

Beyond Designing for Motivation: The Importance of Context in Gamification

Chad Richards¹, Craig W. Thompson², T.C. Nicholas Graham¹

¹School of Computing
Queen's University
Kingston, ON, Canada

²Computer Science and
Computer Engineering Department
University of Arkansas
Fayetteville, AR, USA

chad.richards@queensu.ca, cwt@uark.edu, nicholas.graham@queensu.ca

ABSTRACT

Most design advice for the development of successful gamification systems has focused on how best to engage the end user while imbuing the system with playfulness. This paper argues that it is also critical for designers to focus on the broad context of the system's deployment, including the identification of stakeholder requirements, requirements from the hosting organization, deep understanding of the diversity of the target population, understanding of limits in the agency of the target users, and constraints arising from the post-deployment environment. To illustrate the importance of such contextual and stakeholder analysis, the paper presents issues and associated solutions that were discovered through the creation of a children's nutrition and fitness education gamification system. The problems identified through a broad analysis of context significantly altered the design of the system and led to the realization that the initially conceptualized project would have been unusable. The paper concludes with concrete lessons for designers.

Author Keywords

Gamification; contextual design; educational games.

ACM Classification Keywords

H.5.m [Information Systems and Presentations (e.g., HCI)]: Miscellaneous; K.8.0 [Personal Computing]: Games

Gamification, the use of design elements characteristic of games in non-game contexts [9], has become an increasingly popular research area. Gamification provides a novel way to engage users and solve real-world problems in areas such as defense [15], education [18], healthcare [11, 31], and

scientific research [30]. Research into successful gamification techniques has primarily focused on how best to engage the end user [1, 8, 17, 27] using internal (autonomy, competence, and relatedness) and external (badges, point systems, leaderboards, levels, and quests) motivators [1, 8, 17, 27] and how to make the user's activity entertaining through gameplay [8, 19, 22, 25, 31]. In this paper, we argue that in addition to motivational constructs and entertainment value, gamification systems—tools used to gamify activities—need to consider their *context of deployment*. While this is well established in the field of computer-human interaction, context in design has, to date, received little attention in the field of gamification.

To illustrate the importance of context in designing a gamification system, we report on our experience in the design of *Edufitment*, a framework for educating children in nutrition and fitness. For instance, Edufitment was initially intended for deployment in school classrooms. We aimed to improve the diets of the targeted children by teaching nutrition using a game. However, investigations with our stakeholders revealed that 94% of the targeted children were eligible for free or reduced-cost lunch programs. This reduced the children's ability to choose what they ate during school hours. Had we designed the framework as initially intended, there could have been a large disconnect between the types of foods our program taught the children to eat and the types of foods the children had the option of eating.

This represents just one of numerous examples of how information gleaned from stakeholders and from consideration of the context of deployment was critically influential on the design of the system.

As another example, our experts in nutrition advocated that we follow the popular *We Can!* program due to its national support and proven effectiveness [16, 26]. *We Can!*, however, features a policy of reducing screen time for children [26]. To meet this screen time requirement, our stakeholders imposed a fifteen minute daily gameplay limit. This required us to completely rethink the structure of Edufitment, moving from a single, monolithic game to a framework encapsulating a set of smaller, shorter games, each with a focused educational message.

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CHI PLAY '14, October 19 - 22 2014, Toronto, ON, Canada
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ACM 978-1-4503-3014-5/14/10...\$15.00.

<http://dx.doi.org/10.1145/2658537.2658683>

To facilitate a development process informed by broad investigation of context, our team involved experts in nursing, education, statistics, psychology, nutrition, kinesiology, and computer science. As suggested by Rojas et al., external factors, such as context and choice of platform, and internal factors, such as stakeholder requirements and project goals, necessarily make an iterative process out of a complex intervention involving gamification [28]. We followed an iterative process, meeting weekly for brainstorming and discussion sessions. Group members were assigned tasks involving gathering and interpreting contextual information such as which schools should be involved, the makeup of the student body at these schools, and what guidelines should be followed to provide nutritional advice for children. Each member reported their findings and highlighted any issues discovered. A designated member took minutes of the session to record design issues and solutions. These issues were tackled as a group, and we then assigned new tasks to group members.

This paper is organized as follows. We first consider related work in gamification, arguing that research in this area has focused on motivational constructs to support desired behaviors and techniques to enhance the entertainment value of gamification systems. We further argue that considerably less attention has been paid to the context of deployment. We then describe the background of the Edufitment project and briefly describe the design of the Edufitment system. The core of the paper then explores issues we discovered through our investigation of the broad context of the Edufitment project and discusses our solutions to these issues. Finally, we present lessons learned from this investigative process.

