THE PENNSYLVANIA STATE UNIVERSITY
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THE SOCIOTECHNICAL MEDIATION OF LOWER-INCOME PREGNANCY:

A USER-CENTERED APPROACH TO IMPROVING A HCI DESIGN SPACE

A Dissertation in
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by
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ABSTRACT

Developing and delivering contextually-sensitive user experiences in sociotechnical systems which are geared at helping lower-income women manage their pregnancies requires understanding the human, technological, and the sociotechnical perspectives that are embedded in the mediation of the experience. Yet most digital systems and tools for pregnancy management treat pregnancy experiences as problems: problems of health, problems of socioeconomic status, and problems of consumer power.

Through my depiction of the design space, I give attention to specific situational contexts of lower-income pregnancy. Using a contextual qualitative research approach, and the results of three research studies, I identify the set of information, situations, and interactions of lower-income women around pregnancy-related interactions and management. I detail expectant women’s adoption of technology tools and digital information for guiding their pregnancy management. I focus on the relations between information and social interaction needs relative to the impacts of pregnancy on subjective impressions of wellness, and on the expectant woman’s abilities to adjust her life and her coping strategies to the pregnancy experience. Framing the experience of lower-income pregnancy as a sociotechnical experience that is heavily mediated by digital and mobile technologies, I employ an action process stance towards opportunities and challenges within lower-income women’s lived experience of pregnancy as a structure for my response to the sociotechnical design opportunity.

I provide a set of eight evidence-based design considerations which incorporate the dimensionality of everyday pregnancy experiences into a revised design space. Through my research findings and my eight design recommendations, I offer three contributions to the fields of mobile human-computer interaction design specifically, and the domains of human-computer interaction and medical informatics generally. My first contribution is an articulation of the mobile app design space of lower-income pregnancy. My second contribution provides a scope of the gaps, oversights and issues with existing mobile applications for pregnancy, relative to lower-income women. My third contribution is a set of eight design considerations which reflect a sociotechnical approach to viewing lower-income pregnancy as inter-dependent sets of interactions between humans, technology and information. By reshaping the digital design space of lower income pregnancy, and taking into account the offered design considerations, the intended outcome of a new mobile app for lower-income pregnant women would be increased feelings of pregnancy success, improved information management capacities, and better emotional and physical coping strategies within pregnancy and throughout women’s lives.
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Chapter 1

Introduction

“Socio-technical thinking allows us to think about a broad class of phenomena that are crucial to deciding which technology gets built, how it is designed, and how it fares once it is used in the real world” (Coiera, 2007, p. 6)

Context

This dissertation is a tale of my efforts to address and serve a female population that is often misunderstood and overlooked. What began as a project aimed at reducing gestational weight gain in lower-income pregnant women moved and shifted over time into a story about gaps in design around the sociotechnical nature of pregnancy.

This work began as part of a collaborative project between two Penn State IST faculty and two Hershey School physicians. As a qualitative researcher, I was brought in to the project mid-way, to make sense of the focus group data the investigators had gathered. As I transcribed and coded the initial focus group data, I came to realize that the things the lower-income women were talking about in the focus group conversations had very little in common with neat medical parameters of pregnancy. The project team was looking for stories of issues with eating and diet that could be adjusted through proper education about appropriate gestational weight through the use of a health-related mobile app for pregnancy (MAP). Instead, I heard about how a husband bought a wife a new electric skillet after she had an emotional meltdown about making pancakes for supper. I heard accounts of strangers touching pregnant bellies in elevators, and asking about parenting
intentions, or offering advice on how best to sleep at night with the belly, or how to
burp a baby. I heard stories about being scared that the second trimester intense pain
around a 24-year-old pregnant woman’s belly was a miscarriage, only to turn out to
be a relatively normal example of a Braxton Hicks contraction. I also listened,
sharing in the amusement of the focus group women, at the animated recounting of
one woman’s incredulity at what she saw as a baffling need to buy a new baby seat
for her car, rather than use the perfectly good one her best friend had handed down to
her.

Somewhere deep into transcribing and coding the fourth focus group, it hit me.
What I was hearing was not stories about medical pregnancy and its appropriate safe
management along medical risk avoidance lines. I was hearing stories of lower-
income women’s everyday interpersonal struggle: stories of coming to terms with the
massive amount of changes that make up the experience of pregnancy; stories of
navigating the overwhelming amounts of information about pregnancy as made
available in apps and on the Web, without panicking about the often scary medical
tone; and finally, stories of trying to coordinate activities and information with
family members and close friends while pregnant and experiencing a plethora of
physical symptoms of pregnancy.

My interest piqued, I went swimming in my data. After hearing a few pregnant
women describe how the design of pregnancy apps didn’t meet her needs, I decided
to check out the apps for myself. Following the participants’ preferences for iPhones
and iPads, I downloaded a few pregnancy apps onto my own iPhone, and started
wading through the pink morass of gendered color choices, deeply scientific
language, and fetal development imagery. It was then that I realized there were core differences about pregnancy experiences, albeit still fuzzy in my mind, between the typical ontology of medicalized middle-income pregnancy as seen in the apps, and the ontologies of pregnancy as a sociotechnical experience that was being presented by the lower-income female participants.

The problem was that there existed a gap in understanding about the nature of pregnancy. For the app designers, pregnancy appeared to be predominately a medical concern that was solely of interest to a woman and her doctor. But for the participants in the focus groups and interviews, pregnancy was also emotional, social, inspirational, scary; a nine-month bounded period of a woman’s life where she went through a profound set of personal, social and corporeal changes that was all triggered by a seemingly universal yet simple sociotechnical experience of peeing on a little white stick and waiting to see if a positive or negative symbol appeared.

To my twin selves as a human-centered user experience designer and a sociologist, the issue seemed to be a case of poor interaction and user experience design for apps. It was a case of conflicts between the medical and policy establishments, and the lower-income women that formed the cadre of my participants. It was also a set of tacit misunderstandings and assumptions, between the designers of apps who had an unacknowledged yet visible design bias for middle to upper-income pregnant woman, and the informational, social, emotional and structural dimensions of pregnancy for lower-income pregnant women.

In order to help other women like my participants, I realized that the necessary solution was of a better set of definitions of contexts and needs relative to lower-
income and under-served female populations. What was needed was a human-centered sociotechnical approach to pregnancy app design that recognized pregnancy was deeply inflected by socioeconomic status.

Threaded throughout these stories, too, were issues of the HCI community’s oversight about the importance of designing mobile systems for the specific socioeconomic positions and contexts of pregnancy. To me, these speak to a need to take into account the differences in needs and concerns of different female populations as the women go through pregnancy and motherhood in the United States. Delving into the human science literature, I learned about the way that attending to the processes, people, contexts and time experiences of life events might provide fruitful avenues for more contextual design of digital apps for pregnancy information and management.

After three years of investigating under-served pregnant women, and using their life contexts and needs as design frame for mobile HCI, the end result is this dissertation document.
Objectives

There were three objectives of my research:

1) Develop a conceptual model of the context of lower-income pregnancy, as it relates to impacts on the subjective feelings of wellness of a lower-income pregnant woman, in order to describe and represent her emotional, interpersonal and social position.

2) Describe the design space of pregnancy apps, as it relates to digitally-mediated human interaction features in MAPs, paying particular attention to the way existing apps support or ignore the interpersonal and informational needs of lower-income expectant women; and

3) Provide a set of design frames for improving the information and interaction features within MAPs.

Using a qualitative research approach, I identified network of digitally-mediated interactions of lower-income pregnant women, their spouses/partners, their medical, health and wellness care providers, and their close tie networks of familial and social supporters. With lower-income pregnant female participants, I examined mobile apps that focused on pregnancy information and life management during pregnancy. Understanding that the birth of a child is a major event in a woman’s life, I also focused on the relations between information and social interaction needs relative to the impacts of pregnancy on lifespan wellness, and on the expectant woman’s developing sense of the process towards becoming a parent and an adult. This required that I understand the information seeking and information interaction needs of pregnant women, as well as identifying any gaps in addressing those needs from
existing social and technological avenues. It also required understanding the role of pregnancy in adult development for women.

Working within this problem space, and with an eye to defining the sociotechnical design space of lower-income pregnancy, I have identified three research questions. Each question guided an exploration of a specific perspective within lower-income pregnancy. The three RQs questions address limitations in previous research across the human, technological, and sociotechnical perspectives around lower-income pregnancy.

**Gaps and questions**

<table>
<thead>
<tr>
<th>Research Gap</th>
<th>Research Question</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Human Perspective:</strong></td>
<td></td>
</tr>
<tr>
<td>There is a limited understanding of how lower-income pregnant American women understand and coordinate their pregnancy experiences through <em>mobile digital tools</em>.</td>
<td><strong>RQ1:</strong> What role do mobile apps for pregnancy perform in the information seeking and social coordination experiences of lower-income pregnant American women?</td>
</tr>
<tr>
<td><strong>Technology Perspective:</strong></td>
<td></td>
</tr>
<tr>
<td>There is a limited understanding of whether or not mobile applications <em>appropriately support</em> the informational and interactional aspects within the <em>process</em> of pregnancy experiences for lower-income women.</td>
<td><strong>RQ2:</strong> Do existing mobile apps for pregnancy appropriately meet the informational and interactional needs of lower-income American women?</td>
</tr>
<tr>
<td><strong>Sociotechnical Perspective</strong></td>
<td></td>
</tr>
<tr>
<td>There is a limited amount of work available that addresses the <em>differences</em> in the digital mediation of <em>lower-income pregnancy experiences</em> based on socioeconomic status.</td>
<td><strong>RQ3:</strong> What design recommendations can be provided to improve the sociotechnical design space of pregnant lower-income American women?</td>
</tr>
</tbody>
</table>

Table 1: Identified gaps and research questions
**Approach**

In order to understand and describe lower-income pregnancy as a sociotechnical experience supported by mobile apps, and to understand the current shape and possibilities or silences within existing pregnancy apps, I used a multi-phase research design (Figure 1):

- In **Phase 1**, I transcribed and analyzed focus groups data;
- For **Phase 2**, I created and conducted design interviews and analyzed the outcomes of the interviews; and
- In **Phase 3**, I carried out a scoping and analytic audit of features and functions within commercially available pregnancy apps.

I used the analyzed results of the three phases to conceptualize the design space of lower-income pregnancy, and to create design frames to improve the state of interpersonal support and collaborative information potential in pregnancy apps.

![Figure 1: Design space of lower-income pregnancy](image)
**Outcome**

Through outcomes of my research activities in the multi-phase research approach, I am able to offer evidence to support the idea that a lower-income woman’s feeling of pregnancy success relies heavily on swift access to and interactions around reliable information and trusted social supporters.

Through the **outcomes of my first two research phases**, I show that *lower-income women rely heavily on MAPs during pregnancy*, for information of all kinds, and in some cases, for social and emotional support interactions. This finding addresses **RQ1**, about the role of MAPs in pregnancy management.

Through the **outcomes of my second research phase**, I show that MAPs *do not* appropriately meet the needs of lower-income pregnant women. My investigation into the digital mobile options available for pregnancy management lays bare the middle-to-upper-class bias in MAPs, and showcases a variety of issues in MAPs, mainly related to their overt focus on static medical information. Together with the findings from RQ1, the second research phase provides me with the evidence to respond *No* to **RQ2**, thereby setting up the need for **RQ3**.

Through the combination of the analyzed results of all three research, I created *eight sociotechnical design frames*, which address **RQ3**, thereby giving shape to the sociotechnical design space of lower-income pregnancy in the United States.

Taken together as a whole, this combined research body provides a synthesis of the **sociotechnical experience of information and influence** within the normal life period of pregnancy, and is directed at improving the **design space of pregnancy app design** for lower-income American women.
By reshaping the digital design space of lower income pregnancy, and taking into account the offered design considerations in any future mobile app design activities, the intended outcome of a new app in the future would be improved opportunities for lower-income women to experience and report:

a) increased feelings of self-assessed pregnancy success;

b) improved information management capacities;

c) better emotional and physical coping strategies; and

d) stronger sense of social integration between the pregnant women and her close network of supporters.
Chapter 2

Background

In the United States, research into pregnancy and its management most often conceives of pregnancy as a medical concern. The medical focus is on staying physiologically healthy in order to provide an appropriate gestation environment for the developing fetus. This frequently means there is a strong focus on the pregnant woman’s physical management of her body, particularly as it relates to diet and exercise. However, there is relatively little to no emphasis on the role of the pregnancy as part of a larger process of adapting the experience of pregnancy to the everyday routines of life for lower-income American women.

A number of global and national legislation and policy recommendations have intensified the interest in pregnancy health and wellness in the United States. At a global level, the World Health Organization set out a series of Millennium Goals (Beaglehole & Irwin, 2003), of which one major Goal is Maternal and Child Health. At the national level, the Affordable Care Act specifies pregnancy as a key area for female health, and provides education, dietary supplementation and financial support for expectant mothers, with care provided both through federally funded Women and Infant Clinics (WICs) and through private medical practices.

Generally, the policy focus in the United States still remains embedded in a medical model of care and health promotion, and this extends to the view given to alternate supporters of pregnant women’s health, such as midwives, and to the close social networks that guide, commiserate, and provide the social foundation upon which the women depend for their support. The care philosophies vary from state to
state within the United States, with some states recognizing midwifery as a valid augmentation to traditional medical pregnancy care, and others seeing midwifery as ‘alternative medicine” and thereby treating it as a non-insurable option. This variance across the nation demonstrates that within the landscape of the U.S, there are varied standards of practice in the care of pregnant women.

**Sociotechnical mediation**

The research project that I scoped and managed for this dissertation presents pregnancy for lower-income women as a normal part of a life trajectory. Through my research activities, I explore my participants’ expressions of daily reliance on digital connectivity and mobile apps. I provide their understanding of their pregnancy experiences, and of the challenges they faced in managing the process of adaptation, accommodation, and preparation that pregnancy presents.

**Sociotechnical mediation** is what I call the combined impact of controlling medical discourses, digital connectivity and mobile tools on individuals’ self-identity and self-potential. As an information scholar, an interaction designer, and a sociologist, I wanted to understand the impact that digital tools and digital technology logics have on my participants’ self-identities. By contextualizing pregnancy as a sociotechnical experience, my intent is to provide a broader scope for understanding the possible positive and negative impacts on everyday lives of pregnant lower-income women, as a result of the value-laden digital designs within MAPs.
Human-centered design

*Human-centered design* (HCD) places the needs and goals of human users first, understanding users as the key stakeholders. The emphasis in HCD is on interaction, satisfaction, and enjoyment, and the accomplishment of the intended goals of end users. Therefore, within HCI, the goal of HCD is contextual digital design; or design frames and choices that are made in light of a full understanding of users. The impact of this approach is that it ensures that the end design of a mobile app or a sociotechnical system aligns as closely as possible to actual task accomplishment and goal achievement by the primary stakeholder user base.

For this reason, as a structuring approach to understanding the design space of lower-income pregnancy, I have adopted the Double Diamond model (Figure 2; next page). In traditional digital product development, because the developers usually assume they understand the problem based on a mandate given to them by a client, or based on an idea they have about something that could be marketable (e.g.: a pregnancy app is for medical information for a pregnant woman only), it is typical for developers to go ahead and start creating solutions in code almost immediately.

In contrast, the Double Diamond model, adapted from human factors engineering, prescribes an entire other phase of work prior to ever starting to write a line of software code. Those who use the Double Diamond model to guide design activities do not assume that a mandate is the same as a full problematization
Instead, in order to understand the context of their end users’ needs, and thereby have a well-shaped design space and design rationale, the model asks for human-focused qualitative research, designed to understand the problem or problems, the user’s environment, the user’s social ecology, and their habits, preferences, and goals.

Additionally, the Double Diamond model asks for attention to understanding the needs of other stakeholders in addition to the end user, usually at the secondary and tertiary interaction levels. The inclusion of other stakeholders is based upon the stakeholder’s degree of closeness to the end user. Therefore, the Double Diamond approach (Figure 2) for design projects has two major phases – *problem definition* and *solution specification*, each of which contains a process of *divergence* (needs investigation) and *convergence* (goals recommendation).

My project research was focused on the *problematization of lower-income pregnancy*, in order to *articulate challenges* experienced by lower-income women in
managing their pregnancies, and to expose issues in existing MAP design that might mean there was a misalignment between my participants’ desires and goals for a MAP, and the features and functions in available MAP choices. My problematization phase focused on the concerns and challenges of supporting lower-income pregnancy as a normal life experience. My research focused on understanding the needs and goals of a pregnant woman relative her pregnancy-related interactions around information, activities, emotions and processes. I identified four categories of needs that carry different meanings and manifestations within lower-income pregnancy. Drawing on my analysis of the participants’ conversations, I structured that group of expressed needs around the physical, emotional, social and information dimensions. Therefore, as it relates to HCD, my three research activities were designed to provide a strong definition of the problem of designing for lower-income pregnancy. The research activities provide the details that contribute to a design rationale (Carroll & Moran, 1991; Moran, 1996) which provides a coherent structure to the design space presented by pregnancy. From my findings of pregnant women’s needs, compared against the options for MAPs available to them in the IOS marketplace, I synthesized three issues that need to be addressed in design frames for future MAP development activity.
Motivations

I attribute two over-arching ‘meta’ motivations for this project. The original motivation was expediency, related to my role as a research assistant in an NIH-funded project managed by Penn State faculty. The evolution and revision of my two final motivations are attributed to my own stance as a critical analyst of social issues and design approaches.

Original motivation

The catalyst for motivating my interests in the sociotechnical dimensions of lower-income pregnancy as a design frame for mobile HCI came about in the spring of 2013, when I was employed as a research assistant for two former faculty members in IST. They were co-investigators on a pregnancy mobile app intervention study run by two Hershey Medicine physicians who were also faculty members in the medical school. Their research project was motivated by a broad question about the role of mobile technology in supporting improved understandings of appropriate gestational weight gain, within the constraints and needs of lower-SES women in central Pennsylvania. The population was chosen by that project’s Principal Investigators (PIs), because lower-SES women potentially can experience structural constraints that impact their pregnancy management (e.g.: medical care delays; employment concerns; healthy food availability). The project PIs wanted to create an app specific to the context of educating lower-SES women on what constitutes appropriate gestational weight gain. The app was intended to be deployed to the medical PIs’ client roster, and then studied in a double-blind approach, in order to
gauge the efficacy of the intervention, and the role of mobile tools for better patient activation.

However, in the course of doing the first phase of my research, themes emerged during the data analysis I was conducting which moved the themed results beyond a strictly medical health promotion aspect. Conversations in focus groups and interviews pointed to the neglected role of close network individuals in the pregnant women’s lives, and women suggested that the social support they received from these individuals helped facilitate healthier pregnancies for them. Conversations also suggested that existing apps espoused a design approach which focused on medical risk management and danger avoidance. Participants said that MAPs were not geared to them, because most MAPS that they used promoted a consumer-driven middle-to-upper income approach to experiencing pregnancy and early parenting.

Diving into the literature about pregnancy, I discovered that the area of social support in pregnancy was understudied, and the idea of pregnancy as a normal part of life to be not well understood. This discovery, therefore, acted as the motivation for the remainder of my project.

While I retained my focus on lower-income pregnant women, I came to question the North American over-medicalization of pregnancy, which tended to treat pregnant women as nothing more than an incubator. With this in mind, given my own background in social science, and in interaction science, I set out to understand the neglected social context of pregnancy. I wanted to investigate and describe the dimensions of sociotechnicity within lower-income pregnancy. I saw this sociotechnicity as potentially being related to opportunities for information provision
beyond medical frames and corporeal management, and which addressed other dimensions of pregnancy; dimensions which I understood to be the emotional and social realms of life during pregnancy. Ultimately, I saw potential for MAPs to improve lower-income women’s sense of coping capacity and personal wellness and happiness during pregnancy.

Therefore, in response to the question, “What motivated me to study pregnancy and MAPs in a context larger than mobile health?”, I answer that my first motivation was simple expediency. Pregnancy health and MAPs were the structuring context of the research project which triggered my initial interest. As I recounted in the Context section, because I was brought into a mobile health for pregnancy study by my former co-advisers, the assumption for the outcomes of the research is that we would design and test an anti-obesity MAP. Therefore, studying pregnancy and MAPs was initially motivated by practical concerns.

Revised motivations

It did not remain solely that way, however. The more research I did, the more I realized that there was a larger context to pregnancy management for lower-income women that was missing in existing HCI approaches to the designs of information provision and life management features in MAPs.

My second motivation was my desire to serve and support an under-served female population. My interests in the larger context of pregnancy management as part of a normal life process and experience was activated by the stories I heard from pregnant women in the first two research activities that I discuss herein. As an HCI scholar who espouses a critically-focused human-centered approach to interaction
design, I wanted to redress the gaps in design that women spoke of finding in the
design of MAPs.

