Towards a Design Model
for Women's Empowerment in the Developing World

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ABSTRACT

Pulitzer Prize-winning journalist Nicholas Kristof argues that "in this century the paramount moral challenge will be the struggle for gender equality around the world." In this paper, we present a design model for empowering low-income women in the developing world, in ways that cut across individual application areas. Specifically, this model characterizes a possible trajectory for NGOs and women to engage with each other and among themselves – potentially augmented by technology – to help women escape from poverty. The fieldwork components in this study took place over 15 weeks in three phases, with a total of 47 NGO staff members and 35 socio-economically challenged women in rural and urban India. Interviews and co-design sessions with seven proof-of-concept prototypes showed that women appeared to belong to five distinct stages of "growth" in striving towards independence. We report the technology design lessons from our co-design sessions to illustrate how user readiness, relationship building at the community and family levels, and integration with state, national and international level programs, should be taken into account in the broader context of intervention design.

Author Keywords

Design for inclusion, Developing countries, Digital divide, Gender, HCI4D, ICT4D, Women empowerment.

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Design, Human Factors.

INTRODUCTION

One of the United Nations Millennium Development Goals (MDGs) is to "promote gender equality and empower

women" [16]. Although the MDGs have raised awareness of problems around gender equity, a recent MDGs Progress Report indicates there remains a huge gap to closing gender inequality throughout the world [17]. For instance, women comprise only 20 percent of non-agricultural employment in South Asia, West Asia, and North Africa [17]. The UN notes that "one-quarter to one-half of girls in developing countries become mothers before 18", and that "out of the world's 130 million out-of-school youth, 70% are girls" [28]. A UN Secretary General report states that women in the developing world face violence in varying degrees: forced marriage, spousal abuse, forced prostitution, and infanticide [29]. Nicholas Kristof, the *New York Times* journalist who reports widely on human rights issues in the developing world, describes how husbands inflict violence on spouses for disobedience, how parents spend more on healthcare for infant boys than girls, and how women are forced into sex trafficking. Kristof goes on to argue that "in this century the paramount moral challenge will be the struggle for gender equality around the world" [11].

Most importantly, the UN states that gender empowerment is indispensable for achieving other MDGs [16]. Lessons from developing countries such as China and Rwanda show that advancing women's rights benefits individual women as well as promotes economic development for society as a whole [11]. Specifically, increased schooling for women coupled with social norms that increasingly support their participation in workplaces (i.e. outside the home) leads to higher utilization of society's scarce labor resources. Such productivity improvements postpone childbearing, alleviate population pressures, promote higher exports and result in higher incomes [6, 8, 11, 26, 27]. The latter is significant when "women reinvest 90% of their income back into their household [e.g. their children's education and healthcare], whereas men reinvest only 30% to 40%" [18].

Information and communication technologies (ICTs) can improve lives for women, as well as increase their capacity to contribute to the development of their communities and families (refer to Motivation and Related Work). "Human-computer interaction for development" efforts have targeted domains such as microfinance or maternal health in which women are primary beneficiaries. But despite the range of problems associated with gender equity, there is insufficient

attention on examining the needs of marginalized women in developing countries from an angle that goes holistically beyond specific application areas. For instance, what are the material and social barriers, including gender biases, which hinder their advancement? In the case of non-government organizations (NGOs) who work to promote gender equity, what are the more successful interventions they employ to overcome these systemic challenges? What can technology designers learn from such interventions? How do we design appropriate technologies to complement and possibly even enhance these grassroots initiatives?

In this paper, we address the above questions via contextual interviews with 47 staff members in 16 NGOs that work to improve gender equity in India, and 35 low-income women supported by these NGOs. Through these questions, we aim to learn how the above NGOs improve women's lives in ways that are cross-cutting beyond individual application areas such as health or microfinance. Most of the NGOs we interviewed had participant bases of more than a thousand women each, and are highly knowledgeable about the best practices in this field. We sought to understand the best practices NGOs already employ so as to identify how we could design technologies to augment initiatives that are already effective to some extent. We formulated a model of the women's characteristics based on our interviews. We learned that there is a diverse spectrum, from women who desperately needed support to women who actively sought out personal growth – for themselves, their families, their communities and other women. We subsequently conducted co-design sessions using seven proof-of-concept prototypes to give more subtle insights on this diverse user population and further design directions.

This model shows how the characteristics of marginalized women change over a 5-year period as they grow to realize their potential, the obstacles they and the NGOs supporting them face in their struggle to improve their lives, and the NGOs' best practices for addressing these obstacles. We next present lessons from co-design sessions informed by this model, to help the reader better appreciate the subtleties in the design space that this model implies. As such, this paper's contribution from a human-computer interaction angle is a design model that accommodates the changing needs of a subset of marginalized women in the developing world, and a means by which designers can understand this user group in more detail, to the extent that designers can potentially use this model to evaluate their work. Given the complexity in gender equity, this paper is inevitably only a first step and has its limitations. Specifically, we studied NGOs that engage in training programs with women, and have left less tractable gender-based problems such as sex trafficking and brothel rescues outside our scope.

