how long they have left to complete the game. As mentioned, if the player drops below the heart rate requirement during a non-scheduled time, the health bar will decrease. If the health bar is completely depleted, the player will lose the game. The player will be awarded ExerCoins for out-dancing the elephant. A few royalty-free songs were included in the basic game. In order to extend music selections, original music will need to be created or more royalty-free music will need to be obtained in order to avoid licensing fees and royalties. An additional security measure was added that resets the game if the connection to the Bioharness has been lost. This prevents a user from turning the Bioharness off several times after the game has started in an attempt to win the game with very little effort.

Extensibility:

The proof-of-concept game is sound, and adding graphics and more music turn this into a fully working game that people would be interested to play. Initial graphics have already been developed for the Out-dance the Elephant version of the game but need to be implemented in the game. Aside from extending the proof-of-concept into a polished game, Out-dance the Elephant could take advantage of game statistics provided by the gamification framework. Statistics such as Maximum Heart Rate, Number of Times Elephant Has Been Out-danced, and Most Popular Game Mode are some examples of ways to implementing this feature. Other

body monitors could also be used in place of or in conjunction with the Bioharness, such as the Fitbit activity monitor.

Out-dance the Elephant and Win the Fight are only two examples of simulation games that can be created using heart rate data. For instance, a racing game could be created which has the player winning the race if the heart rate requirement is met. Simulation action games would most likely work best to motivate the player to continue running, jogging, dancing, or boxing, but there are many types of action games that could be created, opening up a world of potential for this concept.

3.4.7 RECORD KEEPER

Game Creators: Chad Richards

Domain Covered: Tracking any entry progress over time

Game Statistics: Record Count, Most Popular Entries, Most Records Entered

Coin Type Awarded: NutriCoins

Game Appearance:
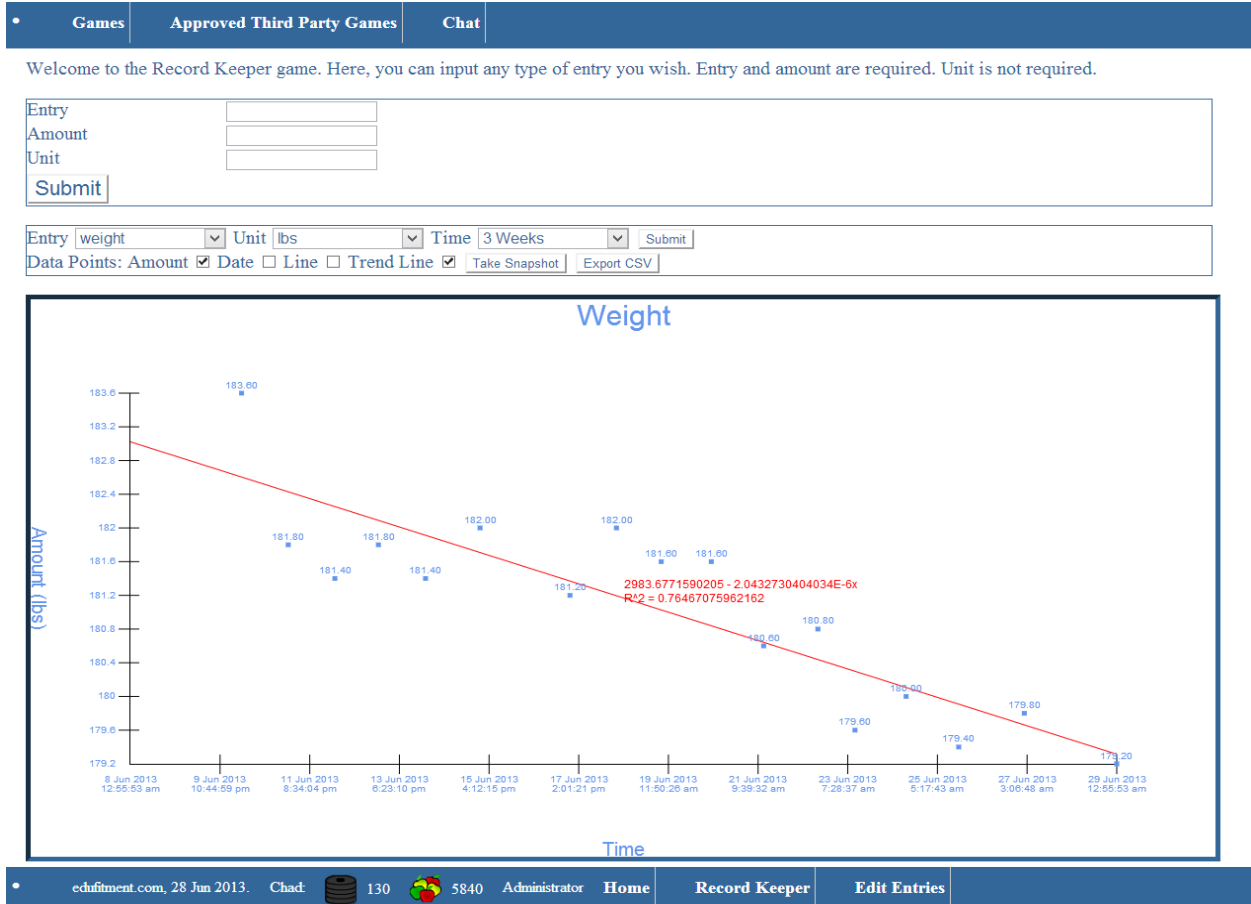
Figure 8 - Record Keeper

Game Description:

Record Keeper is more of an application than a game, but it does take advantage of the edufitment framework and awards NutriCoins for playing the game. The purpose of Record Keeper is to track the progress of an entry over time. Record Keeper can track the progress of any user-defined entry type. For the purposes of nutrition and fitness, entries such as weight, Calories, or number of sit-ups could be stored and tracked to determine, in a graphical manner, how these numbers change over time. In this way, it can measure physical activity performed outside of the framework, such as playing sports or daily exercise, in addition to recording progress in the mini-games. By allowing users to track health information, Record Keeper

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stands as a test of the gamification framework to see if playing these games does, indeed, translate to an improvement in one's health. It also adds to the overall goal of decreasing obesity in children by allowing players to make changes based on results of the graphical data; if a child's health is not improving after playing a subset of games for an extended period of time, changes could be made such as choosing a different subset of games or choosing more exercise games than nutrition games. By continually making changes when progress is plateauing or degrading, eventually a working individual solution for a student could be found. Sticking to this working program could lead to measurable improvements in a child's health.

Record Keeper was created in HTML5 utilizing the HTML5 Canvas element, PHP, Javascript, JQuery, Ajax, and MySQL. HTML5 was used to create the graphical display of entry amounts versus time. Javascript was used to control the Canvas element, setting selectable options such as displaying the amount or entry date. PHP was used in conjunction with MySQL to store entries in the database and retrieve entries from the database. JQuery, PHP, and Ajax were used in combination to convert retrieved entries from PHP data types into a form usable by the HTML5 Canvas element. JQuery and Ajax were also used to repopulate a units select box when a user changes the currently selected entry.

Record Keeper contains three primary functions, one for submitting new entries to the database, one for retrieving entries, and a final feature for modifying entries. To submit a new entry, a player simply enters a name for an entry, such as weight, and an amount. Optionally, players may also enter a unit along with the entry and amount. Once a record is submitted by clicking the Submit button, the record and current entry date and time is then stored in the database and NutriCoins are awarded to the player.

Retrieving entries occurs based on selections made by a player. The player first selects an

entry from the entry list box.   Then, the player selects a unit from a second unit list box.   The player then chooses the period of time to display on the graph.   The time selection box contains the following options: 1 Day, 3 Days, 5 Days, 1 Week, 2 Weeks, 3 Weeks, 1 Month, 3 Months, 6 Months, YTD (Year To Date), 1 Year, 3 Years, 5 Years, and All Time.   This time selection feature enables the user to choose the beginning period to display on the graph.   The end period is always the current date and time.

The x-axis of the graph represents time, from the selected period of time to the current date and time, and the y-axis of the graph represents entry amounts, ranging from the lowest graph point amount to the highest currently displayed on the graph.   Additional options are available for the user to modify how the graph points are displayed.   By default, only the points are displayed.   The amount can be labeled by checking the Amount check box.   The date for every point will be displayed by checking the Date check box.   So long as there are two or more points being displayed, a line will be drawn between each of the points by selecting the Line check box.   A linear regressions trend line will be displayed along with the equation of the line and coefficient of determination (labeled as R^2) value by checking the Trend Line check box, so long as there are two or more points currently being plotted on the graph.   A snapshot image of the graph can be taken at any time by clicking the Take Snapshot button.   This allows a picture of the graph to be saved as a portable network graphics (PNG) file.   All the currently plotted points' information, such as the entry, textual entry date, time stamp, and amounts can be exported to a comma-separated values (CSV) file for use with spreadsheet software by clicking the Export CSV button.   Finally, the footer of the Record Keeper game homepage contains a button to allow the editing of previous entries so that entries can be easily removed or changed.