My third motivation was to address the gaps in understanding within the HCI community around the larger contexts of pregnancy as a normal experience in life. Pregnancy is a time in which digital tools play a prominent role in helping lower-income understand pregnancy challenges and cope with the results of pregnancy events during the nine-month experience. I was motivated to address this in my design space research, in order to suggest ways to appropriately accommodate the change management capacities of pregnant women, in the short term during pregnancy, but also possibly in the longer term, throughout their adult lifecourse.
Chapter 3

Literature Review

As befits work in information sciences and technology, the research that I do is inherently interdisciplinary. Work of this nature is intended to integrate understandings of phenomenon, methodologies and concepts (Pickett, Jr, & Grove, 1999), and to extend or break new ground via the research process in ways that would not be possible within the knowledge of a single field (Aboelela et al., 2007). For this reason, the literature upon which I draw comes from multiple knowledge communities and concern domains. Therefore, the purpose of this chapter is to provide an overview of the existing themes and research directions around:

1) information behaviors and technologies; and
2) pregnancy experiences.

I have chosen these knowledge areas because they relate strongly to my three research questions, and to my intended contribution goals. The themes and research directions frame the concept of pregnancy for lower-income American women as a normal life experience whose information, social, emotional and physical aspects is broadly mediated by a variety of technology options and impacted by a variety of social interactions with others.

Information behavior

The concept of information behavior, and interactions around such behavior, are important to interaction design. Therefore, adhering to Wilson’s call (1981) to make explicit my definition and operationalization of the muddy term, ‘information’, in this section, I present the two main traditions and paradigms within which the term is
embedded. I start with a definition, before considering how information as a concept has been understood within the growing field of information science and library science. Because I highlight in this subsection that information is both object and actor, I then move to a description of the tendency in information science and human computer interaction (HCI) research to privilege either information or individual users within their areas of research. I then move on to an overview of what I broadly and deliberately call social information behavior, before narrowing further to the area of health information behaviors.

Defining information

There are two dominant paradigms of the term information that each structure variations of definitions and utilizations of information as an employable concept (Braman, 1989; Capurro & Hjørland, 2003; Meadow & Yuan, 1997; Nafría, 2010; Zins, 2007). The difference between the two lay in in the way each affects a view of what is considered real and knowable. The first is considered objective and neutral, the second is considered subjective and referential. According to Capurro and Hørland, in the first paradigm, information is the result of ascribing “form to matter” (p. 354). As Buckland states it succinctly, it is “information as thing” (1991, p. 351). Thus, information forms the building blocks of reality, by structuring and assembling data into objectively observable forms, organized often according to digital logics of control and capitalization. Capurro and Hørland say that in the second paradigm, information is a product of the human mind, as it struggles to comprehend reality. Taking from Machlup (1983), Capurro and Hørland say that information is, therefore, a human phenomenon: It is congruent with ideas, and with the ordering of
ideas into messages that are used in the context of shaping human action in the world.

Within the domain of information science, these two paradigms are exemplified by the approaches to information from Shannon and Weaver (1971; 1993) and from Wilson (1981, 1999), on the objective side, and from Dervin (1976, 1983), on the subjective side. For the former view, information is an entity onto itself that expresses a fundamental objective quality of reality. This conceptualization of information is also found in the work of an early pioneer of information science, Norbert Weiner, via his famous dictum “information is information” (1961, p. 132). This maxim signifies that information is not a message. As put forth by Shannon and Weaver, information is independent and neutral of messages and meaning and semantics. By this definition, then, information is apolitical.

The other view of information as espoused by Dervin sees information as the end result of a process of ordering the reality of the world through ideas. Both Dervin, and Capurro and Horland submit that information is also the active process of selecting and interpreting data that is relevant to a specific context. By this view, then, information is processual (Capurro & Hjørland, 2003). It is interpreted data (Machlup, 1983), embedded in an active process of meaning making, via idea generation. This conceptualization of information is one towards which Wilson (2005) eventually moved in his more recent, more processual, and more goal-oriented framework.

Adopting and extending the latter definition of the concept of information, the point then to activating information is to produce ideas and beliefs about the world,
and understandings about the nature of perceived reality. This is information behavior, defined in Burnett et al. (2008, p. 59) as “a state in which one may or may not act on available or offered information”. This is the idea of information as social actor. In this conceptualization, information is the core building block of knowledge (Dretske, 1981). It is information as the “constitutive force in society” (Braman, 1989, p. 239). Viewing information in this way creates balancing tension between the purely rational and objective concept of information in the first paradigm, and the more subjective and situational concept of information in the second paradigm (Dervin, 1983). It is within this tension of information as both objectively perceivable and subjectively created out of human perception of reality, and interaction in the world, that the interdisciplinary field of information science exists (Capurro & Hjørland, 2003; Nafría, 2010; Wilson, 2005; Zins, 2007). It is also within this idea of information as a perceptual building block for action and knowing that the field of human computer interaction exists (Nardi & O’Day, 1999).

**Using information**

The use of information to structure reality, and to support perceptions and judgements about real possibilities for action and for goal achievement, is the focus of a body of research about information use or human information behavior (“HIB”) (Fisher, Erdelez, & McKechnie, 2005; Spink & Cole, 2006). Often grouped under a rubric of ‘information behavior’ or ‘information seeking’, research into HIB focuses on the human search for and use of information to structure, apprehend, and describe reality, in order to shape the potential for action (Ford, 2015).

In this research corpus, information is both a thing to be used, and a reality-shaping force with which users have to grapple in order to solve problems and achieve progress
It is for this reason that there is a proliferating area of research around *information behavior*, understood to be the ways in which a single user seeks and finds information within channels or streams of data, and puts found information to use for the user’s own distinct needs (Fisher et al., 2005; Spink & Cole, 2006).

Studies of information behavior tend to focus on either information search, or information retrieval. Those who study seeking behavior tend to foreground the information and action sequences and processes, and background the user (Ellis & Haugan, 1997; Kuhlthau, 1991; Wilson, 1981, 1999, 2000). As Wilson describes it, such studies “may be to make inferences about need, or it may be to uncover facts relating to other variables related to the design, development or adaptation of information systems” (1981, p. 5). In writing about Wilson’s approach, Godbold says that he and his peers place information behavior “within the *context* of an information need arising out of a *situation*” (Godbold, 2006, p. 2). In this sense, *situation* can be viewed as “a particular set of circumstances that from which a need for information arises” (McCreadie & Rice, 1999, p. 58), and *context* can be considered to be the larger picture of interactive practice within which meaning and possibilities are shaped and circulated (Dourish, 2003). Therefore, the focus of studying information behavior is to improve information systems, in terms of performance, efficiency, or access breadth, in order to improve human capacity to act contextually for their particular situation.

In contrast to the information systems approach, studies that focus on specific users, in what Wilson labels ‘user studies’, place the focus on understanding the cognitive mental models of individual users, their individual rationalizations for their search processes, and the actions to which users put information to use once it is found (Kuhlthau, 1991; Spink & Cole, 2006). In this branch of information behavior research, the intent is to understand a user’s information needs, in order to improve their sense of knowledge and mastery over the world (Pettigrew, Fidel, & Bruce, 2001). It should be noted that approaches to understanding
information behavior do not necessarily map neatly to either of these ends of a continuum—the edited volume by Fisher et al. (2005) lists 69 different approaches to information behavior.

But what of the often collaborative nature of information behavior? The next subsection deals with the social overtones around this aspect of interaction between users and information.

**Social information behavior**

The late 1990s saw a rise in interest in the social habits of users as it relates to information activities. The social interactive elements of information behaviors were originally dubbed *collaborative information behavior* in Poltrock et al. (2003), and then later extended by Reddy and Jansen (2008). Synthesizing a general definition from both teams of researchers, collaborative information behavior (“CIB”) can be said to be a collected set of actions, comprised of collaborative social activities, that are undertaken by a group of people with the intent of addressing and resolving information needs. Reddy and Jansen note that this understanding of CIB encompasses both information seeking behaviors, information retrieval behaviors, and the social and political contexts of information behaviors. Reddy’s earlier collaboration with Paul Dourish (2002) also incorporates attention for the temporal rhythms of social interactions around information behaviors.

Other approaches to social collaborations around information arose out of an epistemological approach based on social and cognitive theory (Hjørland, 2002). This approach argues that information is co-constituted by the cognitive patterns of an individual and the social influences that operate in that individual’s environment, which influence their information use (Bates, 2005; Burnett, Jaeger, & Thompson, 2008; Capurro & Hjørland, 2003; Hjørland, 2002; Jacob & Shaw, 1998; Jaeger & Burnett, 2010). Bates attributes the rise to prominence of an attention to context to Dervin’s (2003) work, and the importance of
the ‘nature of the situation’ to Cool (2001); a position which Reddy and Dourish, and Reddy and Jansen both corroborate. Similar to Reddy and his collaborators, Jaeger and Burnett (2010) speak of the way in which social norms act to direct or constrain future information actions and patterns of behavior through prescriptive social norms.

Others who work within this social information approach to information behavior include Case (2012), Kwasnik (1991), and Lin (2002). While the social informatics approach has a broader focus than just social information behavior, the importance of information in this approach is not ignored. Rob Kling (1996, 2000, 2007; 2003) is the leading theorist in the social informatics domain (Fisher et al., 2005; Nardi & O’Day, 1999).

Because social informatics is a domain term, and the other ‘popular’ term used, collaborative information behavior, appears to me to represent a narrower interpretation of what humans do with information, I have chosen herein to adopt the term social information behavior, because this more accurately portrays the broader nature and richer sense of shared interactions around: informational needs; data processing; application of information towards reshaping mental models; the acquisition of knowledge; and acting meaningfully in specific contextual situations. This term also reflected in the notion of information ecologies (Fidel, 2012; Nardi & O’Day, 1999).

**Health information behavior**

Because the original context of the work I present herein was structured towards the interactions between individuals around gestational weight gain and health issues within pregnancy, I provide an overview of the intersection of healthcare research within social information behavior work. There is a large body of work that considers the role of health professionals in finding, managing, and providing information in healthcare environments. Some examples include: Hirvonen, Huotari,
Outside of the work that focuses on health professionals’ collaborations around health information, there is also an equivalent body of work that examines different types of information behavior for individuals. Much has been researched about online information seeking, particularly for health and wellness. There is a defined body of research that investigates the role of online support networks in fostering feelings of self-efficacy and control over the changes wrought by health challenges or changing health situations (Abrahamson & Fisher, 2007; Centola, 2013; Foster & Global, 2010; Heaney & Israel, 2008; Neiger et al., 2012). Online health support communities are seen as kinds of social collaboration sites around which information can be sought and circulated about a specific condition (Baumgartner & Hartmann, 2011; Borzekowski, Schenk, Wilson, & Peebles, 2010; Campbell & Jovchelovitch, 2000; Gajaria, Yeung, Goodale, & Charach, 2011; Maloney-Krichmar & Preece, 2005; Wellman & Frank, 2001; M. White & Dorman, 2001).

Similar to other health and wellness situations that carry a specific trigger for information seeking, discovering that one’s self or partner is pregnant tends to generate a large amount of information seeking and an array of coordination, cooperation, and collaboration activity with one’s spouse, family and peer networks (Deutsch, Ruble, Fleming, Brooks-Gunn, & Stangor, 1988; Lagan, Sinclair, & George Kernohan, 2010; Lagan, Sinclair, & Kernohan, 2011; Larsson, 2009; McKenzie, 2003). In addition to searching for information about physiological symptoms and corporeal
changes, pregnancy also stimulates a desire to begin to understand the changes having a baby will generate in one’s life (Johansson, Rubertsson, Rådestad, & Hildingsson, 2010). Those changes encompass a wide variety of domain interests, from the financial and career sector, to the social environment and package of social roles, and inward one’s self concept and identity.

For pregnancy, there has been research done on the impact of online communities made specifically for a research purpose (Daneback & Plantin, 2008; Dunham et al., 1998), as in the case of problematic pregnancy due to pre-existing health conditions (Lowe, Powell, Griffiths, Thorogood, & Locock, 2009). There is limited work done on the role of commercial systems (e.g.: BabyCenter.com) on the shared experiences of pregnancy, or of information interactions around pregnancy for pregnant lower-income woman. This is despite research (Guadagno, Mackert, & Rochlen, 2013; Mackert, Guadagno, Donovan, & Whitten, 2014) that the integration of the social support networks into prenatal care collaborations improves long-term wellness, understood as the combined package of psycho-social, emotional, physiological healthy functioning.

**Pregnancy**

The first trimester period is especially crucial to address for pregnant women (Stengel, Kraschnewski, Hwang, Kjerulff, & Chuang, 2012). This period is when the impacts of pregnancy are just starting to be felt, and when the pregnant woman is beginning to notice strong changes to her emotional and physiological state (e.g.: food cravings; mood swings; nausea; insomnia). Women frequently turn to “Dr.
Google” for advice (Kraschnewski, Chuang, et al., 2014; Kraschnewski, Poole, et al., 2014), and also seek out mobile apps for tracking and information.

The policy and non-governmental organizations, the medical informatics (MI) community, the Human Computer Interaction (HCI) and CSCW communities, and the social and behavioral sciences (SBS) communities are also all interested in the potential for mobile health applications for pregnancy. But much of the formal empirical research from those communities examines the use of SMS textual messages for preventative care, or researches pregnancy health problems, or considers pregnancy as an exacerbating factor in other health problems (i.e. HIV/AIDs) or looks at the dangers of birthing in developing countries (Martínez-Pérez, de la Torre-Díez, & López-Coronado, 2013), such as Africa (Lund et al., 2012), Indonesia (Chib, Lwin, Ang, Lin, & Santoso, 2008) and South America (Curioso, Kurth, Cabello, Segura, & Berry, 2008). Often the focus of this work is on care workers, rather than on pregnant women, spouses and families or close supporters.

The treatment of pregnancy in social and behavioral sciences research appears to differ based on the age and socioeconomic status of the pregnant woman. Despite some research which presents an alternative view of age-based patterns of pregnancy experiences (Barcelos & Gubrium, 2014; Bonell, 2004), there is a thread within literature that treats pregnancy during the early childbearing years of adolescence as a social issue (Amy & Loeber, 2007; Barr, Simons, Simons, Gibbons, & Gerrard, 2013; Bonell et al., 2013; Linders & Bogard, 2014). Digital intervention activities for this group of pregnant women are frequently focused on Internet-based resources,
such as websites and community message boards (Sherman & Greenfield, 2013). For older mothers above age 33, HCI literature often focuses on digital interventions intended to get women to the birth event by minimizing the medical and health problems of pregnancy (Wierckx, Shahid, & Al Mahmud, 2014). In cases where social solicitation and sharing of information was the core activity, research often presents experimental designs that are targeted at higher income populations, as in MammiBelli (Hui, Ly, & Neustaedter, 2012).

**Pregnancy as preparation for parenting**

Pregnancy is a multifaceted experience that is a biological change, a processual series of events that is tied inextricably to parenting, and a social transition preparation (Bronte-Tinkew, Scott, Horowitz, & Lilja, 2009; Cordova, 2000; Deave, Johnson, & Ingram, 2008; Deutsch et al., 1988; Grant, McMahon, & Austin, 2008; Johansson et al., 2010; Lawrence, Rothman, Cobb, Rothman, & Bradbury, 2008; Mitnick, Heyman, & Smith Slep, 2009). As a biological and medicalized process, it is primarily concerned with bringing a new human safely into the world, while minimizing the health and corporeal risk to the baby’s mother (Bayrampour, McDonald, & Tough, n.d.; Bonell et al., 2013; McCaw-Binns, La Grenade, & Ashley, 1995; Phelan, 2010; Rkhzay-Jaf, O’Dowd, & Stocker, 2012; Stengel et al., 2012). Research in this vein tends to be situated primarily in the medical sciences literature, and is often concerned with risk avoidance, risk management, and physical health maximization. The focus is often the pregnant woman as a *container of problems* (Kearns & Moon, 2002) related to diet, exercise and other corporeally-situated behaviors that might impact the health of the mother and her developing child.
As a processual series of temporally-inflected events, pregnancy is often structured in written accounts via the trimesterial phases, and is most often tied most closely to the medicalized views, and focused on the culmination event of child birth. The research in this lens does occasionally address pregnancy as a normal process in the female lifecourse (e.g.: Bayrampour, McDonald, & Tough, 2015; Rallis, Skouteris, McCabe, & Milgrom, 2014), though the work that considers pregnancy in this way often does so in hindsight, where the research focus is otherwise on mother and baby parenting and bonding (Barr et al., 2013; Nash, 2011). In this work, pregnancy as a temporal process that is a preparation phase for parenthood is frequently flattened temporally and focuses often on the final event of birth (Grant et al., 2008; Parker, Dmitrieva, Frolov, & Gazmararian, 2012; Smith & Kruse-Austin, 2015), as if there was no need to address the spectrum of experiences, people, and processes of pregnancy, and that there was no possibility that pregnancy might carry life lessons that are transferrable to other change events in the lifecourse.

**Pregnancy as an experience**

Considering pregnancy as a preparation process towards parenting, and as a lived experience strongly inflected by a time element suggests a need to consider individual and collective understandings of social position and individual agency of a specific pregnant population. Because of this, accounting for the temporal flow of experiences in human lives is an important aspect of the design space of pregnancy.

According to Bengston et al. (2011), the social time and context focus of common and everyday life experiences are highly impacted by temporality. Viewing everyday experience through this approach argues for a lens that captures historical,
biographical, social, political and geographical situations, within which transitional change events or *turning points* trigger changes in individuals’ life trajectories. The five principles are:

1. *Linked lives*, highlighting the dynamic interdependencies of people;
2. *Historicity*, signifying the impact of time and physical situation;
3. *Experience* and the timing impacts of experience on later life;
4. *Agency*, describing how personal understanding and effort impacts life outcomes; and
5. *Lifelong development*, showcasing the way humans are always embedded in a process of becoming someone.

Bengston et al.’s five-principle consideration of life experiences is useful when considering the dimensions and contexts of everyday pregnancy experiences.

**Pregnancy and technology**

The life experience of pregnancy triggers a great deal of intense and prolonged information seeking and information tracking activity for the pregnant women. Beyond simple immediate health information, newly pregnant women seek out information related to the impacts of pregnancy on their longer term health potential, as well as on their domestic situation and their psychological methods of emotional and personal adjustments to change. Similar to a variety of change processes triggered in health generally (Baumgartner & Hartmann, 2011; White & Horvitz, 2009), pregnant women turn to the Internet for information and education (Shieh, McDaniel, & Ke, 2009), particularly when they are unable to gain swift access to their preferred medical care provider (Peyton, Poole, Reddy, Kraschnewski, & Chuang, 2014b).

Because of the increasing proliferation of Internet-connected mobile devices, there appears to be an increase in women’s use of mobile applications for health
information and health behavior tracking (Fox & Duggan, 2012), and this seems to be particularly true for pregnancy health seeking and personal management during the period of pregnancy (Agarwal S & Labrique A, 2014; Evans et al., 2014; Martínez-Pérez, de la Torre-Díez, Bargiela-Flórez, López-Coronado, & Rodrigues, 2014) But women also have a strong need to manage their pregnancy as a normal and everyday life experience, one that goes beyond the health factors. Thought of in this way, then, pregnancy is a period of life that carries impacts within and through the emotional, social, relational and structural systems surrounding a lower-income pregnant woman.

What all of these areas of research around pregnancy have in common is that developers and researchers are looking to augment existing approaches to web-based health promotion, through the development of mobile, wearable and social media platforms (Zheng et al., 2013; Zickuhr, 2011). A large area of development in the latter domain is the development of tracking systems and devices intended for individuals to use to track their daily activities related to a variety of health-related behaviors (Klein et al., 2011; Kraschnewski, Poole, et al., 2014; Lagan et al., 2010; Larsson, 2009; Lowe et al., 2009; Shieh et al., 2009; Sparud-Lundin, Ranerup, & Berg, 2011), including diet, exercise, anxiety, sleep, and health condition management.

Partly in response to large scale policy initiatives from social good and political organizations such as the World Health Organization (Briggs, Adams, Fallahkhair, Iluyemi, & Prytherch, 2012) and the United States Government, there is increasingly an interest in using mobile technologies to reach ‘at risk’ populations with
pregnancy. Populations of focus are often situated in developing countries, or in rural areas in developed nations. There exists a general framing of pregnancy as a gendered ‘woman’s issue’ within scientific work, despite the growing calls to include fathers in family planning and pre-natal care (Bond, 2010; Doss, Rhoades, Stanley, & Markman, 2009; Hoge, 2014; Kågesten, Bajos, Bohet, & Moreau, 2015; Lu et al., 2010; Mackert et al., 2014; Marsiglio, 1993; Miller, 2010).