MOTIVATION AND RELATED WORK

While most women in the industrialized world have access to basic resources, they are still battling to be recognized as equals. Feminist research ranges from girls and women in computing in schools and workplaces [2], to how gender identities are constructed during technology use and video-game play [4, 10]. However, these situations are vastly different in developing countries, where many women are not allowed to go to school or work outside the house. In other poverty-stricken families, girls undertake child labor and do not have the luxury of time for videogames. In short, in the developing world, women face different challenges, such as unequal access to basic healthcare, education and a lack of technology literacy.

Past HCI research in healthcare has used mobile videos to increase motivation among rural Indian health care workers, and to help them persuade rural pregnant women to use the local health resources available to them [21]. Mobile text messages have been used in maternal health [23]. Cable television in India has reduced a woman's preference for a son by 70%, and domestic violence by 46% [9]. This study also showed increased school enrollment among children of women who have cable. ICTs have also improved women's employability in the developing world. The Grameen Bank found that their Village Phone program in Bangladesh has "empowered village women economically and socially by reducing and/or eliminating their dependence on other members of their families and giving them increased roles in family decision making," while also enabling women to provide a telephone service to their communities [1]. Parikh has helped microfinance institutions to better capture the microfinance data of rural Indian women self-help groups [20]. Past work in rural handicrafts and cottage industries has researched whether ICTs can be used to raise income for female handicraft workers [5, 25]. Other research in employment has studied how an employment search application can help domestic slums workers to find jobs [14]. Internet cafes have transformed the lives of women in countries like Egypt by giving them access to information and professional development opportunities [30].

The above research raises our understanding of technology use by women and how to address the specific basic needs of women using ICTs. However, many of these efforts have been piecemeal, and have not looked at improving women's lives in a holistic way. They have neither considered their longer-term professional and personal growth, nor barriers that need to be overcome to help women escape the vicious cycles of discrimination, low literacy and schooling, and under-employment, among other problems.

Bardzell [2] poses a list of qualities as a starting point for a research agenda in feminist interaction design. While these design qualities overlap significantly with our approach, we have found that the nature of these qualities have to evolve with the growth of the women we studied. We have also learned to account for intermediate users [24] and women's developmental needs. In international development, there are women empowerment models such as Longwe's which UNICEF has adopted [13]. While this model informs areas to prioritize on, it does not emphasize directions for design.

Lastly, while scholars studying the intersection of ICT and international development have devised metrics and models for capturing gender disparities in technology use [7, 19], these models cannot directly inform design.

TIMELINE AND METHODOLOGY

We conducted the field research in three phases that lasted a total of 15 weeks with a total of 82 participants. We first interviewed 22 NGO staff about the best practices in their women's empowerment initiatives, after which we engaged in co-design sessions with 25 staff and 35 women supported by our NGO respondents to obtain additional feedback that further improved our understanding of gender equity.

Phase 1: Initial Needs Analysis (Jan-Mar 2010, 11 weeks)

In this phase, our goal was to understand the best practices that NGOs used in grassroots-level initiatives for women's empowerment, so that we can identify various opportunities for designing technologies which build on existing practices that have been successful. In total, we interviewed 22 staff members from 12 NGOs. With each respondent, we ran a one-hour semi-structured interview on the characteristics of the communities she or he worked with, daily routines of the women in the communities, social relationships within these communities and problems that women encountered in improving their lives. Our interviews also focused on the NGO staff's daily routines, best practices in their program implementation, and how they evaluate their programs. As each interview proceeded, most NGO staff volunteered information more freely, based on what they thought to be helpful for enhancing our understanding. On average, we interviewed two staff members per NGO.

This phase was time-consuming. NGO staff members were often not available due to their work commitments, and as such, it took repeated reminders to schedule interviews. In selecting NGOs to learn from, we focused on those NGOs with a track record in women's empowerment among low-income communities in India. We were able to secure these interviews via our primary NGO partner, who spearheaded local women's empowerment initiatives for over 2 decades and introduced us to the NGOs she highly recommended.

On average, each of the NGOs impacted about 500 women, and 2,000 of their family and community members. Each NGO had been in existence for at least three years and had implemented gender empowerment programs for national- and state-level government agencies. Four of the NGOs had worked with international non-profit organizations such as UNESCO and UNICEF. We selected staff members with at least three years of experience in gender empowerment to interview. With the exception of two administrative staff, all staff members whom we interviewed interacted closely with their communities at the grassroots level. They helped with matters such as domestic violence, employability (e.g. adult literacy and candle-making), women's rights, infant-care, and maternal health training.

