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Leveraging Health and Wellness Platforms to Understand Childhood Obesity: A Usability Pilot of FitSpace

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***Abstract*— The rates of childhood obesity are at an all-time high, both domestically and around the globe. In an effort to stem current trends, researchers have looked to understand the components of effective and sustainable interventions. Although obesity interventions have often focused on a single lifestyle factors such as activity or nutrition, recent focus has shifted to a broader set of interventions that address multiple aspects of a child's life concurrently. Yet, despite promising outcomes, an understanding of what drives the success or failure of an intervention for a specific child is not yet well understood. To this end we have designed FitSpace, a web-based health and wellness platform designed to help understand how goal setting, activity, and nutrition patterns are tied to a child's social-demographic profile and their overall success in achieving sustainable healthy behavior. The work presented here represents the first step in our research, detailing a usability pilot study of the platform run in partnership with a local high school.**

I. Introduction

Over the past two decades the rate of childhood obesity has reached near epidemic levels [1]. In the United States, data from the 2007-08 National Health and Nutrition Examination Survey indicated that approximately 17 percent of children ages 2-19 were obese, and despite isolated improvements these numbers have only continued to rise [2]. Obesity represents a serious threat to the health and wellness of millions of children. In particular, obese adolescents are at greater risk for both physical and mental health conditions, and have been shown more likely to become obese adults, exacerbating many long-term health conditions [3].

Unfortunately, addressing this epidemic is not as simple as acknowledging its existence. Childhood obesity is a multifaceted problem, driven by the complex interactions of biological, behavioral, social, environmental, and economic factors and their relation to energy imbalance [4]. These factors, known as a child's socio-economic circle, have been the focus of many targeted obesity interventions such as those aiming to increase physical activity or improve nutritional awareness. However, with little progress on sustained improvement, leading health organizations, including the World Health Organization, have recommended the use of more comprehensive intervention approaches [5].

With a growing body of research that suggests many factors, including home influences and the school environment, can contribute to obesogenic environments, these broader interventions, often referred to as collaborative impacts, have been markedly more successful [6]. Yet, the way each factor contributes to the overall effectiveness of an intervention for a specific child remains poorly understood.

Our research intends to address this lack of understanding, aiming to provide insights into the drivers of success or failure for sustained behavior change. Such an understanding can in turn permit those executing interventions to personalize them. Moving beyond best practices dictated by age and sex, and providing the ability to tailor exactly which activity, nutrition, and goal combinations are most likely to be completed by a specific child.

Accomplishing this goal requires two specific actions. First, the creation of a platform to help children track physical activity and nutrition, providing feedback of their daily and cumulative progress. Second, to analyze the platform usage patterns, intervention content, and user demographics themselves to understand the relation between these elements across various population subgroups. The work discussed within this manuscript represents the first step in meeting this goal, outlining the design and usability pilot study of a web-based health and wellness platform, FitSpace.

The manuscript begins with a comprehensive review of the FitSpace platform. Walking through the functionality, interface design, and types of data collected by each component. We then shift our focus to a pilot study of FitSpace run at a local public high school. Using an informal user survey completed by students at the completion of the pilot, we provide insight into their reported experiences, highlighting unexpected challenges and possible takeaways. We conclude with a reflection on the study and a discussion of next steps.

II. Related Works

As childhood obesity establishes itself as a point of concern at a global level, researchers have begun to explore how we as a society can address this epidemic. There exist a number of curriculums and interventions developed to promote children's understanding and involvement in healthy behaviors. These include general activity and nutrition programs (Spartners for Heart Health), those which target obesity directly (FitKids360), and those which aim to influence healthy lifestyle behaviors of children at the community, school and family levels (SWITCH) [7]–[9].

Although these programs have shown success through the use of formal lesson-plans and programming, the decision to utilize a web-based platform was grounded in the research of Silverstone and Teatum who note that current generations are

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"hard-wired to technology" [10]. Looking to "capitalize on flexibility, speed, and lower participant burden," there has been a significant effort to understand the place of these electronic and mobile health interventions in addressing the complex factors around childhood obesity [11], [12].

As researchers look to create more relevant content for an increasingly tech-savvy and younger target audience, an emerging subset of works have focused on the use of gamification as part of obesity intervention and education initiatives [13]. Although promising in the ability to target interventions to children, reviews of the area suggest "substantial amounts and improved quality of research" are required to understand how these techniques can be utilized most effectively to address health behaviors [14].

Perhaps, at least currently, a more promising element of digital interventions is their ability to provide "immediate and contextualized feedback" [15]. As web-based and mobile studies become increasingly popular, the ability of these platforms to tailor the content and experience to a user is one of the most common aspects among successful studies [16]. A general study by Anderson-Bill et al., noted that the success of web-based interventions may at least in part "depend on the extent to which they provide a platform for setting goals, planning, tracking, and providing feedback on targeted behaviors" [17]. It is these ideas of context and feedback that guided much of FitSpace's development.