RELATED WORK

Gamification is an evolving term that is used to describe the process of taking motivational mechanics from games such as badges, leaderboards, levels and points and applying them in a non-game context. Gamification does not necessarily involve the creation of a game; a leaderboard can easily be added to a non-game activity, such as jogging [6, 11] or managing a to-do list [25]. Reasons for gamifying applications include motivating people to change behavior or develop skills, increasing brand loyalty, or increasing user engagement [4]. The guiding idea behind gamification is that the elements of games that make them engaging will still be motivational if they are moved to a new, non-game context.

To date, research in gamification has mainly concentrated on how to make gamification systems fun and engaging for the end user [1, 17, 27]. Advice is drawn from well-established game design principles. For instance, Liu et al. believe that gamification systems should be designed with fun in mind, through well-designed user interfaces and game-like flow [22]. Deterding suggests that systems should provide interesting challenges, clear goals that are varied and well-paced, and feedback that is presented in a fun and exciting, or *juicy*, manner [8].

An increasing number of gamification systems illustrate this

approach. For instance, CARROT is a gamified to-do list application featuring an artificial personality that boasts being “built around character and story instead of meaningless badges and achievements” [25]. *Zombies, Run!* is a gamified fitness application that features a full game, including a gripping story, and “turns the player’s runs into a post-apocalyptic action hero’s fight for survival” [31]. These examples make use of game design concepts, such as story and flow, to create a playful experience for the end user.

Besides advice to make systems playful, designers have been encouraged to significantly focus on engaging the end user [1, 17, 27]. This follows from gamification’s central premise that using game-like elements can increase participation and engagement in an activity [3]. Bunchball, for instance, believes that the “overall goal of gamification is to engage with consumers and get them to participate, share and interact in some activity or community” [3].

Advice for making gamification engaging to the end user has been grounded in psychology, particularly making use of the concepts of extrinsic and intrinsic motivation from self-determination theory [29]. Extrinsic motivators in gamification are game elements such as badges and points. Intrinsic motivators include autonomy, relatedness, and competence [29]. Gamification systems can provide autonomy by giving players a sense of freedom of play [8]. Mastery is provided when players feel as if they are accomplishing something and progressing toward their goals [8]. Relatedness connects players to the system in a way that plays to their goals and passions [8].

Though the bulk of gamification solutions make use of extrinsic motivators, an increasing number of gamification systems are also taking advantage of intrinsic motivators. For example, gamification has been seen as a way to improve student motivation and engagement in schools, where it can provide cognitive, emotional, and social benefits to students [21]. A successful example of this is Khan Academy, which gamifies education in areas including mathematics, science, history, and economics [18]. To engage the student, Khan Academy makes use of external motivators such as badges and quests. It also takes advantage of intrinsic motivators by allowing players to create their own goals, providing a sense of freedom to the player, and by providing real-time statistics to let the players know they are progressing towards their goals.

Additional examples that make use of these principles include Nike+ and Fitocracy, which gamify fitness. Nike+, used by approximately 11 million people, features a point system, challenges, leaderboards, and ways to challenge friends [6], while Fitocracy employs badges, quests, levels, points, and groups [11]. Like Khan Academy, Nike+ and Fitocracy allow players to create their own goals and provide feedback so that players can achieve a sense of mastery. They also bring together large, like-minded communities to promote a sense of relatedness.

While it is natural and necessary to focus on producing a fun and engaging experience, we argue that a third area is also critical to successful gamification—investigating the context of deployment. No matter how entertaining or motivational the system is, inadequate consideration of broader issues of the deployment environment and stakeholder needs can lead to failure.

For example, when Slalom Computing included a leaderboard with the goal of improving facial recognition between long-distance employees, only five percent participated, even with added incentives [20]. Stakeholder requirements were not studied before applying this gamification system, and the system failed. Thankfully, when this was changed to a group leaderboard using randomly assigned teams, the participation jumped from five percent to ninety due to the fact that employees did not want to let their teams down. But, the initial failure reinforces the idea that these systems should not be applied without forethought. Also, Slalom Computing's initial shortcomings may not have been so easily remedied if it had been applied to end consumers instead of employees, which is the typical case for most gamification systems.