We analyzed our data by clustering the NGO responses into affinity groups. It turned out that the women targeted by the NGOs can be clustered into 5 stages in a trajectory of how NGOs engaged with them differently based on their current stage (Figure 1; more in Initial Model). In other words, we organized our findings by these stages after we observed how the beneficiaries have unique characteristics and needs depending on the stage they are in. We also observed that different NGOs worked with women in different stages and had evolved best practices unique to each stage.

Phase 2: Brainstorming (June 2010, 2 weeks)

Armed with the analysis of the interview data from Phase 1, including our model that organized needs and best practices according to the stages that appeared to belong to a growth trajectory, we returned to the field. In Phase 2, we explored technology design ideas that targeted the obstacles faced by NGOs in each stage, as well as design ideas for supporting the best practices for each stage. We started by holding 15 half-hour brainstorming sessions (2-3 staff per session) with 7 NGO staff from Phase 1 who were actively involved in all 5 stages, so that we could have perspectives that transcend individual stages. The sessions prioritized on the problems respondents thought to be most important. In brainstorming with NGOs, we sketched some possible designs to facilitate concrete discussions. Although the NGOs were helpful with design ideas, what was even more valuable was that they voluntarily offered their experiences from interactions with their communities. This contextual information not only informed our designs directly, but was tremendously useful for enhancing our cultural understanding above and beyond what our initial model originally captured.

Next, we conducted 9 half-hour brainstorming sessions with 11 women from the communities. These interviews were in pairs or small groups, except those sessions with women in the Independence stage, which took place one-on-one, since there were fewer women who had reached that stage. Our participants came from the last three stages in the trajectory who were already proactive in taking steps to improve their lives and possessed cellphones. As such, they have enough familiarity with cellphones to suggest ideas, including ideas about mobile applications that aim to benefit them. (The NGOs advised that it was not feasible to brainstorm with women in the first 2 "passive" stages, who were beginning to learn about gender biases and that they needed to stand up for their rights.) The 11 women lived in the urban slums and had monthly household incomes below 8,000 rupees (US$178). The average woman was 30 years old and had five years of formal schooling. The women stitched clothes, embroidered or cooked for a living. Prior to employment (which the NGOs helped them to obtain), many of them faced domestic violence because of alcoholic husbands (which NGOs taught and helped the women to overcome).

Phase 3: Design Feedback, Redesign (Jun-Jul '10, 2 wks)
Our contextual understanding was still limited and could be improved through more interviews, so as to arrive at a more nuanced understanding of the design space. For Phase 3, we developed 12 proof-of-concept prototypes based on the ideas we brainstormed in Phase 2 with NGOs and women in "active" stages. The prototypes were neither intended to be fully functional nor used for usability testing. Instead, they were meant to express the ideas in a more tangible form to participants, so that we could solicit better feedback. In the interviews, we used prototypes as "conversational props" in early-stage co-design [22] to evoke participants into telling us more about their everyday scenarios and how the design ideas would apply (or not).

We carried out these conversations with 25 staff members from 8 NGOs who run initiatives similar to previous NGO respondents. Out of the 25 NGO staff interviewed in Phase 3, 18 were new participants whom we had not interviewed in Phase 1 or 2. To ensure adequate coverage of our model, for each stage, we engaged with an average of 5 NGO staff who are knowledgeable about that stage. We ran 21 similar interviews with 35 women (28 women came from the urban slums while 7 were villagers; all 11 women from Phase 2 participated in Phase 3) using the prototypes, such that there were 6 to 8 women from each stage. Unlike Phase 2, in Phase 3, we included women from the passive stages. Most of the latter were housewives and came from rural regions, because most women in passive stages lived in villages and moved to cities to benefit from their newly-acquired employability skills only after reaching the active stages.

Conducting interviews with women in passive stages was more challenging and called for more sensitivity. Out of deference to the husbands who headed the households, we first showed the prototypes to the husbands before women participants felt comfortable talking to us in the former's presence. In contrast, women in the active stages were more familiar with technology (they owned cellphones), tried our prototypes themselves, and volunteered their perspectives. On the other hand, we had to be more proactive in posing questions to women in passive stages. The latter were also less at ease with technology, and hence we spent more time demonstrating the prototypes to them.

INITIAL MODEL
From NGO interviews in Phase 1, we observed that women supported by the NGOs seemed to progress along a certain trajectory that comprises five distinct stages, in which each stage represents a unique set of approaches that NGOs take to engage with women in their communities to improve their lives. NGOs estimate that women typically take 3-5 years to progress through all five stages, such that the latter's characteristics differ from one stage to another. Furthermore, any stage can be an entry point for an NGO's intervention, e.g. some of the NGOs whom we interviewed only work with women who are already actively working to improve their lives.