Finally, we would be remiss in failing to note a number of commercial fitness and nutrition tracking tools such as LiveStrong and MyFitnessPal [18]. Although these tools are highly functional, their lack of open-source implementations precludes the ability to collect data at the granularity needed for the broader goal of understanding best practices.

III. Platform Functionality

The FitSpace platform can be broken down into three primary components, focusing on elements of 1) activity and rest, 2) nutrition and hydration, and 3) community.

A. Activity and Rest

The initial component of the FitSpace platform focuses on the ability to track physical activity. Activities can be logged on either a per-event basis, intended capture events such as a pickup basketball game, or by allowing the child to set a specific goal. Goals can represent a one-time action, by setting an activity, quantity and a date by which to complete the goal. Or a recurring action, which allows a standing goal to automatically reset at an interval of the child's choosing.

The activity list was initially populated with common sports and workouts, and later augmented with gym modules and extra-curricular activities available at the pilot school.

Fitspace also provides the ability to track rest in the number of hours slept the previous night. Rest can logged directly, or computed automatically by entering the time the child went to sleep and woke up.

B. Nutrition and Hydration

The second component of the FitSpace platform focuses on the ability to record and summarize the nutritional profile of the foods and beverages consumed daily. Nutrition tracking is broken down by meal, and allows children to search and track items through an extensive list populated from the USDA National Nutrient Database.

Extending the ability to track each meal, a child can set a nutrition goal representing an aggregate of their daily food intake. The default goal style allows children to track their consumption against a desired percentage of three macronutrients (proteins, carbohydrates, and fats) displayed in the form of a pie chart. More advanced children can opt to set specific gram intake goals for each of the same macronutrients, with their consumption reported as a bar chart. Finally, should neither type of goal be suitable, they may also opt to set a specific calorie goal for each day.

Aware of the challenge in estimating serving sizes, we focus primarily on capturing the types and frequency of food consumed. To simplify tracking, all items are defaulted to a single serving with the option to specify additional servings should the child wish to provide that level of detail.

C. Community

The third component of the FitSpace platform centers on the social aspects of the child's life. With respect to their direct social circle, children can associate with others on the platform as friends, and affiliate with teacher-moderated groups to provide a central information hub for their classes. While in a broader sense of community, a calendar feature allows school administrators to upload details about upcoming activities and events. Children can RSVP to show interest and to receive a reminder on the day of the event.

FitSpace also provides a set of community elements designed to engage children within the platform. These include the opportunity to earn badges based on their activity and overall usage of the platform, private journaling, and an automatically generated newsfeed, where children can view when friends reach goals, earn badges, and attend events.

Extensive privacy controls allow the child to dictate exactly what information is shared on friends' newsfeeds.

IV. Interface and Data

Fig 1 presents a snapshot of the FitSpace interface. The core functionality is contained in the center column, where children can set and track their activity, nutrition, sleep and hydration throughout the day. The left-hand column provides access to the calendar and profile containing their friends and groups. While the right-hand column holds the news-feed and access to recent journal entries.

Within the goals panel, children can view and quickly track progress towards their three most recently created activity goals as well as create new goals. They can also view their nutrition goal aggregated across meals tracked for the current day. An additional screen provides access to all active goals for tracking, from which goals can also be deleted.

Also provided on the activity panel is the *Week at a Glance* function. Here children view a summary of their progress for all current goals over the past week, as well as an overview of the most frequently tracked nutritional items for each meal.

Moving to the nutrition tab, we find a visual overview of breakfast, lunch, and dinner for the current and previous day. Each meal is presented as a pie chart with sections representing the percentage of the three macronutrients consumed. Clicking a pie chart opens a tracking screen for the respective meal. This provides an interface to add, remove, and update servings for food items, as well as a table containing more detailed nutritional data on each item tracked.

The lower panel provides the functionality to track a one-time activity and rest. Historical one-time activities are displayed in a table in reverse chronological order, and the total hours of rest for the past 7 days shown as a line chart.

Fig. 1. Snapshot of the FitSpace Interface

A. Technical Design

To ensure the highest levels of compatibility, the platform was built as a responsive webpage using only JQuery, HTML, and JavaScript. All database operations were performed through PHP and executed on a MySQL database.

With a child population, security was a primary design consideration. All data was provided securely using HTTPS/SSL, and all passwords salted and one-way hashed.

Data was stored in a de-identified manner behind a firewall at the Notre Dame Center for Research Computing. This was made possible as students did not use their name during registration, but a username of their choice. The mapping of students to their usernames was maintained by the teacher, and was not provided to the research team.

B. Data Captured

At the most fundamental level, timestamps were recorded for all actions, including when children logged on, created goals, tracked activity and meals, etc. However, beyond this, the platform passively captured a significant amount of data pertaining to aspects of utilization and progress.

For each one-time activity, information about the type and quantity were recorded. While for goals, this information was extended to include if and when the goal was completed and the amount of progress made each time it was tracked.

Similarly for nutritional tracking, detailed micro- and macro- nutrient data were extracted from the USDA database for the foods and beverages logged with each meal. We were also able to capture to what degree these items aligned with a childs nutrition goal, and how often these goals were altered.