The importance of understanding context will not be surprising to researchers in human-computer interaction. Participatory design, in particular, involves stakeholders in the design process, helping to ensure that their needs are met. For example, participatory design was used in developing a fitness game for children with cerebral palsy [14], with a team involving health professionals as well as the children themselves. This project reported the need to solve issues outside the game itself, including the need to design special-purpose cycling hardware and the need to support home play. However, the use of such design methods in gamification is uncommon.

Gartner, Inc. has identified the dangers of inadequately considering context of deployment, predicting that 80% of current gamified applications will fail, primarily due to poor design [4]. The 20% that are thought to succeed will be those that clearly identify business objectives and provide a thorough analysis of how gamification can fulfill those objectives [4]. This will take a thorough investigation of stakeholder requirements to accomplish. At least one successful gamification company, Bunchball, already follows this advice, beginning each project with a thorough investigation of business needs [7].

Leaders in the gamification area also share concern over the lack of broad context development. Gabe Zichermann, CEO of Gamification.co and Conference Chair of Gamification Summit, notes that corporations have used leaderboards and “employee of the month” programs for motivation for many decades. But, he and others would like to see research into how well gamification elements such as these work. Zichermann admits, “There aren’t any long-term studies that support... broad, context-based solutions because this discussion didn’t start until 2010” [20].

Theories are emerging to support studies that involve organizational context [27], and some researchers even feel that the purpose of gamification is to advance instrumental organizational goals [24]. But, focusing on the organization is still seen as a symptom of meaningless gamification [27].

Thus, there is much room for research into this important, as yet poorly understood, area of gamification. In this paper, we help to fill this gap by reporting on the broad contextual investigation underlying the design of our Edufitment system for teaching elementary school children about nutrition. We report on issues raised by this investigation that significantly threatened the success of the system. We now introduce the Edufitment project, and then discuss our study of its context of deployment.

EDUFITMENT

The goal of the Edufitment project was to combat childhood obesity in the southern United States. Obesity is a particular health challenge in this region, affecting over 40% of the children in our target schools [2]. We focused on children in fourth, fifth, and sixth grades, representing a total of 1,097 children at two elementary schools. There are many ways to tackle childhood obesity, such as providing healthier meals at school and at home and increasing daily exercise by requiring more frequent or longer physical activity classes at school. These and other approaches have already been attempted at the national and state levels, but the problem remains unresolved. Thus, there is significant motivation to find solutions that actually work.

From summer 2011 to spring 2012, our team of experts held collaborative brainstorming sessions that guided the iterative development of the project. Among their tasks, group members investigated and reported on the context of deployment and stakeholder requirements. For instance, our biostatistician was responsible for determining the makeup of the student body, while our nutrition expert researched what food the schools provided at lunch. These investigations were critical to the design of our system, helping us to avoid errors that would have rendered the system unusable in practice.

Through this process, we created Edufitment, a video-game based system for education in nutrition and fitness—the system’s name is a combination of *education*, *fitness*, and *entertainment*. Edufitment is structured around a web-based gamification framework; it can take elements common to games and apply them in a non-game context. The system contains game elements common to gamification, such as experience points and redeemable points, leaderboards, and dashboards. Edufitment shares gamification mechanics between a set of modular serious games and non-game activities performed outside the system, including logging out-of-game physical activity to gain points in the system.

In addition to gamification mechanics, Edufitment contains several useful features. To aid user privacy, the system supports roles, each with its own set of permissions. The

system is multilingual, initially supporting the German, English, Spanish, and French languages. A plugin game application programming interface (API) is provided for first and third-party games to be added into the system. A chat room allows players to connect to one another and spend earned coins by sending customized messages.

To improve diet at home, it is necessary for the child and, especially, their families to understand what constitutes a healthy meal. Our underlying hypothesis was that, consistent with the approaches described in the previous section, children would find gaming to be an engaging way of learning this material. Based on this hypothesis, we used video games to teach concepts related to fitness and nutrition to children, with the goal of affecting diet change and improving activity levels.

Our games build on a rich history of nutrition games for children. For example, *Squire's Quest! II* is a 10-episode online video game that promotes fruit and vegetable consumption to elementary school children [32]. Each episode provides a different mini-game, such as trivia and matching games, and focuses on specific educational goals related to fruits and vegetables, such as understanding portion size [32]. Other initiatives have researched different aspects of nutrition games, such as story immersion [23].

Despite significant research having been conducted around nutrition games, the vast majority of registered dietitians, considered leading experts in nutrition, have not played nutrition games [12]. They do, however, believe nutrition games can be valuable educational tools [12]. This suggests that the nutrition game field has the potential to benefit from the involvement of experts. This paper is, to our knowledge, the first to provide a detailed look at the multidisciplinary development process of a significant gamification system.

