Designing with Community Health Workers: Enabling Productive Participation Through Exploration

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ABSTRACT
In this paper, we present the results of an 18-month engagement with community health workers (CHWs) in Lesotho, through which we designed a feedback-integrated platform for community health education using mobile multimedia. We initiated a co-design process using participatory action research to empower CHWs to use their own knowledge and experiences to define our shared design and research agenda. We present our process and its outcomes, noting the importance of engaging with CHWs using techniques considerate of their literacy and experience, and the necessity of separating the *concept* from the *artefact* in the process of co-design. Further, we demonstrate how deep engagement and multiple participatory action research cycles give CHWs time to develop confidence and experience around the use of technology in their work. We argue that when CHWs are empowered to contribute their creativity and local experiences in this manner, the outcome is technology that is best suited for their unique context of work, in ways that would not be achieved using conventional approaches to co-design. Finally, we present early outcomes of the co-design efforts, articulating design requirements for a feedback mechanism for CHWs.

Author Keywords
Co-design; Participatory Action Research; Exploration; Community Health; HCI4D; Health Education; Lesotho; mHealth.

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

INTRODUCTION
Much has been said about the potential benefits of multimedia on mobile phones for health education, especially in the context of community health workers (CHWs) [8,22,25]. Use of mobile-enabled multimedia helps overcome lack of formal training, helps CHWs to be more confident, and increases the confidence of the community in the information being disseminated [18]. However in most cases, information dissemination is entirely top-down, with content determined and fixed by non-governmental organisations, ministries of health or other parties typically from outside the target communities.

The Bophelo Haeso (BH) project began in 2012, when nurses were given the resources and training to enable them to create their own videos, specifically for the communities surrounding their health centres. These videos could then be shared with the CHWs attached to the health centre – typically around 25 women from neighbouring villages. As such, target topics identified by the nurses as locally important for the people living in these villages would be covered in the videos. After two years with the BH model of community education, the nurses realised they wanted more feedback from CHWs and improved access to the state of health knowledge and practices in the communities. Furthermore, the CHWs shared struggles they experienced in using the videos in their health education efforts.

In a typical co-design or action research project, the next steps would be to begin an iterative cycle of workshops and prototyping, settling upon a working solution after two or three engagements over the course of a few months or up to a year. This approach, especially in development contexts, suffers from structural problems that often make true co-design impossible. The target users, in this case the CHWs, do not feel comfortable criticising or even using technology. As a result, design decisions are taken instead by the designer, based on interpretation of limited feedback. So we proposed that in spite of their lack of experience with technology, the CHWs have something to offer to the design process.

So how does one overcome such limitations? We argue that, rather than overcoming, one can develop a design process that is considerate of their users' literacy and experience. Techniques in participatory workshops such as role-playing and brainstorming should be paired with frequent and supportive engagement that gives users *time* to develop confidence and experience around the concept under development. Researchers need also be consistent around messaging – separating the prototype artefacts from the concept under development. When CHWs are

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empowered to contribute their creativity and local knowledge in this manner, the outcome is technology that is best suited for their context of work.

In the remainder of this paper we document our participatory action research (PAR) process, sharing experiences and outcomes from three six-month PAR cycles. We articulate both what we have learned about the activity of co-design, as well as the outcomes of our activities with respect to the design of the BH feedback mechanism. We argue that our choice of methodology has helped us co-articulate with the CHWs new, more refined, and more appropriate design requirements than we could have with more traditional approaches, and suggest that deeper and longer engagement in the field is an important requirement for all HCI4D research.

BACKGROUND

Community Health Workers in Lesotho

Despite many health challenges facing rural areas in most African countries, and the increasing need for easily accessible healthcare, there are many rural villages in which there are no health facilities. In such places, one rural health centre, with no more than ten nurses and usually no doctor, serves up to thirty neighbouring villages, some of which are very far from the health centre. In some areas in Lesotho, for instance, people walk for more than three hours to the health centres, because of the highly mountainous terrain and the absence of roads and public transport. In these cases, the only way for people to receive close and quick healthcare is through CHWs. CHWs are normal members of the rural villages (mostly female), with no formal education or training in the health sciences, commissioned and trained by the staff of the local health centres. They serve as the face of primary healthcare in their villages; and have the responsibility, among others, of providing health information to assist individuals, families and the general community to adopt healthy behaviours and to move away from harmful practices.

Bophelo Haeso

The BH project began in 2012, and at its inception, the researchers then developed a computer application to enable nurses to create multimedia health-education content to supplement the training of CHWs [18]. This content was shared with CHWs via Bluetooth to their mobile phones, and then carried into their respective villages for their personal use and to support their health education activities. The BH model works on the premise that these health professionals are well positioned to create content that is linguistically and culturally local and appropriate for the CHWs and the people they serve.

Need for Feedback

After running the BH project for two years, the nurses found that they needed to have improved access to the communities' state of health knowledge and practices; in order to better identify their information needs and general challenges. One way in which nurses identified these in the past was through interactions with patients who come in for consultations at the health centre. However, many rural inhabitants never go to the health centre, but live in the villages with CHWs and interact with them in different ways. We sought to explore if useful community needs and challenges could be elicited for the nurses by enabling the CHWs to collect feedback in the form of comments, questions and complaints [21] that people pose to them as they watch the BH videos and in other engagements.

Together with the nurses, we started this process with recognition that CHWs are the experts on the status of community health and of the gaps in health information in their respective villages. So for the first time, we sought to enable CHWs to contribute their voices, experiences and expertise to the future of community health education [2] The task was to co-design a solution that would make this possible for the CHWs, and attempt to take advantage of a tool that the CHWs were already using to successfully distribute educational content - their mobile phones.