Extensibility:

Record Keeper can be extended in various ways and, with little change, could already work well as a stand-alone application outside of the edufitment framework. One possible extension is to add options to the Trend Line for additional types including logarithmic, polynomial, power, or exponential trend lines. This would help the trend lines to better fit more types of data. Record Keeper could also be expanded to include multiple entries on the same graph. Additionally, Record Keeper could contain an option of viewing one type of entry versus another to see how well they correlate. For instance, a user could track Calories eaten and weight. After an extended time of tracking these entries, the user could view a graph of Calories versus weight and most likely notice that the more Calories a user eats in a day, the higher the user's weight, or conversely, that lowering the number of Calories usually results in a lower weight.

Another kind of extension involves the HTML5 Canvas element itself. HTML5 is a relatively new technology, and the HTML5 Canvas element, especially, is still being actively developed. Currently, there are few graphing packages available for the HTML5 Canvas elements. As Record Keeper is expanded, the graphing utilities implemented could be repackaged similar to the powerful graphing package implemented in the R statistics language and made available as a plugin for other HTML5 Canvas applications.

3.5 META GAME

The meta game is a top-level game that provides a way in which NutriCoins and ExerCoins are spent. There are many possibilities for implementing a meta game in the edufitment framework; two are described below, but others or hybrids are possible.

For instance, if the meta game were a Tamagotchi-style pet, the game could require players to feed the pet nutritious foods and exercise the pet in order to keep the pet healthy and fit. These healthy foods could cost either of NutriCoins or ExerCoins or a combination of both.

That could also open up the possibility of overfeeding a pet leading to a sick, obese, or unhealthy pet.   Players could identify with their pets.   Then, players could begin to understand that energy imbalance can lead to sickness or obesity and potentially transfer that knowledge to their own lives.

Another method, the one currently implemented, is to implement a central hub where users can connect with one another and spend coins on items such as avatar enhancements.   The meta game provides a chat room where users can connect – see Figure 9.   Messages cost NutriCoins to send.   There are three prominent levels of messages: Low, Medium, and High.   Low prominence messages cost 5% of a player's total NutriCoins or 1 NutriCoin, whichever is greater. They have a basic thin border around them and are in a medium font size.   Medium prominence messages cost 15% of a player's total NutriCoins or 100 NutriCoins, whichever is greater. They have a thick ridge border around them and are in a large font size.   High prominence messages cost 25% of a player's total NutriCoins or 1000 NutriCoins, whichever is greater. They have a thick blue and black border around them with a drop shadow and are in an extra large, bold font.

Figure 9 - Meta Game

There are two other notable features of the chat room. The first is that users can send private messages to one another by selecting a user on the list and sending a message. The latter is the principle of invisible moderation. The chat room takes advantage of the roles defined by the edufitment framework. Administrators can see every user in the chat room and send messages to every user. Developers can only see and send messages to other Developers. Healthcare Administrators can see and send messages to all other Healthcare Administrators, School Administrators, Teachers, Students, and Players. School Administrators can see and send messages to other School Administrators within the same school, Teachers within the same school, Students within the same school, and Players. Teachers can see and send messages to other Teachers within the same group (school), Students within the same group, and Players. Students can only see and send messages to other Students in the same school. Players can only see and send messages to other Players. This means that it will not be obvious to Students

when a moderator is in the chat room, such as the school principal. However, every user, despite what role they belong to, can see messages sent to them. Thus, a principal could send a message to a Student account, and that Student would see the message.

There are obvious ways to circumvent the chat room system. After all, there are many freely available chat rooms all over the Internet. Most of these, though, require e-mail addresses to register an account. Elementary age students are often too young to have an e-mail account that can be registered with these chat rooms. Thus, the chat room will work well for our purposes and can be changed or supplanted with another meta game in the future or improved with the addition of features such as a chat avatar and avatar customizations.

3.6 SUMMARY OF THE DESIGN

In this chapter, we began with a discussion on the iterative design process used when developing the requirements for the edufitment gamification framework. Once the requirements were set in place, the framework was created. An initial set of mini-games was then developed to cover a large knowledge set in the nutrition and fitness areas. It was mentioned that players earn NutriCoins and ExerCoins in these games, a part of the points system utilized by the edufitment framework. To give a reason for users to earn coins, a meta game was created for users to connect with one another and spend their coins.

CHAPTER 4 - ANALYSIS

In this chapter, we will analyze how well the edufitment gamification framework and the associated mini-games meet the requirements we set forth at the end of section 3.1.2. First, we were required to create a central gamification framework in which first and third-party games could connect. This framework must use the game mechanics described in Chapter 2 and also have additional features. These additional features were internationalization, a dashboard to view player progress, and security and privacy. Next, an initial set of games must be created for the framework. This set of games comes with its own requirements. The set of games must cover a large area of nutrition and fitness. Metrics must be utilized in the games in order to track player progress. Also, the games must be capable of expanding in the future. Finally, a method of spending currency earned in the games must be implemented.

4.1 FRAMEWORK ANALYSIS

We shall first examine how well the framework met the specified requirements of providing a central gamification framework, implementing game mechanics into the framework, and providing internationalization, security, and privacy.

4.1.1 COMMON HUB FRAMEWORK

As detailed in Chapter 3, the edufitment framework provides a central location for players and first and third-party games to connect on www.edufitment.com. First and third-party games connect to edufitment through a plugin game API, and players may log into the website to play the games. As part of meeting the requirement for security, the plugin game API provides several security measures, including requiring games to provide a unique game name and password before any user credential is validated.

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4.1.2 COMMON METRICS AND COMMON GAME MECHANICS

The gamification framework provides many of the mechanics described in Chapter 2. The first and most prominent is the use of a dual currency. In addition to these redeemable points, experience points are earned through game play. The experience points are used, along with game metrics, in the creation of leaderboards. The leaderboards are also quite prevalent on the edufitment.com website and on each individual game webpage. They are also split up in multiple views in order to promote competition within and between groups. Quests are left up to schools to create in order to allow more flexibility but are an easy task to implement if the framework is expanded to the general public. Because of the age group of the intended players, the social engagement loop was left out of the initial framework. Social engagement loops are a viral marketing strategy which requires users to post content on social networks about the game, but since the core intended players, elementary students, are too young to be able to create accounts on most social networks, this would have been pointless to implement until the framework is expanded to the general public.

The experience points are also displayed as a way of viewing player progress in the central dashboard that was created. This dashboard grants access to private user data, and because of that, roles were created to ensure that private data would only be exposed when necessary. Each role has a unique set of permissions, allowing only access to data that is required by the role. For instance, Developers could add content to games but only have access to other Developer account information and cannot access Student or Player data. In addition to the central framework, game mechanics, security, and privacy methods that were implemented as part of the requirements, internationalization was also made a top priority. The website is already available in four languages and provides a simple method to expand to more languages.

Both logged in players and casual visitors to edufitment.com may view the website in their language of choice.   Moreover, game developers have access to functions using the plugin game API to translate their games to multiple languages.

4.1.3 META GAME

To meet the final requirement for the framework, a chat room was created in which users could connect with one another and spend coins on sending messages.   More prominent messages cost more coins to send, and since each message costs coins, players will not be as tempted to send random messages that flood the chat room.

4.1.4 IN SUMMARY, REQUIREMENTS ARE MET BY THE GAME FRAMEWORK

The framework has met all of the specified requirements.   There is a central location for players to use the gamification framework, and game developers can access the framework through a plugin game API.   Several game mechanics were implemented as described in Chapter 2 with thought of how to expand these if the core audience were expanded.   Security and privacy measures were taken by utilizing roles and requiring games to provide credentials before accessing user data.   Expanding the framework to more languages than the four already implemented was also made an easy task.   Since the framework meets all the requirements set out in the objective of this project and made concrete in Chapter 3, it is considered a success. We must, however, also examine whether the suite of games meets all of its requirements.

4.2 GAME ANALYSIS

The suite of games has its own set of requirements.

4.2.1 GAME DOMAIN CONTENT COVERAGE

As mentioned in the previous section, the games, taken as a set, must cover a significant

degree of nutrition and exercise knowledge. In addition, each individual game must provide metrics in order to track player progress and be extensible. The initial games implemented into the framework were Quiz Show, Food Group Match Up, Calorie Meter: The Card Game, NutriHunt, Out-dance the Elephant, and Record Keeper. Taken together, the games provide wide coverage:

- The Quiz Show is potentially unlimited in knowledge areas of nutrition and exercise because it contains an expandable database of questions and categories.

- The Food Group Match Up, Calorie Meter: The Card Game, and NutriHunt games cover knowledge of nutrition including the ability to determine which foods belong to which food group, how many Calories are in a serving of different foods, and the quantity and types of vitamins and minerals contained in foods.

- The Out-dance the Elephant game provides a demonstration of how to include an activity game in the framework.

- The Record Keeper provides a demonstration of how users can manually record the results of an open-ended collection of activities and exercises.

4.2.2 GAME MEASURES AND METRICS

Since each game must individually supply its own metrics, these shall now be examined for the framework games. Each game provides metrics in the form of game statistics presented on leaderboards, but a player does not have to be on a leaderboard to view his or her own progress. The individual game statistics are displayed alongside the leaderboards so that players may compare his or her progress of each statistic to other players. Quiz Show provides many metrics, including the number of games played, the number of games won, the percentage of questions attempted, the percentage of questions answered correctly, the percentage of questions

answered incorrectly, and the most difficult category.   Food Group Match Up provides metrics including the percentage of correct matches and percentage of incorrect matches.   Calorie Meter contains metrics for the number of correct hands, the number of incorrect hands that are too high in Calories, and the number of incorrect hands that are too low in Calories.   NutriHunt provides the total number of levels cleared, shots fired, and the number of targets hit.   Out-dance the Elephant was created before the framework contained a mechanism for metrics, and metrics have yet to be implemented in this game, but the best metric for Out-dance the Elephant is a physical one, anyway, in the form of lower BMI or lower body fat percentage, which could be stored and displayed as progress over time using Record Keeper.   Record Keeper is, itself, a metrics game. Its entire point is to track progress of entries over time.   Additionally, Record Keeper provides three game statistics: record count, most popular entries, and most records entered.

