

DESIGNING WITH COMMUNITY HEALTH WORKERS:  
FEEDBACK-INTEGRATED MULTIMEDIA LEARNING FOR  
RURAL COMMUNITY HEALTH

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BY

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*In loving memory of Professor Gary Marsden*

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## PUBLICATIONS

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Some ideas, figures, and tables of this thesis have previously appeared in the following publications, wherein the thesis author was the first author:

- Molapo, M. and Densmore, M., DeRenzi B., 2017. **Video Consumption Patterns for First Time Smartphone Users – Community Health Workers in Lesotho.** *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems. ACM, 2017. – Journal Equivalent. Honourable Mention (Top 5% of Accepted Papers).*
- Molapo, M. and Densmore, M., 2016. **Designing with Community Health Workers: Enabling Productive Participation Through Exploration.** *Proceedings of the African Conference on Human Computer Interaction (AfriCHI) 2016 – Best Paper Award: Most Interesting/Provocative Contribution.*
- Molapo, M., and Densmore, M., Morie, L., 2016. **Apps and Skits: Enabling New Forms of Village-To-Clinic Feedback for Rural Health Education.** *Proceedings of ACM Computing for Development (DEV-7) 2016*
- Molapo, M. and Densmore, M., 2015. **How To Choose a Mobile Phone for an ICT4D Project.** *Proceedings of the International Conference on Information and Communication Technologies and Development (ICTD) 2015.*
- Molapo, M., 2015. **Local Games, Local Content, Local Applications - On Mobile: ICTs for Informal Learning in Rural Africa.** In S. Cortesi and U. Gasser, eds., *Digitally Connected: Global Perspectives on Youth and Digital Media.* Harvard University Berkman Center for Internet & Society, 2015, 54–58
- Molapo, M. and Marsden, G., 2013. **Software Support for Creating Digital Health Training Materials in the Field.** *Proceedings of the International Conference on Information and Communication Technologies and Development 2013.*

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## ABSTRACT

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Community Health Workers (CHWs) are an integral part of the rural health system, and it is imperative that their voices are accommodated in digital health projects. In the mobile health education project discussed in this thesis (The Bophelo Haeso project), we<sup>1</sup> sought to find ways to amplify CHWs' voices, enabling them to directly influence design and research processes as well as technological outcomes. The Bophelo Haeso (BH) project equips CHWs with health videos on their mobile phones to use for educating and counselling the rural public. We investigated how to best co-design, with CHWs, a feedback mechanism atop the basic BH health education model, thus enabling their voices in the design process and in the process of community education.

This thesis chronicles this inclusive design and research process—a 30-month process that spanned three sub-studies: an 18-month process to co-design the feedback mechanism with CHWs, a 12-month deployment study of the feedback mechanism and, overlapping with the feedback deployment study, a 17-month study looking at the consumption patterns of the BH educational videos.

This work contributes to the field of Human Computer Interaction (HCI) in three distinct ways. First, it contributes to the growing knowledge of co-design practice with participants of limited digital experience by introducing a concept we termed *co-design readiness*. We designed and deployed explorative artefacts and found that by giving CHWs increased technical, contextual, and linguistic capacity to contribute to the design process, they were empowered to unleash their innate creativity, which in turn led to more appropriate and highly-adopted solutions.

Secondly, we demonstrate the efficacy of incorporating an effective village-to-clinic feedback mechanism in digital health education programs. We employed two

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<sup>1</sup> Unless otherwise stated, the first person plural pronoun (we) is used as the “royal we,” where the thoughts and arguments originate from Maletšabisa Molapo, the researcher and author of this thesis. “We” as used in this case does not necessarily imply collaboration on every thought and argument presented. Where multiple parties were involved in a decision, action, or thought, it is stated accordingly. However, the first person singular pronoun (I) is used occasionally where the plural pronoun could not sensibly be used, due to the personal nature of the first-person reference.

approaches to feedback - asynchronous voice and roleplaying techniques. Both approaches illustrate the combined benefits of implementing creative methods for effective human-to-technology and human-to-human communication in ways that enable new forms of expression.