Participants and Context

By the beginning of the period reported in this paper, BH had two groups of CHWs. A CHW group consists of CHWs whose home villages surround the same health centre – which is where they receive training and from where their work is monitored. At each of the two health centres, there is a nurse (with a Bachelor's degrees in Nursing and Midwifery) who is designated to oversee the operations of the CHWs. The nurse in charge is responsible for the training of CHWs and to ensure that they have the latest information on current health guidelines and priorities. She keeps an eye on the most pressing community information needs, and addresses them by training and sending CHWs. At both health centres, CHWs meet on a monthly basis for training. The distance travelled by each CHW varies; others walk long distances (for up to three hours one way), while others use public transport.

The average CHWs' ages are 49 and 55 at Health Centre 01 (HC1) and Health Centre 02 (HC2), respectively; with an average of 52 across the two health centres. The oldest active CHW is 70 years old, and the youngest is 29 years old. 58% of the CHWs have primary school education only, 12% went through a year or two of high school, and 30% did not complete even primary school. Almost all CHWs can read and write in Sesotho, although many of them (especially the older ones) write very slowly. The few (about 20%) that can read in English do so with struggle.

The CHWs at HC1 started with the BH project in March 2012, and have been part of the project since then. The group at HC2 started with BH in March 2014, but they had all been CHWs long before the start of the BH project. Some of the CHWs have been CHWs from as far back as 1980.

Related Work

There are many technological interventions built to support and improve the operations of CHWs across the different facets of their work [6], and there are benefits in getting the CHWs and the communities they serve involved in designing and situating these interventions [13]. While there is extensive reported research on ICTs for CHWs, there are a few detailed accounts that demonstrate the techniques and implications of involving CHWs in the process of co-designing such technologies. This is the contribution that this paper seeks to bring, by documenting the process with which CHWs co-designed a feedback-integrated community health education model.

There is, however, research that focuses on how to involve people with low literacy and no technical experience in the process of technology design. Maunder et al. recognised that for groups that have limited prior exposure to technology, conventional design activities need to be altered because at the offset, such users will not be able to envisage the use of technology in their contexts, or give any productive feedback as they have no experience against which to judge a technology [16]. The authors recommend, therefore, to first seek to develop the user, and improve their knowledge and understanding of the technology. Ramachandran et al. demonstrate that one way in which this can be done is the introduce simple artefacts early in the design process, and progressively grow the experience of the user [23]. These and related studies show that when progressive design [3] techniques are used, then users' technical experience and expertise are built to a point where they are able to envisage the use of technology in their work, and hence begin to contribute ideas on how it can be used further to meet their needs [9,23].

This paper builds upon, and contributes to, this growing body of knowledge by demonstrating how, by employing different forms of communication and expression, and by giving CHWs time to explore new technologies, we enabled them to find their voice around the use of technology in their work, as well as to productively participate in the process of co-designing a technology with which they were initially completely unfamiliar.

METHODOLOGY

Empowered Design

Throughout the design processes of this study, we embodied Marsden's approach of *Empowered Design* [15], which entails working together with the community of interest to empower people to mould the resulting technologies to fit into their existing structures and ecosystems of life, work, and play. Empowered Design recognises that people, regardless of the circumstances in which they live and their limited exposure to technology, are experts of their own lives and communities [14]; and argues that, when empowered to participate, people are capable of shaping technology solutions to meet their own needs. Rogers and Marsden [24] demonstrate that when we take an approach of empowering, instead of helping, we can successfully equip people with technology to the point where they begin to be their own innovators.

Participatory Action Research

To practice Empowered Design throughout the research cycle, we conducted the study through Participatory Action Research (PAR), which allowed active engagement with CHWs throughout the study [19]. PAR places emphasis on working with the community of interest (in this case CHWs and nurses) to let them identify the problem, and then move on to iterations of solution planning, action (solution implementation), observation, and reflection - involving the community as active partners at every step [1,8,26]. PAR, does, in essence, *empower* people to use their own knowledge and experience to define the design and research agenda [26].

Empowering for Participation

One of the goals of this study was to find the best ways to engage CHWs in the process of designing a working feedback mechanism on mobile phones, or rather, how to empower CHWs to participate in the design and research process. Most CHWs have little or no experience with digital technology (the use of apps, for example). Our goal in empowering CHWs to participate in the design and research processes was to build in them the freedom and confidence to articulate their needs and devise or propose technical solutions [4].

FINDINGS

This section describes the experiences around the three six-month long PAR cycles that we went through, a journey of co-designing a smartphone-based, feedback-integrated health education platform with first time smartphone users.

Cycle 1: Understanding Needs

The first cycle was about the CHWs and nurses discovering and expressing their immediate needs based on their use of BH over the previous years. The cycle was meant to foster a discussion around the existing solution and possibilities for improvement. From March onwards, CHWs used the Nokia ASHA 201 phones, with which they watched and showed BH videos using the phones' native media players from within the phones' galleries. This particular phone model is an advanced feature phone, with a QWERTY keyboard and support for apps from the Nokia store.

After a few months of the CHWs' consumption of BH multimedia on Nokia Asha devices, we held consultation meetings with nurses and CHWs to discuss the future of the project, in June 2014. First, we had a meeting with the nurses - two researchers, nurses who had been involved in BH since 2012, and new nurses who had recently joined the project. After this meeting, we then held focus group meetings with the respective CHW groups.

Consultation Meeting Outcomes

The project name "Bophelo Haeso" was coined at the first CHW consultation meeting at HC1 – *Bophelo Haeso* means

Good Health for My Home Village (or my home community in general, or where I come from). It came from emphatic assertions from CHWs expressing their passion for the work they do, and that even with little to no pay, they do their work because each one wants good health outcomes for her people, good health for her home village.

In observing CHWs' use of the videos and phones, and in discussions with them, we discovered that CHWs struggled to find the BH videos in the phones' galleries, amongst the music videos, personal recordings, and other entertainment multimedia also stored on the phone. With the nurses, we had decided from the inception of the project that we would not limit CHWs by prohibiting them from using the phones for entertainment purposes. We thought, instead, of exploring how to build a place in their phones that would be dedicated to BH. We explored different simple solutions with the nurses, and one of the easiest options was to create a gallery and video player that would only list and play BH videos.

