Bloom: Fostering Healthy and Peaceful Pregnancies with Personal Analytics

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Abstract

Bloom aims to foster healthy and peaceful pregnancies by motivating expectant mothers to sustain beneficial habits and behaviors. It minimizes risk factors by providing daily goals that adapt to the changing needs of the expectant mother over the course of pregnancy and maximizes peace of mind by offering tools that augment self-awareness and facilitate enriched communication between the medical and expectant mother communities. The present study details an iterative research and design process that explored how persuasive design characteristics could be employed to encourage self-monitoring and motivationally sustain healthy behavior in expectant mothers.

Author Keywords

Quantified Self; Self-Monitoring; Self-Tracking; Body Data; Persuasive Design.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous. See:

Introduction

Ninety-four percent of pregnancies in the United States are affected by complications [1]. Figuring centrally
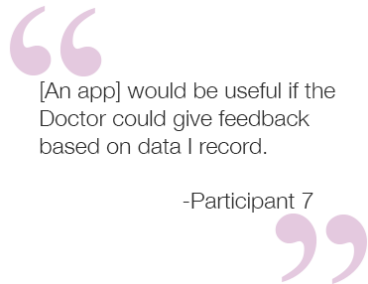
into the development of many of these complications are factors like improper nutrition, weight, activity, hydration, and symptom reporting and management. These factors are associated with conditions that seriously threaten healthy pregnancies, including gestational diabetes, preeclampsia, and hypertension in the mother and limb abnormalities, premature labor, caesarean birth, and macrosomia in the prenatal infant.

Knowledge campaigns and professional prenatal care represent society's chief approaches to sustaining healthy pregnancy habits and promoting awareness. However, these approaches alone have not entirely minimized pregnancy complications. This is due jointly to disparities among the population in accessibility to prenatal care and differences in beliefs about the value and credibility of medical guidelines [2].

Although most women accept the responsibilities of pregnancy advocated by medical authorities - such as maintaining healthy habits, being transparent with medical staff and attentive to their bodies - they often act on these responsibilities with information and guidance offered by their immediate social networks [3, 4]. Expectant mothers' social networks instill peace of mind and are persuasive because they are highly accessible, emotionally supportive, and rich in open dialogue unlike interactions with medical staff where information is delivered authoritatively and abruptly [3]. Problematically, however, information circulated within these networks is often derived from the Internet where misinformation, wives tales, and undue skepticism about medical guidelines often predominate.

User research we conducted confirmed these themes in the literature and provided deeper insight into their

> "[An app] would be useful if the Doctor could give feedback based on data I record.
>
> -Participant 7

causes. Although all expectant mothers expressed interest in maintaining healthy pregnancy habits, they cited the following as obstacles: inadequate communication with prenatal care staff about appropriate self-monitoring, the absence of a centralized resource for daily goals derived from credible guidelines, and the absence of a robust self-monitoring tool.

Therefore, technological interventions designed to promote healthy behaviors in expectant mothers must aim to: enrich communication between prenatal care staff and expectant mothers, integrate and parse medical guidelines into manageable goals, and motivate, incentivize, and sustain behavioral change by supporting self-monitoring.

Design Goals

We seek to foster healthy and peaceful pregnancies by implementing a system that sustains mothers' motivation to improve their health and habits, provides access to customized, credible information and integrates that information into track-able and manageable goals. We strive to offer a framework which enhances the sharing of experiences and information within and between the expectant mother and medical communities. Our application defines expectant mothers as primary users, but is designed to act as a complement to traditional care and address the needs of numerous stakeholders including, but not limited to, obstetrics and gynecology (OB/GYN) doctors and nurses.

Research and Development
Our research and development proceeded in an

iterative fashion and involved discovery and requirements gathering, feature exploration and analysis, design validation and prototyping.

Discovery and Requirements Gathering

Our initial research aimed to understand the broader context within which our application would intervene. We focused on discovering how expectant mothers find and act upon information from medical, technological, and social resources. We surveyed thirty mothers and interviewed six from a mothers' group to understand challenges to a healthy and peaceful pregnancy and discover systems that would help foster an improved experience. We asked questions pertaining to: existent self-monitoring habits, the perceived credibility of guidelines from various sources such as articles, knowledge campaigns, forums, and blogs, issues experienced with prenatal medical care and (dis-) satisfaction with comparable technological pregnancy interventions. In addition, we interviewed eight OB/GYN doctors and nurses to discover how a technological intervention might augment traditional medical care as well as improve relationships between care staff and patients.

From these data we found recurrent themes and developed six personas based on the following dimensions: age, income, health conditions, knowledge of pregnancy, motivations, education level, access to and (dis-) trust of care. These stakeholder and user personas revealed needs, obstacles, and use contexts that supported ideation about intervention components.