While NGOs reported that they have improved the lives of thousands of marginalized women and their families, their best practices were not often rigorously evaluated because program implementation often took on higher priority. This implies that the model given in this section is only a starting point for further research. NGOs state that while they have been successful with several women in the active stages, in contrast, less than 50% of the women in passive stages would usually graduate to subsequent stages. NGOs said that their success rates depend on the women's proximity to urban centers, initial income, family background (e.g. caste, family structure, family size, illness in the family), religious and cultural practices, age, etc.

Stage 1: Powerlessness (passive stage)
Women characteristics: NGOs used terms like "passive" and "powerlessness" to characterize the gender bias in the home that led women and girls to receive less resources (e.g. food, healthcare and technology) compared to male and elder female family members. Mothers, as mediators of information between daughters and their husbands, are what NGO staff called a "stopping channel," since they hesitated to advocate opportunities for daughters to the fathers. There is minimal emotional support for women; they cannot freely vent their problems to their husbands and parents-in-laws. In some upper-caste families, it is disgraceful for women to work for wages, and they are therefore confined at home. Daughters are treated as a burden since their families need to raise money for their dowry. Women are usually barred from owning land. They either cannot afford items such as cellphones, or risk having their cellphones snatched by a male family member if he is annoyed by her use of it.

NGO best practices: NGOs claimed they must be active agents at this stage since women and their families are passive about improving the women's lives. In door-to-door visits, NGOs recruit families to participate in NGO programs with help from local agents, or cite community members known to the families who have already benefited from the NGO's programs. NGOs conveyed the benefits to husbands and parents-in-laws, since their support is crucial for ensuring women's long-term participation in the NGOs' programs (e.g. workshops): "Women's empowerment is not just a women's issue, but is everyone's issue."

NGOs address families' apprehensions by giving them an overview of what will be covered during the workshops and what is expected of participants. NGOs also spend time to show that they care (e.g. "How has your day been?") since women have minimal emotional support at home. An NGO staff reflects: "When you become a part of the woman's family – her best friend, her sister – it is then that you [i.e. NGO staff] are motivated even more to bring her out of her problems." Workshop topics that are priorities in this stage are healthcare (vaccinations, balanced diet, and sanitation), agricultural practices, and making home-made goods.

Stage 2: Initiation (passive stage)

Characteristics: Women deciding whether to trust NGOs, curiosity about what will be covered in workshops, why this information is useful, and having overcome household resistance to attend a few NGO events (with or without husbands and in-laws accompanying). Women are unaware of their rights, the specifics around child rearing, education, health, family planning, sanitation and other developmental topics. At this stage, the women are still passive in that they listen and absorb the information that NGOs present, but do not actively ask questions or act on this information.

Best practices: NGOs build relationships with participants to reduce attrition. A personal connection is strengthened by cracking jokes intermittently, and conducting workshops near the women's homes. Women feel comfortable at the workshops when they see that other women have similar problems. NGOs convene a series of awareness sessions on different topics to promote a holistic coverage. NGOs also hold refreshers to leave the participants with key takeaways to reflect on before the next session. Domains given priority in workshops at this stage relate to relatively basic needs such as healthcare (e.g. healthy diet to prevent malnutrition, first aid skills during emergencies such as snake bites).

Stage 3: Participation (active stage)

Characteristics: This stage is characterized by the woman trusting the NGO, and her desire to learn where and how to solve her family's problems. The family is comfortable with her independent participation in NGO programs. She actively asks questions to clear her doubts during training programs. She seeks help from other participants, staff, and local agents during the sessions, and from local agents such as women and youth groups outside the sessions.

Best practices: Women and NGOs are actively involved in this stage. NGOs hold training workshops more frequently (multiple times a week) with the women on topics such as where and how to exercise their rights, child rearing and hygiene skills, and how to use the latest technology to make homemade products. NGOs provide space as needed for women to practice these skills. Workshops may sometimes invite experts who could address more difficult questions. Women forums are run to prevent families from oppressing women. In this stage, NGOs restrict their events to women only, so that the latter would be more comfortable among themselves. NGOs also stimulate women to ponder more deeply on developmental topics through role-playing, Q&A sessions, movies, puppet shows, films, TV shows, posters, pictures, folk songs, etc. Workshops in this stage focus less on basic needs and more on employability skills (e.g. adult literacy, agriculture, beauty parlor, candle-making, cooking, sewing), and women's rights, including the importance of sending their children to school. Women repeat this slogan at workshops: "We don't want to beg – we just want our rights! We want to make a change in our lives! We'll make our lives successful ourselves!"