From the nurses' meetings, it emerged that their focus had expanded beyond CHW training videos to include media created for the education of patients. At the inception of the project in 2012, nurses directed their multimedia content for CHW consumption only. However, the CHWs also used the content to educate their patients. The nurses then, in response, started to create videos targeted at the rural public. So one of the early requirements from these consultation meetings was that the BH media player would list CHWs' videos separately from public videos, to make it even easier for the CHWs to identify and distinguish the videos.

Additionally, the nurses mentioned that they were curious to know how often and in what scenarios the videos were played, to which we discussed ways in which, with an app, it could be possible to record usage logs, which would show consumption patterns of the different videos. Not knowing what type of logging would be possible, the nurses asked:

> *"With that intelligent app, can it be possible to somehow know what happens when the video is being played? Like if people are confused or if they have a question, etc.?"*

The possibility of this was presented to the CHWs by the nurses in their combined meeting, and the CHWs then contributed an aspiration that:

> *"We could benefit from being able to bring hard questions we receive from people back to the nurses (as well as some of our own)."*

From here, we jointly decided with the CHWs and nurses to pursue a feedback mechanism that would enable recording of questions about the videos as well as more general questions from the CHWs or their patients. Furthermore, also in consultation with all, we decided that the new app (the BH gallery/media player which records usage logs and captures questions) would be delivered on a smartphone of similar cost to the Nokia Asha 201 but improved functionality over the feature phone. We then chose a low-end smartphone, the Nokia Lumia 520. The reasons behind this choice and the details of the process followed were reported in previous BH publications [17].

At this point, CHWs' participation in framing the next steps in the project was only as far as expressing their struggles with the BH phones. Due to their limited prior exposure to smartphones and the possibilities that exist with smartphones and apps, they were unable to contribute any ideas and detailed suggestions on what could be done as a solution to their phone-based challenges. If we were to amplify their voice in the design process, we had to find ways to bring them to a point where they could easily contribute their thoughts, ideas, analyses and experiences.

The App and The Feedback Mechanism

Our methodology was one that said: we do not start by immediately co-designing an artefact (a gallery/media player app, in this case) with the CHWs and the nurses. Instead, after consulting with each of them and discovering their aspirations, we develop a simple artefact [23] – an *exploration artefact* that implements the basic aspirations, as a starting point. We believed that as they began to learn it by using it, their understanding of an app as a tool for work would grow, and they would begin to identify how it works for them, how it doesn't work, what else they need, etc. So this initial app was to be created solely for the purposes of *exploration* and *starting a discussion.*

An app was developed, by end of September 2014, which captured the most important needs for the nurses/CHWs at that point:

1) A gallery/video player dedicated to BH videos only, which lists and plays only BH videos and makes them easily accessible.
2) The BH gallery would allow the separation of CHW-focused videos and public-focused videos by displaying them in different lists.
3) The app would allow CHWs and their clients to record questions.
4) The app would log the consumption of BH videos on each of their phones.

Features 1) and 2) of the app were meant to make it easier for CHWs to access the BH videos, while 3) and 4) were meant to implement the first attempt at the feedback mechanism.

The app included two 'pages' (called pivots in Windows Phone), one listing the videos meant for the CHWs and the other listing the videos meant for the rural public. Pivots allow swiping left or right to move from one to the other. At the bottom of the listing screen, on both pages, there was a record button present on the application bar (Figure 1. (a),

(b)), whose purpose was for CHWs or their clients to record any general question, that is not related to a specific video.

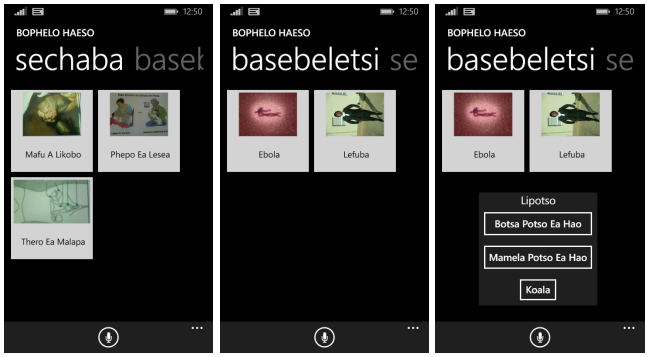

Figure 1 – From the left: (a) List of Public Videos, (b) List of CHW Videos, (c) 'Record Question' Dialog Box.

When a video was selected to play from the lists, three options were available during video playback: pause, record question, and resume. The "Record Question" button was represented by the same microphone icon that was used for recording general questions on the video-list pages (Figure 2(a)). Pressing this button would cause the video to pause, and then bring up the question-recording dialog box. At the end of the recording session, the CHW could resume the video playback the same way as they would after normal pausing (using the resume button). Since the goal as per the requests at previous workshops was to make the app as simple as possible with minimal buttons, a stop button was not included, and the CHWs would be taught to press the back key on the phone to exit the video playback.

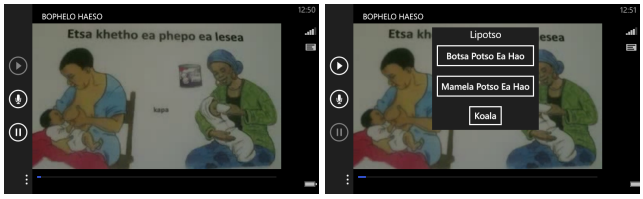

Figure 2 - From left (a) Video playback, (b) 'Record Question' Dialog Box

All the buttons available during video playback were placed on the application bar, which in Windows phone, displays icons only by default, but when one expands the application bar, short descriptions of the icons appear. For the BH app, the descriptions were written in Sesotho: "*Emisa"* meaning "Pause," "*Botsa Potso"* meaning "Ask our Question," and "*Tsoela Pele"* meaning "Resume." The recorded audio files would be stored in the device's music library, for easy extraction via USB onto the nurses' laptops.