4.2.3 GAME EXTENSIBILITY

Aside from metrics, it was required that each game be extensible.   In terms of area coverage, metrics, and extensibility, the games have been well-designed.   Two possibilities for extending Food Group Match Up are adding more foods and imposing time limits for making matches.   Calorie Meter can be expanded by adding additional foods, enabling options for 1500 and 2000 Calorie hands, imposing time limits, creating enemy opponents, and implementing new rules such as avoiding empty Calories.   Because NutriHunt was designed to be highly extensible, there are many options for expanding this game beyond the initial offering.   Of course, additional foods can be added to the game, but beyond that level designers can easily add all sorts of levels using many rule set customizations such as changeable time and ammo limits and the ability to select the winning rule for the level.   The winning rule can include one or more of vitamins, minerals, or macronutrients to be filled.   Certain foods can also be

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programmed to be avoided, such as empty Calorie foods, or the player loses the level. Out-dance the Elephant, though currently a mere proof-of-concept, opens up the possibility for a new type of simulation exercise games. Any game that can be won can be used as a backdrop for the simulation, and if the player is within the required heart rate range, he or she will be shown a winning scenario, but if the player drops below the required range, a losing scenario will be shown. An example of this would be winning a racing game or falling behind in the race depending on the player's current heart rate. Record Keeper is potentially extendable to contain more options for trend lines and the possibility of creating correlation graphs of one entry versus another. Record Keeper could also eventually be packaged as a large, standalone graphics toolkit for the HTML5 Canvas element.

4.2.4 IN SUMMARY, REQUIREMENTS ARE MET BY THE SUITE OF GAMES

The games have, as a whole, covered a large area of domain content, and they can easily be expanded to cover a larger area of nutrition and exercise knowledge. They also provide metrics for tracking player progress. In addition, they are all highly extendable games. This leads to the conclusion that the games have, indeed, met the requirements that were imposed on them.

CHAPTER 5 - CONCLUSIONS

5.1 SUMMARY

During the spring of 2011, the simple idea of creating a health game for elementary school students to help reverse or prevent childhood obesity was brought to the attention of our computing team by a skilled interdisciplinary team of faculty with backgrounds in nursing, education, and kinesiology.   After much discussion, we realized that one simple game could not satisfy the requirements we had identified, that instead a suite of games would be needed, and that there was a need to connect the multiple games into a common framework.   To ensure the ability to monitor student progress, the framework would need to use common metrics, and all games would need to be accessible via a single website.   The framework would need to provide extensibility, security, privacy, and internationalization.

We began development, and as more game mechanics were learned, more were integrated into the framework.   Eventually, the framework contained a dual currency, experience points, game metrics, leaderboards, multi-view dashboards, internationalization, security, and privacy features.   The framework was named *edufitment* as a combination of education, fitness, and entertainment.

The framework was populated with an initial set of games to cover a reasonable portion of nutrition and fitness knowledge.   Quiz Show was created using Unity 3D as a game full of nutrition and exercise trivia that could be expanded to contain a very large set of new categories and questions.   Food Group Match Up was programmed to help players match foods with the correct food group (protein foods, fruits, vegetables, etc.).   Calorie Meter provided a unique card game to help players begin to recognize the number of Calories per serving of different foods.   NutriHunt was developed to extend knowledge of food vitamin and mineral content to

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players.   Each of Food Group Match Up, Calorie Meter: The Card Game, and NutriHunt were all developed in the Unity 3D environment and could all be extended with additional foods and rule sets.   2D Platformer was created to become familiar with the popular Unit 3D game development environment that would be used for the creation of most of the games.   Out-dance the Elephant used a combination of Android and Unity 3D to produce a proof-of-concept exergame.   Record Keeper was developed in HTML5 as a metrics game.

All of the games connect to the framework using the plugin game Application Programming Interface (API) that was developed.   This API contained features for including multiple languages in the games, checking player credentials, entering player scores, and submitting game statistics.   In addition to the plug-in games, a top-level meta game was developed to connect players and provide a way to spend hard-earned coins.

We then provided an analysis of how well the framework and games met the original objective and the requirements we identified near the beginning of the project.

5.2 CONTRIBUTIONS OF THE THESIS

The contribution of this thesis is the development of a structured, secure, multilingual, and expandable healthcare gamification framework that can be used to build nutrition and fitness knowledge in elementary school children, with the potential to teach or modify their behavior. Separately considering the healthcare domain contributions and the gamification framework contributions, we list the following contributions:

- The thesis provides a path for developing suites of games that have the potential to improve nutrition and fitness in children.

- This thesis provides a methodology and architecture for gamifying work and curriculum development that potentially could also be applied in other domains.

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5.3 FUTURE WORK

There are many extensions that can be added to this project. Three kinds of extensions are discussed.

5.3.1 TESTING EDUFITMENT

It has been a substantial effort to design and implement the Edufitment framework. The scope of this thesis is limited to that effort. However, clear next steps would be to refine, customize, deploy, and test the framework, then iteratively and sustainably improve the framework based on user feedback. In more detail, these future needed steps would be:

Refine and Customize. Some of the games do not yet contain age appropriate content and so there is a need for the curriculum and domain experts on our interdisciplinary team to refine the target content for those games.

Deploy and Test. There is an interest in deploying the games as part of a multi-year National Institute of Health grant. The games and game framework would be deployed into selected elementary schools and results would be measured to see if game play increased student nutrition and fitness knowledge and reduced obesity.

Sustainably Iterate. A measure of success would be if the game framework proved measurably effective and if third-party developers added new games so that a sustainable gamification framework evolved.

Almost certainly, there would be significant lessons learned from the above steps and later iterations of the framework might become more effective than the initial prototype.

5.3.2 EXTENDING THE EDUFITMENT FRAMEWORK

There has already been significant discussion on how to extend each game (see section 3.4); therefore, this section focuses on improving the framework:

- In a future version of the framework, many more mini-games would exist. Along with the addition of mini-games, there is also the possibility of implementing many different meta games that make use of the dual currency. As an example, a meta game which requires players to keep a pet healthy could be developed. In that case, NutriCoins and ExerCoins could be required for different pet foods and pet exercises, unlocking new types of pets or new accessories for pets. The pet health might be a mirror of the child's health, and children might be motivated to ensure their pet's health.

- Automatic game statistics would ease the process of adding games to the framework. Currently, each game provides its own set of metrics, which accommodates a large array of individual statistics that can be tracked. This feature, though, also increases the difficulty of adding new games. Because any statistic can be entered, the way in which the statistics are calculated as a group varies per statistic. For instance, a sum of the particular statistic could be the correct calculation to make, but perhaps it would be better for that statistic to be expressed as a percentage of the total of the statistic. The easiest way to facilitate this change would be to require game developers to send information along with the statistic about how it is to be interpreted. This would allow for a common method to be programmed for retrieving game statistics and ease the addition of further games.

- Current game mechanics could be improved. The dashboard could provide a clearer view of player progress by placing game statistics alongside point accumulation. Experience points could be used in more ways than just for the leaderboard; they could be used in conjunction with player levels to unlock new games, for instance. The leaderboards could also be improved to take advantage of advancements made in that

area.   For instance, players could see themselves in the middle of the leaderboard in order to see how much they need to score to rise to the next position in the board.

- The mini-games themselves could be organized so that mastering more elementary games unlocks higher level games that depend on the basic knowledge.

- The social networking aspect of the framework could be extended to enable individuals to compete with other individuals or individuals to join teams, and the team behavior can be tracked in aggregate so that, for instance, fourth grade classes from several schools could compete.

- While competition could be absolute, based on measured ability, an alternative to explore is competition based on relative progress – who has improved the most since the last time.   Another alternative is "stop signal measurements" showing green-yellow-red for students who are excelling or lagging.

- More game mechanics can be employed in the future.   Levels and badges are fun and important concepts in gamification.   Advancing in level could unlock additional games for players, providing the second most important of the SAPS reward system, access. Badges could be awarded to players for accomplishing achievements in each game. Implementing game achievements would provide an enticing reason for players to continue playing the games.   Quests and a social engagement loop could also be implemented if the framework were released to the public.   Providing a reward for completing daily quests such as exercise 15 minutes in Out-dance the Elephant would also be an enticing way to re-engage players.

- Security can be improved.   Though security measures were taken to prevent malicious access to user data, there are several attacks in which the framework is still vulnerable.