The preoccupation in many strains of pregnancy management assistive technology extend and reinforce this framing, focusing most often on alleviating potential health problems in the pregnant woman, in order to ensure healthy birth, and to reduce maternal and infant mortality and complications later in the maternal and offspring lifecourse. The paradigm of the work continues the dominant scientific tendency to present pregnancy as a medical issue (Macleod & Durrheim, 2002; Sawicki, 1999; Turner, 2008). The use of technology is often seen as an educational tool to reach a wider audience within the target population, and as an intervention that helps readjust behaviors towards what is considered to be appropriate, healthy, and risk minimizing, based on medical evidence. The focus in this body of work is often on diet and lifestyle (Carolan, 2007; O’Brien, McCarthy, Gibney, & McAuliffe, 2014). There is some attention to the ways in which technology can help reduce gestational weight gain during pregnancy, in order to minimize pre and post-natal health risks and complications (Siega-Riz et al., 2009; Szwajcer, Hiddink, Maas, Koelen, & van Woerkum, 2008; Szwajcer et al., 2008). Additional areas of focus look at birth event planning, birthing readiness, and tracking of fetal development milestones.
Current work within HCI around pregnancy tends to focus on women from upper-middle to upper socioeconomic status (SES) groups (Gibson & Hanson, 2013). Common in this work is attention to: older women (Carolan, 2007); the perceived willingness for women to share information online (Ley, 2007; Morris, 2014); and to women’s developing sense of their new role of being a mother in their domestic and larger societal circulation. In this body of work, then, the idea of pregnancy as a multi-dimensional process tends to be backgrounded to other considerations. Where there is attention to the more social aspects of pregnancy within the technology domain, the work often examines online communities and pregnant women’s involvement in them (Gibson & Hanson, 2013; Nash, 2011). This area of research also looks at ways to make the fetal development of the baby visible and legible to the outside world (Hui et al., 2012).
Chapter 4

Research Design

The research I conducted for this project consisted of three phases of distinct but connected research activities. Outcomes of the three activities were then incorporated into the design considerations and recommendations that close out my thesis work. Each research activity was intended to augment my knowledge of the challenges of managing pregnancy for lower-income women, and the ways in which pregnant women weave digital apps into their life management processes. My research efforts were also intended to help me understand where the existing commercial landscape of MAPs support or ignore the specific dimensional contexts of lower-income American pregnancy, and where there may exist gaps in support. I was then able to incorporate my evidence-based understanding into delineating a refinement of the design space for MAPS, through by a series of design frames for interaction design considerations.

The three phases of research activities were:

1) a series of focus groups with pregnant or recently pregnant lower-income women,
2) a small set of mobile-design oriented interviews with pregnant women;
3) a scoping study of the landscape of existing commercially available pregnancy health apps on the iOS platform;

The purpose of this chapter is to offer an overview of the qualitative research approach I adopted for my project, and to provide details and results of the research activities I pursued for my dissertation.
I have structured this chapter into four subsections:

1) Research questions
2) Study design
3) Research activities
4) Risk management

**Research questions**

Each of my main research questions and my one sub questions are grounded in my examination of the literature. The Research Questions (“RQs”) are intended to make visible the gaps I have identified in existing design literature, and direct the research activities which provide evidence for space to redress the gaps.

**Research question 1**

| Human Perspective | RQ1: What role do mobile apps for pregnancy perform in the information seeking and social coordination experiences of lower-income pregnant American women? |

My first research question addresses the human gap space, around lower-income pregnancy as a human perspective that carries strong information seeking and social coordination dimensions. Reiterating the intended outcome, my goal in responding to this question via the first two research activities is to present opportunities for mobile technology to play a positive facilitating role in the information seeking and social coordination experiences of lower-income pregnant American women.
Research question 2

| Technological Perspective | RQ2: Do existing mobile apps for pregnancy appropriately meet the informational and interactional needs of lower-income American women? |

As I pointed out in the Introduction, part of the motivation for doing this overall project was the nascent but growing interest within the field of HCI for possibility of a role for digital tools in encouraging more positive domestic life event processes and conclusions. With this in mind, the second RQ acted as a guide for the third research Phase.

Research question 3

| Sociotechnical Perspective | RQ3: Do existing mobile apps for pregnancy appropriately meet the informational and interactional needs of lower-income American women? |

The third research question was intended to address the outcome of the MAP design space analysis. Following after the response to RQ2, this question guides my framing of a set of recommendations to improve the design space of digitally-mediated lower-income pregnancy.

Study design

Guided by my research questions, the point to conducting the research activities within this project was to develop an understanding of the interactions and interdependencies of lower-income pregnant woman. The intent of the three qualitative study activities was to create a conceptual design space around the ways lower-income pregnant women are situated in the digital circulation of interactions and information about pregnancy, across three processes:
1) **a medical process of risks** and dangers (systemic level);

2) **a personal process of stress, adaptation and change** (personal level – pregnant woman and the baby);

3) **a collaborative process of negotiation, coordination, conflict, and compromise** (interpersonal level – baby-mother-father-family-peers).

The methods adopted for my project were expected to illuminate and elucidate this tri-fold consideration of lower-income pregnancy processes. Through the three research activities, the activities are designed to make visible five process-based interactions:

   1) **People** involved in pregnancy management;
   2) **Artifacts** brought into circulation by people to aid in pregnancy management;
   3) **Knowledges** that circulates about pregnancy management;
   4) **Actions** expected or taken around pregnancy management; and
   5) **Temporalities, geographies** and **socioeconomic** influences.

To address my three research questions, I adopted a qualitative research approach. I listened to a set of pregnant participants tell me in a group setting about the typical approach to pregnancy interactions between pregnancy health professionals and themselves. I also probed and discussed the contextual interactions related to pregnancy and technology with a small set of pregnant women, in an individual interview setting. To understand the role of the digital information ecology of pregnancy on pregnancy management, I gathered and analyzed a set of mobile digital applications, all focused on pregnancy support.

Viewing the design space of pregnancy as containing a set of dimensions impacted by the processes in which they are made visible is an approach that is
inherently value-laden and relativist. There are multiple potential standpoints of knowledge and practice around pregnancy as a set of practices and processes, from the biomedical standpoint, from the gender standpoint, the sociopolitical standpoint (e.g.: race, SES, geography) and from the standpoint of lay knowledge. Understanding pregnancy as a complex but common life process required a methodological approach that acknowledges the strong relativism of the varied social realities for each individual involved in a specific pregnancy. I needed to be able to document, understand and represent the situated voices, practices, artifacts, and realities of the various individuals and groups, as each is related to the pregnancy process, and related to pregnancy as a normal life experience that is impact heavily by the socio-economic status of the mother. A qualitative approach to research provided me the epistemological guidance and space to do this.

**Research activities**

I employed a *multiple-method* data gathering and analysis approach in which interpretations of action and knowledge are inherently inductive and emergent from accounts and observations. This methodological approach is appropriate for my research because the intended outcome of my work requires me to construct a multi-faceted contextualized understanding of pregnancy as a design space. I provide an overview table of my activities as Table 2 (next page).
### Table 2: Research phases and responsibilities

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<td><strong>Phase 1:</strong></td>
<td>Inductive iterative open coding <em>(Saldana)</em></td>
<td>n=19 Women</td>
<td>Spring 2013</td>
<td>Shared and Solo:</td>
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</table>
| Focus Groups (N=4 groups) |                        | ● Pregnant/recently pregnant  
● All lower-income  
● Aged 20-33  
● Reading, PA federal clinic | | ▪ No involvement in protocol creation, recruitment, or conducting of focus groups  
▪ *Solo transcription:* Transcribed (verbatim) audio-recorded group conversations  
▪ *Solo analysis:* Coded conversation data  
▪ *Shared findings:* Co-led consensus building workshop on themes with original research group |
| **Phase 2:**            | Case-based thematic analysis *(Stake)* | N=6 Women | Summer 2013 | Solo |
| Design Interviews (N=6 women) |                        | ● Pregnant/recently pregnant  
● 5 lower-income,  
● 1 low-middle-income  
● Aged 24-32  
● State College, PA | | ▪ Designed protocol  
▪ Recruited participants  
▪ Interviewed participants  
▪ Coded conversation data  
▪ Determined findings |
| **Phase 3:**            | Thematic scoping analysis *(Arksey & O’Malley)* | N=493 Initial iOS dataset  
N=192 Working dataset  
N=25 Analysis dataset  
N=17 Final dataset | Fall 2013 & Winter 2014 | Primarily Solo |
| iOS Pregnancy Mobile Apps (N=493 apps) |                        | ● Working dataset n=192  
● Analysis dataset n=25  
● Final dataset n=17 | | ▪ Designed protocol *solo*  
▪ Recruited and coordinated 2 undergraduate assistants  
▪ *Initial dataset:* Supervised initial dataset creation through scripted crawling of iOS store  
▪ *Working dataset:* Collaborated *jointly* with assistants in the iOS AppStore listing review reduction activity  
▪ *Analysis dataset:* Conducted analysis *solo*  
▪ *Final dataset:* Determined findings *solo* |
Research phase 1 was motivated by a desire to understand how women perceive their ability to manage their pregnancy health, what sort of information they possessed or sought out in relation to diet, exercise and weight changes during pregnancy, and what they felt was missing in their own support landscape that impacted their subjective sense of pregnancy wellness.

Research phase 2 was intended to examine how pregnant women perceived the existing design tropes and information presentation options in mobile and web systems for pregnancy, such as color choices, image styles, and information presentation arrangements. It also considered the role of their own support network in their pregnancy management practices.

Working from the outcomes of the prior two activities, Research Phase 3 was intended to assess how well the existing commercial marketplace addressed the needs of pregnant women as it relates to the information, social support and personal management of pregnancy.

Responsibilities

The phased research activities took place over a 19-month period spanning the spring of 2013 to the winter of 2014. Because the first research phase (Focus Groups) took place within an NIH-funded study on the potential for MAPs to have a positive intervention effect on the gestational weight gain of lower-income pregnant women, I held mixed responsibilities within that project, related to my role as a research assistant (see Table 2). My other research responsibilities as solo researcher, completely or partially, for the remaining two research phases are also laid out in Table 2.
Data collection

Focus groups – Phase 1

Data collection was conducted through semi-structured face-to-face discussions with pregnant or recently pregnant women in a focus group setting. Four 90-minute focus groups were conducted in the spring of 2013, at a federally-funded Women and Infant Clinic (WIC) community center near Reading, Pennsylvania. Each group consisted of four to six pregnant women, recruited through targeted advertisements in the federally-funded WIC center, which serves low-income families. Participants ranged in age between 20-33 years old.

During each audio-recorded focus group, participants were asked to provide their opinions on what it takes to have a healthy pregnancy. Participants also described how they obtained pregnancy information and who they approached for social and informational support during pregnancy. They discussed their use of digital devices to educate themselves on pregnancy, and to interact with others about their pregnancy. They spoke about the people, organizations, websites and applications that influenced their understandings of pregnancy. They also shared their opinions of how medical guidelines for pregnancy (Rasmussen et al., 2010) applied to them, around eating, exercise, sleep and stress management.

I made verbatim conversation transcripts from each of the four focus group audio recordings. I then transferred conversation streams of participant responses from each of the four transcripts into an Excel worksheet for management and analysis.

Interviews – Phase 2

Data collection was conducted through semi-structured face-to-face discussions with pregnant or newly pregnant women in a relaxed interview setting. Participants ranged in age
from 24 to 32. Participants were recruited through a poster advertisement on the Penn State campus, and at local community clinics and grocery stores, as well as through a posting on a popular digital community bulletin board service.

Six 45-60-minute audio-recorded interviews were conducted in the summer of 2013. Three interviews took place on the Penn State campus in a neutral meeting room, and two interviews took place in participants’ homes. Interview discussions and interactions were designed to elicit opinions and feedback on the methods and digital tools participants use or have used to educate themselves about pregnancy, and to help them manage the activities, challenges, and daily aspects of pregnancy. In addition to semi-structured questioning about their personal history, their digital technology and social media use, and their typical ways of keeping track of daily activities and events, participants were asked to engage in four activities:

1) Influencer ranking exercise;
2) Image design preference evaluation (Figure 3).
3) Color design preference evaluation (Figure 4);
4) Pregnancy information Internet search exercise.

Each activity’s results were logged and photographed. Verbatim conversation transcripts were made of each of the interviews.
Figure 3: Examples of art vs photo comparison

Figure 4: Example of a color design card exercise
MAPs investigation – Phase 3

Informed by what I learned from participants in my earlier work, and guided by knowledge of information diffusion practices drawn from literature about everyday life (Carey, McKechnie, & McKenzie, 2001; Eriksson-Backa, Ek, Niemelä, & Huotari, 2012; Hargittai, 2010; Vodanovich, Sundaram, & Myers, 2010; S. Weber & Dixon, 2007; Yeoman, 2010), I set out to systematically catalogue, audit and analyze all of the pregnancy apps for Apple Inc.’s iOS mobile platform.

The motivation for this study was my desire to go beyond the perceived bias in decision making heuristics around tool choice, in which users most often simply pick the most highly rated or top of the list option returned in a search, in what has been called a ‘Take the First’ heuristic (Hepler & Feltz, 2012; Johnson & Raab, 2003). I also wanted to respond to early SIGCHI community feedback on a paper drafted out of the first two activities’ outcomes, in which reviewers suggested that there had to be pregnancy applications which already contained all of the educational information, activity management, and social support modules and features requested by our study participants, and it was suggested to us that no new development would be needed. I focused exclusively on the iOS platform, because it was the most used mobile device platform reported by participants in our prior study, and because there is overlap in apps across mobile operating system platforms.

Guided by an information artifact review process called scoping studies (Arksey & O’Malley, 2005) and using a blended case-based approach to typology creation, analysis and reporting (Stake, 2005), I conducted the scoping and analysis project in three activity sets, as depicted above in Figure 5. The first activity set was the identification of a relevant working dataset of applications, and the two pass scoping reduction of the dataset, in order to identify a narrowed and relevant analysis dataset. The second activity set was the detailed review of
the analysis dataset, alongside documentation of aspects and points relevant to the three research questions. Running concurrent to the second activity, my third activity was a consensus building process, which took place as set of discussions with my (now former) co-advisors around the findings and details of the final dataset.

![Figure 5: A representation of the app identification and selection narrowing process](image)

Data collection from iTunes was done using computational and manual gathering techniques. For the computational method, a scripted crawling of the iTunes API was done in the spring of 2014. The script gathered the app name, app publisher, and other associated metadata for each app. The automated gather was augmented by a manual gathering of apps cited by participants in Phases 1 and 2, using a hand search of the iTunes store and through the Google search engine. The combined returned results were imported into an Excel spreadsheet for use and analysis.

The platform restriction to iOS was done largely because participants in Phase 1 and 2 reported their preference for the iOS mobile platform. Additionally, attempts to get an exhaustive list of Android apps failed, due to restrictions in the crawling features of the
Android stores’ APIs. This inability was partly attributed to the complexity and size (>4600 results) of the combined assets in the Google Play and Amazon AppStore catalogs.

**Data analysis**

*Analyzing Phase #1 data - Focus groups*

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**Table 3: Codes used for focus group data analysis**

Analysis of the focus group data was done using an inductive and iterative open coding approach inspired by Saldana (2009). A worksheet tool for capturing coding activities was made in a Microsoft Excel workbook sheet that contained four worksheets, each with the transcripts of the four focus group conversations. The coding pass took place in three stages, with different codes identified for use in each stage (Table 3).

The initial open coding pass involved attributing nine codes as applicable to each conversation snippet within the worksheet for each focus group session (see 1st pass – Open Coding in Table 3, previous page). Because I was not the main investigator for the focus group project, the results of the open coding were discussed to consensus with the project PIs. From that consensus, five additional codes were created for a second focused coding pass (see 2nd pass Focus Coding in Table 3). After finishing the second pass of coding, the
results were again discussed with the project PIs, and four areas of pregnancy needs identification were devised (see 3rd pass - Identifying Needs in Table 3).

**Analyzing Phase #2 data – Design interviews**

The data analysis for Phase 2 (interviews) was done through a thematic analysis case study approach (Stake, 1995). Individual case studies for each participant session were compiled digitally. Each case file included a participant overview of background and status, and the transcribed responses to interview questions. The files also included an action-oriented retelling of the results of each exercise, including visual representations of choices to the two Image and Color Design visual exercises, and a table overview of the participant’s responses to the influencers exercise. The results of the interviews were discussed in meetings with the project PIs. Each case was discussed alone and cross-case, and the coded cases were also collectively compared to the results of Phase 1. When very few differences between Phase 1 discussions and the Phase 2 conversations arose, the PIs and I determined we had reached conceptual saturation, and I therefore stopped at six interviews in total.

**Analyzing Phase #3 data – MAPs investigation**

The primary scope of this research phase was to identify a dataset of iOS apps that are intended to be used to help a pregnant woman understand, manage and share the everyday life aspects of the pregnancy experience with her spouse or close partner. My scoping research activity was conducted by myself, with some assistance from two voluntary undergraduate interns.

**App Dataset**

To narrow down the working dataset of 192 pregnancy apps, I followed an adapted scoping study approach (Daudt, Mossel, & Scott, 2013; Levac, Colquhoun, & O’Brien, 2010; Levac et al., 2010), commonly used in nursing literature reviews and health research reviews.
The purpose of a scoping study for literature is to systematically guide an audit of a given literature body, with the goal of identifying, quantifying, and analyzing key boundaries, themes, and gaps within the assembled subset. Adapting the scoping study approach for a software audit meant using its general research flow, with its attention to auditing the state and shape of the final dataset, and reflecting that process flow in a flow diagram (Figure 5). The scoping process guided my analytical method of determining the intent, audience, key functions and features of each application. Overall, I used the scoping approach’s attention to thematic analysis and gap identification to guide my later analytic process.

To create the dataset, I worked with two undergraduate interns to perform a scripted gather of names, publishers and metadata of every app in the AppStore that mentioned pregnancy in the title or overview about the app (N=493). To manage the filtering and evaluation process, my team maintained the list of apps and the evaluation process codes and notes in a Microsoft Excel workbook.

First pass: Evaluation of relevance

The first activity was an evaluation of relevance. Informed by the previous research findings, I designed a set of inclusion and exclusion criteria to guide the evaluation of an app’s fit for my research needs. By examining the identified metadata for the app, I was able to remove apps from the initial dataset based on the following exclusion criteria:

- Duplicates (e.g. paid versus non-paid version)
- Non-English apps
- Apps not available in the American version of the AppStore
- Retired apps or defunct apps (apps not maintained to the then-current version of iOS)
- Inappropriate apps for the study intent (e.g.: games for kids; faked pregnancy tests; baby name generators; fertility information aids)
- Incomplete entries
- Specialist user rather than pregnant woman and supporters (medical students, nurses, midwives, community health workers, educators, or insurers)
- Lack of focus on the entire 9-month experience of pregnancy (i.e. antenatal journal; hospital packing checklist; baby shower planner)
- Not focused on pregnancy (i.e. countdown clock for life events; post-partum journal)
- Single purpose app related to a single aspect of pregnancy (i.e. kick counter; database of foods to avoid; yoga poses)

The metadata I used to make this determination included primarily the publisher’s description of the app and the AppStore category in which the app appears:

- **Include**: Education; Health & Fitness; Lifestyle;
- **Exclude**: Entertainment; Reference; Productivity; Utilities

This evaluation of relevance activity using the metadata yielded a reduced dataset of only those apps that appeared be a full-featured multi-module pregnancy education, life management, and pregnancy support app. Apps that fit this definition were those that were comprised of a package of functional modules designed to provide physical or psychological health information, fetal development information, everyday life tracking and logging activities, and the support of sociality and relational capacity during pregnancy. This scoping evaluation on the initial dataset removed 301 apps, producing my initial working dataset 

\( (n=192) \).

**Second pass: Exclusions based on AppStore listing review**

In the second activity for the scoping process, the reduced dataset was more carefully examined for indicators drawn from the focus group and interview work. The examination occurred by looking at the app’s detailed listing page in the web version of the AppStore. Indicators used included an app’s apparent intended use purpose, and its multi-functionality...
Use purpose: While many inappropriate apps were excluded from the dataset in the first pass, the second pass yielded apps that were still not truly intended for interactive pregnancy education, daily management and memory capture by a pregnant woman and/or her spouse or partner. For example, I found apps that appeared well designed, and which appeared to be directed at a pregnant woman and her spouse or partners, but on deeper investigation, they were identified as still being intended as eBooks, platforms for digital magazines, or entertainment apps.

Multi-functionality: I determined that an app was multi-functional if it provided a set of functional modules that addressed any combination of pregnancy education, everyday activity logging, tracking, life management, social support, and life memory capture. For this reason, I excluded apps that had a single purpose, such as ‘belly bump’ photography, weekly countdown trackers, kick counters, baby name voting games, or packing lists of what to bring to the hospital for the birthing.

Second pass evaluation and reduction further removed 167 apps from the dataset, producing my analysis dataset (n=25).

Detailed evaluation and analysis

The final activity set for the project consisted of case-based directed data analysis, and of a process of meaning and consensus construction, intended to provide evidence to address my research questions.