The recorded audio files were not listed in the app, and the reason was that we did not want to have too many features in the app, as agreed in initial discussions with nurses, to avoid overwhelming the CHWs. We wanted the exploration app to do only three things: list videos, play videos, and allow the recording of questions. However, the record-question dialog box would allow the CHW to preview the audio before confirming the record (Figure 2 (b)). The record dialog box included three buttons: *"Botsa Potso ea Hao"* meaning "Begin to Ask Your Question," "*Mamela Potso ea Hao"* meaning "Listen to Your Question*,"* and "*Koala,"* meaning "Close Dialog Box/Confirm".

Cycle 2: Exploration and Ownership

Deployment and Training

The exploration artefacts – the exploration version of the BH app and the new Nokia Lumia smartphones - were deployed in October 2014, to 54 CHWs (24 at HC1 and 30 at HC2). At that time, only five CHWs had ever interacted with a touch-screen device. To make the phones easier to use, we changed their settings, and removed the features and apps that would confuse CHWs. Using the new phones and the BH app, the CHWs would consume the same videos they used to play from the gallery of their Nokia Asha phones.

At the beginning of the deployment, training workshops were organised to introduce CHWs to the phones and the app. It was made clear to them during the initial presentations that this version of the app was solely for the purpose of giving them a chance to explore a new technology. A common Sesotho phrase was used to explain the release of both the new phones and the app: *"li tlohelleng li hole 'moho!"* which translates to "let them grow together!" The meaning was that the CHWs were being introduced to both the phone and the app, and that they would learn one through the other, i.e., learn the phone by using the app, and learn the app while exploring the phone. The CHWs were then given six months to get familiar with the phones and the app *through using them* in their daily work and personal lives. Only at the end of the six months would we begin discussions around the future of the feedback integrated BH.

Mid-Cycle Workshop

At the mid-cycle workshop in January 2015, a new version of the BH app was installed, with no visible changes to CHWs, but improvements in robustness and logging. The primary purpose of the workshop was to encourage further learning and exploration of both the smartphones and the BH exploration app. New additional BH videos were released to CHWs, four from the nurses, and two created by the BH research team. The videos from the researchers were created in response to the CHWs' requests – one covering the use of WhatsApp, data bundles, and Internet settings on the smartphones, and another describing the features of the BH app. The workshop in January 2015 was not meant to re-design the feedback mechanism or the app that implements the mechanism yet, but for CHWs to bring forth their general experiences to give us all (CHWs, nurses, researchers) an idea of how far they were on their journey of learning and gaining familiarity with the new technology in their hands.

Since receiving the new phones, CHWs at HC1 were instructed by their nurse to submit written reports. These reports were tables that included the details of the people to whom the videos were shown, the videos shown, the dates of the showings and a few words summarising the comments given by the viewers. The challenge with this arrangement was that some CHWs write slowly, and many were unable to fully express the viewers' comments in one small column, on paper.

By January 2015, only 10 of the 54 CHWs had asked a health related question in the BH app, giving a total of six general questions and 12 in-video questions across both health centres. Otherwise, all but 11 of the CHWs had some non-work-related recording, such as of a child singing or playing (10 CHWs), of a radio program (15 CHWs), or CHWs practicing the use of the recording feature to themselves (24 CHWs). Our common analysis of the CHWs' experiences was that all of them were definitely using the phones (albeit learning at different paces), and that some of them were beginning to have suggestions for changes they would like to see in the feedback mechanism or the app, and requesting support for different issues that affected their work with the smartphones.

Cycle 3: Productive Participation and Use

Reflection and Planning Workshop

April 2015 marked the end of the explorative PAR cycle, when we would collaboratively reflect over the last six months, and plan action for the next PAR cycle. This was the beginning of true participation. The CHWs had been given six months in the field with old and new educational videos on a new smartphone, consumed from the BH exploration app. It had been made clear that the previous six months were for learning, further exploration, gaining familiarity with the technology, and identifying what is important and useful to them.

The goal of the workshop was to enable a space where we could all work together productively [7] and where each would feel empowered [15] to articulate their needs and contribute their knowledge and experiences from the last six months. We sought to understand, from this workshop, the dynamics of the interactions between CHWs and the patients in the villages. We sought deeper understanding of what happens between the CHWs and different groups and individuals, in order to best support the capturing of feedback in those interactions.

To enable this space for productive participation and collaborative thought, we used 1) role-playing to give CHWs a platform to simulate the CHW-patient interactions and to report their experiences using drama, and 2) brainstorming techniques to give CHWs a chance to express their needs and contribute alternative solutions. As we had learned over the years participating in CHW training sessions, role-playing was used extensively as a training method by the nurses and other trainers.

At each health centre, the CHWs were divided into four groups, and each group was tasked to come up with a scenario based on their experiences, which would show the interaction of a CHW with a patient or a group of people in the village. In each group, one or more CHWs would act as CHWs and the rest as the village people. The groups then staged the dramatized scenarios, showing how, if at all, they use the phones to show the multimedia content and capture feedback in the middle of their interactions. CHWs imitated the behaviours and words of their patients, and by acting them so, they were indirectly reporting the experiences from their daily CHW-Patient interactions [11,15]. We all observed the skits by each of the groups, and general group discussions were held thereafter, where CHWs discussed the future of the current feedback mechanism and BH app.

We then followed up with a brainstorming session led by the statements: "*Ke lakatsa eke nka…*" (meaning "I wish I could…"), and *"hoja…?" (*meaning "what if…?") [20]. "I wish I could…" was used to encourage CHWs to express changes they wished to see, and new ways in which they sought for the BH technologies to support their work. "What if..." was used for CHWs to generate ideas for alternative approaches to feedback capturing, as the CHWs' simulations and discussions had indicated a few problematic issues with the initial approach to feedback.