The Edufitment framework contains four initial games dedicated to nutrition education, an application for recording any activity performed outside the system, and a proof-of-concept exergame. The nutrition games include a quiz show game similar to *Jeopardy!*, featuring an expandable database of questions and categories. A matching game similar to *Bejeweled* (see Figure 1) helps children understand what types of foods belong to which food group. A hunting game similar to Nintendo Entertainment System's *Duck Hunt* allows for a variety of winning and losing conditions, such as shooting only foods that are high in Vitamin C. A poker-like card game (see Figure 2) teaches the number of Calories that are in different foods. The activity-recording application allows manual entry activities performed outside the game, such as walking or playing sports. Finally, the exergame requires players to keep their heart rate elevated to win. Through its plugin architecture, Edufitment allows additional games to easily be integrated.



Figure 1: Calorie Meter—the Card Game

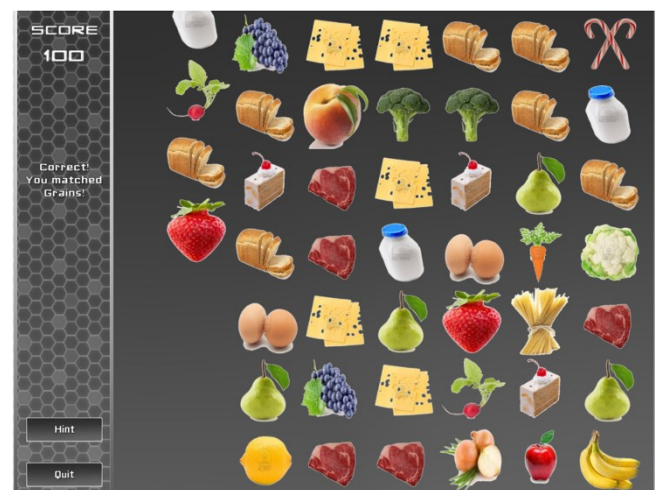


Figure 2: Food Group Match Up

Edufitment is currently a robust prototype, and further refinement and testing of the games will be required before it is ready for broad deployment. The design and development process underlying Edufitment allowed us to understand the critical importance of context in the design of gamification systems. In the next section, we explore issues that were brought to light by our detailed investigations and show how they affected many aspects of the project, including the framework, the deployment environment, and the games developed for the intervention.

THE IMPORTANCE OF CONTEXT IN THE DESIGN OF GAMIFICATION SYSTEMS

The complementary expertise of our multidisciplinary team members permitted investigation of stakeholder requirements, informed by the context in which the system was to be deployed. As we shall see, this process helped identify issues that could lead to significant problems in the deployment of the system. Specifically, we found five key areas where deep understanding of context was critical:

Issue	Example	Solution
Stakeholders may bring critical requirements	Stakeholders followed a nutrition program that advocates reduced screen time	Developed small, short games focused on specific educational messages
Hosting organization may bring critical requirements	School administrators set a high bar for demonstrated efficacy before being willing to allocate class time to intervention	Sought alternative venue for deployment
Target audience may lack means to change behavior	Elementary school children do not typically shop for or make their own food	Enabled parents / guardians to play along with their children
Diverse population may introduce critical requirements	Healthy meals presented by program may not be familiar to the targeted culture	Developed an expandable database of foods, allowing familiar foods to be easily integrated into the system
Addressing post-deployment may reveal key concerns	Team of IT professionals would not be available post system deployment	Developed full-featured, easy-to-use tools to allow new administrators to quickly become familiar with the system

Table 1: Summary of issues discovered and solutions

- The *stakeholders* in the process—for example, educators, experts in nutrition, parents, or the children themselves—may bring requirements that would be hard to predict without their input, but which are critical to the success of the system.
- The *organization hosting the intervention*—in our case the schools and eventually civic centers—may bring critical requirements.
- Members of the target audience may *lack the means to change their own behavior*, requiring designers to identify who has the agency to permit behavioral change and ensure that they are engaged in the intervention.
- The target population may be *diverse*, and some parts of the population may have specific and important requirements.
- The *intervention may last longer* than the availability of the initial research or development team. To be successful, the intervention may require identification and support of stakeholders who will continue the intervention into the future.

In the following sections, we discuss these issues, and illustrate them through our experience in the Edufitment project. A summary of these issues is listed in Table 1.