Provided a malicious party knows the location of the API scripts and the variable names for storing the unique game name and password, the party could attempt a brute force attack by continually attempting to login with a new game name and password until successful. This attack is unlikely to occur given the attacker would need to know the correct variable names and would have to attempt both different game names and passwords, but it is still possible. To aid in preventing this type of attack, if the connecting game does not provide valid game credentials, a game could be locked out after a few incorrect login attempts. Another attack, which is more feasible, is that a user of the framework could log in on a public computer and forget to log out. There is no solution currently provided for this attack, but an improvement could be to require the user to re-enter a password each time a form is submitted (such as the form for removing a user). A third attack affects the core user base, Students and Players. The edufitment.com website provides a list of approved third-party games, but if the user was unaware or if a malicious party were to make a game with the same name and look as one on the approved list, the user could be tricked into entering his or her credentials to a malicious party. There are not many solutions to this other than what has been provided, a list of approved third-party games. Users could report suspicious games, and administrators could also send out notices to players warning them to stay away from malicious games. If a user does become susceptible to this attack, they could request their password to be reset. A final vulnerability exists from an insider attack. Because there is a chat room, social engineering techniques could be employed by attackers to convince users to expose their credentials. This would involve an administrator investigation of the claim that there is a malicious user

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convincing others to become vulnerable, but every chat message is stored in the database and can be reviewed, if necessary.

- Because the intended audience is children, there is a challenge to expand the framework to older groups of players. A different set of games might be needed for different age groups, given older players would probably not want to play the same games that younger players would be interested in playing. In addition, the leaderboards would need to be separated by age groups, and the chat room would be of particularly high importance to split into age groups. Granting older players the ability to chat with minors would provide a real risk to the younger players in the form of predators, so strong controls on who can communicate with whom are needed.

The edufitment framework was kept generic to allow for the possibility of extending it in the future. For example, games of any type could be added to the framework. Also, new coin types can be created. Because the framework works well for the purpose of teaching nutrition and fitness knowledge, keeping the framework generic allows for the possibility of re-purposing or broadening the framework to teach or gamify other curriculum. Instead of tackling only one serious world issue, a future edufitment could provide a valuable approach for solving other serious issues. Despite the various challenges, the framework should be released to the general public in the near future because obesity is a worldwide epidemic extending to adults and children; edufitment is attempting to contribute a novel way of approaching this issue; and if the approach works in this application domain, it is worth trying in other domains.

5.3.3 LOOKING TOWARD THE FUTURE: INTEGRATION FRAMEWORKS

The healthcare monitoring community is evolving bottom up from vendor-specific solutions toward more integrated, interoperable solutions. As listed in Appendix A, there are a large

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number of healthcare monitoring devices available today, each encapsulated within its own application. Many health monitors are closed and do not have an API, especially those that deal with medical conditions where the provider is subject to security and privacy rules such as the Health Insurance Portability and Accountability Act of 1996 (HIPAA). Patients diagnosed with a life-threatening disease may be given a home healthcare monitor to treat, say, congestive heart failure. It is common for patients with certain several problems to have other severe problems that require other kinds of monitors (e.g., diabetes). Often these monitors are not integrated, leading the healthcare community to vend "stove-pipe" solutions that cannot interoperate. Elderly and infirm patients are being asked to self-monitor using systems with different interfaces and the learning curve is often too high. Furthermore, information learned by one system is not shared across the application boundary with other applications. This, however, is important because, for instance, alerts to high weight gain might indicate high sodium which might mean congestive heart failure.

Some devices, such as the Fitbit, provide a step in the right direction in the form of an external API for developers to integrate into other systems. Because there are many available monitoring devices and a growing trend of self-monitoring, it is conceivable that individuals would use more than one health monitoring device. Even if all monitoring devices provided public APIs, though, each API is different, and connecting to an API requires a different set of functions and technologies to be employed.

A second step in the right direction are so-called integration frameworks which provide a common website or cloud-based store for a variety of data feeds. The basic design of integration frameworks currently takes advantage of device APIs by providing a central framework that plugs in monitoring APIs. At present, several home health monitoring systems

have attempted to implement this concept and create a system of simultaneously monitoring multiple aspects of a person's health. However, without standards, these systems are competing.

In the future, it would be extremely useful if all of these devices would provide similar plug-and-play technology to facilitate cross-communication between many devices, which would complement the healthcare industry's move toward a common patient record. In order to facilitate cross-communication between many devices, there needs to be a standard for communication between APIs in much the same way as SCORM produces a communications standard for e-learning applications [33]. Thus, the future of frameworks lies in the ability to overlap data between frameworks, and that will require creating a system of standards for inter-framework communication.

In Chapter 2, specialized user model integration frameworks were identified, including Khan Academy; others include eBay, Best Buy's Reward Zone©, and Fitbit. Each framework discussed is highly encapsulated. Khan Academy can only access data within its own framework. Fitbit is similarly limited. Nike Plus, eBay, Best Buy's Reward Zone© program, and even the edufitment framework are all limited in that they cannot share data with other frameworks. Edufitment provides a gamification framework for plugging in health games. It was developed to be very generic in the way it connects so that expansion of the framework would be a simple task. Edufitment also provides a plugin game API for developers to integrate games into the framework. This is a way of bringing data into the edufitment framework from other developers. The converse, providing an API for exporting data from the edufitment framework to other developers, would be another step in the right direction. In this way, integration frameworks can model a user's health status but also their knowledge of nutrition and

their exercise regime, thus extending the kinds of knowledge stored about a user.

There is a growing need to integrate multiple frameworks in order to obtain a more complete picture of a user's data. A movement known as the Quantified Self will most likely influence the advancement of such integrated frameworks. Quantified Self is a term used to describe tracking all aspects of life such as biological patterns (e.g., weight, blood pressure, sleep patterns), but also tracking and analyzing financial, social, communication, location, and activity behaviors of a person [35]. With the growing trend of life-logging, the future of frameworks lies in the ability to easily combine the data from various frameworks to form a comprehensive model of the user.

BIBLIOGRAPHY

[1] Center for Science in the Public Interest. (n.d.). Obesity Factsheet. Liquid Candy: How Soft Drinks are Harming America's Health. Retrieved from http://www.cspinet.org/new/pdf/sdtaxes_obesity_factsheet.pdf

[2] World Health Organization. (2011, March). Obesity and overweight. World Health Organization Media Center Factsheets. Retrieved from http://www.who.int/mediacentre/factsheets/fs311/en/index.html

[3] The Economist Newspaper. (2011, December 10). All the world's a game. Retrieved from http://www.economist.com/node/21541164

[4] Liberman, D. (2013, January 11). Worldwide Consumers Spent $62.4B On Movies In 2012, Up 2.1%. Deadline New York. Retrieved from http://www.deadline.com/2013/01/worldwide-consumer-spending-movies/

[5] Zichermann, G., & Cunningham, C. (2011, August). *Gamification by Design.* Sebastopol, CA: O'Reilly Media, Inc.

[6] Schell, J. (2008). *The Art of Game Design: A Book of Lenses*. Burlington, MA: Elsevier, Inc.

[7] Challenge.gov. (2013, March 7). Apps For Healthy Kids. Retrieved from http://appsforhealthykids.com

[8] The Scientific Research Society. (n.d.). Behind the Scenes of Foldit, Pioneering Science Gamification. *American Scientist.* Retrieved from http://www.americanscientist.org/science/pub/behind-the-scenes-of-foldit-pioneering-science-gamification

[9] Serious game. (n.d.). In *Wikipedia*. Retrieved June 20, 2013, from http://en.wikipedia.org/wiki/Serious_game

[10] BBY Solutions, Inc. (2013). Reward Zone. Retrieved from https://myrewardzone.bestbuy.com/about/

[11] eBay, Inc. (2013). eBay Bucks: Frequently Asked Questions. Retrieved from http://pages.ebay.com/rewards/faq.html

[12] Gamify, Inc. (2012, February). SAPS. Retrieved from http://gamification.org/wiki/SAPS

[13] Gamification Corp. (2013). Cash is for SAPS. Retrieved from http://www.gamification.co/2010/10/18/cash-is-for-saps/

[14] 4SquareBadges. (2013). The Full List of Foursquare Badges. Retrieved from http://www.4squarebadges.com/foursquare-badge-list/index.html

[15] Boy Scouts of America. (2012). Introduction to Merit Badges. Retrieved from http://www.scouting.org/scoutsource/BoyScouts/AdvancementandAwards/MeritBadges.aspx

[16] Schwartz, B. (2004, December). The Tyranny of Choice. *Scientific American Mind*, 69-75.

[17] Novak, J. (2012). *Game Development Essentials* (3rd ed.). Clifton Park, NY: Delmar, Cengage Learning.