Co-Design Session Outcomes

The simulations gave the nurses and the researchers a new view into the CHWs' work in the villages. While the CHWs usually narrate their experiences during meetings, finer details of their interactions with people and the issues they face had never been as clear as they were in the simulations. For example, we learned that the majority of CHWs show the BH videos to people in groups, not to individuals as we had imagined. Of the eight simulated interactions, only in one did a CHW show a video to one person only, and the CHWs confirmed this to be true even in practice, that it is not often that they engage with only person. The CHWs composed the simulations with impressive creativity, and seemed to thoroughly enjoy expressing their experiences in this manner.

The simulations left the CHWs feeling involved and relevant to the progress of the project. One CHW even stood up, at the beginning of the discussions at HC2, encouraging her colleagues to be vocal and expressive in the discussions, saying:

> *"…let us all contribute our thoughts, so that no one's knowledge and experiences remain unheard. Among us, we have different types of knowledge. Others are experts of technology, others are experts of health, but we (CHWs) are also important because we are the direct servants of the people, and experts of what happens in the villages."*

Discussions included the experiences that the CHWs had with the explorative BH app. All CHWs confirmed that

they had no difficulty launching the app and playing the videos, but many were confused by a button in the question-recording dialog box that read, "*Mamela Potso Ea Hao*" - "Listen to Your Question." This button served the purpose of giving the CHWs an option to preview a question after asking it; but to many, it read as a binding command to listen to the recording. In the simulation where one CHW paused a video in the middle of playback and recorded her discussion with a patient (discussion lasted 4 minutes, 17 seconds), she played the whole discussion back to the patient before confirming it and resuming the video. The CHW said she thought the app would not allow her to resume the video playback if she did not "follow all the steps."

Talks on the feedback mechanism dominated the discussions, and the main issue that emerged was that the current feedback arrangement where CHWs had to pause videos during playback to record questions was not working well. Most CHWs agreed that this did not come naturally because of the kind of conversations they have with people, saying that most people do not ask one short question, but they have long arguments or discussions, often before or after watching the video. Even as seen in the simulations, it was in only one of the eight simulations that a recording of a question was done in the middle of the video playback, and it seemed forced and interruptive of the CHW's flow. One CHW attested that doing this in the field made her look absurd to her clients, because she would pause a video for them to ask questions, and then sometimes struggle to return to the video playback. She said:

> "*I just want to select my video and play it - something straightforward so that I look confident to my people. I can pause and resume if I have to - that's easy - but recording on top of a playing video confuses me.*"

The brainstorming exercise at both centres allowed CHWs to propose alternative methods of feedback, and the most prominent suggestions at the two health centres were:

> **At HC1*: What if*** *we stop reporting our work with BH videos on paper, and record our reports by speaking into the app instead (like we did with questions)? We could speak so much more than what we are able to write.*

> **At HC2: *What if****, when I am with the people, I do not focus on any recording, but instead simply focus on playing and pausing videos? Then when I am alone I can record a summary of the questions they asked me, and the discussion we had?*

The App and The Feedback Mechanism

The common resolution regarding the feedback mechanism, then, as resolved from the co-design activities and brainstorming sessions, was that the next feedback mechanism would be CHWs' *Audio Diaries* - spoken reports done by CHWs. In the reports, the CHW would state the number of people she met, the discussion they had, the video she showed, and then report on any questions or comments they had before or after watching the video.

In terms of the BH mobile app, the next version would be one that implements this new feedback mechanism and incorporates all the needs expressed by the CHWs. In the new app, we would remove the current features of question recording: the one which formed part of the video player (because CHWs made it clear that it is not ideal for them to record anything during video playbacks), and the one that was placed on the application bar on the video listing page (because it was not very easy to use - it was a small microphone icon on the application bar).

In the discussions about the procedure of making a recording in the explorative BH app, the CHWs had expressed that they felt they had to press too many buttons to get a recording done, and wished for a simpler way to record in the next app. Additionally, the new app had to give them access to their recorded files, but still in an easy-to-find, easy-to-use manner.

The new app was developed as entry into the next PAR cycle. In this version, the video player and the listing of the videos (CHWs' separate from Public's) remained the same because all CHWs confirmed these were easy for them to do, but the small question-recording icons were removed from the video list page and the video player. A new pivot was introduced as a page dedicated to reporting - Figure 3 (a), and the CHWs would cycle through all three (CHWs' videos page, public's videos page, and reporting page), by swiping in either the left or the right direction.

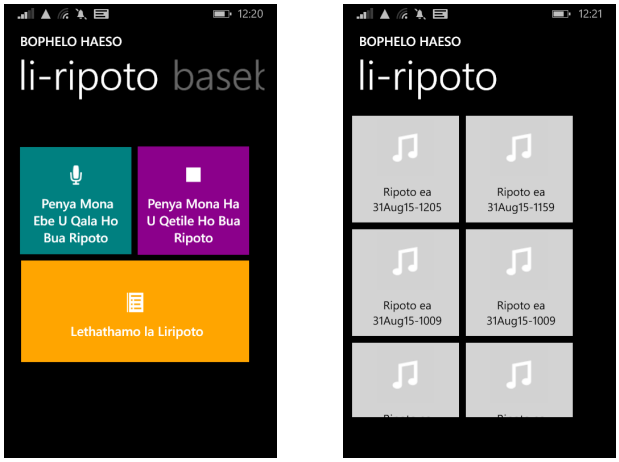

Figure 3 - From left: (a) The new reporting screen, (b) The listing of recorded reports (Li-ripoto)

The reporting page included three big buttons reading: *"Penya Mona Ebe U Qala Ho Bua Ripoto"* meaning "Press Here to Begin Recording Your Report," *"Penya Mona Ha U Qetile Ho Bua Ripoto"* meaning "Press Here When You Have Finished Recording Your Report," *and "Lethathamo la Liripoto,"* meaning "List of Reports*."* The CHW could press the first button to start a recording, and then press the

second one upon completion and the recording would be done – in two clearly visible steps.