Stage 4: Adoption (active stage)

Characteristics: This stage is characterized by the woman having internalized knowledge about developmental topics such that she can accrue benefits to herself and her family. She has started to gain more freedom and respect – both within and outside her family, since they have started to see the fruits of her work. One NGO staff boasts: "Fathers get sensitized after seeing the fruits of NGO efforts – education gains, girls getting jobs, lowering dowry, women's products getting sold. It's not just the woman, but the welfare is happening to the whole family." Her routine has become much busier since she has to balance work with household chores. NGOs tell us that the woman can afford to purchase her own cellphone since she is economically self-sufficient.

Best practices: While NGOs continue to hold regular events for women to voice their needs and help them solve their problems, at this stage, NGOs begin to take a passive role by not offering to help on a daily basis, since they want the women to take charge of their own lives. When women want to learn new things, they know where to seek training resources. Workshops at this stage focus on helping women grow financially (e.g. microfinance, employability skills). NGOs encourage women to support their daughters' further studies more actively: "Girls have started going 20km away from home to college. Previously, daughters would not be allowed to pursue higher education because colleges are far from the village. After our initiatives, mothers now force fathers to take daughters by motorbike to college."

Stage 5: Independence (active stage)

Characteristics: With independence in this stage, a woman is less vulnerable to domestic violence. She exerts a higher degree of control over her life. She is capable of ensuring that she and her daughters are not discriminated against due to both gender and non-gender factors. She knows how to access economic, social and political resources. She joins local women's groups and shares her positive experiences with women who are in earlier stages of the trajectory. A subset of the women in the Independence stage undergoes training to become local social workers, political leaders, or NGO staff. Some of the women in this stage are leaders in the family and community.

Best practices: In this stage, NGOs play a passive role and offer support only when women or their families seek help. Usually, there is no need for NGOs to help since the woman is now independent and can in fact support other women in earlier stages. The latter, who are seeking a better life after seeing positive examples in their community, will seek help from local agents, women in the Independence stage, and the latter's families. The training needs of most relevance to women in the Independence stage include learning to be a local politician, nursery school teacher, government social worker and NGO staff member.

DESIGNS FOR WOMEN'S EMPOWERMENT

In this section, we present the initial design ideas from the brainstorming sessions with NGOs and urban slums women in Phase 2. Due to limited space, we emphasize the cultural factors that motivated the designs rather than the designs themselves. We believe a focus on the former enables better appreciation of the design rationales and design space. In total, we came up with 12 designs, but only describe 7 of them here because the others turned out to be less practical.

While only 4 NGO staff members used desktop applications at work, all of them used computers for personal purposes. All of them owned cellphones, which they used at work for communicating with colleagues, organizing workshops and meetings, etc. For these reasons, our designs focused on the cellphone, as opposed to the desktop computer.

Household Surveys (all stages)

In all stages, NGO staff consistently indicated that program implementation takes higher priority than evaluation. NGOs as such claim that the lower emphasis on evaluation is a key obstacle to understanding the impacts their programs have and how to improve them. Data collection is the first step. Existing data collection efforts begin during door-to-door recruitment visits, where NGOs currently record data about families (contributions by husbands vs. wives to household incomes, number of daughters vs. sons in school, etc) on paper to keep track of the households they visited. This data is then entered into spreadsheets when NGO staff return to their offices. This data entry step is especially cumbersome since there is data from dozens of participants in a single workshop. Less-established NGOs skip this step since more resources are allocated to program implementation, even though baseline data from such surveys can inform NGOs on which programs (both new and ongoing ones) are most appropriate. Since existing surveys involve multiple-choice and numeric responses, a survey application on a cellphone is feasible (whereas text input is difficult on cellphones).

SMS-based Relationship Building (Initiation stage)

During Initiation, a best practice is for NGOs to strengthen relationships with their communities to facilitate continual, active involvement in NGO programs. However, due to the huge numbers of beneficiaries, NGO staff have almost no time to interact with their communities between visits. We designed a desktop-based application that NGOs can use to keep in touch with their local agents and communities more regularly via text messages on cellphones. Messages can be reminders about NGO events or material covered in the last workshop. While the women are semi-literate, texting is nevertheless feasible because their husbands are literate and can pass on the message. This application builds on another best practice for Initiation, i.e. NGOs need to target families as a whole and not exclusively women only.

In the NGOs' experience, since women are so caught up in their chores and childcare matters, earlier reminders are forgotten by the next day, which is why the application has to support the broadcast of event reminders on the same day they are held. NGO staff were excited about this design: it can help women and their families feel more connected to the NGOs, act and reflect on knowledge acquired during the workshops, and hence see short-term benefits of applying this knowledge. NGOs expect the latter to motivate women and their families to attend more programs, and graduate sooner into subsequent stages of engagement.