Final dataset data analysis approach

To guide my analytic activities in the final dataset, I employed a case-based approach (Stake, 2005). Each of the 25 apps was treated as a discrete case, with the entire dataset treated as a combined case. To analyze the apps, I used a purposive and constant comparative
analysis coding approach within each case and cross-case, directed at identifying commonalities, differences, patterns and structures within the dataset. The coding process was guided by the knowledge I gained in Phase 1 and 2 about the pregnancy experience for lower-income women, and from general tenets of good mobile design (Ahtinen et al., 2009; Chang, Kaasinen, & Kaipainen, 2012; Kaptelinin & Nardi, 2006, 2006; Tidwell, 2011). Because each of the 25 apps had already been coded in activity 1 and 2 according to its study relevance, audience, functionality, and purpose, the point to coding in the final dataset was to analyze and identify evidence, within and cross case, which would enable me to address our three research questions. To facilitate depth analysis, each app was installed onto three iOS device types: an iPad Air, an iPhone 5S, and an iPod Touch.

**Risk management**

The risks of a qualitative research approach are minimal. The potential anticipated risks that were managed in my work were:

1) *technological interruptions* or failures during interviews, on either the participants’ side or the researcher’s side;
2) some *mild social or emotional discomfort* on the part of participants; and
3) the possibility of *an app no longer being available* for the iOS

**For Risk 1,** of failures on the participant’s side, interruptions or failures could include loss of electrical power at the participant’s location, loss of connectivity to mobile or Wi-Fi networks. To mitigate this, I arrived for focus groups and interviews prepared to use my own cellular data service as a backup connectivity point, if needed. I mitigated possible recording failure by checking for appropriate recording volume and storage of video data during the opening of the interview, prior to collecting consent.
For Risk 2, an anticipated minor potential risk was the possibility of pregnant participants’ discomfort when discussing their pregnancy with me as a researcher, alongside the in situ management of some biological demands of their own bodies, such as an increased frequency in a need to urinate. While pregnancy inflects this a bit more strongly, the two aspects described are nevertheless typical of all qualitative studies with humans. I minimized or managed the psychological discomfort by doing perception checking at intervals during the interviews and focus groups, and offering a break at the halfway point. I paused the recording and stepped away to allow the participants space and time to re-center themselves. This break also addressed the physical risk, as it allowed participants to tend to any biological needs they were experiencing at that time.

For Risk 3, there existed in Phase 3 (MAP investigation) the possibility of a loss of access to the app, due to a change in the Apple operating system that could render it unusable, or a deletion of an app’s listing information in the iOS marketplace. Screen shots were used to mitigate this risk. The marketplace listing page for each app was digitally captured as an image and archived. The analyzed functional modules and features in each final dataset app in Phase 3 were image-captured and archived.
Chapter 5

Findings and Synthesis

In my analysis of the iOS app marketplace for pregnancy, I found that apps focused mainly on the end result of pregnancy (the birth event) and focused almost exclusively on the physical health of the pregnant woman, defined according to medical guidelines. This supports previous work which suggests that pregnancy care in the United States has become increasingly locked into a medical frame (Rising, 1998; Root & Browner, 2001; Rúdólfsdóttir, 2000). This means that the idea of engaging pregnant women in self-care and psycho-social peer support with their spouse or close domestic supporter was largely absent, and the information and support paradigm instead trended towards a medicalized notion of a solo pregnant individual, who was mitigating risks leading to a birth event. In the pregnancy apps, I could find little evidence that developers or designers had an awareness of pregnancy as a multi-faceted sociotechnical experience. As a result, my MAPs investigation corroborated the accounts from my participants about the lack of social interaction and the narrow concept of pregnancy information within digital designs.

Through analysis activities were conducted as three phases of research activities, the outcomes were compared both within-phase and cross-phase. The research activities were intended to study the context of pregnancy for lower-income women, and to understand the role of existing technology applications in supporting or improving pregnancy health for them.

- A main finding from Phase 1 (focus groups) and Phase 2 (interviews) was the identification of four types of potential needs for pregnancy support of lower-income pregnant women, around physical, emotional, informational and social dimensions. These
shaped a research discourse of change and adjustment, shaped by the often-repeated story that ‘every pregnancy is different’.

- A main finding of Phase 3 (audit of pregnancy applications) was a corroboration of the reports heard from participants in the earlier research phases. In particular, I found: a lack of support for sociality or emotionality in pregnancy apps; a highly medicalized tone of pregnancy information; a focus on physical risk dimensions of pregnancy; and a generally static non-interactive design approach in most apps.

The findings from my research activities are structured according to the needs identified by participants in Phase 1 and 2. The physical, emotional, informational, and social dimensions of pregnancy are how I have chosen to present this set of needs, shaped by participants’ shared idea that each pregnancy is different than the others, and because of this, specific guidelines cannot apply to them. I then separately present the results of Phase 3, demonstrating how the majority of applications are aimed at pregnant women solely, and are intended mainly for medical information and education, and for preparing women for the birth event. I close off my presentation of research findings as a synthesis of all three phases of research. I discuss the implications that my research endeavors provided to my process of discovery. By using the findings to present a justification for the narrowed focus on social support and information needs going forward herein, I then conclude this subsection.

**Pregnancy needs**

Stories from the focus groups and interviews made it clear that participants viewed pregnancy as a process of managing change and difference, both within their pregnancy, and between different pregnancies (for those participants that were multiparous). In addition to the obvious and understandable preoccupation of getting to the birth event as easily and as
healthy as possible, pregnancy also meant finding new ways to adjust and cope with the changes wrought to their selves, their activities and their environment, as a result of their pregnancy. The kinds of changes of which participants shared most frequently related to their bodies, their emotional states, their awareness and understanding of pregnancy, and their social roles and situations.

Participants talked about fluctuating energy levels, about problems sleeping, about food cravings and aversions, and about mood swings.

“I don’t know if mine is really cravings. It’s more a matter of… what can I keep down? It’s like, and it’s random…like the other day, the first thing that pops in my head that I think I can eat. I grab it. It was sardines and mac and cheese. So gross. But it was like… SO GOOD!? Cause it was like… it was the only full plate that I could eat that day… so it was just, like, it’s been random, like one minute, it could be CHOCOLATE, and I had to go out and buy, like, four chocolate bars, and like, just have this chocolate fix… and like other days it could be soup? Or salad? I’m just all over the place right now with food.” (FG1)

“My husband bought me a Wii Fit several pregnancies ago, and I use that, but not during (pregnancy) …I’m good and consistent when I’m not pregnant, but as soon as I get pregnant, I’m exhausted and you’re nauseous, and you just got a lot of other things… but yeah! Trying to do the Wii Fit with the toddlers are crawling all over you?! It just doesn’t happen” (FG4)

Participants also talked about changes to their habits, including how they parented existing children (if they had them), how they managed their work duties, and how they felt their spouses, family members and friends reacted to them and to their growing ‘belly’.

“Yeah, I would also say the whole hormonal balance, and a lot more lower back pain, and the fact that my son isn’t walking yet, and my stomach is getting out there and out there and it’s just a lot harder to bend down and pick him up and carry him around…”

“Up until July I was also running a small business, doing wedding cakes? Which I decided to put on pause, just because physically it’s pretty demanding and it takes up a lot of my free time, or all of my free time. So I stopped doing that in July, but it was work definitely when you think of

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1 The outtakes from Focus Groups and Interviews have been tagged according to their source. Numbers for focus groups (FG) indicate the session number of the four focus groups. Numbers for interviews (I) correspond to participant case numbers.
the pregnancy, and the anticipation of what was coming. Seemed like too much on one plate.”

Participants talked about how pregnancy also included a process of changing who they are as a person; of adapting to the impending change of becoming a parent for the first time or again, as well as changes to their spousal dynamic.

“I often feel bad for my husband ‘cause he doesn’t know what he’s coming into when he comes home from work, you know? Like, I could be happy, I could be off the wall, I could be psycho… he doesn’t know… he doesn’t know what you’ve dealt with all day.” (FG4)

“I unfortunately suffered morning sickness from week 6 until week 39 when she was delivered? So luckily my husband did 90% of the cooking, and we split on the housecleaning, the taking care of the house.” (I1)

The change process often also included helping others manage the change the pregnancy brought to their shared lives, particularly for a woman’s spouse and any existing children. For multiparous women, those who were having a second, third or sixth baby, they spoke of the differences in the pregnancy process for them between each pregnancy, which led to the often-repeated story that ‘every pregnancy is different’.

“One thing about the Babbycenter app is in their little messages that they send, it has the little note down at the bottom saying, “every woman’s pregnancy is different”. You could experience different things. This is just a general, like, broad spectrum, of what you could be feeling and where your baby should be”. (FG1)

“At my last appointment, I had a follow up with a dietician… but all the questions I answered… nothing really needs to change. A lot of it could be water gain. So the guidelines are there and that’s great, but obviously, with everyone it’s different.” (FG1)
While participants talked a lot about change and difference in their lives, both changes because of pregnancy and differences between pregnancies, they also recounted stories that shared common concerns, and recurring needs or desires (“wishes” in their language) about the experience of pregnancy. I have summarized these needs in Table 4. I have chosen to group the needs according to their expressed dimension of experience: Physical; Information; Emotional; and Social.

**Physical needs**

Because the initial research phase was focused on understanding how to help pregnant lower-income women have healthier pregnancies, a line of questioning in focus groups centered around weight gain. It became quickly apparent in each group that most participants did not know how much weight they should gain during pregnancy.

“A healthy weight gain? 30 pounds? I think…hmm…I have no clue”. (FG3)
Some participants did have knowledge of weight gain guidelines, but appeared to be unconcerned by the recommendations, suggesting their own pregnancy was different because of a variety of factors.

“I always thought it wasn’t about how much weight you gained as long as the baby’s weight was gaining.” (FG3)

“For me, I’m hoping I don’t gain that much, but if I do, I do.” (FG3)

Participants were largely unaware that it is normal to lose weight in the first trimester, and that the weight gain guidelines are based on a total weight gain by the end of the pregnancy.

“I think it depends on your starting weight to begin with… I had lost 10 pounds in the 1st trimester, they said you’re underweight… but now I went in for my last checkup and he had a growth spurt, but there are other things factoring in like I had lost weight… so he went, ‘I’m a little concerned’, and I said, ‘You told me I needed to gain 40 pounds?!’” (FG2)

Participants also did not always show an awareness of the fact that weight gain guidelines depend on where a woman’s weight falls on the Body Mass Index (BMI) weight guidelines categories (Stengel et al., 2012).

There were also stories of food cravings and aversions. Alongside and within those stories were tales of pregnancy dietary restrictions, stress and energy levels, and the impact of other family members on a woman’s ability to eat for a healthy pregnancy.

“America is like fast food capital … (so I ate) fast food, because I couldn’t cook at home, I couldn’t stand the smell… I couldn’t go out to a restaurant. You go to fast food, you go the drive-thru, you don’t have the smells except for exactly what you want… so it’s either that or cold cereal.” (FG1)

Overall, two themes emerged from discussions of physical needs, as presented through discussions about dietary choices and activity participation.

The first theme was the participants’ expression of a feeling of *lacking control over their body*. Within this theme, I heard narratives that highlighted the dominance of the
embodied experience of pregnancy over medical guidelines and dictates. According to participants, the pregnant body is something to which they listen and submit, rather than something they actively manage. Symptom management in particular was singled out as a dominant reason for ignoring dietary best practices. Participants spoke of listening to their body’s dictates, by succumbing to food cravings, avoiding other foods that triggered heartburn, nausea and vomiting, and generally managing what they did eat around what their body would apparently tolerate.

“I mean I was nauseous during the first trimester, but it really didn’t matter. I mean, I guess…it didn’t really matter what I ate. I would just eat, then be nauseous. Morning sickness...bad name. No, it could be lunch, it could be dinner. The morning sickness...yeah that wasn’t just in the morning” (I3)

Pregnant women’s bodies controlled them, and the ‘best’ way through a pregnancy is to listen and succumb to whatever the body requires of the woman throughout the pregnancy. Thus, immediate needs of the body—for instance, eating only hash browns to avoid nausea—overtook longer-term needs, such as eating a balanced diet.

“It all depends on the cravings...on the body type. The first one I couldn’t eat anything healthy, I had to eat junk food or soda just to keep the normal food down.” (FG2)

“For me, I think it’s really hard not to eat, I get cravings. I think my body needs a type of vitamin or something” (FG3)

The second theme was the widely-held belief that every pregnancy is unique, and therefore pregnancy guidelines, and particularly weight and exercise guidelines, do not necessarily apply. In each focus group and interview, the participants spoke about the uniqueness of each pregnancy:

“Like...each pregnancy is different. It’s so funny, like, I would have something, like some healthy cravings? And I would eat healthy and everything would be fine. As soon as I crave junk, the junk will come right out.” (FG4)
Women told a number of stories that presented justifications for their understandings either of appropriate weight gain, or of how their own weight gain was acceptable because of extenuating circumstances.

“Besides, I heard from a lot of people that if you plan on breastfeeding, you lose a lot of the weight afterwards… “(FG3)

“I asked my doctor, ‘doesn’t height have a lot to do with it’? She said, ‘yeah, but you’re just way over’. I’m 5’8” so I’m thinking that might be why…” (FG3)

The appearance of extenuating circumstances was often due to a misunderstanding of the correct progression of weight gain over an entire pregnancy period.

“It’s hard because a girl I work with has only gained 10 pounds with every pregnancy, and all her kids are healthy…but some people gain 90 pounds… My friend’s sister gained 90 pounds but it was all fluid… she went into the hospital and she lost 40 pounds, all in fluid.” (FG2)

Some of the participants spoke of not being willing to let pregnancy ‘get them down’, and stated that they tried hard to stick to a normal or regular food and exercise routine, despite their pregnancy.

“I’ve been trying not to, honestly…um…because of in terms of my exercise routines, and then also, what I think of things I actually do at home… um… and in part because I really LOVE to cook. So that’s one thing that even when I’m super tired, that’s a nice thing to be able to come home and do. I really enjoy it. Um…does that answer that question? Yeah. I’ve still been going to yoga, like…you know, three times a week.” (I4)

“That’s another one. Even when I’m feel like I can’t quite scrape my face off my desk at work, I think, this is important, and I always feel better afterward? So I think this is important. I should go.” (I4)

**Emotional needs**

Even with the stated desire to keep life going normally, an additional theme that exacerbated participants’ ability to make or maintain a healthy diet and consistent physical activity behaviors was self-care of mind and body. Stories of fatigue, stories of stress, and of the constant changing needs of the woman’s body presented challenges.
“You set a goal, like, ‘I’m going to work out for half an hour’... and then you go and you work out for five minutes and you’re just done. Tired. Very tired.” (FG2)

Energy levels are variable in pregnancy, according to participants, yet very few of the women I spoke with showed an awareness of the potential to improve energy levels or stress management through appropriate diet and exercise:

“I go to the gym but it’s not the same. I feel more fatigued now. I see myself quitting, pretty quick.” (FG2)

Along with fatigue and stress came emotional upheaval, both as a result of the woman’s changing status in the home, and also attributed frequently to ‘hormones’.

“I often feel bad for my husband cause he doesn’t know what he’s coming into when he comes home from work, you know? Like, I could be happy, I could be off the wall, I could be psycho… he doesn’t know… he doesn’t know what you’ve dealt with all day.” (FG4)

The energy, stress and emotional affordances within each woman’s unique experience of pregnancy were also cited as the reason for their indifference to the demands of many pregnancy-focused mobile apps, whether for self-monitoring health behaviors or tracking other aspects of pregnancy. The requirement to digitally write down everything a woman eats and every exercise activity they do may seem simple, but in the daily juggling act of a pregnant woman, the suggestion that they should actively track and record their activities was met with incredulity, laughter and sometimes derision. It was likened to the activity of trying to maintain a baby book of the baby’s first days.

“I do like to keep a baby book of their first year. I try to do at least that, so they know when they got their first tooth and they know when they took their first steps, that’s important. But the time needed!? It would be nice if I could find an app for that. Because finding time to pull the book out and write it in? No, it’s hard.” (FG4)

A key outcome then of emotional needs was the desire to at least be able to quickly and easily communicate their emotional valence to their core pregnancy social supporters, in order to mitigate
what was seen as the ‘aftermath’ of the emotional upheaval they encountered, the presence of which they attributed to fatigue, stress and hormones.

**Social needs**

To cope with the many changes that come with pregnancy, participants singled out specific people in their life as being a pregnancy saver or “sanity check”, such as a domestic partner or husband. A “good husband” was mentioned in most focus groups as one of the most important people in their lives when it came to being able to ‘make it’ through pregnancy:

“Cause my husband, like, for example, he comes off work and he will...he goes off to do something with the kids and leaves me by myself. That helps me because if he didn’t do that, I will be sitting in the kitchen, eating...bingeing and just being so mad! I dunno, he just gives me time alone. That really helps me to just control myself. Emotionally.” (FG4)

“As far as my husband. I mean… he’s very very supportive. Incredible for me. So any changes have only been him wanting to help out in any way he can. We generally are pretty mindful about our diets anyway, but he’s been taking good care… he feels like one of the things he can do to contribute is to make sure I’m eating right, so he’ll make dinner more than he might have before.” (I2)

Key to that support appeared to be a spouse’s ability to ‘read’ the pregnant woman’s mood, ascertain their need and solve it, whether it be for foot rubs, food cravings, or in the case of the following example, purchasing a new pancake griddle:

“I was trying to make pancakes, using a new recipe. And they weren’t turning out right. My pan was burning them...And so I was getting mad and...the kids are getting yelled at, and all of a sudden my husband disappears...and then I ask... ‘Where is your dad?’... ‘He went out in the car’... ‘ohhh well he’s really going to get it!’...But he comes in, with a brand new griddle! He went out and bought me a griddle! And I just started bawling! I plugged in the griddle and the pancakes are saved... like, he saw what the real issue was, was all my pancakes were burning and turning out so he went out and took care of it. I thought that was really nice...you just get in a really bad mood about stuff and that totally defused it. So that’s the best thing he could have done, when he bought me a griddle.” (FG4)
Despite the importance of the spouse or domestic partner in pregnancy management, participants noted that most commercial pregnancy apps available for their smartphones or tablets were clearly geared at the pregnant woman only, containing pink color schemes, stereotypically feminine imagery, and advice and alerts about “my pregnancy.”

“Seems like the apps are pink for pregnancy. Even the app What to Expect is pink and purple. And you don’t have an option to change the background or anything so that is...a man can’t have it on their phone without people going, “Ooooooo you’re purple!... You’re purple!!” (I1)

They expressed a desire to have an app that was for more than just themselves.

“Hey it’s my husband that went and found all the apps, not me. Um… he’s the computer savvy one… (Pregnancy apps) should be related to the whole family. Um...I guess even in a children’s section, on an app, if it is a mother who has two previous children, something so she can bring the children into the pregnancy, so that they are following along with them, as well, it’s not just a one person.” (I1)

Women did at times collaboratively look at website or app content with their family. For instance, participants reported sharing app-provided photos and descriptions of fetal development with adult and child family members, as well as watching online videos about pregnancy with spouses or children:

“I had little guys … that wanted to know what the fetus was looking and what things it could do. So I like that Baby Center thing too, and I REALLY like the little videos? When I would show the kids all the little video clips of the baby developing. Those are REALLY good videos. And I would show ‘em, cause they send you the picture every week of what your fetus looks like.” (FG4)

Given the popularity of social networking tools, a surprising finding, was that the women said they were largely uninterested in sharing their pregnancy experiences online through social media, or securing social support from people outside of their close social circles. They were careful not to ‘overshare’ on social networks, only providing basic information about their pregnancies, if anything.
“I’m not a super active social media user, in that, I think I’m sort of into the things that are kind of mainstream, I guess? I don’t over use? I have Facebook but I don’t… I will put pictures up, I don’t post update statuses, I don’t have a twitter account.” (I2)

“I shared a little bit? But I didn’t share a lot of the information on my pregnancy, on the Facebook. Some of it the people didn’t need to know.” (I1)

“I literally use only Facebook, and that’s like the one thing. I’m aware of all of those. I will say that’s one thing…Cause I am aware of all of those others. But...Yeah, I don’t use ‘em. And actually it’s more…I think it’s more based on a time thing? That I’ve just decided not…to…engage. Because they take a lot of time and they feel like...I feel, I guess...I guess I feel well-connected enough, to the outside world, that I don’t feel I miss it.” (I4)

None of the women were interested in using online forums to connect to other pregnant women, or in joining an online pregnancy club. Such clubs typically group women with similar weekly progressions together in a chatroom or discussion forum, and all of the participants said that they ignored those sorts of online venues for sharing and support.