Finally, based on our longitudinal study of video consumption, we provide empirical evidence of offline video consumption trends in health education settings. We present qualitative and quantitative analyses of video-use patterns as influenced by the CHWs' ways of being and working. Through these analyses, we describe CHWs and their work practices in depth.

In addition to the three main contributions, this thesis concludes with critical reflections from the lessons and experiences of the 30-month study. We discuss the introduction of smartphones in rural villages, especially among elderly, low-literate, and non-English-speaking users, and present guidelines for designing relevant and usable smartphones for these populations. The author also reflects on her position as an African-born qualitative researcher in Africa, and how her positionality affected the outcomes of this research.

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## LIST OF ABBREVIATIONS AND MEANING

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<b>ASHA</b>	<b>Accredited Social Health Activists</b> , community health workers as commonly called in India.
<b>ART</b>	<b>Anti-retroviral (ARV) Therapy</b> , a combination of medications used to treat/manage HIV. ARV drugs do not kill or cure HIV, but slow down its replication and progression to AIDS.
<b>BH</b>	<b>Bophelo Haeso</b> , the name of the project within which the work reported in this thesis was conducted. It is a Sesotho term that loosely translates to “Good Health for My Community”
<b>CHW</b>	<b>Community Health Workers</b> , members of rural communities who are trained to offer basic healthcare support, services and education in their home villages.
<b>HAP</b>	<b>Human Access Point</b> , a member of the researched community who acts as a proxy user, champion or gatekeeper into the community.
<b>HC1</b>	<b>Health Centre 1</b> , the first health centre where the study was conducted.
<b>HC2</b>	<b>Health Centre 2</b> , the second health centre where the study was conducted.
<b>HCI</b>	<b>Human Computer Interaction</b> , the field of study within which this research was conducted - which studies the design and use of computer technology by humans.
<b>HCI4D</b>	<b>Human Computer Interaction for Development</b> , a sub-field of Human Computer Interaction that focuses on designing for under-served, low-resourced and under-represented regions.

<b>HIV</b>	<b>Human Immunodeficiency Virus</b> , an incurable (as of 2017) virus that that damages the cells in the immune system and over time causes acquired immunodeficiency syndrome (AIDS).
<b>HSF</b>	<b>Health System Functions</b> , common functions that a health system must perform.
<b>ICT4D</b>	<b>ICT for Development</b> , the study on the use of information and communication technologies to foster social, economic, and political development, with emphasis on helping under-served, low-resourced and under-represented regions.
<b>IVR</b>	<b>Interactive Voice Response</b> , a technology that allows humans to interact with a computer system via voice DTMF (Dual-tone multi-frequency) tones input.
<b>mCHW</b>	<b>Mobile Technologies for Community Health Workers</b> , generally used to refer to all mobile technologies used to support the operations of Community Health Workers.
<b>NLP</b>	<b>Natural Language Processing</b> , the application of computational techniques to the analysis and synthesis of natural language and speech.
<b>OS</b>	<b>Operating Systems</b> , low-level software that supports the basic functions of a computer, or, as used in this thesis, of a mobile phone, e.g., Android, Windows Phone, iOS.
<b>PAR</b>	<b>Participatory Action Research</b> , a research approach that places emphasis on working actively with the researched community in problem identification, solution planning, action, observation, and reflection.
<b>PMTCT</b>	<b>Prevention of Mother-To-Child Transmission</b> , interventions to prevent transmission of HIV from an HIV-positive mother to her foetus/infant during pregnancy, labour, delivery, or breastfeeding.

<b>SMS</b>	<b>Short Message Service</b> , a service for sending short messages between mobile devices.
<b>STI</b>	<b>Sexually Transmitted Infections</b> , infections that are transmitted from one person to another by way of unprotected sexual intercourse.
<b>TB</b>	<b>Tuberculosis</b> , an air-born bacterial infection that attacks the lungs and can affect other parts of the body.
<b>USSD</b>	<b>Unstructured Supplementary Service Data</b> , a communication technology that is used to send text between a mobile phone and an application program on the Global System for Mobile (GSM) network.
<b>UX</b>	<b>User Experience</b> , the general experience of a person using a technology artefact.
<b>VHW</b>	<b>Village Health Workers</b> , a common alternative reference to Community Health Workers.