Stakeholders May Bring Critical Requirements

Stakeholders involved in the project can bring requirements that are hard to anticipate, but that may be critical to the success of the system. It is essential to understand these requirements early, before incorrect assumptions become deeply embedded in the design of the system.

An example arising from our project involves competing requirements around screen time. As mentioned in our introduction, the nutrition program agreed upon by healthcare experts promotes reduced screen time as one of its primary goals, yet our product was to be a video game. This

demonstrates that there are times when two good initiatives can conflict in nonsensical ways, and this conflict must be resolved.

The nutrition program selected, *We Can!* (Ways to Enhance Children’s Activity & Nutrition), is sponsored by the National Heart, Lung, and Blood Institute, the National Institute of Diabetes and Digestive and Kidney Diseases, the Eunice Kennedy Shriver National Institute of Child Health and Human Development, and the National Cancer Institute [26]. It has been successful in schools with similar demographics to our target schools, which is one of the primary reasons this program was selected [16]. The program has helpful tools, tips, and worksheets for parents and caregivers to encourage healthy eating and increased exercise in their children [26]. The problem is that the program also heavily advocates the reduction of screen time exposure for children.

Video games, such as those used in Edufitment, can support the *We Can!* goals of education around nutrition and fitness. But video games are played on a computer, game console, or smartphone, contradicting the requirement to reduce screen time. *We Can!* has only three primary objectives: eat right, get active, and reduce screen time [26]. Our health care experts argued that if we adhered to only two of the three requirements of the program, we would be unable to claim to be following it. The team concluded that the extensive press and positive public feeling about *We Can!* gave us little choice but to adhere to the initiative. Thus, we needed to find a way to reconcile these conflicting requirements, rather than considering our system to be an exception to the screen time requirement.

We solved this issue by imposing a system requirement that games must be playable within fifteen minutes. This required us to reconsider our original plan of creating one large game, instead creating several smaller, modular games that each

addresses one focused area of knowledge. For example, the match-up game addresses the single question of understanding food groups. The requirement for games to be modular led to the development of a flexible and extensible gamification framework that can accommodate and link many games. This, in turn, allowed us to target different areas of knowledge, age groups, genders, ethnicities, and skill levels, and allowed us to add new games to the framework.

To further emphasize our support of *We Can!*, we provided an additional application as part of the suite of games that granted players the ability to record any activity performed outside of the game and to view the progress of that activity over time (e.g., if 20 push-ups are entered today and 25 the next day, they could see this on a graph).

These two solutions, developing short games and including an application that recorded activity performed outside the system, allowed us to adhere to the *We Can!* initiative and to the requirements of the stakeholders. Had this requirement been discovered after development, complete re-design and development of the game might have necessary, and the collaboration between the technical and healthcare team members could have been put in jeopardy. Stakeholders are not the only ones that can bring critical requirements to the gamification system, though. In the next section, we will demonstrate that the organization hosting deployment may also bring its own requirements that affect the development of the system.

Hosting Organization May Bring Critical Requirements

Initially, the system was targeted for deployment in classrooms or computer labs at schools. Target schools had been identified based on their demographics and proximity to the research team. We reasoned that delivery of the intervention within a school would help ensure a large degree of participation and would have given the children a convenient place to use the system. There is evidence that using educational games in schools can be advantageous, since gamification can promote classroom engagement and provide useful tools for teachers [21]. However, gamification can also take up valuable time and teaching resources and can promote to students the notion that external rewards are expected if they put forth effort to learn [21].

Ultimately, however, the school administrators were hesitant to fit use of the system into an already busy school schedule. They set a high bar for demonstrated efficacy before being willing to allocate class time to the use of Edufitment. This made the idea of deploying only in classrooms or computer labs at schools infeasible until trials had been successfully completed elsewhere, and as such, we needed to consider other venues.

We identified two free, school-based civic centers that were already highly popular with students and provided many services, including an on-staff nurse. Further investigations at the schools and the civic centers, though, led to the

discovery of issues with the ability to effectively reach the target population, which will be discussed next.

Target Audience May Lack Means to Change Behavior

The core strategy underlying Edufitment was that increased knowledge in nutrition would lead to improved eating habits. Members of our target population of elementary school children typically do not shop for or prepare their own food, and so have limited choice in what they eat. Our team's investigations revealed that our target children may consume much of their daily Calories at school and at the civic center, and even in those venues, their choices are limited in a negative way.