Information needs

Coping with change and the upheavals of emotions and physicality and social interactions that come with pregnancy often necessitates a large amount of information seeking and synthesis. As mentioned in the background section, there is often a prolonged period between when women find out they are expecting and when they first visit a medical professional, regardless of their socioeconomic status. Women reported having to wait between eight and fourteen weeks before having their first appointment. Participants also stated that the lack of early care from medical providers meant that in lieu of answering specific questions, they received printed medical material, a largely non-preferred format:

“Today they gave me a whole bag of pamphlets and flyers and... didn’t explain or go over them with me... and now I have to go home and try to go through them, while I have a kid running around... and when you’re a new mom that’s overwhelming.” (FG1)
Overall, participants wanted information immediately upon either suspecting they were pregnant, or confirming pregnancy status. According to participants, the information they sought online during their first trimester usually started with searching for the indicators that they might be pregnant. Based on their search results, all of the participants reported purchasing and using home pregnancy tests². As their pregnancy progressed, information searches in the first trimester related mainly to managing dietary concerns around what was acceptable to eat, and how to eat around food aversions. Their information needs, therefore, changed somewhat within each month of pregnancy, roughly following the trimesterial process of pregnancy.

In many cases, Google came to replace clinician advice:

<table>
<thead>
<tr>
<th>Trimesters</th>
<th>Key Discourse</th>
</tr>
</thead>
</table>
| 1ˢᵗ Trimester | Adjustment  
Confirming pregnancy  
Understanding dietary concerns  
Learning about pregnancy |
| 2ⁿᵈ Trimester | Accommodation  
Managing unusual symptoms  
Adjusting daily life to pregnancy  
Coping with emotions  
Balancing medical with folklore |
| 3ʳᵈ Trimester | Preparation  
Educating about birth event  
Modifying home environment  
Dealing with anxiety about birthing  
Preparing for parenting |

Table 5: Temporality of informational and coping activities in pregnancy

² Most of the women in the focus groups reported using pregnancy tests from dollar stores, and often used many tests just in case a few were wrong because they were "cheap”. One participant reported using just under one hundred tests.
“With new moms, they’ll have all types of questions... they’re getting sick...feeling miserable. So they can get helpful tips. Instead of getting all the info late...so women are going on Google to get their own answers because their doctors won’t see them.” (FG1)

“I found myself using Dr. Google, because I couldn’t get an appointment until I was at 14 weeks. They just wouldn’t see me.” (I1)

In the second trimester, participants reported that they most often searched for unusual symptoms related to pregnancy, so as to investigate whether something was normal, or whether a symptom or event presented a reason to call the doctor. The bodily and emotional changes brought on by pregnancy triggered many questions. It is not surprising, then, that pregnant women resort to seeking informational support from non-clinical information sources, such as family members, friends, and Internet resources such as search engines and certain pregnancy-oriented websites (e.g. BabyCenter.com, mommy blogs).

“I did a lot of Google searches and, um, Pinterest!...My little mommy blog things, just looking at different things. Like, my… my doctor didn’t tell me about round ligament pain, until…gosh! Maybe four weeks ago...but I was having it from you know, like, 13 weeks on...so I was having this severe cramping, and like, there is something wrong!? What’s going on? I am freaking out...so between, you know, Google research, and my sister who just recently had a baby as well, and talking with her…and then obviously talking to my doctor eventually...” (FG1)

In the final trimester, searches were often related to the birth event (such as premature birth and epidurals), nursery preparation, and newborn and infant parenting questions. Although the searches were seen as helpful, women noted that the act of searching for information online in could yield more questions, confusion, and anxiety than answers.

“Two weeks ago, I was having pain around my belly button then I started to spot. Well I Googled it…it asked if I was showing signs of ectopic pregnancy, and all that, so that’s where sometimes Googling is not a good thing.” (FG2)
Consequently, instead of referring to the potentially scary online sources or the perceived impersonal clinic-provided information, women at times turned to their social circles for information and support. All of the focus group and interview participants mentioned a range of folklore knowledge as a core influence on their ideas of pregnancy management and health. This folklore knowledge was diffused through the strong influencing role of family members, friends and the vague but powerful “they say” as information providers and emotional supporters, but also as challengers against dominant and medical discourses.

“If I have a question, I will just call my mom and dad and say ‘this is what’s going on’…they can tell me what to do…other than that, I’m not… Like, nobody tell me… ‘do it!’…” (FG1)

“I discovered on becoming an adult that I didn’t know a lot about the real amount of calories I actually needed in a day. Or... um… the amount of exercise I truly needed in a day. And the Weight Watchers app was great for that. I don’t use it at this point, because I’ve heard that you should not use it during pregnancy.” (I4)

This section has discussed the findings about pregnant women’s needs, gathered in the focus groups and interviews. I have recounted four types of needs: physical, emotional, informational and social. I have also laid out the temporal patterning and attitudes that appeared in women’s trimester-based information seeking process. In the next section, I will report on the findings from the iOS MAPs investigation (Phase 3), where I found that the final dataset of 31 apps demonstrated a strong concern for providing pregnancy information, particularly about physical aspects of pregnancy, but apps often failed to account for the emotional and social contexts of pregnancy.

**Gaps in apps**

In research Phase 3 (MAPs investigation), I undertook a feature, content and design analysis of pregnancy-related applications available within the iOS commercial marketplace.
Through this activity, I determined that there are two dominant information paradigms for pregnancy apps: education; and tracking. The primary audience for the apps in my Analysis dataset was pregnant women: 25 of the 28 apps were for solely for pregnant women, and the 3 apps for fathers all had significant issues which affected my assessment of their quality and applicability to actual user needs.

In the first analytic pass of the Analysis dataset of 25 identified MAPs intended for personal use by pregnant women and her supporters (Table 6). I identified 9 categories of features or modules. Those features were:

- Educational component (guides; reference material; general info; medical info)
- Event tracker (doctor’s visits, first kick)
- Activity tracker (diet, exercise, contractions)
- Calendar (personal; health events; upcoming milestones)
- List manager (tasks; shopping; doctor conversations; birth event preparation)
- Social support and networking (forums; chat systems; posting to Facebook or Twitter)
- Content sharing (with spouse, extended family, existing children)
- Reflections (journals; diaries; blogs)
- Photography (take or make a photo; aggregate photos; make time lapse growth videos)
<table>
<thead>
<tr>
<th>Multi-module apps for pregnancy management</th>
<th>Intended user</th>
<th>Educational Information</th>
<th>Events</th>
<th>Activities</th>
<th>Calendar</th>
<th>List Manager</th>
<th>Social Support</th>
<th>Content Sharing</th>
<th>Reflections</th>
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Table 6: Apps shortlist evaluation by modules
As is shown in Table 6, many apps contained multiple modules (e.g.: Figure 6). However, none of the apps contained all nine identified module types.

![Figure 6: Pregnancy Companion multi-module application](image)

**Educational component**

An educational component was the only universal module found in all 25 applications intended for pregnant women. Educational components were assessed by looking at the types of reference material provided, the degree of which the information made reference to medical or scientific research, and the language, voice and tone used to provide that information.

Educational modules largely used medicalized language, and the modules tended to appear in applications in one of four forms:

1. Simple ‘tips and tricks’ highlights of aspects of pregnancy;
2. Daily or weekly fetal development information nuggets;
3. Wiki-styled articles on general pregnancy; and
4. In-depth medical article-length overviews of risks and dangers.
While the educational information appeared to be of high quality in most apps written by medical experts, the actual written style and presentation of content sometimes obscured the message. For example, I found several instances of poorly written informational content in all three of the apps intended for fathers, and in approximately one quarter of the apps intended for expectant mothers.

A notable information approach to educating pregnant women on the developmental size of their baby was the comparison of the fetal size to that of a wide variety of common and uncommon fruits and vegetables (Figure 7 and Figure 8).

Figure 7: The fruit and vegetable comparison paradigm from Mediclinic, Wellness2 and TheBump
Activity tracking

A number of apps contained what I have called activity trackers. These are features and functions that enable a pregnant woman to enter and track a variety of information about pregnancy. The expectation was that there would be a lot of diet, exercise and sleep tracking, following and adopting the quantified-self paradigm of self-tracking applications, devices and systems. This was the case in the large well-funded ‘name brand’ and popular apps (e.g. *My Pregnancy Today by BabyCenter*), but was otherwise not true in most apps. The most frequent option for tracking in the overall dataset was fetal kicking activity, or contraction timing.
Calendar

This module appears functionally similar to the event tracking modules, but uses a standard grid calendar visual design. Calendars often appeared to be designed mainly to keep track of upcoming medical appointments.

List manager

List management in the applications often took the form of ‘to do’ or task lists. Some apps used the list manager design approach to help women plan for conversations. Others were intended for use as shopping lists, most often for things to bring to the hospital for the birth event, or to prepare the baby’s nursery.

Social support and networking

Social support was a feature that I expected to find featured in most of the apps, based on the prominence of online forums and chat in popular pregnancy websites. However, outside of the apps that were offshoots of those websites, few of the apps contained much functionality for social support or interpersonal networking between pregnant women, or between a pregnant woman and her existing social support network.

The expectation that many apps would have a ‘posting’ ability that would post updates, photos or statuses to existing popular social networking sites, such as Facebook or Twitter, turned out to be incorrect. The same is true of the expectation (taken from focus groups and interviews) that apps would enable the solicitation of information and support from a woman’s existing social network. Only three of the apps allowed for posting updates from it to Facebook. The other four apps (BabyBump; Happy Pregnancy; My Pregnancy Today; The Bump) that did contain a social support and networking...
feature were all intended for getting support from other women who use the corresponding website and/or apps, often through a design approach called a ‘birth club’\(^3\).

**Content sharing**

The idea of having an app that would allow the sharing of various kinds of content related to the progress and experience of pregnancy came from conversations with focus group and interview participants. Participants spoke of wanting to share content from the app with a self-selected social network of family and friends. However, my analysis showed that none of the apps surveyed enabled this feature.

**Reflections**

Participants had spoken of the desire to be able to quickly write down thoughts and reflections on the pregnancy experience. Because of this, there was an expectation that apps would enable journaling, blogging, or scrapbooking capacities, similar to content sharing and photography capacities. But again, none of the apps had functional capacities for this that actually worked.

**Photography**

Given the proliferation of use of mobile photography in everyday life, and because of the prevailing idea of baby bump photographs in popular culture and discourse, there was an expectation that many apps would offer the ability to take or make a photograph, aggregate photos into albums or scrapbooks, and possibly provide the option to make time lapse belly growth videos. Driven by conversations with participants, there was also some curiosity as to whether or not photographic capacities in apps might tie into popular

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\(^3\) This is a sorting and grouping logic within the app (and corresponding website) which matches a woman with other women according to their shared expected due date week.
photo or image sharing websites such as Instagram or Pinterest, or social media sites, such as Facebook or Tumblr. This expectation did not manifest in the app dataset. Only two apps allowed for the making and sharing of photographs (BabyBump Pregnancy Pro with Baby Names, 2014, My Pregnancy Today | BabyCenter, 2014). In both apps, the module was designed for the sharing of photographic content with strangers, a feature for which the participants displayed some suspicion or derision.

**Audience**

I found that the majority of applications were intended for newly pregnant woman. While some apps did make claims about being usable by both expectant parents (n=8), as well as by the expectant woman’s close family members, my analysis revealed that the apps frequently excluded the father, either explicitly through offering no actual content relevant to dads, or tacitly through the user experience choices, particularly through pronoun usage, activities tracked and gendered color choices (with pink being the single most prominent color).

Most of the apps that attempted to include fathers were either static e-books, or did so by attaching a single functionality piece, such as a list maker of what to bring to the hospital when contractions start. The few apps that explicitly targeted expectant fathers were surprisingly insulting to the role of this life partner. As one example, the mPregnancy app (mPregnancy - for Men with Pregnant Women, 2009) listed in the Apple Store’s “Health & Fitness” category, the baby’s growth is equated to the size of a cigarette, a can of beer and a football (Figure 9), and the app gives advice to the dad on how to gauge his partner or spouse’s moods, so that he knows when to initiate sex or leave the house to avoid her ‘hormones’.
I catalogued and identified 6 major functionality modules in the final 17 app dataset:

1) **Reference encyclopedias** about pregnancy health and fetal development

2) **Guides**, frequently tied to expected delivery data, containing weekly or daily information overviews (‘info nuggets’, ‘Tips & Tricks’); also Food and exercise guides and Baby Development Guide

3) **Trackers** and **logs**: Birth countdowns; Dietary intake logs; Exercise logs; Contraction and kick counters; Health indicator calculators; Progress trackers (weight gain, baby bump growth, etc.)

4) Heads-up **dashboard** presented in an ‘at a glance’ progress display, providing a combined information view. Often consisting of weekly countdown, a weekly info nugget, a weight or health indicator stat drawn from trackers, and a reflections feature, usually a reminder to take a belly bump photograph

5) **Reflections** capabilities, usually text and/or photo journals, often expressly meant to document the change in the pregnant belly through what various apps called a ‘bumpie’

6) **Social support** functions or integration
In terms of interactivity (i.e. Table 7), I found that the majority of data in apps was static. Although most modules drew on lightweight profiles to provide shallow customization or integration, most were simply asking for and providing tracking information based on the user’s first name and birth event due date. Features in guides, trackers and dashboards made the most use out of expected due data information. While I had expected social interaction to be the most interactive module style, this was not corroborated. For the majority of apps that did not include discussion group features, the most interactive module was actually the varying manifestations of Reflections features and functions. excluded the father, either explicitly through offering no actual content relevant to dads, or tacitly through the user experience choices, particularly through pronoun usage, activities tracked and gendered color choices (with pink being the single most prominent color). While a few apps had profile options to specify a role in

<table>
<thead>
<tr>
<th>Type</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Modules</td>
<td>Static information</td>
</tr>
<tr>
<td>Guides</td>
<td>Static information, Leverages user profile data</td>
</tr>
<tr>
<td>Trackers &amp; Logs</td>
<td>Shallow customization, Leverages user profile data, Light interactivity</td>
</tr>
<tr>
<td>Dashboards</td>
<td>Shallow integration, Leverages user profile data, Light interactivity, Integrated or consolidated views facilitated by profile and user preference data</td>
</tr>
<tr>
<td>Reflections</td>
<td>Solo user-input data storage</td>
</tr>
<tr>
<td></td>
<td>1. Within app only – no export OR:</td>
</tr>
<tr>
<td></td>
<td>2. Exportable as PDF</td>
</tr>
<tr>
<td>Social Support</td>
<td>App or User Generated social content</td>
</tr>
<tr>
<td></td>
<td>Unidirectional: sharing of app-generated content to Facebook, Twitter or Email</td>
</tr>
<tr>
<td></td>
<td>Bi-directional: Hosted web-based discussion forum provision</td>
</tr>
</tbody>
</table>

Table 7: Overview assessment of interactive capacity.
pregnancy other than that of the mother, the choice changed nothing in the information content, presentation or app functionality.

**Eliminating fathers:** It is notable that in the second pass use and feature analysis, I had to eliminate all four of the ‘father specific’ apps present in the working dataset. Most of the apps that attempted to include fathers were either static eBooks, or apps with a single functionality piece, such as a list maker of what to bring to the hospital when contractions start. The few apps that explicitly targeted expectant fathers were surprisingly non-serious about the role of this life partner. As one example, the app *mPregnancy - for Men with Pregnant Women* (2009) listed in the AppStore’s “Health & Fitness” category, the baby’s growth is equated to the size of a cigarette, a can of beer and a football, and the app gives advice to the dad on how to gauge his partner or spouse’s moods, so that he knows when to initiate sex or leave the house to avoid her ‘hormones’. The app *Mr. Dad on Pregnancy* (2013) is billed as being adapted from a popular book on becoming a father, but the app itself is just a trivia game tangentially related to pregnancy.

**App purposes**

Given that every pregnancy app in my dataset contained large amounts of information about pregnancy and its impacts, I determined that the main purpose of pregnancy apps is the provision of medical content about fetal development, weekly changes in a woman’s pregnant body, and ways to manage or mitigate risks to maternal and child health during pregnancy. The informative purpose of the apps was mainly slanted towards *change education*, primarily corporeal changes and fetal development, as
well as guiding a woman’s understanding of the impact of her diet, exercise and lifestyle choice on fetal development. A secondary purpose was change tracking, again tied primarily to fetal development and corporeal changes. I found the support paradigm within apps is informational support around a medicalized notion of pregnancy as a corporeal series of changes. This is underscored by frequent references made to discussing various aspects of pregnancy with a woman’s doctor. For example, in the app iPregnant, women are told in week 4 to “Discuss my exercise routine with my health care provider”, in week 17 to “Check whether my doctor has done the Rh blood test or not” and in week 19 to “Ask my health care provider about safe acne solutions”.

One additional finding about the way information in pregnancy apps was provided as a directed activity was the way in which many apps contained enticements to purchase a variety of consumer goods and services, often with links to major retailers’ baby registries. The gamut of suggestions in the apps ranged from personal care items (special pillows; body lotions; maternity clothes), home ‘babyproofing’ safety items (cupboard locks; baby gates), personal services (masseuses; nursery decorators; photographers) and additional health care practitioners (doulas; lactation consultants; chiropractors). This finding is noteworthy because it appears to corroborate the idea that pregnancy apps are intended for the middle to upper class pregnant women, as the costs of additional care and service providers is often outside the financial reach of many women, including my participants.
**Social or emotional support options**

Pregnancy is a shared experience, and participants in the prior research phases noted that they were most interested in collaborating and sharing aspects of the pregnancy experience with their spouse or partner first, and then with a few select family members or close friends. They asked for a shared app that gave an expectant couple the ability to share stories, ask questions, send and receive photos and send activity reminders or requests (such as doctor appointments or grocery errands). They wanted to be able to share their feelings about their pregnancy with their close support circles. Based on my analysis of the audience and purpose for apps, I found that apps generally do not provide this functionality (Table 6).

The idea of supporting a daily, intimate, emotion-laden, lived experience of pregnancy through a mobile app, using a collaborative social support approach which includes the spouse or partner and family or close friends, is currently not well-supported by iOS pregnancy apps (Table 8). In the few apps that did offer some limited capacity, it was comprised of short stock emails from a single screen in the interface. In a few of the apps that did purport to include Facebook or Twitter connectivity, my use testing found that such connectivity was not actually functional. Instead of being an avenue to facilitate social support, 8 out of the 17 apps in the final dataset acted as a progress guide that was intended to generate awareness of a woman’s place in her pregnancy. A further 3 acted as pregnancy trackers, keeping a pregnant woman alerted temporally to where her pregnancy was in terms of her baby’s current and upcoming development, and encouraging her to log changes to her body. I recognize that some of the collaborative functionality I looked for but did not find might be possible through other non-pregnancy
focused apps. However, it appears plausible that the ability to include collaborative personal information management into a pregnancy app would lend some urgency to digital interactions with spouses and close supporters who might receive such notifications and content. This would support the idea of pregnancy as part of an everyday life experience during the nine months of its occurrence.

**Synthesis**

**Birth over wellness**

As also reported by participants, I found that the digital app landscape for pregnancy is dominated by a birth event planning design approach, rather than a health and wellness management paradigm. A large majority of apps included calendars, event and activity trackers, educational tips, baby development educational content, baby bump photo management and list managers, leading me to call them ‘multimodal apps’. Some of the analyzed apps did attempt to include information and options related to ‘in the moment’ activities that are loosely correlated to pregnancy management, such as meditation, tips to managing social outings (i.e. where to sit when at the movies), advice on sexual practices in pregnancy, and other items geared more at the mother’s general well-being than at the health event of the baby birth.

Looking deeper at the information areas within the apps, I found that most were a kind of ‘gloss’ on the larger app purpose of either educating for healthy birth or directing attention to advertisements for baby and pregnancy related products. Much of the information and functionality in the apps was targeted at risk avoidance or reduction, following a medical model of pregnancy management. Dietary management modules
often focused on what foods or medications to avoid. Exercises were often framed not in terms of helping the pregnant woman feel better and stronger, but instead, about how to be sure not to harm the baby. Modules such as kick counters and weight measures were also often framed around making sure the baby was healthy.

I also note that the majority of pregnancy multi-functional apps in the final dataset focused on baby development imagery (fetus pictures; baby bump measurements) and on countdowns, lists of what to bring or buy for the hospital visit or nursery, and on other tracking and countdown devices such as weight gained or number of contractions. Because of this, I determined that understanding and preparing for the childbirth event appeared to be the dominant guiding model or ‘paradigm’ in pregnancy apps.