# 1 INTRODUCTION

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No one should die because they do not have access to proper health information—especially when the rest of the world lives with an excess of information and resources on the web. No one should watch their children ail and die from preventable conditions simply because they did not know enough about necessary care and prevention. No one should experience avoidable disability just because they do not have a platform to ask questions about health or medicine, when the rest of the world has multiple (even real-time) platforms on which to engage with health professionals and receive help in making the right health choices. Community Health Workers (CHWs), with the help of digital technology, are increasingly becoming integral in narrowing these gaps for citizens in marginalised locations. Designing these digital technologies such that they will be useful, usable and adopted by CHWs is critical. The work reported in this thesis seeks to contribute towards ongoing research on designing with and for CHWs, to make it easier for them to use technology to support and educate those who are often unreached by mainstream health education.

## 1.1 HEALTH EDUCATION IN RURAL SUB-SAHARAN AFRICA

An alarming number of preventable deaths and ailments occur in rural areas of sub-Saharan Africa today. The problem is complicated and multifaceted, but one primary cause is limited health knowledge (Shangase *et al.*, 2016). Many people fail to prevent infection and manage their ailments with low-cost or freely-available treatments because they are not aware of, or fail to understand, correct healthcare practices (Healthphone™, 2014). Due to insufficient health knowledge, people refuse to undergo essential medical tests, fail to adhere to treatment, and make poor lifestyle choices (Molapo and Marsden, 2012, 2013). These issues can be addressed by giving rural communities access to better

health education in a manner that addresses their specific knowledge gaps and local information needs (Stephens, 1972). Various health education and health promotion efforts have shown that access to relevant information can reduce misconceptions, encourage citizens to access healthcare facilities, and educate the public towards leading healthier lives (Dray *et al.*, 2012; Campbell *et al.*, 2014; Kumar *et al.*, 2015). However, most people who live in rural villages do not have regular access to health professionals, mainstream radio, television, or the web. They are thus cut off from regular methods of health education.

Unsurprisingly, these remote areas have some of the highest rates of HIV infections, untreated tuberculosis, and maternal/neonatal mortality, morbidity, and complications. Many citizens of rural villages do not have adequate access to health professionals who can provide health education, diagnosis, and support. In some places, one (often understaffed) health centre serves more than twenty villages, some of which are very far from the health centre. In these cases, communities rely on CHWs for some healthcare services and support.

## 1.2 COMMUNITY HEALTH WORKERS

CHWs, also sometimes referred to as Village Health Workers (VHWs) are (mostly female) members of rural villages, trained by the professional staff at local health centres and commissioned to their respective villages. 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<sup>2</sup> to adopt healthy behaviours and to move away from harmful practices. In Lesotho (the country where this research was conducted), as in many other African countries, CHWs are integral members of the healthcare force. They are at the frontline of the rural health system and, in many areas, are the most accessible healthcare providers (Braun *et al.*, 2013; Gautham,

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<sup>2</sup> ‘Community’ as used here and in subsequent mentions, refers to the people who live in the villages in which CHWs work. Often, a CHW works in more than one village, and the population she serves and lives among is referred to as her ‘community.’

In instances where ‘community’ refers to the collective of all CHWs, nurses and other healthcare staff that work with them, it is clearly indicated.

Iyengar and Johnson, 2014). They bring essential services closer to remote populations (Bonnell *et al.*, 2017), and are valuable in providing timely and locally-relevant health information to their communities (Quality and While, 2014). In villages, CHWs care for patients, provide health education, promote healthy lifestyle choices, conduct household visits and, when circumstances call for it, mobilise people to make use of the health services and facilities offered at (sometimes geographically distant) hospitals and clinics. In Lesotho, a CHW serves a village (or village clusters) with an average population of over 200 people.

CHWs do not have any formal education in the Health Sciences. After selection, they receive initial training, followed by mandatory monthly sit-ins (meetings) at the closest health centre. At the meetings, they receive continued training and support, often offered by nurses and other staff who are based at the rural health centres. Most CHWs have low levels of literacy. While they are at the frontline of health service delivery in their villages, they sometimes struggle to learn and to retain some health concepts (Campbell *et al.*, 2014). They are aided in part by frequent engagements with nurses.