[18] Civilization (video game). (n.d.). In *Wikipedia*. Retrieved June 20, 2013, from http://en.wikipedia.org/wiki/Civilization_(video_game)

[19] Regan, S. (2012, October 20). Ananth Pai uses games and technology to reach every student. *TC Planet Daily*. Retrieved from http://www.tcdailyplanet.net/news/2012/10/20/ananth-pai-3rd-grade-teacher-uses-games-and-technology-reach-every-student

[20] Mayo clinic staff. (2011, May 6). Obesity: Definition. Mayo Foundation for Medical Education and Research. Retrieved from http://www.mayoclinic.com/health/obesity/DS00314

[21] National Cancer Institute at the National Institutes of Health. (2004, March 16). Obesity and Cancer: Questions and Answers. National Cancer Institute Factsheet. Retrieved from http://www.cancer.gov/cancertopics/factsheet/Risk/obesity

[22] Black, R. (2009, September 24). Obesity is now the leading cause of cancer. New York Daily News. Retrieved from http://articles.nydailynews.com/2009-09-24/entertainment/17932457_1_colorectal-cancer-common-cancers-cancer-deaths

[23] IDF Atlus Third Edition, WDF backgrounders, and WDD website. (n.d.). Key Facts. World Diabetes Foundation. Retrieved from http://www.worlddiabetesfoundation.org/composite-976.htm

[24] WebMD Medical Reference. (2008). Causes of Type 2 Diabetes. WebMd, LLC. Retrieved from http://diabetes.webmd.com/guide/diabetes-causes

[25] Center for Disease Control and Prevention. (2010, August 3). Adult Obesity. CDC Vital Signs. Retrieved from http://www.cdc.gov/vitalsigns/AdultObesity/

[26] Center for Disease Control and Prevention. (2011, July 21). U.S. Obesity Trends. Overweight and Obesity Data and Statistics. Retrieved from http://www.cdc.gov/obesity/data/trends.html

[27] Associated Press. (2011, November 14). 1 in 10 Adults Could Have Diabetes by 2030. ABC News. Retrieved from http://abcnews.go.com/Health/DiabetesNews/wireStory/522-million-peoplediabetes-2030-14944807#.TsafFITjuSo

[28] Moisse, K. (2011, August 25). Obesity Rates Projected to Soar. ABC News. Retrieved from http://abcnews.go.com/Health/Wellness/obesity-rates-projected-soar-report/story?id=14381466#.TsagEITjuSo

[29] Give a man a fish and you feed him for a day. Teach a man to fish and you feed him for a lifetime. (n.d.). In *Wikipedia*. Retrieved June 20, 2013, from http://en.wiktionary.org/wiki/give_a_man_a_fish_and_you_feed_him_for_a_day._Teach_a_man_to_fish_and_you_feed_him_for_a_lifetime

[30] Hernandez, H., Graham, N., Fehlings, D., & Switzer, L. Designing Action-based Exergames for Children with Cerebral Palsy. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '13), 1261-1270. doi: 10.1145/2470654.2466164

[31] Fitbit, Inc. (2013). Fitbit. Retrieved from http://www.fitbit.com/

[32] Khan Academy®. (2013, March 7). Khan Academy. Retrieved from https://www.khanacademy.org/about

[33] Rustici Software. (2013, March 7). Scorm Explained. Retrieved from http://scorm.com/scorm-explained/

[34] Zephyr Technology Corp. (2012). BioHarnessTM Remote Physiological Monitor. Retrieved from http://www.zephyr-technology.com/products/bioharness-3/

[35] Quantified Self. (n.d.). In *Wikipedia*. Retrieved June 28, 2013, from http://en.wikipedia.org/wiki/Quantified_Self

APPENDIX A - NUTRITION AND FITNESS APPLICATIONS AND MONITORS

This appendix contains a representative, but incomplete, list of nutrition and fitness applications and monitors.   The descriptions replicated include short marketing blurbs taken from the relative application's website.   For an infographic about mobile health apps, see

- See http://mashable.com/2012/04/29/best-fitness-apps/

A.1 APPS - FITNESS

RunKeeper Pro
Frequently compared to Nike+, this app, which is only compatible with the 3G or 3GS iPhones, finally offers a tracking system to runners, cyclists, hikers and skiers alike. The app uses GPS technology to track your route and speed, and automatically uploads your data to the RunKeeper website (runkeeper.com) after your workout. You can log in to view a history of all your activities, see the exact paths you've traveled (including elevation!) and share your progress with a built-in option to post to Facebook or Twitter. A free version is also available but only the Pro shouts updates at five-minute intervals through your headphones.
Cost: $9.99

C25K
The appropriately named C25K (Couch to 5k) app is perfect for those who are new to the jogging world. A nine-week regimen—at three days a week—guides you through 30-40-minute sessions, each designed to improve your endurance. The first week calls for 60 seconds of running followed by 90 seconds of walking for 20 minutes plus a five-minute warm up and cool down. The second week increases to 90 seconds of running and two minutes of walking. Intensity continues to increase each week and an audio prompter tells you when it's time to run or walk so you can focus on more important things.
Cost: $2.99

iTreadmill
Too busy to hit the gym? Turn on this app, put it in your pocket, and go about your day as it accurately tracks your steps, distance and average speed. While most pedometers aren't equipped to work in pockets and purses—you normally have to carry them or holster them in nerdy belt straps—this one is. You can even set the Pacer Dial, which ticks off beats to keep you marching up to speed. The counter automatically pauses when you stop and restarts when you move again.
Cost: $1.99

GymGoal ABC
Learn the ABCs of weight lifting with your new gym buddy. Like its for-cost brother ($4.99), this app has 280 exercises with animations and written instructions, 52 workout routines (adjustable for four levels of expertise) and the ability for you to add your own images. While you can't log your daily workout routine, there are calculators for computing target heart rate,

BMI, BMR and body fat percentage. Got flabby arms? Choose the body map menu, select the biceps option and you'll be presented with more than 50 arm-toning moves.
Cost: Free

FitnessBuilder
The price may seem steep but this is the mother of all fitness apps. It's got over 200 workouts, which can be picked automatically by the app's technology to create the best session for you. It's also loaded with over 2,0000 images and videos, five fitness timers, complete tracking capabilities, an arsenal of calculators and the ability to ask their exercise physiologist a personal question. The app can be upgraded for $4.99 a month, more than doubling the amount of the workouts, videos and accessory applications.
Cost: $9.99

iFitness
This is one of the most popular paid apps and offers more than 230 exercises sorted by body regions or muscle group plus 100 instructional videos. Like GymGoal, you can add and edit custom exercises of your own. Also on hand: 12 routines created by fitness experts, workout and weight logs, graphing technology, the ability to e-mail said workout logs to yourself, stop-watch timers and more. It's got a few less bells and whistles than FitnessBuilder.
Cost: $1.99

A.2 APPS - NUTRITION

Lose It
Consolidate your workout journal and food diary into one (or start keeping them) with this handy tracker. Inputting data can get tedious but the food library is extensive and includes name-brands plus generic categories like fruit, coffee and chicken (broiled, oven roasted, etc.). Each food type includes accurate Calorie, carb, fiber, fat, sodium and protein values, which you can track on a separate page. Add in your daily exercises—including the intensity and hours spent—and it calculates how many Calories you ate, how many you burned and how much more you can eat that day. For added motivation, a graph based on your data shows how much weight you've lost.
Cost: Free

GoodFoodNearYou
Perfect for frequent travelers, this app recommends healthy food options based on your location, which is tracked by GPS. It targets popular casual dining restaurants, fast-food restaurants, grocery stores and convenience stores nearby. Tap one of the suggestions and a lengthy list of healthy menu items appears, complete with Calorie, fat and carb totals. Once you decide on a place, simply let the built-in map guide you to gastro-satisfaction.
Cost: Free

NutritionTips
Did you know that cut melon must be thrown out after two hours? Or that the leanest beef cuts include round steaks and roasts? Or that oysters contain protein, calcium, phosphorus and iron? This colorful app has fun factoids like these and more than 500 others to help you have a safe and healthy diet. Each tip is written on a sleek Post-it look-alike. Swipe the page or shake your

device for a new tidbit.
Cost: Free

MyFitnessPal
The easiest to use food diary on the web - Track what you eat with just a few clicks from anywhere with an internet connection - at home or at work

A searchable food database of over 2,060,000 items - and it's growing everyday!

Your own personal food database - add your own foods and recipes at any time and access them from anywhere with an internet connection

Free mobile apps for iPhone and Android - so you can log your meals and exercise even when you are on the go

Support and motivation from people just like you - Our discussion forums let you learn from others, share your own tips, receive and give encouragement, and make friends.

A personalized diet profile - customized to your unique weight loss goals.

Flexibility - our system can support any diet like Atkins, the South Beach Diet, the Zone, and more. No matter what diet you're on, we can help.
Cost: Free

A.3 APPS - UNIQUE

Zombies, Run!
Zombies, Run! is an immersive running game and audio adventure. Experienced actors and writers have created the mobile game's incredible storyline.

All you have to do is run. There are currently 23 audio missions available. Your character "Runner 5" will collect supplies, ammo, medicine and battery along the way, which you must distribute at the end of the mission. Survivors of the post-apocalyptic world are counting on you.
Price: $7.99 for the iOS, Android, or Windows Phone app.

Missile Wars
Power your workout by getting a group of friends together to play this GPS-based mobile game.
Users must move out of the way of fake missiles in this video game. Friends can send missiles to any target on the in-app map. Players have 60 seconds to avoid an "explosion," so be prepared to run.
When joining the game, anyone in the world can send a game missile your way.
Price: Free iOS app

Strava Cycling
Strava is a company hoping to empower runners and bikers with their GPS-powered apps. The technology puts workouts, commutes and movement into context on the Strava.com website — graphing heart rate, distance and progress. Different kinds of statistics are meant to enhance your training.

Users are encouraged to best their own personal records or challenge friends to a competition. Connect with Facebook or Twitter to challenge friends' records. In the app's feed, you can also "give kudos" and add comments to encourage friends' activity.

On the app's "Explore" tab, find local paths and areas to run. Or, compete in official Strava app-wide challenges such as running 50 kilometers in three days — for fun.