Educational Stories (Initiation and Participation stages)

One of the NGO best practices during Initiation is to give women enough time to assimilate and reflect on what they learned in a workshop, during the interval (usually a month) before the next workshop (where a new topic is covered). It is easy to forget the details of what was covered, and since the women are semi-literate, they cannot take notes during workshops. NGOs claimed this problem severely impedes the women's learning. We learned many NGOs already use, in workshops, the Meena educational stories developed and distributed by UNICEF on paper handouts [15]. The stories revolve around the character Meena in narratives that raises awareness on gender-related topics (e.g. the value of taking one's baby for vaccinations and the role that husbands can play to complement their wives). While existing stories are conveyed in a comic form, they are paper-based and require NGO staff to narrate. We designed a cellphone application for women to access similar stories and narratives in the absence of NGO staff. Mothers and NGOs liked this idea; the former could review content from the workshops in the mothers' free time in the afternoons. Infant-care mattered most to the women we interviewed. We therefore adapted a Meena story on this topic into digital format and presented it for feedback in Phase 3. An important step was to adapt the original story from the mother character's point of view and voice (it is currently from the daughter's point of view), so that mothers can better relate to it.

Baking Trainer (Participation stage)

One of the best practices is to enhance vocational skills, one of which is to cook for a living. The NGOs and women told us they catered food for international companies and five-star hotels located nearby. Their market research showed there is a huge demand for baked food (e.g. muffins) in the Indian catering market, hence they wanted to learn to bake such food. NGOs currently teach how to prepare such food with actual demonstrations at workshops. The recipes were often adapted for the women's kitchen, whose cookstoves and other cookware differed from Western kitchens. These workshops suffered from the same drawbacks as the above Meena comics in terms of retention and low-literacy. We designed a mobile application for baked recipes with local language voiceovers to help the women learn new recipes, as well as review food preparation steps and ingredient lists.

Report Card (Adoption and subsequent stages)

Mobile learning for low-income children in the developing world has demonstrated promising educational gains [30].

Poor parents are also increasingly enrolling their children in private schools that charge affordable fees (about US$2.5 per month), as an alternative to public schools, if they can afford (likely for mothers in Adoption stage), since private schools are more accountable. We designed an application for teachers (or mobile learning applications) to send and display a child's progress as a report card. This application enables mothers to be more involved in their children's education. Mothers said they will use it to encourage their children to complete their classes. They also said they were more interested in viewing summary data (e.g. number of course modules completed) than details (e.g. performance on individual modules), which they cannot understand.

Morning Reminders (Adoption and subsequent stages)
Work-life schedules become hectic in Adoption. Women new to this stage struggle to remember their deadlines and tasks. In line with the best practice that women in this stage should strive to be independent and help one another (vs. relying on NGOs, unlike the above SMS application), we co-designed an application that women could use to send multimedia reminders to one another. Women told us they liked this application – it not only helps them to remember their commitments but also show one another their support through mutual reminders.

Community Recruitment (Independence stage)
Women in the Independence stage can be effective agents for recruiting other community members to participate in NGO programs. The women are already known and trusted by the community, and can invite community members in groups rather than approach them door-to-door. However, women in the Independence stage are only learning to give workshop talks on developmental topics, and could benefit from tools to do this. Since community members said they often watch television game shows (e.g. Antakshari, a traditional game in India where a team sings a song based on the last letter of the opposing team's song, or lose a point) and play similar games with neighbors and family members, we designed a mobile game that plays Antakshari songs on developmental topics. Women said the informal game setting and content presentations via the cellphone makes them less nervous about having to describe the benefits of NGO initiatives to community members in their recruitment drives.

LESSONS
We implemented the above designs and used the prototypes as "conversational props" with NGOs and women in Phase 3 to explore the design space for operationalizing NGO best practices using technology. Although this section presents redesigns to some of the above designs, we believe what is more important are the sociocultural findings evoked using the prototypes that illuminate the design space further.

Lesson #1: In considering technology platform, keep in mind user's readiness to be proactive
The NGOs and women both indicate that differences in individual ownership of technology suggest different design directions: from communal technology platforms in passive stages (television or radio) to more individualized platforms (e.g. cellphone) in active stages. Male family members own cellphones but are not accustomed to sharing the cellphone for long periods with women in their households, since the cellphone is considered a resource mostly for the privileged (male) individuals in the family. On the other hand, when women approach economic independence in the Adoption and Independence stages, they buy their own cellphones. In addition, in the Participation and Adoption stages, we noticed that women preferred using the cellphone over the television or radio for applications such as Baking Trainer, so that they could access the recipes at their own pace.

Coincidentally, there is another parallel here. In designing technologies for women in the developing world, perhaps the television and radio (which usually involves passive interaction from the viewer once switched on) are suitable media to communicate information to women in the passive stages, whereas the cellphone may be more suitable in later stages when women are more proactive in advancing their well-being. This observation is in line with the NGOs' best practice of having women in their communities take as much personal responsibility as possible in later stages. It also implies that the nature of the technology platform to target is not so much constrained by ownership patterns as the user's readiness to use it actively to access information beneficial for the user's personal well-being.