CHWs in Lesotho serve on an almost voluntary basis. Most of them receive a stipend of about M300 (~25 USD) per month, often paid in aggregate every three months. In some cases, CHWs are paid only once a year and, in the worst cases, there are CHWs who do not get any payment. Regardless, the CHWs continue to serve out of passion and a commitment to have an impact on the health outcomes of their communities. Some CHWs reside in hard-to-reach villages, but they ensure that they attend all the training sessions and meetings, even though this requires them to walk for more than three hours (one-way) to arrive at the health centre.

CHWs perform a wide range of Health System Functions (HSFs), and there are several ways in which their work can be supported by mobile technology (Derenzi *et al.*, 2011; Fiore-Silfvast *et al.*, 2013). However, the research project reported in this thesis focused on supporting CHWs in only one HSF: helping them promote healthy behaviours in their communities.

### 1.3 CHWS AND VIDEO HEALTH EDUCATION

Mobile multimedia has been used as an educational medium for low literacy populations in a number of projects including the Digital Green Project (Gandhi *et al.*, 2007), Digital Study Hall (Randolph *et al.*, 2005), the Story Bank Project (Frohlich *et al.*, 2009) and in general skills training (Ladeira and Cutrell, 2010). Each of these projects has demonstrated the potential of mobile multimedia in delivering non-textual educational resources while taking advantage of the ubiquity of the mobile phone. Projects such as Video Kheti took research on multimedia use in rural settings further by finding new ways of enabling low-literate information consumers to locate and manage media on mobile devices (Cuendet and Cutrell, 2013). Educational videos on mobile devices have therefore been used in a variety of contexts, and have proven effective as tools for informal training and learning among the low literate (Gandhi *et al.*, 2007; Frohlich *et al.*, 2012; Treatman and Lesh, 2012; Fiore-Silfvast *et al.*, 2013; Healthphone<sup>TM</sup>, 2014).

Video-based instruction can be traced to the late 1940's and early 1950's, in the early days of using television for education (Gibbons, 1977), and has since evolved and been applied in various contexts including for purposes of health education. For health education in particular, several scholars have proven that the use of audio-visual content on mobile phones is effective in promoting behaviour change (Ramachandran *et al.*, 2010; Molapo and Marsden, 2012; Treatman and Lesh, 2012; Mitchell, 2013) and in improving people's understanding of health concepts (Schooley, San Nicolas-Rocca and Burkhard, 2015). Further research has found that the sensitivity to local cultures in the video content, and applying various and appropriate localisation approaches, help improve the adoption, acceptance and use of health videos (Sorcar *et al.*, 2017; Vashistha *et al.*, 2017).

In the context of rural health, previous research has demonstrated that CHWs are best positioned in rural villages to be the disseminators of multimedia health content to support community health education (Ramachandran *et al.*, 2010; Vashistha and Anderson, 2016). Several researchers have explored a variety of approaches for equipping CHWs with health videos for patient education (Ramachandran *et al.*, 2010; Treatman and Lesh, 2012; Fiore-Silfvast *et al.*, 2013; Molapo and Marsden, 2013; Kumar *et al.*, 2015). While the deployment details in these studies differ, a common result is that CHWs feel

better supported to handle community health education and counselling when equipped with educational videos (Ramachandran *et al.*, 2010; Molapo and Marsden, 2012; Treatman and Lesh, 2012; Kumar *et al.*, 2015). In some deployments, CHWs showed health content in video viewing clubs or convened community members or specific target groups (such as mothers) to show videos on a projected screen (David and Asamoah, 2011; Mathur *et al.*, 2011; Kumar *et al.*, 2015). In other deployments, videos were shown on a mobile phone in a session with an individual or a small group of people (Ramachandran *et al.*, 2010; Treatman and Lesh, 2012).