Price: Free Strava Cycling iPhone app, Strava Running iPhone app, Android Strava Cycling app and Android Strava Running app.

Charity Miles

You'll walk, run and bike for longer, knowing your miles are earning money and raising awareness for charities.

Charity Miles is a free and easy-to-use app that tracks your exercise mileage. Walkers and runners earn $.25 per mile and bikers earn $.10 per mile. There's currently $1 million to give away.

Select which charity you're exercising for when you launch the app. The charity will receive your winnings after you share your activity on Facebook or Twitter from the app. The nine charities currently signed on with Charity Miles include Feeding America, the U.N. World Food Programme and Achilles International.

Price: Free iPhone and Android app.

Fleetly Fitness

Fleetly offers loads of workout routines for different sports and targeted for different body areas. There are also quick full-body exercise routines for when you're low on time.

Every workout comes with a description, video, tips and an area to log your progress. With Fleetly, users can also join open challenges such as "36,500 Push ups in 2012" or "500 miles in 2012."

Fleetly also gamifies exercise, which encourages users to move to earn points and badges for workout accomplishments.

Price: Free iOS app

Fitocracy

Their story:

They would often provide advice and guidance only to see their friends give up for a variety of reasons.

Sometimes it'd be because they didn't see progress quickly enough. Other times it'd be because they didn't have others to work out with them. And many times it'd be because working out was just... well, work.

So in August 2010, Richard got the idea: what if fitness could be turned into a game? After all, both he and Brian understood how addictive it could be trying to get to that next level, beating that next boss, and completing that next quest (not that they spent their childhoods doing that or anything...) They also realized that the addiction games create was the exact same addiction that drives their fitness efforts every day.

And so Fitocracy was born. Fitocracy's mission is to make fitness a more fun, more addictive experience. Play Fitocracy to beat challenges, push your boundaries, and show your friends who's boss. Get addicted to your fitness.

Cost: Free

Nexercise

FEATURED ON CBS, THE DOCTORS TALK SHOW AS A GREAT WAY TO GET MOTIVATED & GET MOVING TO LOSE WEIGHT.

Play with friends, earn rewards, get support, defeat challenges, and track your progress on the

largest fitness mobile interactive game of its kind.

With 100+ activities, Nexercise is the perfect community based motivational coach and training tool for any diet or weight loss program.

Effortlessly Track: Aerobics, Badminton, Ballet, Baseball, Basketball, Biking, Beachbody, Bowling, Boxing, Calisthenics, Canoeing, Capoeria, Circuit Training, Core Workouts, Cricket, CrossFit, Cycling, Dancing, Disc Golf, Diving, Eliptical, Exercise Ball, Fencing, Football, Golf, Gymnastics, Hacky Sack, Handball, Hiking, Hockey, Horesback Riding, Housework, Hula Hoop, Insanity, Jiu Jitsu, Jogging, Judo, Jumping Rope, Karate, Kettlebells, Kick Boxing, Kickball, Krav Maga, Lacrosse, Laser Tag, Les Mills, Marching, Martial Arts, Medicine Ball, Netball, P90X, Paintball, Parkour, Pilates, Ping-Poing, Playing with other(s), Pole Athletics, Polo, Pullups, Pushups, Racquetball, Rock Climbing, Rowing Machine, Water Rowing, Rugby, Running, RushFit, Situps, Skateboarding, Skating, Skiing, Snow Shoveling, Snowboarding, Snowshoeing, Soccer, Softball, Spinning, Squash, Stairs, Stairmaster, Surfing, Swimming, Tae Bo, Tae Kwon Do, Tai Chi, Tennis, Trampoline, Treadclimber, Twirling, Ultimate Frisbee, Volleyball, Wakeboarding, Walking, Weightlifting, Wii, Wrestling, XBox Kinect, Yardwork, Yoga, Zumba and MORE!

Cost: $1.99

RipDeck

RipDeck is a workout generator modeled on a deck of cards. Each suit is a different exercise and the number of repetitions is based on rank.

The cards are shuffled and displayed one at a time. The workout ends after the last card has been completed.

Cost: Free

GymPact

People who use GymPact make 86% of the workouts they commit to.

Have you ever bought a gym membership and never used it? GymPact helps you keep your own fitness promises. Earn real money for making your workouts — paid for by those who missed theirs! With cash on the line, you'll find it easier than ever to get to the gym and see real results.

A.4 APPS - CHILD-ORIENTED

Balanced Meal

Most children don't understand what it means to have balanced meal thanks, in part, to parents who don't encourage healthy portion sizes and fast food restaurants that skew portions to make a buck. The Balanced Meal app allows you to input your child's age and gender and then allow them to drag food across a scale. Once the foods that your child has selected equate a healthy meal, the scale will be balanced. The app is a great tool to use to teach your child about correct daily caloric intake.

Fooducate

Fooducate is a terrific app for older children, allowing them to scan barcodes and learn what's really in the food that they choose. Each food in the app's database is given a grade: A, B, C or D, along with an explanation of the grade given. Your child can quickly see if a food has too much sugar, excessive amounts of salt, high fructose corn syrup, or trans fats. The app will provide

health alternatives to foods that have received poor grades, helping your child make smarter food choices.

Bon'App
Bon'App features one of the most comprehensive food databases out there. Pre-teens and teenagers can utilize the application to set daily caloric goals; set sugar, salt and fat intakes based on age and gender; and learn how to construct a food journal in order to keep track of their fitness goals. The app promises to help your children learn how to eat better in just a few short weeks of use.

Pick Chow
The Pick Chow app promises to help children create five-star meals without the help of their parents. Children can drag their food choices to a virtual plate, adding up the amount of protein, carbs, sugar, fat, and sodium as they go. Meters on the side of the screen alert your children when healthy levels of these nutrients are surpassed. Once your child has created a balanced meal, they can email you their meal plan and you can add the ingredients to your shopping list.

Smash Your Food
The Smash Your Food app has won several awards and endorsements, and is a great way to teach your children about nutrition. Children smash "bad" foods and learn why they are considered unhealthy. If you are looking for a fun way to teach your young children about proper nutrition, this is the app you've been waiting for.
Children today are technologically oriented and often learn best when lessons are fun, vibrant and interesting. If you are looking for ways to teach your child about healthy eating and proper nutrition, these five apps will help to ensure that your children learn what makes some foods unhealthy, and provide the tools they need to make better choices. Whether your children are in kindergarten or middle school, teaching them about proper nutrition will be a lesson that they will carry with them throughout their lives.

The Snack Neutralizer
The Snack Neutralizer is a tool designed to be used in the classroom. The purpose of the site is to open up student's eyes to the consequences, both good and bad, associated with what they eat. As a teacher I have used this in my class with incredible and unexpected result. The challenge is to be 'snack neutral'. You may choose your snack, however you must work it off over the course of the day. Certain snacks can be worked off during recess, other take a lot more. The snack neutralizer is a tool that can be useful to anyone wanting to know more about the nutritional value of the foods they eat. The Snack Neutralizer is 4 tools in 1.Find out the Calorie count and nutritional value of any food you consume.   Given a specified food how much of a given activity will it take to burn those Calories. Find out food high in a given nutrient. You may limit this search to specific food group. Finally find food high in a nutrient and low in a second nutrient. For example foods high in protein and low in total fat. This search may also be limited to specific food groups.

PapayaHead
Family Meal Planning Website that allows each family member to fill out a unique profile of likes, dislikes, allergies, and unique nutritional requirements.

Fun Drag and Drop tools let the family build a meal plan for the day and graphically see the nutritional results of thier choices.   Likes, dislikes, and allergens are also flagged.

The Meals can put put on a convenient shopping list and the plans and recipes can be printed out.

Tony's Plate Calculator

The Tony's Plate Calculator is an online tool that can help you calculate the nutritional values for a single item, an entire recipe or a full day's worth of food.

If you just want to look up the nutrition for a single item, you can perform a Quick Search.   The Calculator will then present you with search results from both the MyPyramid database (which can let you know what food groups you are eating) and the USDA's Nutrient Database (which can give you information like you would find on a Nutrition Facts label).

But if you want to know more than the nutrition values for a single item, if you want to look at an entire recipe or an entire day, the Tony's Plate Calculator can do that too.   By combining multiple ingredients into a recipe, you can find out the totals for the recipe and the nutrition values for servings of that recipe.   Those servings can go into recipes for meals.   And those recipes for meals can be combined into the recipes for what was eaten in an entire day.

The Tony's Plate Calculator is a powerful, flexible tool to let you know what is going onto your plate.

Trainer

Trainer gives players the responsibility of caring for creatures who all have dietary and fitness needs. Unlike any other title currently on the market, the Player actually trains with the creatures. When one of the creature exercises, so does the Player! Both benefit from this shared activity.

The primary goal of Trainer is to give players the opportunity to discover, seek and share health information. Through experiential learning, Players will quickly gain insight into how nutrition and fitness impacts their daily lives - removing many of the stigmas surrounding diet and exercise. Furthermore, through a customized gameplay experience, Players will be encouraged to exercise on a regular basis – attaining their fitness goals both in-game and in real life!

Fitter Critters

Fitter Critters is a game platform designed to transform children's attitudes toward eating and nutrition, while developing the skills they need to become informed consumers capable of making better choices about their own diets. The game is played over an extended period that will typically last weeks. Each day requires a few minutes of interaction, allowing it to be easily accommodated into classroom instruction (see the accompanying unit plan for teachers).