Our intervention was particularly directed toward at-risk and special-needs populations. We discovered that approximately 94% of the children (1,097) being considered for deployment of the system were eligible for free or reduced-price lunch programs at school. Unfortunately, Gunderson et al. have shown that children in the National School Lunch Program receive a large portion of Calories from fat, which is associated with obesity [13]. This could result in a mismatch between the types of food provided at school lunches and the types of foods our system teaches the child to eat.

Additionally, the civic centers under consideration for hosting Edufitment provide food, but this food is not of the healthy form advocated by our program, again potentially undermining our educational program. To help improve the food provided at the centers, we reached out to Feed Fayetteville [10], a group dedicated to providing healthy food to the community. We soon realized that despite the desire to help of Feed Fayetteville, it would be difficult to raise the necessary funds to change the food offered to the approximately 1,100 children targeted by the intervention.

Since we could not change diet at the schools or civic centers, this left the home as the final area to influence nutritional choices for meals. Because children do not typically make their own meals, it was considered important to reach the children's families. The idea was to provide "stealth" education for parents by having them play along with their children in order to promote a positive change in the children's meals at home. This posed a problem, however.

Contrary to our expectations, we found that children who attend the civic centers after school are not typically accompanied by family members; therefore, children would not play with parents/guardians at those locations. While we wanted to host Edufitment at the civic centers in order to introduce the children to the games, we realized that it was going to be necessary to allow home play as well, to allow the parents/guardians to take part.

Thus, as requirements became clear, our vision of the system evolved from a standard PC-based application that could run on school computers to a centrally hosted online deployment that could be accessed both in the civic centers and at the children's homes. Computers with internet access would be

available at the civic centers, supporting the choice of developing a web-based application.

Since our intervention was now targeted at involving parents and guardians in the home, we continued to investigate the home environment and discovered issues related to the diversity of our population.

Diverse Population May Introduce Critical Requirements

Diets differ from home to home, impacting the form of dietary suggestions that our system should make. Investigations of the target population led to the discovery that approximately 72% of students (837) being considered for deployment of the system were of Hispanic ethnicity. Analysis of public school student BMI data for a 5-year period in the targeted area shows that 36% of Caucasian children in grades K, 2, 4, 6, 8, and 10 are classified as either overweight or obese. As discouraging as this is, nearly half (48%) of children of Hispanic ethnicity are classified as overweight or obese in the same grades [2]. This suggests that diet may vary between the populations [5].

It was therefore important for our system to account for possible differences in diet due to culture. We wanted to influence at-home diet, changing the foods selected at home to healthier options. The diet suggested by our intervention, however, must not be so different from the participants' cultures that it has no chance of being accepted. Thus, we needed to find ways to suggest modifications to the participants' current diets that would be beneficial to their health but would also be within a familiar palette of food.

For example, a game might present, as an example of an unhealthy meal, traditional southern fare of fried chicken with macaroni and cheese, collard greens, breaded fried okra and cornbread. This may be a staple diet for some, but might not be a common main course of a Hispanic family. Taking into consideration the family's palette, a healthy meal recommendation might consist of a quesadilla using a corn tortilla filled with chicken, avocado, chopped onion, tomatoes, and cilantro. In order to allow healthier choices to be made from foods conventional to the families, we developed an expandable database of foods, containing names, images, and nutrition information of each food. This database was shared between all the games developed, allowing familiar foods to be easily integrated into the system.

Along with potential diet differences, language barriers may exist at the children's homes. Though only 7.1% of Arkansans ages five and up speak or hear a language other than English at home, in the targeted area, this number increases to 38.7% [33, 34]. Since we intended that families would play the games alongside their children, our system needed to ensure that language was not a barrier.

To provide a potentially more familiar language at home and to prevent any potential barriers to using the system, extensive attention to localization was prioritized early in the development of the gamification framework. Although

multilingual capabilities were an eventual goal, the investigation of the children's home environment changed this to a high priority of the system. This led to the integration of multiple languages within the framework (English, Spanish, French, and German), using a flexible mechanism allowing simple future extension to additional languages.

Addressing Post-Deployment May Reveal Key Concerns

With development and deployment issues addressed, our teams began to investigate post-deployment concerns. Our development was performed by students in computer science and computer engineering programs, limiting our ability to provide a technical team to support the system post-deployment. We wanted to enable third-parties to add modules to our system in the future. We also knew that our target population was children, introducing particular sensitivities around privacy. Each of these observations led to issues that could affect post-deployment success had we not identified them during the development process.