The last button was labelled "List of Reports," expressed in that manner so that CHWs knew it was optional to view the list, as opposed to if it read, "Press Here to See Your Reports," which could again confuse them into thinking that viewing the list was a mandatory step in the recording procedure. The list of existing recordings, named by date and time of recording, were displayed in the same wide thumbnail holders as those that display the videos (a style which CHWs confirmed was easy for them to use).

Deployment and Training

At the beginning of September 2015, the second app was released onto CHWs' phones - implementing the new feedback mechanism based on CHWs' audio diaries or audio reports. After installation, the CHWs were introduced to the new interface. They were asked to do a few tasks in Conceptual Model Extraction style [12], such as "can you try to start a recording?," "what would you do when you were done speaking?," "try to find the recording you just made." Most of the CHWs at both health centres appeared to understand how the recording on the new app works, without any problems.

Mid-Cycle Workshop 1

As with previous cycles, a mid-cycle workshop was organised for check-in in November 2015. After two months with the new feedback mechanism, there were a total of 89 relevant audio reports made, recorded by 21 of the 40 CHWs who attended the meetings where the reports were collected. In this current cycle, although not every CHW had a relevant health report, 90% of the CHWs had some form of recording in their phones (recorded using the BH reporting feature), such as of music playing on the radio, a CHW singing, a church service recorded, etc. This showed that while others were not recording reports, they did know how to purposefully use the recorder in the app.

At both health centres, we talked about the CHWs' experiences with the new feedback mechanism and the BH app, with the discussion led by CHW representatives. Most of the CHWs who had not submitted any reports said they knew what was required but they had just not started reporting. We followed the discussion with role-playing as we had done in the previous cycle - where the CHWs who had begun with the reporting served as CHWs, and everyone else as their audience/patients. After the encounters with their audiences, the CHWs in the play then recorded their reports to demonstrate how they do it. They then explained the different ways in which they use the recording feature, and how easy and useful it is, citing examples that made the other CHWs excited to begin reporting.

Mid-Cycle Workshop 2

We held another follow-up workshop a month later (in December 2015). By then, a total of 98 relevant audio reports had been collected in one month, from 25 of 31 present CHWs. This meant that three months after launching the new feedback mechanism, across both health centres, a total of 41 CHWs had submitted at least one report, and a total of 187 reports had been received. While the CHWs had three more months till the end of the cycle by the time of writing this paper, the feedback received in this co-designed feedback mechanism greatly outweighs, in numbers and quality of content, the feedback attempted on the explorative feedback mechanism (where a total of 32 audio files were collected in six months, from 21 of the 54 CHWs).

The current PAR cycle will conclude with a reflection and planning workshop.

BH APP AND FEEDBACK MECHANISM

The reported PAR cycles have resulted in a feedback-integrated BH platform, that allows CHWs to easily access and consume educational videos that address different health issues for the communities they serve. Within the BH mobile app, we have co-designed a feedback mechanism which the CHWs have moulded to fit their different structures of life and work. There is not one prescribed way of capturing audio reports, but CHWs employ different styles that lead to the most productive feedback farming – styles identified by the CHWs themselves through increased use. The different styles of capturing audio diaries are those that neither the researchers nor the nurses would have anticipated, or would have suggested. Even the CHWs themselves were only able to discover and initiate these styles after they were given time to learn and explore different possibilities with the smartphones in their own space of life and work.

The primary benefit of the operational BH feedback mechanism is that it allows new types of information to be revealed to the nurses, which would never reach them otherwise. With the information revealed in the feedback, nurses discover the topics that are most urgent to address with their educational videos, and identify the groups that need more attention or help. Additionally, in-situ audio reporting presents new benefits for capturing the majority of issues in the communities, many of which remained unsaid or were forgotten when the primary platform for feedback exchange was the discussion at the CHWs' monthly meetings. Because of the ubiquity of the mobile phone, reporting from within the BH app can be done anywhere, and at any time; so knowing that they have a chance to report frequently makes CHWs more vigilant in the community, to observe and report issues that they would otherwise overlook.

Table 1 summarises the process, activities and outcomes of the three PAR cycles leading to the feedback-integrated BH platform.

	Understanding Needs (Mar – Sep 2014)	Exploration and Ownership (Oct 2014 – Apr 2015)	Productive Participation and Use (Sep 2015 – Apr 2016)
Design Process Activities	- Consultation meetings - Focus groups - Observations of phone use	- Workshops to encourage learning and exploration	- Drama workshops to report experiences and express ideas - Brainstorming sessions
BH Activities	- CHWs consume BH videos using Nokia Asha native gallery and media player	- CHWs consume BH videos using the BH exploration app on Nokia Lumia - CHWs produce written BH reports	- CHWs continue to consume BH video using the BH gallery and player app - CHWs record diaries (audio reports) in BH app
CHWs' Experiences. Needs.	- CHWs struggle to find BH videos among many individual multimedia files - Need for village-to-clinic feedback	- CHWs getting more familiar with smartphones and apps	- CHWs find it easier to record reports, and reports come in a myriad of styles
CHWs' Participation	- CHWs report challenges - CHWs can't contribute new ideas	- CHWs contribute new ideas - CHWs can better articulate their challenges and needs	- CHWs are increasingly vocal about what works for them - CHWs initiate and propose new ways of using the BH app
Cycle Outcomes	BH exploration app, implementing: - BH gallery/media player - BH logs and audio questions as feedback	- CHWs' increased personal experience with smartphones and apps	- A new feedback mechanism - A new BH app co-designed with CHWs - New methods of capturing further feedback, identified by CHWs through increased use

Table 1 - Summary of the three PAR cycles

DISCUSSION AND IMPLICATIONS FOR DESIGN

We present lessons and implications for designing with and building for CHWs, which we learned over the years that we worked with CHWs, especially while co-designing the feedback-integrated BH platform with them.