In many of these studies, CHWs and the communities they served received and adopted video-based educational health with enthusiasm. Videos draw the attention of the public and are seen as a sophisticated approach to health education (Kumar *et al.*, 2015; Schooley, San Nicolas-Rocca and Burkhard, 2015). CHWs reported that when a higher authority (such as a nurse or other health professional) spoke in a video, it increased the credibility and authority of the message presented. The videos also helped to present concepts more accurately than if the CHW herself were to verbally describe everything to the patients or the general public (Fiore-Silfvast *et al.*, 2013). Another primary benefit of video-relayed health messaging is that a video can address essential but highly-sensitive content which CHWs, out of cultural reservations, would not have the freedom and boldness to thoroughly articulate (Treatman and Lesh, 2012; Fiore-Silfvast *et al.*, 2013). Additionally, multimedia health content improves CHWs' self-efficacy (Ramachandran *et al.*, 2010; Kumar *et al.*, 2015) while motivating them to initiate more health education and promotion initiatives.

#### 1.4 CLOSING THE FEEDBACK LOOP

One gap in the field of video-based health education is that in most the projects, the flow of information is unidirectional. That is, it is a top-down model primarily focused on getting health information to rural populations, rather than on receiving relevant feedback from the consumers of the information. Content is created by or in collaboration with nurses based in rural areas. The information is disseminated in the villages, but there are few structures in place to enable the content creators to learn from the mentalities, misconceptions, and concerns of the populations served. For example,

while videos present essential health guidelines, some individuals may continue down the wrong path because of their previously-learned misconceptions. Unless the content creators are aware of these misconceptions, they cannot adequately address them in the educational videos.

One way in which health professionals can identify misconceptions and knowledge gaps is by assessing the feedback (comments and questions) that people pose to the CHWs as they watch the health videos (Perrier *et al.*, 2013). Sorcar *et al.*, (2017) created a digital HIV curriculum in which, in addition to the core topics identified by experts, the content addressed frequent questions that students asked about HIV. At the gatherings at which CHWs show and share health videos, many questions arise. These questions reveal the prevailing attitudes and mentalities of the communities (Ramachandran *et al.*, 2010). But how, then, can these be captured in a structured, continual manner that would inform content creators of the real information needs of the targeted populations?

## 1.5 RESEARCH STATEMENT

The research reported in this thesis was conducted to build upon existing research that has demonstrated the potential of supporting CHWs' public health education work using mobile multimedia. Our goal was to find a solution that best employed the expertise of local nurses in educating the rural public, with emphasis on finding effective ways to capture village-to-clinic feedback, and hence achieve a complete multimedia learning model for the rural health system.

We wanted to investigate how to best support CHWs in gathering data on the misconceptions and misinformation trends in their communities. We also worked to establish how such data could be used to improve understanding of the state of the information needs in the villages, and hence to inform the creation of future multimedia content.

Throughout the study, we employed Empowered Design approach to Participatory Action Research (PAR). Through literature review and experimentation, we sought to find the best techniques to empower CHWs (who had limited experience with digital technology) to productively and confidently participate in the participatory design and

research processes leading to the development of the complete multimedia learning model.

## 1.6 RESEARCH QUESTIONS

- \* How, considering the limitations of literacy and data costs, can a mobile solution be designed that would assist CHWs in eliciting health knowledge gaps and misconceptions in rural villages?
  - Does a CHW-appropriate, asynchronous-voice technology help elicit public health feedback in rural settings?
  - In what ways can the non-technological approach of roleplay supplement the technological feedback to open new forms of communication and expression?
- \* How, by overcoming the barriers posed by low digital literacy, can we best empower and engage CHWs to productively and confidently participate in co-design activities?
  - Can the use of exploration probes improve CHWs' ability to participate in the design process?
  - What techniques stimulate empowerment for CHWs?
  - How can role-play be applied to give CHWs new forms of communication in the technology design process?
- \* What factors affect CHWs' use of educational health videos? How do CHWs use videos over an extended period?
  - What intrinsic/extrinsic motivation factors affect patterns of use over time?

## 1.7 THESIS OUTPUTS

The research reported in this thesis presents:

- \* An overview of the design, deployment and evaluation of a working multimedia learning platform that supports health content creation, distribution, consumption, and feedback elicitation;
- \* An account of the effectiveness of a feedback mechanism incorporated into a mobile content consumer application, with regards to eliciting local health knowledge gaps and misconceptions;
- \* An illustration of how to enable participants with limited technology exposure to participate productively in co-design, focusing on co-design readiness; and
- \* A report on the lessons learned from studying the consumption patterns of health education content provided to CHWs for health education which can be useful to other researchers working in the field of CHW training or mobile-supported health education.