Though our technical team would be available for modest ongoing support, it was not expected that a team of IT professionals would be available to provide expert-level support to the system once deployed. Having such a team available to maintain the system would significantly raise deployment costs. This led to two requirements. There would need to be stakeholders (such as teachers, members of the civic centers, or volunteer healthcare professionals) to take on the role of administrator, and administrative features would need to be developed to facilitate this role.

One of the difficulties of having a stakeholder act as administrator is that this is an add-on to their already existing job, limiting their available time [21]. To address these requirements, we developed administrative tools with ease-of-use as a primary goal. For administrators, a dashboard was created to view participant progress and allow participants to be added, modified, or removed from the system. Also, several games provided easy support for extensions, such as the Quiz Show Game that provided the ability to add new categories and questions. To remove additional constraints of the administrator role, features were provided to participant accounts so that they could easily change personalized settings such as their preferred language or system of units.

A second observation for a post-deployment Edufitment was that we wanted to allow third-parties, given approval, to be able to add additional games to the system. To address this requirement, a plugin game Application Programming Interface (API) was developed. This API provides access to the framework's features, and provides secure access to user data. Features provided by the API include the ability to submit a player's score, to submit game metrics measured after a round of play, and to retrieve language translations for the game.

One final observation, that our target population is composed of children, means that precautions must be taken by our

system to keep the children's data private. Roles were developed with varying levels of access to user data. This prevents the general public or malicious parties from being able to access personal data of a child in the system. In all, seven roles were defined: administrators, developers, healthcare administrators, school administrators, teachers, students, and players.

LESSONS LEARNED

We have argued that understanding the context of deployment is a critical aspect in the design of a gamification system. We view this as the third important pillar of design, in addition to a consideration of user engagement and the entertainment value of the system. We have argued that this third pillar has to-date received comparatively little attention. Our examples from the design of Edufitment show just how significant requirements drawn from contextual analysis can be, and that a poor understanding of these requirements could lead to ultimate failure of the system during deployment. We now reflect on the lessons learned from this design exercise and on how these lessons might apply more broadly.

Design should be interdisciplinary and participatory. Human-computer interaction has long taught that it is important to include stakeholders in the design process, not just as people being consulted on occasion, but as full-fledged members of the design team. Our experience shows that in gamification, this advice is particularly important.

Through our development, we found that the set of people whose input is required in a design process can be extensive. End users are required for testing of the entertainment value and persuasive properties of the games. Domain experts are required to set requirements for the intervention and ensure that the content of the system is appropriate. Representatives of any organization hosting the deployment are required to participate; in our case this included members of the schools' administration and representatives of the civic centers. Experts with a broad understanding of the target users are required to ensure that the full diversity of the user group is captured. In cases where long-term support from the development group may not be available, champions must be identified who can help plan how the system will be deployed and maintained over time.

This leads to a concrete recommendation that members of the design team should be aware of HCI processes, such as participatory design, contextual analysis, and stakeholder identification and analysis, and should use these approaches early and throughout the design process.

It is important to foster positive collaborative efforts by ensuring the goals of the system and stakeholder objectives are aligned. We observed that requirements from some stakeholders may not be obvious to other stakeholders and may, in fact, conflict. We saw this in our design where the team of healthcare experts was committed to following the *We Can!* program, which limits daily screen time. This conflicted with the initial idea of having a single game that

encompassed a large portion of nutrition and fitness knowledge. We resolved this by developing a suite of games that could be played in short bursts and were tied together by a central, shared gamification framework.

This example illustrates that two good initiatives can sometimes conflict. Design of a gamification solution, must, therefore be open to compromise, and designers should be careful not to inflexibly commit to a particular idea too early. Designers must be willing to adapt to stakeholder objectives and should seek ways to resolve conflicts that are satisfactory to all parties involved.

It is important for gamification systems to align with the objectives and constraints of the organization hosting deployment. In addition to stakeholders, the organization hosting deployment can bring forth its own set of critical requirements. In our case, these requirements were so stringent that we chose to change venues altogether, from the schools that we had initially targeted. It proved difficult to fit the system into an already busy school schedule, and the system needed to prove its efficacy before administrators would consider modifying the school schedule. Our solution was to use venues already popular with the target audience for deployment, school-based civic centers combined with home deployment.

Hosting organizations may not perfectly match the requirements of an intervention. In this case, it may be that the best that can be done is to identify and be aware of any such issues. For example, food available to children attending the civic centers was not of the healthy form that is recommended by our Edufitment system. Also, children attending the centers were usually not accompanied by their parents/guardians, and therefore do not receive the benefit of their families learning along with them. In any deployment environment, it is important to ensure that the requirements of the hosting organization are thoroughly researched so that the gamification system can effectively align itself with the organization's goals and constraints [4].