Our research indicated that common among users was the feeling that personalized feedback on lifestyle

behaviors was scarce and rarely available from prenatal care staff – offering insight into why users turn to alternative resources for more specific advice and guidelines. Also revealed was that users were frequently unaware of whether or not a symptom, experience, or behavior was worth the attention of medical staff. Subsequently, they sought feedback from others for peace of mind, even if they understood such feedback lacked merit. They frequently reported feeling rushed in appointments and struggled with presenting their experiences to their doctor. Many used diaries to log symptoms, weight, and questions for doctors but found this practice cumbersome and ineffective in advocating their needs at the time of the appointment.

In sum, our findings indicated that expectant mothers did not adequately self-monitor due to a lack of reliable and accessible information, efficient self-monitoring technology, and incentives. Our design strategy explored methods for responding to these problems.

Design Process

Guided by insights from our surveys, interviews and personas, we drafted and presented four storyboard and interaction sketches to users. These storyboards reflected problematic experiences that were often faced by users according to our research. They were paired with an interaction sketch that preliminarily demonstrated how the application would intervene. These sketches were modeled off of persuasive design principles shown in the literature to be effective in motivating behavioral change [5]. For example, one sketch demonstrated using social comparison to motivate behavior. In this sketch, a mother was experiencing morning sickness she deemed normal and

Figure 1: A storyboard and interaction sketch we showed to users to demonstrate how our application would intervene in a problematic situation.
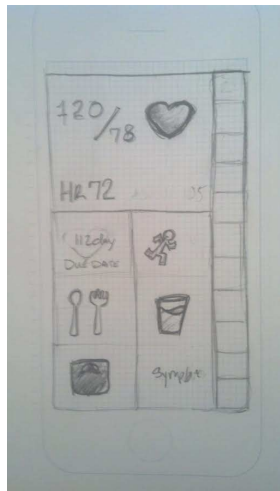

Figure 2: A select dashboard screen from our paper prototype.

unalarming but upon comparing the frequency of her morning sickness with similar mothers, decided to arrange a doctor's visit. After we presented these storyboard and interaction sketches to users, we asked users to comment upon the suitability of our intervention for the illustrated experience.

These sketches helped us understand what would motivate users to self-monitor. We discovered the majority of users regarded the following as critical:

- Recording and tracking features for nutrition, hydration, activity, weight, symptoms and mood which could be quickly reported to prenatal care staff.

- Daily goals for nutrition, hydration and activity based on credible guidelines.

- A comparison tool that highlights differences in symptoms, physiology, etc. against like-bodied mothers and alerts them of abnormalities.

- An insight utility that detects patterns across users' input – such as symptoms, nutrition, and activity.

These features came to represent our essential intervention components.

With this clear set of features in mind, we looked to similar self-monitoring applications – e.g., JawBone, FitBit, etc. – to guide us in the implementation of sound information architecture and task flows. We conducted cognitive walkthroughs on these applications to explore strengths and weaknesses of existing task flows and arrive at a strategy to guide our interaction design.

Design Validation

After generating a paper prototype based on these features, we validated the design iteratively by conducting a usability evaluation, a semi-structured interview containing open questions and a forced priority ranking exercise, and administered the System Usability Scale (SUS) [6].

Our usability evaluations were conducted with five volunteer participants and employed a free-play, think-aloud procedure. Participants interacted with core application screens and their feedback indicated problem areas at the level of information architecture and task flow.

After the usability evaluation, the semi-structured interview was conducted. We asked questions pertaining to the viability of our features for addressing problems. We also asked users to rank application features against one another in order of their importance. Responses from these exercises further clarified user priorities and informed our use of screen real estate in the detailed prototype.

Lastly, the SUS questionnaire was administered. The results of the questionnaire served as a benchmark for the application's usability that the design team sought to improve upon with the final design.
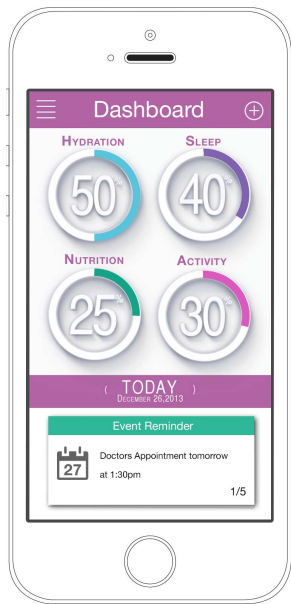
Figure 3: Bloom's dashboard
visually represents daily progress
at-a-glance.