## 1.8 THESIS OUTLINE

In **Chapter 2**, we provide a background to the Bophelo Haeso (BH) project—the broader project within which the research for this thesis was conducted. This chapter addresses the feedback gap within the project and describes the context and participants discussed throughout the thesis. There is an emphasis in this chapter on the importance of prioritising the voices of CHWs in both the design process and in the rural health education model. We also discuss the methods we applied to make this work possible. The chapter concludes by presenting an overview of the 30-month study that forms the core of this thesis.

**Chapter 3** describes in detail our experiences from three six-month-long PAR Cycles: a journey of co-designing a smartphone-based, feedback-integrated health education platform with CHWs as first-time smartphone users.

**Chapter 4** then presents the results of deploying the co-designed BH feedback mechanism. The chapter discusses two approaches employed to elicit feedback:

asynchronous-voice technology and roleplay. It concludes with a discussion of the lessons learned through the feedback mechanisms.

Beyond feedback elicitation, CHWs also got involved in their core activity of educating the rural public using provided health education videos. **Chapter 5** presents the longitudinal study that was run to understand the ways CHWs disseminated the content given to them. The chapter includes an analysis of the usage logs generated during the 17-month-long study, supplemented with data from interviews and user-experience testing sessions with the CHWs throughout the research period.

Throughout the 30 months that we ran this project, we gathered noteworthy insights into CHWs' use of smartphones for the project. **Chapter 6** presents these insights, first by discussing our decision to use smartphones in the project (drawing on lessons from 50 ICT4D projects that preceded ours), and then by reporting on CHW experiences as first-time smartphone users and analysing how their usage experiences evolved over 24 months.

**Chapter 7** presents the reflections by the researcher, leading to **Chapter 8**, which summarises the contributions, limitations of this research and identifies opportunities for future work.

## 1.9 CHAPTER SUMMARY

This chapter has introduced the thesis, describing the need for health education in rural Africa and the role that CHWs play in these contexts. It introduced mobile multimedia as a tool for rural community health education. It then presented the primary argument for the need of feedback elicitation in rural community health education projects, stated the research statement and research questions, and concluded by giving the thesis outline for the remainder of the document.

## 2 BACKGROUND AND METHODS

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### 2.1 PARTICIPANTS AND CONTEXT: BOPHELO HAESO

The work reported in this thesis built upon an existing project in Lesotho—the Bophelo Haeso (BH) Project (Molapo and Marsden, 2013)—which began in 2011. In the BH project, rural-based nurses create videos on varying health topics that they identify as critical or relevant for the communities they serve. The videos are then disseminated on mobile phones in rural villages to educate the public and provide CHWs with quick references to health materials.

The BH project works with two groups of CHWs who operate out of two separate health centres in rural Mafeteng, Lesotho. Throughout the thesis, we designate these centres as Health Centre 1 (HC1) and Health Centre 2 (HC2). A CHW group consists of CHWs whose home villages surround the same health centre—the location where they receive training and from where their work is monitored. At both 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 training the CHWs and for ensuring 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 those needs by training and commissioning CHWs. At both HC1 and HC2, the nurses serve as the primary healthcare providers. There are no doctors at these centres, as is the case for many rural clinics in Lesotho. Nurses are therefore seen as the 'doctors' of the community and are respected in the villages that surround the health centres.

In March 2014 (when the study reported in this thesis began), there were 54 active CHWs, originating from 45 villages. All but one of the CHWs were female. The average ages of the CHWs were 49 and 55 at HC1 and HC2 respectively, with an average of 52 across the

two health centres. The oldest active CHW was 70 years old, and the youngest was 29 years old. Thirty-one (58%) of the CHWs had only a primary school education; seven (12%) went through a year or two of high school, and sixteen (30%) did not complete primary school. Almost all the CHWs could read and write in Sesotho—the native language in Lesotho—although many of them (especially the older ones) wrote very slowly. About 20% could read English, albeit with some struggle. The CHWs at HC1 started with the BH project in March 2012, and the group at HC2 started with BH in March 2014. However, they had all been serving as CHWs for years before they joined the BH project. Some of them had served as CHWs since as far back as the 1980s. At both health centres, CHWs met monthly for training. Some CHWs walked to the health centres for their monthly meetings, while others used public transport.