This means that there is a gap in addressing the entire experience of pregnancy across the nine months, relative to participants’ accounts, and to my own investigation of the iOS MAPs. While pregnancy is obviously intended to yield a healthy child through the birth event, the experience of pregnancy carries a number of important events and aspects that can be instructional for life generally, including how to make changes to one’s life to adapt to changing circumstance, and adapting to the need to become a parent. I found that existing applications did not address this wellness aspect of pregnancy appropriately. This suggests there is an opportunity to consider the ways in which the entire experience of pregnancy is a major process within the life of a pregnant woman and her spouse or domestic partner. It is a process that can carry a focus on more than simply the mother-as-incubator approach, which was the dominant information model in existing applications.
<table>
<thead>
<tr>
<th>App Name</th>
<th>Functional Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian Pregnancy</td>
<td>Stock email message</td>
</tr>
<tr>
<td></td>
<td>Stock Facebook post</td>
</tr>
<tr>
<td>BabyBump Pregnancy Pro</td>
<td>Birthclubs;</td>
</tr>
<tr>
<td></td>
<td>Forums;</td>
</tr>
<tr>
<td></td>
<td>Birth announcement blast</td>
</tr>
<tr>
<td>Dr Miriam Stoppard Pregnancy</td>
<td>No social support feature</td>
</tr>
<tr>
<td>Essential Pregnancy</td>
<td>Stock Facebook post*</td>
</tr>
<tr>
<td></td>
<td>Stock Twitter post*</td>
</tr>
<tr>
<td>ExpectingBaby by Enfamil</td>
<td>SMS message – Birth Event</td>
</tr>
<tr>
<td>Happy Pregnancy Ticker</td>
<td>Discussion forum*</td>
</tr>
<tr>
<td>I’m Expecting</td>
<td>Discussion forum</td>
</tr>
<tr>
<td></td>
<td>(users grouped by mom age)</td>
</tr>
<tr>
<td>iPregnant Pregnancy Tracker Deluxe</td>
<td>Stock Facebook post*</td>
</tr>
<tr>
<td></td>
<td>Discussion forums</td>
</tr>
<tr>
<td>Mediclinic Baby - Pregnancy</td>
<td>No social support feature</td>
</tr>
<tr>
<td>My Pregnancy Today-BabyCenter</td>
<td>Birthclubs</td>
</tr>
<tr>
<td></td>
<td>Baby gift registry</td>
</tr>
<tr>
<td>bloom</td>
<td>Discussion forums</td>
</tr>
<tr>
<td></td>
<td>(parenting generally; requires Facebook)</td>
</tr>
<tr>
<td>Ovia Pregnancy Guide</td>
<td>Content sharing – Facebook</td>
</tr>
<tr>
<td></td>
<td>Content sharing – Twitter</td>
</tr>
<tr>
<td></td>
<td>Content sharing - Email</td>
</tr>
<tr>
<td>Pregnancy ++</td>
<td>No social support feature</td>
</tr>
<tr>
<td>Pregnancy Companion II</td>
<td>Stock Facebook post*</td>
</tr>
<tr>
<td></td>
<td>Stock Twitter post*</td>
</tr>
<tr>
<td></td>
<td>Stock email message</td>
</tr>
<tr>
<td>Pregnancy Smiles</td>
<td>No social support feature</td>
</tr>
<tr>
<td>The Pregnancy Journal</td>
<td>No social support feature</td>
</tr>
<tr>
<td>The Bump Pregnancy</td>
<td>Birthclubs</td>
</tr>
</tbody>
</table>

* Did not work (broken)
**Individual, not collaborative**

I heard from participants that apps almost exclusively focus on the pregnant woman, with a secondary focus on the interactions between a woman and her doctor. This report was corroborated in Phase 3.

In the first two research phases, participants reported they would have preferred apps that allowed them to selectively share key milestones and information about their pregnancy between themselves in the expectant couple, and also with a small group of pre-identified family members and close friends. Instead, I found that most apps did not allow for any kind of information sharing with close ties. A few popular apps did provide options for ‘birth clubs’, linking expectant strangers together according to their expected delivery date. Only one app provided the option to share information about the pregnancy process and the pregnancy experience with an app user’s chosen close tie individuals. For apps that did not provide discussion forums, social support is shallowly conceived to mean info posting to social media via pre-packaged messages taken from app content. I find this to be less than ideal, because of the way such updates would present to an indiscriminate audience, potentially causing a kind of “baby fatigue” circles because of this type of information broadcast is not selected or controlled by the user. There is also less motivation to act from the support network back to the pregnant woman.

Previous HCI work (Adams, Baumer, & Gay, 2014) has argued that mobile devices support a particular kind of *staccato sociality*, in which support seeking, sharing and interacting around issues happens continuously in short bursts while a user is engaged in other daily tasks. I found this a persuasive approach that is not yet present in pregnancy apps, but should be considered for future development initiatives. A staccato support
approach could then more broadly include a pregnant woman’s known social supporters, drawn selectively by the woman or expectant couple from their existing family and friendship networks.

Therefore, I found that the vast majority of apps perceived the expectant mother to be the sole target user for pregnancy apps, a finding that again corroborates participants’ accounts. I found abundant evidence of this, via the user interface design approaches in the apps. Throughout the app datasets at the working level of analysis all the way through, I saw a design emphasis on the color pink, sparkling sprite graphics, baby bump imagery, and functionalities like kick counters. None of the apps addressed the collaborative aspect of pregnancy management between expectant couples, and therefore none treated pregnancy as a collaborative life experience within a couple’s relationship, or between a woman and her close supporters.

**Grouped tools rather than multi-functional modules**

Aside from the *Pregnancy Companion* app, few of the selected apps fulfilled the multi-functional app promise suggested in most AppStore’s marketing literature for pregnancy apps. In most cases, the interfaces and interactivity are not well implemented. For example, the list of tracking and logging functionality in the *iPregnant* apps is long, yet my use test of the app found that many of the features did not work well, or were not well integrated with one another.

I took note that many of the apps appeared to use the same general design paradigm of providing information on the top and links to other modules and the app’s settings on the bottom. In the more amateur-seeming apps in final 17 app dataset, the modules
displayed all offered the same functionality: a calendar or tracker; a ‘tips’ or ‘info’ area, a baby names feature; a hospital bag list maker. Some apps switched out the baby names or hospital bag with a photo manager for ‘belly bump’ pictures or social media canned messaging of where the woman is at in the pregnancy. I also found instances of content that was repeated almost verbatim between very different apps, suggesting the use of some form of stock boilerplate content and app code, perhaps from a repository such as GitHub.

**Upper-SES focus**

In the focus groups and design interviews, women highlighted the way that apps were written for an audience that did not appear to be directed at women of their SES. The app review corroborated the women’s reports. Based on the highly technical language frequently used in apps, the impression given off by apps was that the target audience for MAPs was a more highly educated female. Additionally, through the many ways in which a specific consumer stance on pregnancy was showcased in various recommendations on diet, exercise, leisure time use, and baby-related products, the consumer at which this was directed appears to be (at minimum) upper-middle class. In this way, MAPs did appear to focus on the upper-SES pregnant woman, and therefore, it is my determination that MAPs ignore the specificities and challenges of pregnancy for lower-income women.
**Peer review**

The results of Phases 1 and 2 have been presented and published in both the fields of HCI and medicine. For HCI, the results have been published as a peer-reviewed long paper for the 2014 ACM conference on *Designing Interactive Systems* (Peyton, Poole, Reddy, Kraschnewski, & Chuang, 2014a) and as a poster for both the February 2014 ACM Conference on *Computer supported cooperative work & Social Computing*, and the November 2014 ACM conference on *Supporting Groupwork*. For medical science, the work from Phases 1 and 2 has been published as a peer-reviewed journal article in the June 2014 edition of the *Journal of Medical Internet Research* (Kraschnewski, Chuang, et al., 2014) and presented as a paper at 37th Annual Meeting of the Society for Internal Medicine (Kraschnewski, Poole, et al., 2014). A paper from the results of Phase 3 is under development as a submission to an CSCW-focused journal.
Chapter 6

The Design Space

“The objects of our design are not just specific protocols, or technologies, or even individual human–technological interactions, but include an attempt to shape, or at least accommodate, the social environment” (Coiera, 2007, p. 4).

Design challenges

The design space around lower-income pregnancy as an everyday life experience that can be managed in a MAP presents design challenges. There are three design challenges that became most visible in my research findings. They relate to the context of pregnancy, the impact of SES on differences in pregnancy experiences, and the view of pregnancy as an inter-dependent series of interactions.

Consideration of pregnancy in a broader context

The dominant American view of pregnancy as that of a female health event that guides the biological incubation of a fetus towards the birth event narrows the scope of pregnancy to that of a medical concern. The larger scope of pregnancy as a common, everyday, lived experience is thereby in danger of being ignored, silenced or simply minimized. Designing appropriately for pregnancy suggests designing for the larger context of pregnancy. This means that in addition to providing sound medical advice around gestation and physical symptoms, technological aids would need to also provide support for the social and cultural aspects of the overall pregnancy experience.

Accommodating SES influences in pregnancy experiences

There are a number of structural constraints and challenges within pregnancy for lower-income women which highlight the ways in which socio-economic status inflects
the lived experience of pregnancy in ways that are markedly different than the experiences of higher SES women. While the broad process of a pregnancy generically applies to all pregnant women, the ways in which pregnancy is experienced in the United States frequently differs greatly across ethnic, economic, and cultural lines. The differences in experience based on socioeconomic, sociocultural and sociopolitical dimensions thereby inflect the lived experience of a specific pregnancy context according to the social position the pregnant woman holds as part of a defined group within American society.

Examples of issues in which the experience of lower-income pregnancy is demonstrably different from other, higher-income strata of pregnant women include:

a) access to early care;

b) capacity to get and understand appropriate information across the experience;

c) ability to ‘live up’ to the expected standards of wellness, around such things as diet quality, and exercise ability; and

d) capability of redirecting personal finances towards proper quantities of disposable income, and to earmark the income for baby supplies, maternity clothes, and maternity leave.

Where pregnancy is viewed as a problem, a threat, a risk, a lack (of skill, ability or knowledge) or a social burden, it is the case that that said burden is carried disproportionately by the poorer, darker, more disenfranchised groups in America, as was the case for my study participants.
Understanding pregnancy as an inter-dependent set of interactions:

When pregnancy is viewed solely as a biological and physiological event, the focus is on the woman and her body. This ignores or threatens the role of the expectant spouse or life partner in the process. In turn, this might lead to the partner feeling excluded from a life development process that also deeply impacts him. This oversight also re-inscribes outdated gender norms of behavior relative to impending parenthood and the role of the man in a child’s life. The design challenge here is to better understand how fathers are already incorporated into pregnancy care and process management, and to identify gaps in support and information provision that can be addressed in a mobile technology aid. The challenge, then, is how to incorporate the larger scope of pregnancy into digital apps that support a wider range of interactions beyond the strictly medical and the female biological contexts.

Pregnancy experiences as a contextual trinity

The three design challenges of understanding larger contexts, of accommodating and minimizing SES influences on pregnancy experiences, and also of adjusting design to enable interdependent interactions – all illustrate the need for a nuanced understanding of pregnancy experiences for lower-income women, viewed as a trinity of context, process, and interaction. The intertwined challenges and dimensions of pregnancy for lower-income women are important to consider when critiquing and designing technological tools to support pregnant women in their everyday life experiences and management of their pregnancies.
Design gaps

There are a number of websites and mobile applications that focus on information needs of pregnant women. Similarly, there are many web and mobile tools for diet, activity, and weight tracking available at low or no cost. However, these tools may not be appropriate for addressing the problem of excessive gestational weight gain. In North America, existing pregnancy apps appear to frequently be tied to for-profit publishing websites (e.g.: Babycenter app tied to BabyCenter.com), rather than medical or healthcare sites. For-profit commercial websites predominantly focus on basic medicalized information about pregnancy, reflecting the general circulation of a conceptualization of pregnancy as strictly a medical concern.

Research-based and NGO-supported maternal mobile health app development efforts have focused almost exclusively on developing countries, often relying heavily on SMS messages pushed to women (Evans et al., 2014; Evans, Abroms, Poropatich, Nielsen, & Wallace, 2012; Parker et al., 2012). Yet there is a lot of interest in expanding mobile applications to provide pregnancy support in North America, particular among lower-income women in inner city or rural environments. As discussed earlier in the Pregnancy and technology section of Chapter 3, when looking more broadly at the existing medical and HCI research space of mobile applications for activity, diet, and weight tracking, they too have blind spots when it comes to the needs of lower-income pregnant women.
Design space

Framing design according to the logics of sociotechnical theory suggests that the researcher-designer should direct their attentions to the study and specification of digital systems functions and user experiences (Baxter & Sommerville, 2011). While there is a large amount of variance, as to what sociotechnical systems are, and how such systems should be designed, a unifying feature is a central concern for designing for human interaction with other humans in digital environments, and enabling humans to identify, employ and extend information to their life contexts in ways that are appropriate, contextual and pleasurable. Therefore, sociotechnical systems designs require a deeply contextual understanding of social phenomenon that impact the design, adoption, management, and use of digital information and interaction systems (A. Lin & Cornford, 2000; Sawyer, 2005; Sawyer & Tapia, 2007). It is about “transforming lives, not transforming information” (Kaziunas et al., 2015).

Action process of pregnancy as change management

The transformation of lives during pregnancy highlights an attention to the impacts of human experience grounded in temporalities. By viewing pregnancy as a part of a normal human experience of life changes, I support a sociotechnical understanding of lower-income pregnancy that is grounded in the five principles of Bengston et al.’s (2011) action process:
1. **Linked lives**, highlighting the dynamic interdependencies of people;
2. **Historicity**, signifying the impact of time and physical situation;
3. **Experience** and the timing impacts of experience on later life;
4. **Agency**, describing how personal understanding and effort impacts life outcomes; and
5. **Lifelong development**, showcasing the way humans are always embedded in a process of becoming someone.

As humans come to rely more heavily on digital mediation in their lives, all types of digital artifact designs are increasingly and inherently sociotechnical. Regardless of whether the intended outcome of design is a corporate system, a consumer website, or a mobile app to support life management, each system must adopt a user experience model that dictates the choices of functionality and user interface approach.

An interaction designer must therefore decide how to achieve a balance between people, information, and technology when studying or specifying new interaction elements and options in a new or redefined design space. In the case of my work, a MAP for lower-income pregnant women must respect the context and challenges of the pregnancy experience, beyond the medical framing of pregnancy, beyond the pregnant woman as solo frame of the pregnant woman as the only interested party, and beyond the notion of an app as mainly intended for providing static information and for inciting consumerist behaviors. Such a MAP must also pay attention to the principles of the multi-faceted action process of human development, as situated within the pregnant woman’s experience of pregnancy. This means attending to and incorporating aspects of the pregnant woman’s action process, as situated in:
• social interdependencies,
• temporal and biographical qualities of her pregnancy experience,
• constraints and challenges presented to her personal agentic capacity by her socioeconomic status; and
• the change process and adaptation to personal transition that is inherent to pregnancy.

**Framing a design space**

Adopting the Double Diamond model’s (Figure 2, p. 13) divergence and convergence approach to problematization provides contextual richness and specificity to a design space. This is particularly apropos when the definition approach to the design space specification also incorporates an action-oriented processual mindset, thereby providing further depth and breadth to problematizing and describing the space.

In many ways, sociotechnical systems design and human-centered design share a lot of similar tenets and preoccupations when it comes to defining or reframing a design space for HCI work. Both share a concern for both the goal orientation of the primary stakeholder, the users, as well as their overall sets of characteristics (Alter, 2010). Framing a sociotechnical design space requires understanding the interaction and information needs of the primary stakeholder, as well as understanding and incorporating the inclusion of secondary stakeholder options, without alienating or ignoring the potential expertise interaction capacity and reliable information available from tertiary stakeholders.
For my project, I was able to fully problematize the possibilities and problems with MAPs for lower-income pregnant women needs as primary stakeholders. I received some insight into secondary needs through my design interviews, and from the feedback on microsystem involvement in pregnancy assistance reported to me by participants in focus groups. In terms of getting tertiary stakeholder need identification, I conversed extensively with two medical doctors engaged in maternity care (i.e. the original PIs for the focus group project), and I also had a long series of discussions with a group of midwives at a birth clinic in Reading, PA\(^4\).

For the context of lower-income pregnancy, a human-centered design project that is intended to augment incorporate information collaboration, activity coordination, and emotional support through redefining and redesign MAPs, the pregnant woman would be the primary end user and stakeholder. Secondary stakeholders are likely to be members of her close network – her spouse or partner, her immediate family, and her closest friends. Tertiary stakeholders could be community partners, such as case workers at the local WIC clinic, or church friends, or any other person or community group that might have the ability to provide assistance, advice, and support to the primary or secondary stakeholders.

\(^4\) I have not integrated the study results of latter tertiary group, however, into my problematization for this design space, because of IRB ethics approval and funding conflicts that constrained reporting on the study outcomes.
**Sociotechnical aspects**

In this chapter, drawing on the synthesis of results of my problematization of lower-income pregnancy model, I will offer a series of contextual design frames that could augment or improve the appropriateness of the use of a mobile digital app for the lower-income female who is coping with and managing the impacts of a pregnancy on their lifecourse trajectory.

I highlight the mobile technological framing of the recommendations for this design space, because of the specific inflections mobile assemblages bring to design. Sawyer and Tapia (2007) contend that the context for a group or situation makes available a new set of sociotechnical interactions within an assemblage of action potentialities. For my purposes, I find this potential for micro-empowerments persuasive. For the processual action context of life for my pregnant participants, the mobile assemblage that could be activated to push back against medicalized power structures and discourses, and create a space for small empowering acts of sociality, includes all of the various networks, be they wireless or geographical or interpersonal. The sociotechnical assemblage represented by digitally-mediated pregnancy could potentially facilitate new or changed affordances of expanded information and data access for under-served lower-income pregnant women.

Because the sociotechnical character of digital mobility can alter the “procedures followed, norms of behavior [relative to events, systems, and others], governance structures, and both institutional and environmental constraints” (Sawyer & Tapia, 2007, p. 154), there is the potential for incremental changes in self-knowledge and future behaviors that might enable the means for pregnant women to engage with their own temporalities, contexts, corporeality, and local knowledge outlets, thereby feeling more
enriched by their pregnancy experience, outside of the narrow medicalized view. The overarching longer-term goal of facilitating a sociotechnical mobile assemblage for lower-income pregnant women is to increase coping, resilience and feelings of self-worth. It is also to digitally-scaffold women’s feelings of capacities for empowered action in the face of future life experiences.

To support the potential of this form of sociotechnical mobile assemblage, I provide an overview of the eight design frames, and I give an example drawn from my pregnancy research as illustration of that frame. For me, each pregnancy-related example is employed as a kind of design prompt, or ‘teachable moment’. The pregnancy examples act as a contextual frame through which I can consider the impacts of design on experience management more generally. After each prompting example, I then deliver my recommendation for the design features required to accommodate the example functionality or interaction within a life process management mobile app. I accompany my design recommendations with an argument for how adopting the recommendations might impact the user-centeredness of a MAP and its sensitivity to the specifics of the experience of lower-income pregnancy.

I propose the following eight design-directed frames (Table 9) for interaction designers working within the design space of lower-income pregnancy and its sociotechnical character, as mediated by MAPs. Because the recommendations are intended to add structure to the sociotechnical design space, rather than specify functionality for a specific MAP development effort, I call the 8 recommendations design frames. Each frame is intended to act as a design prompt or goad for thinking through specific issues within the design space.
## Set of design frames

<table>
<thead>
<tr>
<th>FRAME</th>
<th>CONTEXT</th>
<th>BASED ON RESEARCH</th>
<th>OUTCOME</th>
<th>DESIGN OPPORTUNITY</th>
<th>ACTION PROCESS PRINCIPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adaptation education</td>
<td>Leverage experiences into teachable moments</td>
<td>Literature</td>
<td>Improve subjective feelings of life management and event coping</td>
<td>Create teachable moments through thinking prompts and social feedback circles</td>
</tr>
<tr>
<td>2</td>
<td>Timing sensitivity</td>
<td>Design modules according to the temporal information stages</td>
<td>Activity 1</td>
<td>Temporally appropriate information acquisition and improvements in coping skills</td>
<td>Provision of information according to temporal patterning.</td>
</tr>
<tr>
<td>3</td>
<td>Perceptions of uniqueness</td>
<td>Provide options in-app for flexible personalization;</td>
<td>Activity 1 &amp; 2</td>
<td>Increased adoption of app and feelings of information and support pertinence</td>
<td>Create personal profile option that reinforces subjective feelings of uniqueness and specificity</td>
</tr>
<tr>
<td>4</td>
<td>Self-guided info-seeking</td>
<td>Facilitate unanchored information</td>
<td>Activity 1 &amp; 2</td>
<td>Increase feelings of self-efficacy and competence</td>
<td>Equal opportunities for discussions around expert and lay knowledge provision</td>
</tr>
<tr>
<td>5</td>
<td>Social support</td>
<td>Contextual and social ecological app use</td>
<td>Activity 1 &amp; 2</td>
<td>Reduced stress and improved coping processes and feelings</td>
<td>Social collaboration around identity, emotional issues, physical demands, and role change</td>
</tr>
<tr>
<td>6</td>
<td>Selective sharing</td>
<td>Support selective intimate interactions with closed group contacts</td>
<td>All activities</td>
<td>Feelings of control and respect for privacy</td>
<td>Research most important supporters and design appropriately for their information and inclusion</td>
</tr>
<tr>
<td>7</td>
<td>Staccato sociality</td>
<td>Enable “short and bursty” social interactions</td>
<td>Activity 1 &amp; 2</td>
<td>Increases follow-up interactions which decreases social isolation</td>
<td>Visualized emoticon messaging via app or SMS; also micro network chatroom</td>
</tr>
<tr>
<td>8</td>
<td>Data termination and migration</td>
<td>Leverage and extend photos, activity tracking data, and journal reflections for use post-pregnancy</td>
<td>Activity 3</td>
<td>Data longevity and reuse for future social sharing</td>
<td>Provide options to offload data to cloud storage or physical artifacts</td>
</tr>
</tbody>
</table>

Table 9: Overview of sociotechnical design frames as derived from research activities
In the following section, I will individually replicate each individual design frame drawn from Table 9 in the opening of each frame’s discussion, before providing rationale and further details on the frame’s character.