Finally, a CRON job captured nightly snapshots of the database, providing the ability to look retrospectively at any data element leading up to, and during, periods in which a child was more or less successful in achieving their goals.

V. Pilot Study

While this work discusses the results of a single pilot study, FitSpace was launched twice. First at a local charter school, where just prior to launch the teacher running the pilot left the school. Rather than scrap the effort, we decided to launch FitSpace as an alpha test. Students were given access to the platform to find bugs, but there was no requirement of use from the new teacher and no user data was collected. This paradigm proved effective, allowing us to address issues as they were found without corrupting research outcomes.

Taking our experiences and updated platform, we then launched a formal pilot program at a local public high school. The pilot was run as part of an Advanced Health class elective, which consisted of 9 students ranging from sophomore to seniors. As an additional benefit, the high school provides each student with a laptop their freshman year, which ensured they could all access the web-platform.

It should be noted; citing concerns over the potential to promote bullying, the high school administration requested we disable student-to-student messages. However, teachers could still utilize messaging within their moderated groups.

Prior to both launches, consent was obtained by all students and parents, using the study and consent documentation approved by the Notre Dame Institutional Review Board.

VI. Results and Discussion

At the conclusion of their term, students were given the opportunity to take an informal user survey consisting of 11 questions. In accordance with the pilot nature of this work, the survey focused on the students use of the FitSapce platform and their perceived utility it's features. The initial 8 questions asked students to rate each feature a scale of 1-10, and provided a free-response box for additional comments on their use of the feature. The final 3 questions allowed for more general open-ended responses about potential additions or changes to the platform. In total 7 of the 9 students returned the survey, however one student's responses were removed as they provided no useable feedback.

Looking to the features with the highest utility rating, we find they centered around the goal setting functionality, with activity goals and nutrition goal functionality receiving average scores of 7.2 (σ: 2.7), and 6.5 (σ: 2.7) respectively. We find it particularly affirming that students felt the breadth of goal types were sufficient to capture their activity and nutrition use cases, with an average rating of 6.8 (σ:2.4).

Moving to the features with the lowest rating we find that almost unanimously the lowest rated item was the newsfeed (μ:3, σ: 2.1). This is understandable, as without messaging the friends functionality was rarely utilized, resulting in the newsfeed only highlighting the students own actions. This was closely followed by the social media components (μ:4.5, σ:3.8), likely for much of the same reason.

Beyond the raw utility scores, perhaps more telling of the students experience in the pilot were the insights and observations captured through their written responses to the final three questions. By far the most consistent comment across the responses was the request to provide FitSpace as a mobile application. Although the webpage was responsive, its use on a phone was somewhat hampered without a mouse. We have since implemented a mobile interface for the platform, designed to better respond to the intricacies of touchscreen interactions and small screen sizes.

Additionally, one comment which stood out requested "an online calendar to help schedule and organize your goals." As students can track multiple goals concurrently, an overview of the upcoming week, highlighting timelines to their future goals may provide some students greater motivation.

Finally, perhaps most encouraging, we found comments which suggest that tracking helped make some students more self-aware, with one student noting "It makes me push myself," and "I have started paying more attention to how many calories I consume and how I'm going to burn them."

VII. Challenges

Often it is the unforeseen challenges that result in most formative learning opportunities over the course of a user study. FitSpace was no exception, encountering two primary challenges in the technical aspects of nutrition tracking and social aspects of integrating the platform into a classroom.

1) Nutrition Tracking: The initial challenge stemmed from the complexity of selecting specific food items. We found that students who purchase food, or were provided food based on economic need, had difficulty tracking as they often were unsure of exactly what they were eating. Looking to the survey responses, students indicated a desire to simply select the items they picked from the cafeteria, without the need to know specific food types.

Further, one student whose survey indicated they were gluten-free remarked that they would like to track "things like rice-based snacks." While we were able to find such foods in the database, they are often listed with unintuitive description formats i.e. *rice cake, cracker-type*. Suggesting that although the USDA food database is complete, we must improve the ease in finding these specialty items.

2) Classroom integration: The second challenge focused on how the platform was used during class time. Watching during a check-in visit, we noticed that coordinating the class to take out laptops, navigate to a webpage, and login took almost longer than the time for students to log their data. From a design perspective, the streamlined nature of tracking could be perceived as a success. Yet, the resulting empty time created around logging suggests that, to be sustainable for long term use, a greater effort must be placed on integrating FitSpace into established classroom workflows.

VIII. Conclusion and Next Steps

We believe the overall experience of the pilot represents a strong first effort in the platform's development. The survey responses and highlighted challenges provided immediate and actionable feedback from which we can advance the ability of FitSpace to measure student's daily and cumulative progress. Further, we have continued to refine and improve the platform, exploring ways to increase the precision of the data captured, such as the ability to link wearable devices.

The next phase of the project will deploy FitSpace to a larger setting through which we can collect and evaluate data regarding the broader objective of understanding the types of goals, activity and nutrition patterns indicative of success across varying demographics and interest profiles.

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