In the game children are given responsibility to make nutritional choices for a virtual pet. Meters showing daily nutritional requirements and limits fill as the player gives the critter food. Each day the meters are reset so they can be filled again. Food may be purchased at a grocer or harvested for free from a garden. Players can get creative by combining foods into recipes, which can be saved and prepared again automatically. Meals of high nutritional quality can be sold for a profit.

Critters who are consistently served more nutritious diets will lead healthier and more prosperous lives. They will earn more money at work (paid daily), and win sports competitions more often. Earnings may be used to buy more food or to decorate the critter's house.

By contrast, critters who frequently exceed their daily limits for fat, sugar, or Calories will grow unhealthier over time. Not only will they earn less money at work, but they will be more likely to

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fall ill and miss an entire day's wages. They will perform poorly in sports competitions. Critters who are fed high-fat or high-sugar junk food will start to reject healthier choices with increasing frequency, creating a slippery slope where poor choices reinforce one another. The underlying theme of the game is that choices have consequences.

Through interaction with the game, children will learn:

The relationship between nutritional choices and physical health.

The broad nutritional attributes of food, and the importance of whole grains and vegetables in their diets.

The nutritional merits and drawbacks of specific foods items. How to read and evaluate nutrition labels critically.

How to choose healthier breakfast, lunch, dinner, dessert, and snack foods.

The benefits of keeping a garden and using it as a source of food.

How the body uses Calories, and the effects of both over-consumption and under-consumption.

The effects of exercise on health, and how an active lifestyle affects daily caloric needs.

As a game platform, Fitter Critters will be extended over time. Starting in Fall 2010, players will be able to:

Use the restaurant to share the meals they've invented with all Fitter Critters players.

Grow more crops in their gardens and assume greater responsibility for their care.

Pair their critters up with other players' critters in sports competitions.

Build additions to their houses, and purchase more functional items with which to decorate.

Visit other players' virtual houses to see how they've customized them.

Personalize their critters and select from a range of character models.

These efforts are all geared toward fostering sustained engagement with a worthwhile educational experience. Ultimately, Fitter Critters is a vivid demonstration how games can be used to effect positive change in people.

Food Buster

Do you know food? Welcome to Food Buster, the game show that asks you to carefully stack food items that don't break our scale. For each round you'll try to find foods with the fewest Calories, least added sugar, and least amount of saturated fat. The fewer the Calories, the more points you'll get. When you're done, you can learn about all of the food items you had available, complete with personalized results on how much exercise it would take to burn off each item. Welcome to the Food Buster game show!

Food Hero

Food Hero is an engaging and exciting game that encourages kids to make more nutritious food choices and become more physically active. The goal of the game is to become a Food Hero by eating right and completing a set of running, biking and swimming challenges.

Eating healthy balanced meals every day helps you build strength. By eating right, you also earn gold which you can use to buy cool props that help you complete the challenges. If you eat too much, you become sluggish and the sports challenges become harder to complete. If you don't eat enough, you become too weak to compete. If you don't eat a balanced diet, you also lose points.

HealthySocial is a non-profit project based at Children's Hospital Boston focused on developing innovative ways for using social networks to promote positive health behaviors and attitudes. We are currently developing social capabilities around the Food Heros application.

Hungry Hiker Build-A-Meal

Expedition Health, a new permanent exhibit at the Denver Museum of Nature & Science, is themed around a Colorado mountain expedition and is filled with interactive physical and digital activities. One of the most popular is HUNGRY HIKER Build-A-Meal, upon which this web application is based. The application ties physical activity with good eating habits in a fun and engaging way, as you build a balanced meal to fuel a hiker to the summit. The message is simple: Eat a variety of healthy foods every day.

According to the USDA, one in three children in the U.S. is overweight, yet getting kids to follow the MyPyramid guide to healthy eating is difficult. HUNGRY HIKER Build-A-Meal simplifies the notion of balanced eating, adds an element of challenge, and allows kids to practice and improve their performance. Here's a hint to improve your HUNGRY HIKER score—and your health: Your plate should be half-full of colorful fruits and veggies. As First Lady Michele Obama says, "Eat the rainbow."

Work It Off!

This mobile application for Android phones teaches children the correlation between the Calories they eat and the Calories they burn.

The user verbally speaks a food (e.g. hamburger) into the phone and is given options to Work It Off!

This application benefits all age groups. It is especially fun for kids because it turns learning about Calories and exercise into an entertaining, interactive game that they can play with their friends.

A.5 DEVICES AND MONITORS

Fitbit Aria Wi-Fi Smart Scale
Bathroom scale that keeps track of progress, uploads to fitbit.com account.
Tracks weight, body fat %, and BMI.
Recognizes up to eight users.
$129.95 on Amazon: http://www.amazon.com/gp/product/B0077L8YFI

Fitbit Ultra Wireless Activity Plus Sleep Tracker
Has an accelerometer to track movement.
Tracks Calories burned, steps taken, distance traveled, and sleep quality.
Discrete enough to wear all day long on clothing.
$99.95 on Amazon: http://www.amazon.com/Fitbit-Wireless-Activity-Sleep-Tracker

Withings – Wi-Fi Bodyscale
All the same features as as Fitbit Aria above.
$159 on Amazon: http://www.amazon.com/gp/product/B002JE2PSA

Kinect with Your Shape: Fitness Evolved software (for Xbox 360)
Fitness Activities for Everyone – Over 90 hours of activities, including Boot Camp, Cardio Boxing, Jump Rope, and Dance classes.
Design a workout tailored to your fitness level, goals, schedule, and preferences.

Motion Tracking provides feedback specific to your body.

Has exercises targeting specific muscle groups: abs, arms, legs, glutes, back, and more.

Share and compete with friends and the global Your Shape community online.

$34.09 on Amazon: http://www.amazon.com/gp/product/B0050SYUAS

Kinect sensor is $109.96 http://www.amazon.com/Kinect-Sensor-Adventures-Xbox-360

Wii Fit Plus with Balance Board

Users can input the amount of time they want to spend on their workouts or select an area for personal improvement, and Wii Fit Plus will suggest a number of diverse activities for them.

Users can mix and match which strength and yoga activities they prefer on a given day.

Users might be asked to run an obstacle course across a series of platforms, zoom across a beach on a Segway x2 Personal Transporter or flap their arms to help their hilarious chicken-suited characters aim for targets.

Players also can see estimates of Calories burned and can even activate a feature that lets them weigh their dogs or cats.

$94.67 on Amazon: http://www.amazon.com/gp/product/B002BSA3EM

TrekDesk Treadmill Desk

Integrated treadmill desk designed to let you walk on treadmill while working

Attaches to almost any treadmill; workspace measures 72 by 34 inches

Includes manuscript holder, three-level file folder; and top telephone/headset stand

Two cup/utility holders; adjusts to users between 5 feet, 4 inches and 6 feet, 4 inches tall

Supports up to 55 pounds of equipment; weighs 57 pounds

$479.00 on Amazon: http://www.amazon.com/gp/product/B002IYRBI0

Bodybugg

Check out the bodybugg® system

One the most recognized brands in Health and Fitness Tracking, the bodybugg Calorie management system is a proven solution in weight loss management. The bodybugg system works by keeping an accurate daily record of Calories consumed vs. burned making it easier to stay informed, make decisions and more effectively manage your weight.

What does it do?

The bodybugg system includes sleek wearable devices that are complemented by a user-friendly web based program. Plus, with the new bodybuggSP™ system, you can get retail-time access to your daily activity through your smartphone* (Android™ and iPhone).

Additional benefits & features

  Uses specialized sensors to track Calories burned

  Manages Calories consumed via a web based program (FREE for 6 months with initial purchase)

  Tracks your steps with a built-in pedometer

  Phone coaching session to help get you started

  PC and Mac compatible

  Runs on a rechargeable battery

Cost: $99.99 at 24hourfitness.com: http://mystore.24hourfitness.com/search.php?subcat=148

BodyMedia FIT LINK Armband Weight Management System

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The technology used in the Bodymedia FIT system has been clinically proven to improve weight loss by 3x

Validated to be accurate; provides the most accurate Calorie burn in the market

Multi-variable tracking using four sophisticated sensors; armband captures over 5000 data points, per minute, to track everything from temperature, sweat, steps, Calories burned and sleep quality, every minute, of every day

Logging meals made easier with pre-loaded foods and restaurant menus; manually enter your own recipes and meals as well

Free iPhone and Android application uses Bluetooth technology to show real-time statistics on Calories burned, steps taken, activity levels and daily nutrition through food consumed

Cost: $149.00 on Amazon http://www.amazon.com/BodyMedia-Armband-Weight-Management-System

Nike+ FuelBand

Nike+ FuelBand tracks your activity through a sport-tested accelerometer. Then translates every move into NikeFuel. Nike+ FuelBand tracks running, walking, dancing, basketball - and dozens of everyday actions. It also syncs up with a motivational web and mobile experience. So put it on and get moving.

It starts with a goal. How active do you want to be? Set your Daily Goal and Nike+ FuelBand tracks your progress, lighting up from red to green throughout the day. Get to green and you've hit your goal.