(1) Incorporate social adaptation education

![Figure 10: Social adaptation education via teachable moments (Frame #1)](image)

Pregnancies are liminal periods of the lifecourse, in which the old ways of being and doing may no longer fully apply to the impending changed situation and sense of self (Field, 2009). While the processes within a pregnancy experience may be stressful, pregnancy as a sociotechnical context of everyday life can be very positive generally, especially when considered in retrospect. An individual can learn much about themselves, their life outlooks and coping approaches as a result of actions and outcomes experienced during major life experiences. The lessons learned are considered to be teachable moments. The term was coined by Havighurst (1953), and later incorporated into health and wellness promotion (Lawson & Flocke, 2009; Phelan, 2010) and into design thinking (Brown, 2009; Buchanan, 1992; Kelley & Kelley, 2013). Within pregnancy, teachable moments across a few or all dimensions of pregnancy offer an opportunity for lower-income to adjust future actions in light of new understandings.
gleaned from their pregnancy experience. The tacit desired outcome of teachable moments for individuals is to improve subjective feelings of life management and event coping in periods of stress and change, as summarized in Figure 10. As a design prompt, teachable moments are actual examples of lived experience that incorporate both actionable information and potential opportunities for opening up sociotechnical design to solutions that offer small yet profound impact on individuals.

Through my discussions with my participants, I discovered that pregnancy is an excellent example of an experience that is rife with such teachable moments for adjustments to self-identity, and for adaptation to social roles and the social perceptions of others, a finding that is consistent with more activist approaches to pregnancy, such as those within much of the midwifery literature (e.g.: Rising, 1998; Stapleton, Osborne, & Illuzzi, 2013). One obvious and core part of pregnancy that reflects this is the adjustment to the idea of being a parent (again, or for the first time), with all of the life and self-impacts which that social role carries with it. My participants spoke of having to “come to terms” with what being a parent would mean to them, to their close others, and to their societal presentation of self, either as a first time mother, or as part of understanding how to parent multiple children. There were many other small and large adaptations during the period of pregnancy for my participants, and each adaptation carried within it the potential for being a teachable moment. Whether it was the need to quit smoking and watch one’s diet, in order to both ensure the health of the developing baby, or the health of the mother in the short and long term, because “I want to be sure I’m around to see my baby get married and have kids of their own”, or it was the desire to become a better
person overall in order to be a better role model and parent, pregnancy offers many teachable moments.

Each of these moments is a kind of design prompt. Participant reports of experiences encountered during pregnancy highlighted opportunities for changing habits, or ideas about themselves, or their mid and longer term life goals. Each experience offers an interaction space in which I glimpsed large and small aspects of the specific context of lower-income pregnancy that can be positively impacted through information provision and interaction design in an app or system. These interactional elements could come in the form of designing for reflection, a feature frequently requested by my participants but rarely provided in existing pregnancy apps. This kind of functional feature might be a module which contains thinking prompts that encourages users to think about the larger ramifications of their current experiences on their lives and that of those important others in their lives that might be also impacted by the life experience. It could also incorporate journaling features, either by textual, photographic, or filmed input by end users, that act as a record of reactions, thoughts and emotions to the current events that can be referred to later on in the individual’s life, thereby showcasing change across the individual’s biosocial history. It might also incorporate a social sharing function with actants in the user’s microsystem, which creates a kind of *social feedback circle*. 
(2) Be sensitive to pregnancy timing

If a human life is understood as a sequential organizing of experiences, then it stands to reason that the timing of a pregnancy on a woman’s adaptation to the sequencing of her life should be seen as an important dimension for pregnancy. Understanding the timing of a pregnancy within in a woman’s lifecourse means also incorporating an understanding of their sociodemographic profile into design choices. It also necessitates a strong attention to the ways in which the experience of time throughout the processes of pregnancy experiences may inflect those experiences. Because pregnancy can be seen to be a kind of *life disruption event*, which is then followed by a process of coming to terms with “the new normal” (Massimi, Dimond, & Le Dantec, 2012), designers need to be comfortable designing for both disruption and normalization.

In design terms, this presents the challenge of not assuming that a design choice of tools, modules, features, or even user interface (UI) choices will be just as applicable mid-course of the experience, or end of the experience, as it was at the outset. It is typical in all life disruption experiences to undergo temporal stages of acceptance, adjustment, reconciliation, preparation, and accommodation, relative to the knowledge and actions

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**Figure 11: Demonstrate sensitivity to temporal patterns of pregnancy (Frame #2)**
and changed sense of self demanded by the changed life circumstance (Bengston et al., 2011; Hamburg & Adams, 1967; Roberson, 2005; Thoits, 1995). The period of acceptance may appear objectively short to someone outside of the experience, but for the person directly involved in it, that acceptance may feel like it takes a long time. Staring at the pregnancy test stick may only take a few minutes in objective time, but my participants reported feeling like they were out of body, experiencing the realization of pregnancy slowly, as if time had become attenuated. Same was true of the waiting period between discovering pregnancy and being able to see a medical professional for the first time. Yet women reported that the end of the pregnancy was a period of “time flying”, and one in which the embodied aspects of pregnancy made it feel as if the birth event was never going to happen fast enough.

The aspect of a temporal series of stages of coping is a feature I identify as being core to pregnancy. Therefore, for apps oriented to pregnancy management and coping, I suggest that design choices should be made with an eye to the temporal patterning and variable flows of coping behaviors. As my first two research activities highlighted, coping during pregnancy experiences has stages that each carry within them a temporal rhythm, in terms of acceptance, adjustment, reconciliation, and incorporation of the pregnancy’s longer-term outcomes and life impacts. The experience design of digital apps should include an awareness of such temporal patternings, and could even be structured around the contextual temporal processes themselves, so that the app could help users understand and adjust to the processes at a time scale that makes the most sense to them within the temporal patterning of their specific pregnancy.
Another impact of the temporal patterning of pregnancy is the timing of a need for social support and different kinds of information. If interaction designers know which people close to the pregnant woman need to activated at what temporal points of the overall pregnancy process and experience, then the designed support artifact can be setup to prompt and scaffold the seeking and securing of those support-oriented interactions.

I also suggest keeping interfaces as lightweight as possible. For instance, my participants enjoyed taking and sharing pictures, but did not like having to fill out a lot of forms, flip through quizzes, or actively remember when it was time to input information into a tracking app. Rather than designing systems with lengthy, complicated interaction, overwhelming amounts of text, or extensive nested menus, I recommend the use of simple designs. These could be a small number of personalized tips/tricks for a given pregnancy stages and concerns, text messages with reminders or activity prompts, and photographic journals, rather than textual journaling. Similarly, I advocate for lightweight data input techniques, such as yes/no questions, checkboxes, or taking photos rather than entering large amounts of text. By offering options to interact with and through the app in ways that feel intuitive and fast to the user, the focus can remain more on coping with pregnancy, and less on the learning curve of app adoption.
(3) Tailor to the perception of the uniqueness of each pregnancy

In addressing pregnancy in sociotechnical design, and in providing modules and functionality that support contextual life management issues, I urge attention to perceptions of uniqueness women reported feeling within each pregnancy. An app’s lifestyle management, social support, or health recommendations should strive to avoid appearing too generic or impersonal. The goal should be to address the user’s sense that each woman’s experiences are inherently different from anyone else’s, a finding from my research that is supported in other HCI work (e.g.: Huh, Patel, & Pratt, 2012). When discussing potential designs for pregnancy activity tracking apps, one participant remarked, “As long as it goes by your individual person… not a hundred other people of one group…”

This idea that every pregnancy experience is different is one that was heard repeatedly. I acknowledge that this self-report may not differ greatly from individuals’ perceptions of their own life experiences generally. In pregnancy, particularly, the fact that my participants were pregnant adds a crucial difference: the aspect of concern by the mother about her own and her child’s morbidity and mortality. The sociotechnical challenge, then, for pregnancy as a life experience is to investigate and understand the
perceived uniqueness of that particular experience, and then incorporate interactional
design elements in apps that align to the uniqueness perceptions.

From a design perspective, this suggests that MAPs should be setup to maintain a
balance between providing individualized advice, support and information for subjective
feelings of stress management, wellness and life management capability, while still also
incorporating the necessary avenues of social support and informational provision
suitable for the specific pregnancy experience in question.

Paying attention to others in an individual’s home life, as they place demands on her
time or ease her path through her pregnancy experience, suggests an important profiling
step. Knowing who provides help or who challenges the pregnant person, and applying
these understandings to design, can provide a personalized app experience.

As an example, some potential personalization features could include: how to talk to
an existing child about pregnancy challenges; overviews of fetal development in a
specific week; or how to work around food cravings and aversions while also playing
head cook for the family home. While existing apps and sites such as BabyCenter were
used by our participants, they noted that the sites focus mainly on the baby’s
development, with some light attention to future parenting challenges (particularly related
to consumer goods), as opposed to the overall health of mother. Identifying the gaps in
sociotechnical support systems, like the ones mentioned here for pregnancy, would be
important if the goal of the digital app is to enable role-based profiles for the support of
the pregnant person.

Privacy sensitivity should also be incorporated, as should data migration, a
contextual framing aspect that I address later as frame number eight.
(4) Scaffold self-guided information seeking

My research demonstrates that there is both a support gap and an information gap in lower-income women’s pregnancy experiences that needs to be filled. The gap exists between information need and provision, and between individualized support and medical practice. The idea of pregnancy as a period of accommodation and adjustment to constant changes necessitates a large amount of appropriate and contextual information about the way to manage experiences and processes at specific periods of time during the overall experience. In conceptual terms, this can be called unanchored information work (Klasnja, Hartzler, Unruh, & Pratt, 2010).

In the illustrative case of my participants asked for pregnancy information that simultaneously accompanied both trimesterl changes in physical and emotional aspects, and the aspects of parenthood preparation via self-guided education. In a correlating aspect to frame number three, I suggest that information provision should be grounded in the variability of the pregnancy experience timing within each woman’s lifecourse. Additionally, I recommend that the variability of needs for information according to both

Figure 13: Provide equal opportunities for self-guided knowledge provision (Frame #4)
self-seeking and collaborative information seeking strategies should be accommodated, where possible, within MAPs.

In particular, I found that addressing the differences between medically-correct information and “folk wisdom” is one area in which health interventions could have a notable impact early in a woman’s pregnancy. The key design prompt here is one of balance. While expert knowledge is highly desirable, and should be presented in language and imagery appropriate to the lower-income population, it should not be assumed that folk wisdom is not equally necessary or reliable in different aspects (Abrahamson & Fisher, 2007). As women reach out to their social circles to get information about their pregnancy experiences and the impacts of those experiences—or as they receive unsolicited information from supporters and strangers alike—there is the issue of inaccurate or competing information, when compared to expert knowledges. For instance, one popular piece of folk wisdom is the idea that pregnant woman should be ‘eating for two’, which implies the need to eat significantly more food than they did pre-pregnancy. However, experts say that eating for two is not a literal prescription and should be interpreted to mean eating the required caloric intake to support both mother and baby; a prescription that carries with it the need to only add an average of 200 more calories a day. At the same time, sometimes the folk wisdom can be become the expert knowledge, as in the current trend towards baby swaddling and wearing.

Therefore, designers need to be careful not to over prioritize expert knowledge, or openly denigrate folk wisdoms. Even if an experience design could possibly enable the circulation of some inaccurate information, sometimes the outcome of feeling fully supported and understood by one’s microsystem of people may be able to have larger
scale positive impacts on self-efficacy and stress reduction (Hamburg & Adams, 1967) than if the system had not allowed for such information exchanges. The key, then, for designers is empathy; incorporating into the information design a mutual respect for all close tie people who play important roles within the lower-income woman’s life.

Additionally, in what appears to be a clear intervention possibility, I advocate for the creation of plain, jargon-less advice for pregnancy management. This intervention should acknowledge circulating discourses about pregnancy processes or experiences that are misguided or outright wrong, while offering positive and sound life management and event process support.

(5) Substitute strong social support in place of weak consumer registries

<table>
<thead>
<tr>
<th>Context</th>
<th>Based on finding</th>
<th>Outcome</th>
<th>Design Opportunity</th>
<th>Action Process Principle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contextual and social ecological app use</td>
<td>Activity 1 &amp; 2 Offer contextualized social support features in place of baby registries</td>
<td>Reduced stress and improved coping processes and feelings</td>
<td>Social collaboration around identity, emotional issues, physical demands, and role change</td>
<td>Linked lives</td>
</tr>
</tbody>
</table>

Consumer goods registries were a frequent appearance in pregnancy apps, and were an aspect of app design that was often incongruent within the stated purpose of pregnancy apps. Yet a far more important aspect of pregnancy experiences was often absent – that of social support. This might be due to the fact that social support is poorly understood in HCI design research.
Generally, social support can be roughly parsed out as a concept, a process, or an environment. As a concept, social support is difficult to pin down. At times, it comes to sound more like a process than an act. In other instantiations, such as in design within HCI, the concept appears as a goal or a set of power relations. Depending on how and where it is used, and by whom with what background, the term social support therefore carries with it an inherent bias towards some smaller aspect of it when plugged into human interactions. At either a conceptual or process level, social support carries a multitude of meanings, and connotes a variety of different approaches to understanding what social support is, and how to provide it or enable it.

As a usable concept, I find social support to be a heavily contextual framing of a social interaction. In thinking of social support as a framing of a social context of human development, I see this concept of framing evident in Shumaker and Brownell’s discussion: “In considering support, we are trying to understand the act of support itself; who provides what and for what intended outcomes” (1984, p. 16; emphasis in original).

Within the MAPs I studied, and within HCI work more generally, I have found multiple instances of design incorporating shallow impersonal social interactions of some form, be it in terms of information provision, social media sharing, or communicative updates or posting of generic content. Yet I have found comparatively few instances of functions and modules for deep and personalized social support. Given that social support can be a force, a process, and an environment, the fact that it often written off as an ill-conceived concept is troubling to me.

I view social support as an inherent part of sensemaking processes, which in turn, is part of developing a conscious habit of self-reflexivity. Developing the self-reflexivity
habit is important for life management competence. “Having an ongoing conversation with your whole self about what you are experiencing as you are experiencing it” (Nagata, 2004, p. 139) contributes to a sense of self-knowledge, through a “constant awareness of embodied responses” which can be leveraged “as a tool for self-monitoring” (Pagis, 2009, p. 265). Self-reflexivity can contribute to resilience, thereby scaffolding improvements in a woman’s life more generally, post-pregnancy.

I advocate for a stronger conceptualization of social support within human-centered design work, and specifically when working in the design space of lower-income pregnancy. Designers should strive to design for the interactions of support around pivotal life experiences, following Shumaker and Brownell’s concept. Doing so requires understanding that a pregnancy involves more than the pregnant woman. Instead, an app or system design that respectfully includes social support as a module or features should allow for a contextual ecological use of the tool. This means enabling app use and app interactions between primary and secondary stakeholders, understood to be the pregnancy woman and her core group of close supporters. Social support can mean emotional coping support, stress reduction, a co-creation of meaning about what the pregnancy experiences are about (Hamburg & Adams, 1967), or any number of other active interactions that are directed at networked empowerment (Lee, Walker, Burleson, & Hekler, 2015).
(6) Include some (but not all) of a user’s social circle

![Diagram](image)

**Figure 15: Include and support selective intimate interactions (Frame #6)**

What each woman considers to be her social circle will include people of varying degrees of intimacy, drawn from across the variety of people in her life, and the variety of social contexts in which she interacts (e.g.: school, work, church, neighborhood). This extends from her spouse or significant other and offspring, to her parents, grandparents and siblings, out to her friends, in-laws, and kin, and out still further; to co-workers, church friends, and other members of more far-flung relationships globally. Each pregnant woman has informational needs and emotional touch points that require digitally-mediated support at a variety of levels of intensity and frequency (see Figure 15).

Yet, in the case of pregnancy, based on my participant reports and my investigation of MAPs, and drawing on visual presentation and informational design within pregnancy apps, most pregnancy-related apps are geared only at the pregnant woman. My participants spoke of being frustrated by the lack of support available to their spouses through the apps, and the sense of alienation felt by their partners as a result of the gendered design of apps, which was incongruous with the fact that many spouses were
considered to be important influencers and supporters in women’s lives. They also spoke of the distaste they felt of not being offered the option to include key members of their microsystem in social interactions and information sharing from an app. They decried the impersonal nature of anonymous discussion forums, and they worried about causing pregnancy update fatigue across their generalized social media platform due to canned ‘info blasts’ from pregnancy apps. Privacy and selectivity were important aspects to their social interactions online (Figure 15).

Within the HCI and social media literature referenced earlier in Chapter 3, there appears to be a widely held assumption that women are social sharers, who will want to share pregnancy and early parenting information widely over a diverse set of social networks. Yet, based on my research, this does not appear to be a popular practice. Most of my participants reported that, within the context of their pregnancy, they used Facebook very intermittently to share general pregnancy updates (sonograms and baby bump photos being most cited), but they did not have the time, energy or inclination to go beyond these limited sharing practices.

While there is the need for social inclusion and cohesion in app designs that understand and incorporate an individual lower-income woman’s pregnancy experience, designers should not assume that social networking systems and tools can adequately address this crucial aspect of pregnancy. My participants’ disinterest in and distrust of pregnancy discussion forums, social media venues, and chat rooms conflicts with prior HCI work (Curioso et al., 2008). This raises a question for future research: who goes to support forums willingly, who does not, when do they use standard social media, and what accounts for these differences?
There is research that suggests this divide draws on differences across the structural levels of society (Fox, 2011; Hill, 2001; Tixier & Lewkowicz, 2011, 2015; Yardi & Bruckman, 2012), owing in part to differences in social interaction styles between socioeconomic strata and ethnic divides. I suggest that further research is needed to determine the impact of social media and forums on pregnancy experiences for lower-income women. I also advocate a consideration for the impacts of socioeconomic position on social media sharing habits. In the interim, I would advocate for a cautious approach to social sharing.

This is one design frame that requires a carefully detailed understanding of the specifics of the primary population for whom a sociotechnical system is to be specified and introduced. Asking questions of different potential lower-income pregnant women during the human understanding research phase of a design project should uncover the specific desires, emotions and needs relative to the sharing of information about the pregnancy experience. Before designing for any kind of social sharing of information, including social media, and before assuming that a social media ‘blast’ is all that is needed, it is vital to grasp the relative levels of comfort about private versus public sharing, or individual versus group forums, or specific versus anonymous identify that is appropriate for the pregnancy experience for this population.
(7) Enable staccato sociality

This seventh sociotechnical design frame correlates heavily to Frames #5 and #6. In considering usage patterns for health apps specifically, and lifestyle apps generally, I am reminded that mobile app use is particularly sporadic across daily life. Some days, an app will be incorporated into the day in multiple ways at multiple times. On other days, it will barely be consulted at all.

This usage style is what Adams, Baumer and Gay (2014) call “short and bursty” digital interactions. I find inspiration in their idea of *staccato social support*. They use the term to refer to short and intentional asynchronous social interactions around specific support contexts. They suggest that designing for staccato sociality is particularly appropriate to the usage patterns within mobile apps. Relating staccato social support to pregnancy, I consider it to be a useful concept to describe various kinds of coordination activities, such as those between a pregnant women and her spouse or domestic partner (Figure 16). Imagine a social feature that would enable a pregnant woman to send a directed private blast to her partner via a quick canned emoticon or text message that encapsulates alerts about her physical and emotional state on a given day. The blast might
also offer the option for a quick request, such as “bring home fast food – I can’t cook today”. Alternately, adapting staccato sociality into functionality for more general pregnancy experience use could take the shape of an in-app ‘chat room’ feature between trusted supporters and the pregnant woman.