It is important to understand and work with the limitations of the target population. A population identified as the target of an intervention may have characteristics that significantly affect its ability to respond to the intervention. These could include access to computers and internet, physical, cognitive and linguistic abilities, ability to travel, or restricted availability due to work, scholastic, or family obligations.

Our target population, children in elementary schools, had limited ability to affect the desired change in diet on their own. For an intervention such as ours to be successful, nutritional education needs to lead to change in actual diet. Barriers to this change are that children do not typically make their own meals, the children we targeted had limited dietary options at school due to eligibility in free or reduced-price lunch programs, and the food available at civic centers was not consistent with the goals of our program.

We addressed this problem by enabling home-based play of

the games, to encourage parents to play along with their children. This required us to develop the framework and suite of games for web-based online play, supporting access at schools, civic centers, and home.

Other target groups could have similarly restricted agency; for example, meal planning may be restricted for populations such as prison inmates, members of the military, university students on meal plans, or people residing in retirement homes. It is important when designing gamification systems that aim to affect behavioral change to ensure that the target audience is actually capable of affecting the desired change, and to adjust the intervention in cases where it is not.

It is important to be sensitive to cultural differences within the target population. People's culture can influence their likes and dislikes, their frame of reference, and therefore may influence their engagement with a gamification system. Thus, it is important for designers to understand the cultural makeup of their target population and to be sensitive and inclusive in their design to how culture can impact the success of their system.

We found that diets differ significantly between homes within our target population, and that significant numbers of our population use languages other than English at home. We solved the issue with diet differences by including an expandable database of foods shared by our games in case, for instance, our targeted population is more familiar with foods such as sopas or barbacoas than poutine or sushi. To reduce language barriers, we prioritized multilingual capabilities early in the development of the system.

When designing any gamification system, it is important to understand that differences like these may exist within the target audience and to be sensitive to cultural differences. For example, gamifying a business that sells flowers may need to take into consideration that sending a red flower could be considered a romantic gesture in one culture but could be associated with death or funerals in another.

It is important to address post-deployment concerns during the development process. It is essential to investigate post-deployment concerns before deeply entering into the development of a gamification system. For example, our system relies heavily on the notion that a champion could be identified to take on the role of administrator post-deployment. It was therefore necessary to develop simple, yet powerful, administrative features that could be used by people with limited technical skills and limited time. To prevent malicious third-parties from tampering with children's data, we developed security layers that prevented unwarranted access to data and identified the party connecting to the framework. Finally, since our target population consisted of children, privacy was of high concern. Roles were developed with varying access to data so that malicious parties outside the system would not be able to easily access the children's data.

In general, it is important to consider who will maintain the

system post-deployment. Will there be a team dedicated to troubleshooting players' problems and providing routine security patches, or do members of the target community need to take on these roles? It is also important to consider how the system can handle expansion. Systems can grow stale if they are not readily changed or if content remains static. There should be a plan in place to handle the addition of extra content to keep players engaged with the system. Finally, it is important to determine how the privacy of players will be addressed. Player privacy is a critical concern when gamifying. It is essential to investigate what types of data need to be passed from the players to the stakeholders, to determine who will have access to this data, and to inform the players about the types of data being shared.

CONCLUSIONS

Gamification is used to motivate users, and most of the research performed in the field to-date has focused on how to accomplish this. We have argued that in addition to considering the fun and engagement of the system, designers must also be concerned with the broad context of deployment and the stakeholder's requirements. We have provided examples showing how a process considering such context can lead to the discovery of significant problems that may not be found when focusing solely on user engagement.

Specifically, we identified that it is important to consider the requirements of both the stakeholders and the organization hosting the eventual deployment of the gamification system. We argued that the target population may have unexpected limitations on their ability to carry out behaviors advocated by the system. We have shown that it is requisite to identify who does have the necessary power and also engage them in the intervention. We discussed issues that can arise from diversity in the target group and considered the importance of planning for post-deployment maintenance of the system.

ACKNOWLEDGEMENTS

We would like to acknowledge the hard work of Taylor Yust for helping develop several of the games and to the multidisciplinary team of experts who made this project possible:

Jamie I. Baum, Nancy J. Smith-Blair, Karee Elise Dunn, Denise Garner, Marie-Rachelle Narcisse Jean-Louis, Kelly Vowell Johnson, Adrienne Shaunfield, Kristen N. Jozkowski, Marcia A. Shobe, and Angela Smith-Nix.

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