Productive Participation By Exploration, Frequent Engagement, and Long-Term Deployments

Our approach was to introduce the CHWs to the idea of an app in their context of work, and give them a chance to explore the technology for six months, before we began any conversations about the future of how the technology could be appropriated to enable effective feedback elicitation. We gave them *time* with the smartphones, the app and the BH content on their own to enable independent discovery and exploration through use [11,15]. The artefacts were not deployed as prototypes in that they were not meant to simply elicit responses or early feedback on a proposed solution; and not technology probes [10] in that they were not meant to gather information about the CHW user group – but an *explorative artefact*, for the purpose of giving the CHWs a chance to get familiar with the technology to the point that they might be in a better position to give feedback and articulate their ideas.

At the end of the explorative PAR cycle, we engaged in role-playing activities to enable CHWs to report their experiences of exploring the BH app and the new smartphones. The outcomes of the role-playing exercise shaped the next and current version of the BH app and feedback mechanism. The contributions that the CHWs made were possible because they had sufficient time with the technology to build cases of use, observe struggles, and to begin to imagine what else could be possible with the devices and the BH app.

We argue, therefore, that the quality of the CHWs' participation in the design process would have been compromised if we engaged in the design activities too early. In the first few months of cycle 2, the CHWs were still familiarising themselves with the technology, and it could have been difficult for them to talk about the ways in which it does or does not integrate into their ways of life and work when they did not fully understand the technology itself. The CHWs attested to the benefits of this progressive exposure to technology, one saying at the end of PAR cycle 2:

> "*I am very grateful that the BH team gave time to allow us old people to find our feet with these sophisticated phones. Now we are able to talk about what we know. When we say something is not working well, it is because we know it is not working well, not because we simply do not know how to use it.*"

However, familiarity does not fully emerge in one cycle. In this case, the second cycle entailed the deployment of a new phone as well as a new application based on aspirations expressed in the previous cycle. The six-month acculturation period, with a mid-cycle workshop to checkpoint further emphasised our desire to ensure that the CHWs felt comfortable enough with the new technologies to be confident in expressing their own desires. Meeting the CHWs often to check on their progress gave them motivation to learn more and ask questions. Our work so far has covered three six-month long PAR cycles, over which the CHWs' experiences, confidence and technical competence have improved.

We argue, from these experiences, that where increased capacity to participate productively in co-design is sought,

there is value in allowing a longer deployment with the technology in the field, accompanied by frequent engagements.

The Concept vs The Artefact

We learned through the workshops with CHWs that we had to clearly separate the feedback mechanism (the concept) from the artefact (the app) that implements the mechanism, in order for them to fully contribute to the evolution of each. We helped them understand that the artefact was a tool to make the concept possible, and as we progressed with our workshops, we helped them view the merits and challenges of each in isolation, while appreciating the connection between them. We wanted the CHWs to have the understanding that if they discovered that the artefact was not working towards realising the goal of the concept, the artefact could be thrown out and another method of implementing the concept sought.

Similarly, decoupling the concept and the artefact meant showing the CHWs that if the general revelation was that the concept in itself was not a worthy or relevant cause, then the concept could be cancelled without necessarily killing the artefact if the artefact provided other services. In the case of the BH app, if the feedback mechanism would be cancelled, only the features of the app that implement the mechanism would be cancelled with it, leaving behind features of dedicated video listing and playing. We argue that it is important to begin the design process with CHWs ready to fail a concept or the technology (the artefact) where *they* find it necessary [5].

We recommend therefore, that designers avoid approaching the design process from the angle that says:

> *"Come, let us design an app that will be appropriate and useful for you."*

but to say, instead:

> *"Here is an example of an app. It is imperfect, but it attempts to implement concept C. Its purpose is to introduce you to what can be possible with an app in your context of work. Go and use it, and after a few months, if you think this kind of thing can help your work in making Concept C possible, then we will have a discussion on how a more appropriate and useful artefact could be designed for you."*

Using Relatable Techniques To Enable Productive Engagement

In our workshops, we used techniques such as role-playing and local approaches for encouraging discussions, which are all techniques with which the CHWs were already familiar. These techniques allowed richer expression from CHWs than we could not have achieved with verbal articulation. During the role-playing sessions, CHWs designed simulations (skits) with the creativity that surprised all researchers and nurses. They injected many of their experiences in defining the plot, characters, themes, settings, etc., of their simulations. These exercises enabled further discussions and led the CHWs to feel like legitimate contributors to the design process, as learned from their comments - they felt that their experiences are a valued component to the process.

CONCLUSION

We engaged in three participatory action research cycles of six months each, with the purpose of co-designing a feedback mechanism for the rural health system with nurses and CHWs. We engaged the CHWs in the participatory process from the beginning, on the premise that with increased use and exposure to mobile technologies, they would come to a point of being more empowered to contribute productively to the design process. Our results confirm that the participation of CHWs improved over the 18 months of the study because they were given *time to explore* new technologies in their own space of work, life and play. With improved familiarity, they could then engage in productive talks about how such technologies could be used in their work. With the CHWs and the nurses that train them, we designed a mechanism of collecting feedback from the rural villages regarding different health issues through the phones of the CHWs.