## 2.2 BOPHELO HAESO NEEDS FEEDBACK

The BH model is based on the premise that educational content produced by local health professionals becomes locally relevant (linguistically and culturally) and can address the specific information needs of the target communities (Molapo and Marsden, 2012, 2013; Kumar *et al.*, 2015). When a nurse is based at a rural clinic, he or she interacts with rural patients daily, and can assess the limitations of their health knowledge. However, only a small percentage of the rural population visits the health centres and meets with the nurses.

Due to the low centre attendance, after two years with the BH model of community education, the nurses found that they were still missing important feedback. They did not know enough about the different ways in which the video content they produced was consumed by the rural public, the contexts in which the content was used, or how people responded to it. They wanted to learn more and to get a clearer picture of the communities' evolving knowledge gaps and the mentalities and practices in the villages so that they could tailor future content to the more specific needs of the villages they serve.

Unlike nurses, the CHWs are permanent residents in their respective villages, and thus experience first-hand the evolving mentalities that people hold regarding different health

issues. As such, if nurses were to receive deeper insight into the state of health knowledge in rural villages, then CHWs were ideally placed to serve as their chief informants. Additionally, if feedback from the villages were to reach the nurses, it would be by giving CHWs the tools to be the voices of their communities by engaging them as experts of their domains and recognising the power of their voice and their position (Braun *et al.*, 2013). Based on this information, we realised that there was a need to develop technical channels to improve the knowledge flow from the CHWs and the villages they represented to the content creators. We would accomplish this by taking advantage of the position, power and voice of the CHWs (Campbell *et al.*, 2014).

### 2.3 PRIORITISING CHW VOICES: CO-DESIGN READINESS

While there is extensive reported research on mobile technologies for CHWs (mCHW), there are few detailed accounts that outline the techniques and implications of involving CHWs in the process of co-designing such technologies. There are significant benefits in getting the CHWs involved in the design process (Kumar *et al.*, 2015). Most mobile health tools (especially mCHW) facilitate process improvements as well as the CHWs' compliance with standards and guidelines (Braun *et al.*, 2013).

CHWs are often involved in collecting data on patients and recording the activities they perform, often using mobile phones. However, not much work has been done to use mobile technologies to enable CHWs to collect or record the misconceptions and knowledge gaps they deal with in their daily jobs in the villages.

This lacuna is where two of the main contributions of this thesis lie: Chapter 3 chronicles a journey in which we sought to give CHWs a voice in the design process while Chapter 4 describes how we sought to find ways to give CHWs a voice as the primary informants on the state of public health knowledge.

Together with the nurses, we started this research and design journey with the recognition that CHWs are the experts on the status of community health and health information in their respective villages. We thus sought to enable CHWs to contribute their voices, experiences, and expertise to the future of community health education (Campbell *et al.*, 2014), and to enable a new dimension of valuable data collection for

them. Our task was to co-design a solution that would make this shift possible for the CHWs, and attempt to take advantage of the tool that the CHWs were already using to distribute educational content successfully: the mobile phone. With the objective of designing such a feedback mechanism through collaboration with the CHWs, an important methodological question arose: how do we approach the design and research process in a manner that would best engage the CHWs and allow them productive participation in the design process?

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 (Ramachandran *et al.*, 2007). Due to limited prior exposure to technology, users—in this case, the CHWs—enter the design process with limited ability to express needs, limited capacity to express their creativity in the design process, and little freedom and empowerment to critique or build on the ideas of others. In other words, they are not *co-design ready*. What often results, then, is that their creativity and voices are curbed, and major design decisions are ultimately taken up by the designer based on his or her interpretation of often limited feedback. Our objective in this study was to follow a design process that would take the CHWs' literacy and experience into consideration while recognising them as the core players in the rural health system for which the feedback mechanism would be designed.

## 2.4 METHODOLOGY

This section describes the methods and approaches that underpinned this work. We have applied and localised these methods to the culture and language of the participants of this research, and further details on how they were applied emerge as the document unfolds, and the thesis chronicles the journey of this research agenda.