Adams et al. suggest that the lightweight time demands that these features enable increases the amount of follow-up type interactions between supporters and the primary app user. The end result of following up frequently via the app is a feeling of social inclusion and a reduction in feelings of isolation and of being misunderstood (Figure 16). Given that this kind of social support approach “has a greater prevalence of esteem support, which builds respect and confidence” (Adams et al., 2014, p. 653), the presence of staccato social support features could provide a demonstrable positive effect on self-judged feelings of pregnancy coping capacity, thereby helping women feel that they are doing pregnancy right.

(8) Provide appropriate app data termination or migration

A troubling finding of my MAPs investigation was the frequent lack of attention to data migration, which I contextualize as end-of-use needs. Pregnancy is a process of the
lifecourse which is assumed to have an eventual end to it. The process cycle for pregnancy is strongly defined. Barring the unintentional loss of pregnancy due to miscarriage, pregnancy is defined as a 38-40-week occurrence within a woman’s life. Even allowing for extra weeks for accommodation for the birthing experience and the transition to the new baby, this means that the general life expectancy of use of a pregnancy app would be around 45 weeks’ maximum. Because of this, there should be an expectation that app use will discontinue between weeks 38 and 45 at the most, if it is used for the entire duration of a pregnancy experience (Figure 17).

However, very few of the pregnancy apps I examined showed any appreciation for the discontinuance of the app, and for the ramifications this has on data management, termination, and off-loading, migration, or storage. Given that some of my participants asked for photo and textual journaling features in a pregnancy app, where they would take ‘belly bump’ pictures and measurements, and store personal reflections about their day to day life throughout their pregnancy experience, with the goal of sharing it with their child later on in the child’s life, this lack of attention to data migration and off-loading is deeply troubling. My analysis of the MAPs landscape showed that this retirement aspect of app usage was not considered in the vast majority of apps. Yet a number of apps did allow for cataloguing and storing belly bump measurements and other journaling and reflection-related activity data (as depicted in Table 6).

The design recommendation here is obvious. Any life management app should have a defined retirement protocol incorporated into the end of life procedure for the app’s use discontinuation. This protocol should be strongly communicated, and should allow for the flexible offloading of data to both popular cloud storage services, such as Google
Drive, Dropbox, iCloud or OneDrive, or to personal repository and management options, such as printing out everything created within an app, or emailing everything to one’s self, or simply downloading a compressed file for local storage. Alternately, per a request from the focus group #4 participants, photographic, journaling and reflection data should be able to be integrated into a type of printed photojournalistic ‘baby book’ or ‘memories book’, similar to the type of service offered by commercial services such as Shutterfly and Mixbook.

On a more progressive positive note, I see opportunities here, however, to leverage the audiovisual capacities of mobile devices such as smartphones, or cloud-aware voice-activated speakers, such as the Amazon Alexa ecosystem of devices. Why not offer the ability to make a multimedia book that plays audio recordings or small video snippets at various points? Bridging the digital to physical divide, I find opportunities as well to incorporate multimedia memories and stories into a small auto-playable or pressable device. These could be included in a paper book, or something that plays automatically when pages are turned to the corresponding page for the memory. Taken a step further yet, a device like this could be incorporated into any number of physical artifacts, from stuffed animals to clothing or bedding or art installations.

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5 Purchasing a greeting card at a large chain retailer of greeting cards and paraphernalia triggered part of this idea. I found several examples of greeting cards that played music when you opened them, or allowed you to record your own voice greeting into them. The last suggestion was triggered by an experience at the retailer “Build a Bear” where you can voice record something on a small box to be incorporated into a stuffed animal.
Chapter 7

Conclusion

“Sociotechnical research is premised on the inter-dependent and inextricably linked relationships among the features of any technological object or system and the social norms, rules of use and participation by a broad range of human stakeholders” (Sawyer, 2014).

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<th>Articulation of the mobile app design space of lower-income pregnancy</th>
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<td>There is a limited understanding of how lower-income pregnant</td>
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<td>pregnancy to appropriately scaffold the</td>
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<td>information seeking and social</td>
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<td>coordination experiences of lower-income</td>
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<td>pregnant American women?</td>
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<tr>
<th>THE TECHNOLOGICAL PERSPECTIVE IN THE DESIGN SPACE</th>
<th>Scope of the gaps, oversights and issues with existing MAPs relative to lower-income women</th>
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<td>Addresses a Research Gap</td>
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<tr>
<td>Do existing mobile apps for pregnancy appropriately meet the informational and interactional needs of lower-income American women?</td>
<td>There is a limited understanding of whether or not mobile applications appropriately support the informational and interactional aspects within the process of pregnancy experiences for lower-income women.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THE SOCIOTECHNICAL PERSPECTIVE IN THE DESIGN SPACE</th>
<th>Understanding pregnancy as an inter-dependent set of interactions between humans, technology and information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responds to RQ3</td>
<td>Addresses a Research Gap</td>
</tr>
<tr>
<td>What design recommendations can be provided to improve the sociotechnical design space of lower-income American women?</td>
<td>There is a limited amount of work available that addresses the differences in the digital mediation of pregnancy experiences based on socioeconomic status.</td>
</tr>
</tbody>
</table>

Table 10: Contributions as responses to gaps and RQs
Contributions

As depicted in Table 10, I offer three contributions to the cross-disciplinary information domains that are represented within the fields of HCI, social computing, and medical informatics.

The human perspective

<table>
<thead>
<tr>
<th>THE HUMAN PERSPECTIVE IN THE DESIGN SPACE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articulation of the mobile app design space of lower-income pregnancy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Responds to RQ 1</th>
<th>Addresses a Research Gap</th>
<th>Domain Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>What opportunities exist for mobile apps for pregnancy to appropriately scaffold the information seeking and social coordination experiences of lower-income pregnant American women?</td>
<td>There is a limited understanding of how lower-income pregnant American women understand and coordinate their pregnancy experiences through mobile digital tools.</td>
<td>CSCW</td>
</tr>
</tbody>
</table>

Figure 18: Human perspective in the design space of lower-income pregnancy

While the gaps in formal medical care during pregnancy are visible and troubling, I found even more troubling the stories of confusion, isolation, distress, fear, and fatigue. In the highly sophisticated care system that is the American pregnancy support network, the fact that lower-income pregnant women often had to wait out one entire trimester of pregnancy before getting guidance and advice points to a systemic structural failure. Turning to “Dr. Google” and other digital sources of information, most notably pregnancy apps, women reported frustration, worry, and fear. The tone of most apps was too medical, they said; a finding borne out in my pregnancy app analysis.

The overall human narrative of unexamined and unassisted pregnancy for lower-income women is distressing. The narrative is one of confusion and stress about the prevalent narrow view of pregnancy as a medical process or a social problem. Many of
the hardships and issues participants reported are related to adjustment to changes, whether that was corporeal changes, social status changes (from woman to mother) or structural socioeconomic changes.

Viewing lower-income pregnancy through my qualitative research findings, I consider pregnancy to be a life experience that is modulated by a woman’s socio-economic status, which in turn influences her lifestyle choices, her health, her medical access, and her use of mobile and connected technologies. I also understand pregnancy to be shaped and managed by other key social actors in the pregnant woman’s life, whether those actors are her spouse or domestic partner, her family and close friends, or the information sources upon which she relies, both medical and digital. Taken together, there exists a set of needs that have little to do with medical pregnancy, or to risk management discourses. Instead, a lower-income woman’s life management needs during pregnancy relates more strongly to her ability to access and understand pertinent information, obtain emotional and social support from her close ties, and cope with the need to adapt daily habits according to the imposition of physical changes and demands presented to her by her own pregnant body.

The human perspective in this design space represents the scope of the needs of the lower-income female participants in my research. It presents an articulation of the mobile app design space of lower-income pregnancy, and therefore addresses my first primary research question (RQ1), as reflected in Figure 18.
The technological perspective

Using the needs identified by my participants, and the outcomes of my iOS MAP scoping exercise and in-depth analysis, I reveal a need for better access to and support of women by the overall market of apps generally. By understanding pregnancy as a mediated sociotechnical experience, and by focusing on social support aspects in order to address the plethora of negative emotions and experiences I heard in the focus groups and interviews through supportive app technologies, I identify gaps in the existing offerings for pregnancy, as it relates to social support (Figure 19). The gaps I have described provide openings for technology-based interventions and education via mobile devices, by expert-offered formal support and by kin and friends informal support.

I show that the existing narrow and individualized focus of medical information provision in MAPS narrows opportunities for expectant fathers to become more involved in everyday experience of pregnancy, as a kind of co-constituent in pregnancy. Women asked for the ability to better include their partners in pregnancy management, but I have illustrated how apps shut out fathers and close supporters, by not providing opportunities

<table>
<thead>
<tr>
<th>Responds to RQ2</th>
<th>Addresses a Research Gap</th>
<th>Adds to a Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do existing mobile apps for pregnancy appropriately meet the informational and interactional needs of lower-income American women?</td>
<td>There is a limited understanding of whether or not mobile applications appropriately support the informational and interactional aspects within the process of pregnancy experiences for lower-income women.</td>
<td>Medical Informatics</td>
</tr>
</tbody>
</table>

Figure 19: Technological perspective in the design space of lower-income pregnancy
to collaborate, coordinate, and cooperate with them around pregnancy information and events. Instead, apps only offer opportunities to interact with strangers.

There is a role here for MAPs to better mediate this experience, and improve a woman’s subjective feeling of wellness. By **scoping the gaps, oversights and issues with existing MAPS**, I detail the technological perspective of the design space, and I therefore addresses my second primary research question (RQ2), as it is delineated in Figure 19.

**The sociotechnical perspective**

<table>
<thead>
<tr>
<th>Responds to RQ3</th>
<th>Addresses a Research Gap</th>
<th>Adds to a Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>What design recommendations can be provided to improve the sociotechnical design space of pregnant lower-income American women?</td>
<td>There is a limited amount of work available that addresses the differences in the impacts of the digital mediation of pregnancy experiences by digital apps that are attention to differences in needs based on socioeconomic status.</td>
<td>HCI</td>
</tr>
</tbody>
</table>

**Figure 20: Sociotechnical perspective in the design space of lower-income pregnancy**

I understand the sociotechnical perspective to be the inter-dependency of people, processes, contexts, and time as it relates to the inter-dependence of each on digital technologies. The outcome of the needs identification activity for both RQ1 and RQ2 give shape and definition to the four main dimensions of human experience, as depicted in the contextual display of key features, actors, needs, and information (see Figure 21, next page).
Given this more nuanced perspective, of lower-income pregnancy as an action-oriented experience grounded in the people, processes, contexts and temporalities of everyday life, I have identified opportunities for digital apps to play an acting role in improving the experience of pregnancy as mediated sociotechnical experience. Coupled with the described design space, the full assemblage provides the overall problematization of the design issue of appropriate digital design of MAPs for lower-income pregnant women.

Congruent with both the philosophy of problematization of the Double Diamond model, and the sociotechnical approach to design specification, I have positioned lower-income pregnant women as the central stakeholders and the main users of concern. Embedding their perspective into the problematization, I use the four dimensions of people, process, context, and time within women’s daily lives as a structure for my response to the sociotechnical design opportunity. My solution to that opportunity within the design space of lower-income pregnancy was to provide a set of eight evidence-based design considerations that incorporated the dimensionality of everyday pregnancy experiences for women like those in my studies into design. Across all eight design
frames, I have argued that new contextual sociotechnical approaches to MAPs design should be shaped along lines of interaction for the pregnant woman; interaction with information, with physical manifestations of trimester-based pregnancy, with emotional states, and with important social supporters. The multi-dimensional nature of the sociotechnical perspective of lower-income pregnancy showcases the way that pregnancy, technology, experience, and information are intertwined in the American context, and expands the design space of lower-income pregnancy beyond a strictly medical and consumer experience.

There is a role for MAPs to better mediate experiences with the design space of lower-income pregnancy. It is possible to use mobile technologies to improve a pregnant woman’s subjective feeling of wellness, but it needs better design frames to inspire and direct future design activities. By understanding pregnancy as an inter-dependent set of sociotechnical interactions, with pregnant women (and their supporters), with information, and with mobile digital technology, and by presenting a set of 8 design frames that are embedded in this design space, I open up opportunities to inspire and direct future design activities. This sociotechnical perspective on the design space addresses my response to RQ2, as it is depicted in Figure 20.

**Limitations**

There are two limitations to this work, relating to analysis bias and generalizability.

In larger multi-researcher qualitative projects, it is typical to have three or more research analysts independently analyze the entire set of gathered data, then compare and discuss the results of analysis in order to achieve a consensus of meaning and impact.
This is typically called inter-coder reliability. This process is not feasible in a thesis project, where there is a single researcher-analyst. I have worked to minimize coder bias by perception-checking the results of each interview outcome with my faculty mentors and advisors, and discussing deviations in interpretations, until we achieve a consensus.

The participants in the focus groups and interviews were deliberately chosen from a lower-income female population in central Pennsylvania. Given the specific qualities of my participants’ experiences, the study and its outcomes are limited to the extent of how they might be generalized to a wider American population.

**Implications**

Pregnancy is more than a medical event. It is an important experience phase in the adult lifecourse. It is a training ground for parenting, and for a host of other social roles in the larger context of the adult lifecourse. Like many adult experiences, it involves a fluctuating series of processes related to adapting to the changes, incorporating them into the self-concept of the individual, and into the individual’s social role.

There is a tendency to pathologize otherwise normal life experience activities and sociotechnical processes, though usually with the best intentions to help, direct, and preserve life at the larger population level. But there is a sad consequence of the risk and danger management discourses of medicalized management of human adult experience: a gradual reduction of ideas of what is normal for adults, and what can be healthy. Medicalization of otherwise normal human experience constrains the wide variability in self-presentations and adaptation mechanisms and processes that should be part of
individual adults finding their unique paths for their own lives, and living their lives fruitfully across their lifecourses.

The sociotechnical reduction of normal adulthood is a phenomenon I find worthy of scrutiny, due to the way designers and developers frequently appear to forget that all design is value-laden. Adults increasingly rely on mobile apps to manage memory, sort out tasks and processes, and understand themselves. It behooves HCI designers to consider the power relations and discursive functioning of value-laden systems of digital rule, and to be wary of re-inscribing systems and discourses that reduce or limit the possibilities for human expression and self-actualization.

Life is about change. It is about acceptance, adjustment, and accommodation to the rhythms and flows of structuring events in adult lives. Broadening the focus in digital app design, beyond a narrow consumerist or medicalized concept of otherwise normal lifecourse experiences, provides one way to broaden the impact potential for digital apps to be positive actors in the lives of otherwise normal adults.

**Reflections**

Guided by a sociotechnical human-centered approach to design, and a human development ecological understanding of human lifecourse experiences, I have used *formative* evaluation methods (i.e. “exploring the kinds of needs that might exist” Coiera, p.4) to explore and explain the potential contexts and use cases of lower-income pregnancy-oriented needs that might present opportunities for revised or new socio-technical systems design. As Coiera says, “our logic of design must take account of
context, and specifically resources and competition for resources” (p.4). This has been my goal.

At the outset of this project, my intent was to understand the contextual needs of a specific population undergoing a specific pregnancy experience. My choice of pregnancy as my particular sociotechnical meta-frame was driven by both opportunity and applicability. While I was given the opportunity to work within the design space of mobile health management, the research I did as part of that time and outside that project provided a look at lower-income pregnancy as a multidimensional experience in an adult lifecourse. I felt I needed to respect the contextual nature of lower-income pregnancy, by presenting it as a both health-oriented embodied experience, and a temporally-bounded period of the lifecourse with ramifications on longer-term issues of role strain, self-identity, and social presentations of self. I need to better understand and define this different design space that was more than medical, more than physical, more than individual.

Existing digital health and wellness design research appears to mainly address the pregnancy needs of women in developing countries, despite the World Health Organization’s recommendations to address reproductive health and wellness issues at a global level. As my work has illuminated, there is a mandate available to address pregnancy-related needs in North America through better design approaches to mobile apps. By targeting vulnerable populations of racialized lower-income women, and by examining a corpus of pregnancy mobile apps, I have described and demonstrated that gaps exist in the way apps ignore a few dimensions of pregnancy: socioeconomic patterns of care and information access, and cultural patterns of sociality and self-management. I
argue that designing appropriate MAPs that address the gaps requires research into lower-income women’s specific realities, paying particular attention to social, emotional and informational support needs and valences.

I was originally guided by global best practice recommendations for digital health and wellness design, as derived from the World Health Organization, and through design and health literature. But it was through my research into a variety of lower-income women’s particular pregnancy contexts that I discovered that each woman believed her own pregnancy to be unique; a finding that has ramifications for digital health and wellness interventions generally, and which presents challenges specifically for sociotechnical design spaces.

The outcome of the first two of my research activities shows that it was social efficacy and a subjective sense of personal wellness that was possibly more at stake than physical health and fetal risk, when considering the experience of pregnancy as an adaptation to a seemingly normal experience within the adult lifecourse of a woman.

My third research activity demonstrates that virtually all pregnancy management mobile apps are calcified into a model of pregnancy as a female-only medical issue of managing risk and reducing health dangers to the developing fetus. This points to a large opportunity to revise this approach. When I mapped the existing designs and functionalities within pregnancy apps to the pregnancy ecology model, I discovered a large amount of ignorance around the social experience of pregnancy. There was also selective blindness for the perceived uniqueness of pregnancy – the vast majority of apps simply regurgitated general pregnancy health and risk avoidance information.
Building my findings into an overview of the *sociotechnical dimensions* of the experience of lower-income pregnancy, I give definition to the design space. The sociotechnical dimensional overview of the normal experience of pregnancy for lower-income women is intended to showcase the need for digital support options that are more than just medicalized health support. My research has made visible the fact that the largest influencer of how lower-income pregnancy is enacted comes from a top down approach, out of cultural norms, ideals and moralities, followed by the medical establishment’s understandable focus on corporeal risk and fetal health and development. This meant that the opportunities for feeling supported, understood and under control (in what participants called “doing pregnancy right”) are visibly reduced by this population’s socioeconomic status. This is due, in part, to the way in which care system limits their access to medical support and appropriate information. This can also be attributed in part to the fact that existing options for using MAPs to manage their pregnancy reinforces the medicalized frame of pregnancy and ignores interactional opportunities in favor of medical information provision.

I have argued for flipping around the emphasis in designing for lower-income pregnancy wellness and efficacy. By placing the individual and their close supporters at the core of sociotechnical app design, I use the sociotechnical dimensions of pregnancy to frame out eight opportunities for contextual sociotechnical design of future MAPs for this population.

The eight opportunities, or what I have called *design frames* are intended to support the notion of pregnancy as part of a normal set of experiences in individual lifecourses, through the appropriate design of digital systems to facilitate better management and
support of pregnant women. Through those frames, and their action orientation towards collaboration, coordination, cooperation, and conflict management, I showcase the way the that temporality and contextual sensitivity are important areas for design consideration. The historicity of time and physical situations must be accounted for in sociotechnical systems approaches. Human lives are linked together in systems of mutual interdependence with technology and with established processes and policies. The design space for supporting lower-income pregnancy is inherently sociotechnical. This dimensionality requires design frames that reflect and support this ontological approach.

Outside of the medical context, pregnancy for lower-income women has dimensions which inflect and infuse the experience of pregnancy with specific challenges and opportunities. In this design space, designing and offering mobile apps for pregnancy management must be sensitive to the dimensional issues and demands. In order to have the ability to play a positive role in the lives of lower-income women during pregnancy, all three of the human, technological and sociotechnical perspectives must be brought into design considerations. Only then will lower-income women feel that the design space better reflects their identity, their context, their temporality and experience of pregnancy.


Kraschnewski, J., Poole, E., Peyton, T., Blubaugh, I., Feher, A., & Reddy, M. (2014). Calling “Dr. Google”: Does technology fill the gap created by the prenatal care visit structure? *Journal of Internal Medicine, 29*, 44.


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- Carleton University – Ottawa, ON (2010-2012) Awarded Masters – Sociology

Peer-Reviewed Publications & Proceedings
- [June, 2014]. Peyton, T., Poole, E.S., Reddy, M., Kraschnewski, J. & Chuang, C. “Every pregnancy is different”: Designing mHealth for the pregnancy ecology. ACM DIS2014

Grants and Awards
- iConference Doctoral Consortium [March, 2016]
- Pennsylvania State Graduate Exhibition [April, 2015]. Second Place winner.
- Rising Stars in Electrical Engineering & Computer Science Workshop [November 2014]
- Grace Hopper Conference – PHD Graduate Scholarship [October 2014]
- Broadening Participation Workshop [CRA-W] – Scholarship recipient [September 2014]
- AT&T Graduate Research Fellowship [August 2014]
- Penn State– University Office of Global Programs: Graduate Research Travel Scholarship [April 2014]
- ACM – Women’s Council [ACM-W]: Graduate Research Travel Scholarship [February 2014]
- ACM SIGCHI: CHI’13 Best Paper Honorable Mention [May, 2013]
- York University: Canada Graduate Scholarship [SSHRC] [2008]