Make life a sport. Turn every day into a game. Challenge yourself to capture records, reach new milestones, and unlock special achievements. Go on a streak by seeing how many days in a row ou can hit your daily goal.

Track your progress. Sync your Nike+ FuelBand every day to visualize your results. See your peaks, your valleys, and your progress.

NikeFuel counts all the activities of your athletic life. Running, walking, basketball. Nike+ devices measure your moves and turn them into NikeFuel. And since NikeFuel is calculated the same way for everyone, you can compare and compete with anyone.

Visualize Your Progress. See all your activity in rich graphs and charts. Spot trends, get insights and discover things about yourself you never knew before.

Play With Friends.   NikeFuel is calculated the same way for everyone no matter your age, gender or sport of choice. Share with friends to see how you stack up.

Get Extra Motivation.   The more you move, the more NikeFuel you earn. Do more and unlock awards, trophies and surprises.

Share Your Success.   Share your accomplishments with friends and other Nike+ members. Get cheers and since NikeFuel is a universal metric, challenge them to match it.

Cost: $202.58 on Amazon http://www.amazon.com/Nike-WM0104-002-Black-Fuel-Medium

Motorola MOTOACTV

The cutting-edge fitness tracker and smart MP3 player that supports more than 40 activities:

GPS & Accusense

Distance. Pace. Speed. Elevation. Full color maps. From elliptical machines and treadmills to outdoor sandy shores and urban asphalt – we record your every move.

Smart MP3

Which tunes really move you most? MOTOACTV knows and creates your personal high

performance list.

Heart Rate Monitor

Burn more Calories, perfect your interval training, and reach peak performance with our precision HRM.

Calls & Alerts

Now you See it: Facebook, Twitter, texts, calls and weather updates, live as it happens on MOTOACTV

Challenges & Competitions

Want to challenge your family, your friends, or your city to a little friendly competition? Create a race, join a race and see who's at the top of the leaderboard – all at the MOTOACTV Training Portal.

Lifetracker

Every step you take, every move you make, every Calorie you burn – all day, every day.   You do it, we track it.

Cost: $289.99 on Amazon http://www.amazon.com/dp/B007KTQU5I

Basis

Heart Rate…without a chest strap.   Your heart rate is a great indicator of overall health and activity. With Basis, you can see how your heart responds to interesting moments in your day. Special sensors monitor your heart rate and more to calculate the Calories you burn, and how sleep patterns and activities play into your wellness.

Multiple sensors, complete picture.   A 3D accelerometer measures how active you are. Temperature and galvanic skin response sensors provide new insight into how your performance is impacted by events in your day. These factors in relation to your heart rate give you the richest picture of your wellness.

Up-to-date research.   All the information you receive is customized based on your data by our science team's sophisticated algorithms. We're constantly refining and adding to the product based on new scientific research, so you can be sure you're getting comprehensive feedback, always

Your information is safe.   You are in control of your data, so you decide what to share — or whether to share. And we store your data in our highly secure, industry-standard cloud computing infrastructure, so you can be sure that it's protected. Your privacy is important, and we'll take extreme care of your data.

It's stylish.   Designed by the best in the industry, Basis flat-out looks good. Its sleek design will complement your tracksuit, your business suit, your bathing suit, even your birthday suit. It's the perfect accessory, for your diverse lifestyle.

Comfort is key.   Basis was engineered with your comfort in mind, so it won't get in the way. It's ultra-light, so you'll barely notice it's on your wrist. Unlike some other health gadgets, Basis is truly wearable and comes in a familiar form factor that you can customize.

Take it anywhere.   Rain or shine, indoors or out, it doesn't matter where you are — Basis is water-resistant, so it's ready to go with you. And since it can always stay on your wrist, you won't lose it or accidentally toss it into the washing machine with your laundry.

Customizable.   Ready for something new? Just snap on a new band to swap your office look for your evening look, your workout look for your out-for-coffee look, your Tuesday look for your Wednesday look. With upcoming straps in a range of colors, materials, and styles, Basis lets you express yourself.

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Put it on and go.   After a quick setup process, you won't have to waste your time configuring the device or switching between sleep and exercise "modes"—Basis automatically tracks and organizes your activities, and provides you with valuable feedback. All you have to do is wear it.

Track Calories, sleep, and more.   See how many Calories you burn, monitor your heart rate, and learn how sleep and other activities affect those metrics. Basis makes it easy to view trends over time, as broadly or or in as much detail as you'd like. Want to see something new? Just let us know—we plan on adding new metrics based on feedback from Basis users.

Smart, connects to the Internet.   Basis is connected to the Internet so your stats automatically upload to your account via USB (Bluetooth coming soon). The set-up is simple, and only takes a few minutes. Plus, Basis is smart. Using the Internet connection, it's easily updated with new features as they're added. Your Basis is always cutting-edge.

Your health dashboard.   Your online dashboard provides deep insight into all of your daily activities, so you can learn how they affect your overall wellness. Best of all, the basics are totally free. Look for Basis mobile apps in the future, so you can check in on your progress, right from your smartphone.

Stay informed.   The first step to forming healthy habits is awareness. With Basis, you can monitor how your daily activities impact your overall wellness — understanding and listening to your body will help you achieve the best results possible.

One step at a time.   You can't change everything all at once, so Basis will suggest small but significant goals you can target every day and week. And as you progress you'll earn points for all your healthy activities, so you can compare your results to previous weeks.

Share your experience. Learn from others.   Share your achievements with your friends so they can cheer you on as you progress. A little encouragement goes a long way. You can also use the data to give and get tips from other people working on their wellness and trying to lead a healthier life.

Export your data.   Export your data easily to analyze it in more depth as part of our Premium feature set. In the future, we'll also be adding the ability to extend your data to other apps. So, if you use another program to monitor your diet, you can take your Calories burned from Basis and compare it against your caloric intake. And let's be clear—you control sharing your data at all times.

Cost: Preorder for $199 at mybasis.com

Striiv

The first smart pedometer

With every step, Striiv learns your behavior and motivates you to walk a lot more. Striiv creates personal challenges based on your level of activity, so you reach your fitness goals as you move throughout the day. It's fitness, for the rest of us.

There are a lot of fitness programs, but they're not really for you.

You have a busy life and fitting in time to change your clothes, work out and then get back to your daily commitments just doesn't happen. You need something easier, something that works, and something that motivates you.

What if exercise was as easy as walking? Leading studies have shown that walking just 30 minutes a day can dramatically reduce weight gain and the risk of heart attacks, stroke and diabetes. The average Striiv user is walking over 3 miles and 12 flights of stairs every day, for a total of 90 minutes of activity – that burns as many Calories as running 2 miles a day!

Striiv makes walking easy. Striiv motivates you to add thousands of steps to your day: to walk

more, to take the stairs more often, and to reach your fitness goals just by being more active. It turns 10,000 steps a day into playing a game, donating to charity, and competing with friends.

And it fits into your life. With Striiv, fitness becomes an integral part of your everyday life. People who use Striiv take advantage of more opportunities to walk, climb stairs and be more active. Everything about Striiv – from the touch screen and games to the colorful accessories – is designed with fun and positive reinforcement in mind.

Cost: $99.00 on www.striiv.com

Alivecor

AliveCor aims to provide medical professionals, patients, and consumers worldwide with mobile-powered devices, data, and analysis to identify, prevent, and manage life-altering diseases from anywhere in the world.

THE DEVICE As a first offering, AliveCor has developed a clinical-quality, low-cost mobile ECG heart monitor. The device is compatible with the iPhone 4 / 4S and enables patients to monitor their heart health anywhere, at any time, and provides physicians with an additional heart health assessment tool.

Cost: Not yet available, more info at alivecor.com

Wahoo Blue HR Heart Rate Strap for iPhone 4S

Wahoo Fitness Blue HR heart rate strap is the world's first Bluetooth Smart heart rate strap made for the iPhone 4S. This heart rate strap and App combination transforms your iPhone into an all-in-one training device, great for runners, cyclists, and other fitness enthusiasts. The Wahoo Fitness Blue HR heart rate strap connects wirelessly to the iPhone 4S without the need for any adapters and delivers accurate real-time heart rate data through the free Wahoo Fitness App. Additionally, our open API allows other popular Apps, such as Strava, RunKeeper, MapMyRide, Cyclemeter, MotionX-GPS, and 321Run to work with the Blue HR. With the Wahoo Blue HR and your favorite fitness App, you now have your heart rate data, your playlists, your phone, GPS maps and more-- all in one device!

Cost: $79.99 at www.wahoofitness.com

Withings - Blood Pressure Monitor

The first blood pressure monitor for iphone, ipad and ipod touch

Measure your blood pressure in one gesture and all your tracking is automatically done

Detailed results are displayed and the application will provide recommended values, using the iphone display capacity at its best

Cost: $129 on Amazon http://www.amazon.com/Withings-BP-800-Blood-Pressure-Monitor

iHealth Blood Pressure Monitoring System for iPod Touch, iPhone, and iPad

Use with free included ihealth app for monitoring, tracking and storing blood pressure readings

Offers clinically accurate systolic, diastolic and pulse measurements

One-button operation with easy-to-follow touch-screen prompts

Safely latex-free

Simple, Attractive, Elegant interface

Cost: $65.39 on Amazon http://www.amazon.com/iHealth-Pressure-Monitoring-System-iPhone