Lesson #2: Design technologies to involve the entire family in the NGO's program
In co-designing the SMS Relationship Building application with NGOs, the latter opined that putting husbands in the position to relay text messages to their wives helps to make them feel included in the NGO programs. As a result of not bypassing the husbands, they will be more inclined to lend their support to their wives to attend the programs on their own. The broader lesson is that as much as our original goal is to empower marginalized women, we have to recognize that empowering men and other family members is part of the process for improving women's lives.

Similarly, in the case of Report Card, women told us they would not only be empowered to encourage their children to complete all their learning modules, but would also like to share their children's scores with other members of the household such as parents-in-law. The women are excited that the prototype allows them to take control of something (in this case, their children's education) within the family, while also involving the family in the children's education, so as to nurture an even more supportive environment for one another's well-being.

Lesson #3: Design technology-aided learning programs such that their user-interface elements evolve with the stages of engagement

We had incorporated cultural elements into our application designs so as to make them more culturally relevant. For instance, we had a voiceover for a cultural greeting (e.g. "Namaste!") at startup time. We observed that women, especially those in the Powerlessness and Initiation stages who do not have cellphones, reacted to this greeting by placing their palms together in the Namaste posture. Given their low levels of exposure to technology, they told us that this cultural element in the prototype made them less afraid of the cellphone as a device to interact with. The fear of technology is commonly reported in the HCI4D literature [12], especially among the lowly educated, for reasons such as nervousness about damaging the device. Our findings suggest cultural design elements can reduce such barriers.

In reviewing our training prototypes such as Baking Trainer and Meena, NGOs commented that women in the passive stages have more free time than women in the active stages, and hence watch television programs such as Balika Vadhu (soap opera on child marriage) and Bollywood movies like Swades (a village becomes self-sufficient in electricity as a result of a community effort). NGOs told us that although women in the passive stages watch such programs for their entertainment value, the programs also have a side-effect of raising viewer awareness on educational issues, including developmental topics. By implication, similar entertainment aspects (e.g. the comics and engaging storyline in Meena) are critical for making training materials more appealing.

However, once women graduate to subsequent (active) stages, NGOs observed they do not need such entertainment elements to engage their interest, since they had already started to witness the benefits of learning new topics (e.g. how to bake a new dish). For instance, women told us they wanted to see more recipes in Baking Trainer. As such, once women reach the active stages, they exhibited a need for applications with more educational content. Similarly, while we used cultural elements such as diyas (lights) in Report Card to represent scores using culturally familiar symbols (e,g. five diyas to symbolize five modules that are finished), the women said they preferred to have numeric symbols representing the scores instead. It turned out that while the women struggled with arithmetic operations, they had been attending adult literacy workshops and have been acquiring basic numeracy skills. Numbers in user-interface design allowed them to practice these skills.

Moreover, instructional design needs to transition from the application as a "trainer" to the application as "on-the-job assistant." For example, while women in the Participation stage found the training materials in Baking Trainer useful, women in the Adoption stage (who, unlike the former, are already cooking for living) requested modifications to make the application more useful in helping them in the kitchen with their tasks *while* they are performing baking tasks. For instance, the latter women told us they cannot look at the phone's screen when they are cooking, and want the application's design to emphasize more audio (vs. visual) instructions to remind them about recipe steps when they are baking.

The scaffolding supports in an application's instructional designs should also be structured such that it fades out as the user becomes more accomplished at her task. However, while instructional design practices often recommend that scaffolding support be gradually removed so that the learner does not become over-reliant on them, we did not witness this inclination among women in our co-design sessions. Instead, we observed that women from the Adoption stage tried out the application on their own, and wanted the audio prompts to remind them about tips (e.g. "poke fork into the potato for faster boiling") and precautions (e.g. "wait 15 minutes to allow for cooling before peeling the potato") only when they could not recall these steps.

As a final note, we emphasize that some application designs are relevant to more than one stage. What is more important is to recognize that the same application may nonetheless have to involve different design considerations to meet the unique needs of each stage.

Lesson #4: Design to promote relationship building in each stage of engagement

NGOs believe that technology can improve communication and trust between different social groups as women move through the stages. We found that designs for passive stages should support NGOs in communicating with community members for instances such as planning events with local agents or reminding women of items covered in workshops (e,g. wash hands before cooking). Designs in active stages should help women to clear their doubts during workshops, voice their needs to the NGOs, enable women in the same stage to help one another manage their daily tasks, and help women in advanced stages to recruit community members to NGO initiatives. Some instances of relationships fostered via technology are listed more concretely below:

Wife-Husband: NGOs feel the SMS Relationship Building application could increase husband-wife interactions during the Powerless and Initiation stages, since the male members in the family own the cellphone, and women need to ask for the phone to retrieve the messages, or male members could proactively relay messages from their phones to the women. Although this "use case" puts husbands in a position of control, NGOs claimed it is crucial not to threaten the existing social hierarchies between husbands and wives that are viewed as acceptable by families in the passive stages. By using technology to promote more interactions between spouses that are related to events and topics intended to improve household welfare, NGOs believe these engagements will hasten their adoption of practices and mindsets that will help them to graduate sooner to the active stages.