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REFERENCES

1. Fran Baum, Colin MacDougall, and Danielle Smith. 2006. Participatory action research. *Journal of epidemiology and community health* 60, 10: 854–7. http://doi.org/10.1136/jech.2004.028662
2. N. Campbell, E. Schiffer, A. Buxbaum, E. McLean, C. Perry, and T. M. Sullivan. 2014. Taking knowledge for health the extra mile: participatory evaluation of a mobile phone intervention for community health workers in Malawi. *Global Health: Science and Practice* 2, 1: 23–34. http://doi.org/10.9745/GHSP-D-13-00141
3. George Chin and Mary Beth Rosson. 1998. Progressive design. *Proceedings of the SIGCHI conference on Human factors in computing systems - CHI '98*, ACM Pr., 611–618. http://doi.org/10.1145/274644.274726
4. Andy Dearden and Haider Rizvi. 2008. Participatory IT design and participatory development: a comparative review. *Proceedings of the 10th Anniversary Conference on Participatory Design*, Indiana University, 81–91.
5. Melissa Densmore. 2012. Claim mobile: When to Fail a Technology. *Proceedings of the 2012 ACM annual*

conference on Human Factors in Computing Systems - CHI '12, ACM Pr., 1833.
http://doi.org/10.1145/2207676.2208319

6. Brian Derenzi, Gaetano Borriello, Jonathan Jackson, et al. 2011. Mobile Phone Tools for Field-Based Health care Workers in Low-Income Countries. *The Mount Sinai journal of medicine, New York* 78, 3: 406–18. http://doi.org/10.1002/msj.20256
7. Susan M Dray, Ann Light, Andrew M Dearden, et al. 2012. Human Computer Interaction for Development: Changing HCI to Change the World. In *The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications. Human Factors and Ergonomics*, Andrew Sears and Julie A Jacko (eds.). Taylor and Francis Group, 1370–1391.
8. Brittany Fiore-Silfvast, Carl Hartung, Kirti Iyengar, et al. 2013. Mobile video for patient education: The midwives' perspective. *Proceedings of the 3rd ACM Symposium on Computing for Development - ACM DEV '13*, ACM Pr., 1.
http://doi.org/10.1145/2442882.2442885
9. Mark Hartswood, Rob Procter, Mark Rouncefield, and Michael Sharpe. 2000. Being There and Doing IT in the Workplace: A Case Study of a Co-Development Approach in Helathcare. *PDC*, 96–105.
10. Hilary Hutchinson, Wendy Mackay, Bosse Westerlund, et al. 2003. Technology Probes : Inspiring Design for and with Families. *Proceedings of the SIGCHI conference on Human factors in computing systems.*, ACM, 17–24.
11. Margot Jacobs and Ramia Mazé. 2004. Design-by-doing: Workshops for Designing Interaction. *PDC*, 114–117.
12. Matt Jones and Gary Marsden. 2006. *Mobile interaction design*. John Wiley and Sons.
13. Neha Kumar, Pallavi Lal, Richard Anderson, et al. 2015. Projecting Health: Community-Led Video Education for Maternal Health. *Proceedings of the Seventh International Conference on Information and Communication Technologies and Development - ICTD '15*, ACM Pr., 1–10. http://doi.org/10.1145/2737856.2738023
14. Gary Marsden, Andrew Maunder, and Munier Parker. 2008. People are people, but technology is not technology. *Philosophical transactions. Series A, Mathematical, physical, and engineering sciences* 366, 1881: 3795–804. http://doi.org/10.1098/rsta.2008.0119
15. Gary Marsden. 2008. Toward Empowered Design. *Computer* 41, 6: 42–46. http://doi.org/10.1109/MC.2008.207
16. Andrew Maunder, Gary Marsden, Dominic Gruijters, and Edwin Blake. 2007. Designing interactive systems for the developing world - reflections on user-centred design. *2007 International Conference on Information and Communication Technologies and Development*, IEEE, 1–8. http://doi.org/10.1109/ICTD.2007.4937419
17. Maletsabisa Molapo and Melissa Densmore. 2015. How To Choose a Mobile Phone for an ICT4D Project. *Proceedings of the Seventh International Conference on Information and Communication Technologies and Development Notes - ICTD '15*, 10–13.
18. Maletsabisa Molapo and Gary Marsden. 2013. Software support for creating digital health training materials in the field. *Proceedings of the Sixth International Conference on Information and Communication Technologies and Development Full Papers - ICTD '13 (1)*, ACM Pr., 205–214. http://doi.org/10.1145/2516604.2516632
19. Raymond Mugwanya, Gary Marsden, Dick Ng'ambi, and John Traxler. 2012. Using a Participatory Action Research Approach to Design a Lecture Podcasting System. *International Journal of Mobile and Blended Learning* 4, 2: 67–86. http://doi.org/10.4018/jmbl.2012040105
20. Michael J. Muller and Allison Druin. 2012. Participatory Design: The Third Space in Human-Computer Interaction. In *The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications. Human Factors and Ergonomics*, Andrew Sears and Julie A Jacko (eds.). Taylor and Francis Group, 1125–1153.
21. Trevor Perrier, Abhigyan Kaustubh, Abhishek Gupta, and Richard Anderson. 2013. Questioning feedback. *Proceedings of the Sixth International Conference on Information and Communications Technologies and Development Notes - ICTD '13 - volume 2*, ACM Pr., 112–115. http://doi.org/10.1145/2517899.2517945
22. Divya Ramachandran, John Canny, Prabhu Dutta Das, and Edward Cutrell. 2010. Mobile-izing health workers in rural India. *Proceedings of the 28th international conference on Human factors in computing systems - CHI '10*, ACM, 1889.
http://doi.org/10.1145/1753326.1753610
23. Divya Ramachandran, Matthew Kam, Jane Chiu, John Canny, and James F. Frankel. 2007. Social dynamics of early stage co-design in developing regions. *Proceedings of the SIGCHI conference on Human factors in computing systems - CHI '07*, ACM Pr., 1087. http://doi.org/10.1145/1240624.1240790
24. Yvonne Rogers and Gary Marsden. 2013. Does he take sugar? *interactions* 20, 4: 48. http://doi.org/10.1145/2486227.2486238
25. Derek Treatman and Neal Lesh. 2012. Strengthening Community Health Systems with Localized Multimedia. *Proceedings of M4D 2012*, February.
26. Maggie Walter. 2009. Participatory Action Research. In *Social Science Methods*. Falmer Pr., London, UK, 1–8.