Current Design

Bloom's application features employ persuasive design principles to incentivize users to record and anonymously share their body data and uses that data to build a community that nurtures healthy and peaceful pregnancies. Self-monitoring, goal setting and tracking, comparison, and insight tools represent Bloom's essential intervention components. As we soon describe, these components minimize risk factors to the mother and developing infant by intervening before harmful habits are formed. Furthermore, they maximize peace of mind by augmenting the awareness of the mother and offering a rich, integrated, and streamlined framework for the exchange of information between significant communities during her pregnancy.

Features

Bloom's self-monitoring features represent the first intervention component. Our literature review and initial research revealed that nutrition, hydration, activity, symptom, mood and sleep monitoring were critical to record and that mothers could be incentivized to do so if data entry was expedited and customized feedback was provided. For example, bloom's nutrition feature expedites input by offering a multitude of entry options and provides customized feedback by flagging foods that are harmful to the developing infant and informing the user of deficiencies in nutrition. In doing so, the feature eliminates the burden placed on users to research independently or worry. This feature was altered and improved after our usability evaluation which revealed that mothers prefer to see nutrition information visualized according to pregnancy-relevant criteria such as vitamin levels, macronutrients and food groups.

Goal setting and tracking augment these self-monitoring features. Mothers can use default daily goals derived from medical guidelines for nutrition, activity, hydration and sleep that adapt to changes throughout the pregnancy. For example, Bloom's daily macronutrient goals change as protein intake requirements increase during each trimester. We discovered through our usability evaluation, however, that users with complicating health conditions wanted to create custom goals with their prenatal care staff. We addressed this need in our current iteration to maintain and support an ideal continuity between traditional treatment and Bloom.

The "Compare" tool provides a data-driven way for users to visualize how they relate to like-bodied mothers in terms of symptomology, weight, nutrition, activity level, hydration and sleep. For example, suppose a user in the eighth week of her first trimester is concerned about her weight fluctuation. She may use the compare feature to obtain a visual representation of how normal this fluctuation among mothers with a similar due date and starting weight. In this way, "Compare" provides additional insight to users about whether or not their lifestyle or symptomology is atypical among like-bodied mothers and, subsequently, how warranted a visit to the doctor may be. This feature received praise in our usability evaluation and was not significantly altered throughout our iterations.

Bloom's "Insights" feature also aims to augment the self-awareness of expectant mothers by recognizing patterns in users' input. As the considerable changes in physiology resulting from pregnancy often cause confusion, "Insights" leverages existing user input to help users understand hidden connections between things like mood, nutrition, symptomology, and sleep.
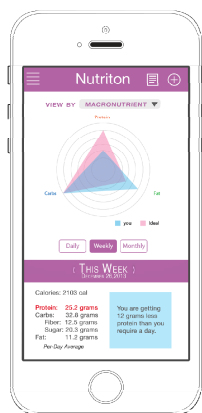
Figure 4: Bloom's nutrition tracking visually compares user nutrition to macronutrient, vitamin, and food group ideals. It highlights and explains deficiencies.
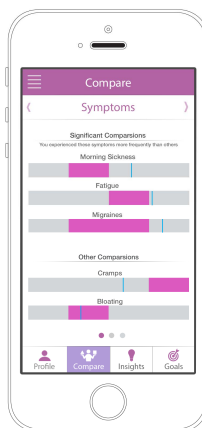

Figure 4: Bloom's compare feature.

For example, a first-time mother undergoing an unplanned pregnancy may be unaware that her fatigue in the first-trimester is less severe when she takes a brisk walk in the afternoon. Feedback from our user interviews revealed that users thought "insights" might increase anxiety. As a result, we redesigned "insights" dialogues such that they always appear with recommendations and explanations.

Bloom's "Social" feature aims to mimic the natural exchange that takes place in users' support groups and social networks. Forums provide users with a place to vent surfacing concerns and questions. Users also possess a news feed where content from favorite forums or befriended users is populated. Mothers may use the feature to discuss things like emotionally managing special health complications, prenatal yoga routines, or items for newborns. This feature was designed due to insights from our usability evaluation that the application was too medical and that fun and open dialogue would benefit building a community.

Conclusion

Our study explored and discovered strategies for encouraging self-monitoring and motivationally sustaining healthy behavior in expectant mothers. Subjective feedback we received from our design validation indicates enthusiasm for the application. Future iterations and research will investigate opportunities to further automate data entry, provide richer data to medical professionals, and refine feedback content to reduce anxiety and increase locus of control. For example, Bloom may better address numerous clinical and sub-clinical concerns of users by integrating and leveraging wearable technologies that capture blood pressure, heart rate, and movement

data. Research into bloom's perceived credibility and authority will further inform the design of feedback and notification content to ensure the application is recognized among users as a complement, not a replacement, to traditional care. If adopted on a large scale and in this way, the application may improve accountability, communication among users and stakeholders, and ultimately reduce the impact of misinformation on healthy pregnancies.

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