NGOs-Local Agents: NGOs want to plan interventions with local agents, especially in earlier stages by sending mass SMS messages to them, so that specific concerns and needs of women in the targeted communities could be considered.

Women-Women: A common theme in Educational Stories and Baking Assistant is that women in the Adoption and Participation stages not only want to have access to training material, but also want access to people who can reply to their questions. On trying out Educational Stories, women in the Adoption stage voiced that they would like to be able to contact other women in the community who had already finished the steps taught in the application, or with local government healthcare social workers. Similarly, women in the Participation stage wanted to connect with the head chef (a woman who has reached Independence stage) or the NGO agent.

Lesson #5: Design to promote holistic coverage of development

NGOs told us they would like the SMS-based Relationship Building application to be more tightly integrated with the Recruitment Survey, so that they can better keep track of the progress that the women have made on each topic. To interact more with their beneficiaries, NGOs also suggested that mobile versions of these applications be designed for themselves. When co-designing with the NGO staff, they re-iterated that one of their best practices is to hold sessions on multiple topics to approach the women's learning needs from a more holistic angle. To facilitate this holism in our application designs, we created a pictorial menu such that there are multiple icons to represent different topics such as increasing awareness about a daughter's schooling, growing mango trees, and infant vaccination. NGOs believe that this interface design would help the women see and explore all the topics at a high-level, so as to facilitate the best practice of having the women reflect on previously covered topics in their free time, before the NGO runs the next workshop on a new topic.

Lesson #6: Design for integration with state, national, and international level programs

One NGO best practice is to integrate grassroots initiatives with state, national and international level programs. While some of the more established NGOs collect indicators, such as those listed by the UN in the MDGs, or those given in state and national level surveys (e.g. number of children, no. of girls in school, no. of boys in school, household incomes, percentage of household income contributed by female members, land ownership), the newer NGOs do not collect all the necessary information about their participants to be able to integrate or compare their participant results with state, national and other international level surveys. The chief reason is that the latter do not have the staffing level to research and define indicators for data collection. By making these state, national and international surveys available to such a survey application in the form of mobile survey templates, NGO staff claimed it would enable them

to collect all necessary indicators during their meetings with participants, save on upfront survey creation time, skip data entry, and speed up data analysis and evaluation processes.

CONCLUSION AND FUTURE WORK

While the best efforts of NGOs have enabled thousands of marginalized women throughout the developing world to contribute to their own well-being, and that of their families and communities, there is a long distance to achieving the United Nations Millennium Development Goals – for both greater gender equity and other developmental targets. In this paper, we present a five-stage model of how NGOs can effectively engage with socioeconomically disadvantaged women – potentially using technology to augment NGOs' best practices in this area – and fleshed out this model using lessons from our co-design sessions with both NGOs and women. We subsequently illuminate the women's differing characteristics in each stage based on our field research. We also elaborate on how this engagement takes on different forms, from NGOs encouraging women, reminding them and imparting knowledge to them, to ultimately having the women ask questions, seek better lives on their own and helping women in earlier stages. Our research provides a starting point for further research on how technology can be designed to advance women's well-being around the world.

We have shown how women in different stages could and should be thought of as users with distinct characteristics. Despite these differences, we have learned that technology designs need to promote an instructional sequence that leverages cultural elements to overcome fear of technology, use entertaining elements to interest women in professional development, and gradually incorporate numeric symbols to reinforce emerging numeracy skills. Most importantly, we have observed that learning does not take place in isolation, and that technology designs should strengthen learning communities in which women in advanced stages can give back by supporting the growth of women in earlier stages.

Future research will need to investigate if technology can be used to accelerate the advancement of women in the developing world, such as in shortening the time they need to graduate from each stage to the next. In addition, since women are traditionally denied access to resources such as cellphones in the passive stages, our NGO respondents are particularly excited to experiment with loaning phones to women in the Initiation stage. Designing for personal growth is arguably a grand challenge in HCI. NGOs have historically found it most challenging to target women in passive stages, which is why they are keen to experiment more with technology in these stages. Since NGOs have performed fairly successfully in the active stages without technology, the passive stages are perhaps the greatest opportunity for HCI to make a difference. We propose that collaborating with NGOs to make cellphone loans is one way for HCI researchers to open up this segment of the design space and perform this line of future research.

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