### 2.4.1 *Participatory Action Research*

We conducted the study using Participatory Action Research (PAR), which allowed for active engagement with the CHWs and nurses as active research participants throughout

the entire process. PAR places emphasis on working with the community of interest (in this case CHWs and nurses) to let them identify problems and then to move on to iterations of solution planning, action (solution implementation), observation, and reflection (Whyte, 1989). The process involves the community as active partners at every step (Baum, MacDougall and Smith, 2006; Walter, 2009; Fiore-Silfvast *et al.*, 2013). PAR does, in essence, *empower* people to use their knowledge and experience to define the design and research agenda (Walter, 2009).

To bring PAR to life, we employed Marsden's *Empowered Design* approach (Marsden, 2008). The notion of pursuing empowerment to achieve true participation has also been found by other researchers to be effective in productively engaging populations in marginalised contexts (Ertner, Kragelund and Malmborg, 2010; Ssozi-Mugarura, Blake and Rivett, 2016; Wulandari *et al.*, 2017). This approach empowers participants to directly contribute towards shaping new technologies to fit into their existing structures and ecosystems of life, work, and play; and to suit their existing socio-economical condition. 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 (Marsden, Maunder and Parker, 2008). It argues that, when empowered to participate, people are capable of shaping technology solutions to meet their own needs.

Rogers and Marsden demonstrate that when we take an approach of empowering rather than 'helping' people, we can successfully equip them with technology to the point where they begin to be their own innovators (Heeks, 2008; Rogers and Marsden, 2013). Jones *et al.*, (2016) explored these approaches through participatory workshops in which emergent users (for whom advanced technologies are 'just within grasp') were empowered to imagine the future mobile phone in their context and to innovate for themselves what the future of the mobile phone might be. This study shows how, when people are given a chance to innovate, they can contribute local experiences to defining the next technology that would best address their unique needs. We chose to employ the Empowered Design approach throughout the entire research journey, as the objective was to foster the empowerment that would allow real participation by the CHWs.

### 2.4.2 *Role Play as A Tool for Design and Feedback*

Roleplay has been used for centuries in design processes (Svanaes and Seland, 2004). In Human Computer Interaction (HCI), roleplay is mostly used to evoke new ideas, to bodystorm (brainstorming in full bodily movements), to evaluate ideas or prototypes, to communicate a concept, to train specific behaviours, to build user empathy, to seek deeper user understanding, or to navigate contexts that are initially unfamiliar to designers (Iacucci, Iacucci and Kuutti, 2002; Oulasvirta, Kurvinen and Kankainen, 2003; Svanaes and Seland, 2004; Thoring and Mueller Roland M., 2012; Matthews, Gay and Doherty, 2014). Theatre has also been used to encourage dialogue between users and designers (Newell *et al.*, 2006). The general value of roleplay is in its capacity to lead to new insights and richer communication that could not easily be expressed or understood through discussion alone (Matthews, Gay and Doherty, 2014). The bodily approach of the dramatised act allows tacit knowledge to become explicit. It also inspires creativity and deeper thought (as drama appeals to more senses than verbal language) while making the process more personal, experiential, and generative (Brandt and Grunnet, 2000; Simsarian, 2003; Leon, 2005).

### 2.4.3 *The Human Access Point*

Often in conducting HCI research in marginalised settings, we, the researchers are outsiders to the research setting. This is even true for 'local researchers' like myself (a more extended reflection on this is presented in Chapter 7). To conduct human-centred design in settings like this, it is recommended that researchers engage the communities through non-governmental organisations or individuals that already live or work within the research setting (Blake and Tucker, 2004, 2006; Gitau *et al.*, 2012). Blake and Tucker refer to these people as "human access points" (HAPs).

Other researchers have since found and confirmed the benefit of engaging through HAPs as 'proxy users', intermediaries, champions and gate-keepers (Marsden, Maunder and Parker, 2008; Ssozi-Mugarura, Blake and Rivett, 2016). HAPs can translate the context and needs of the community to the researchers, but also possess enough understanding

of the technology to translate technical concepts and the research process to the community in ways that would not be possible by an external researcher.

## 2.5 THE 30-MONTH STUDY

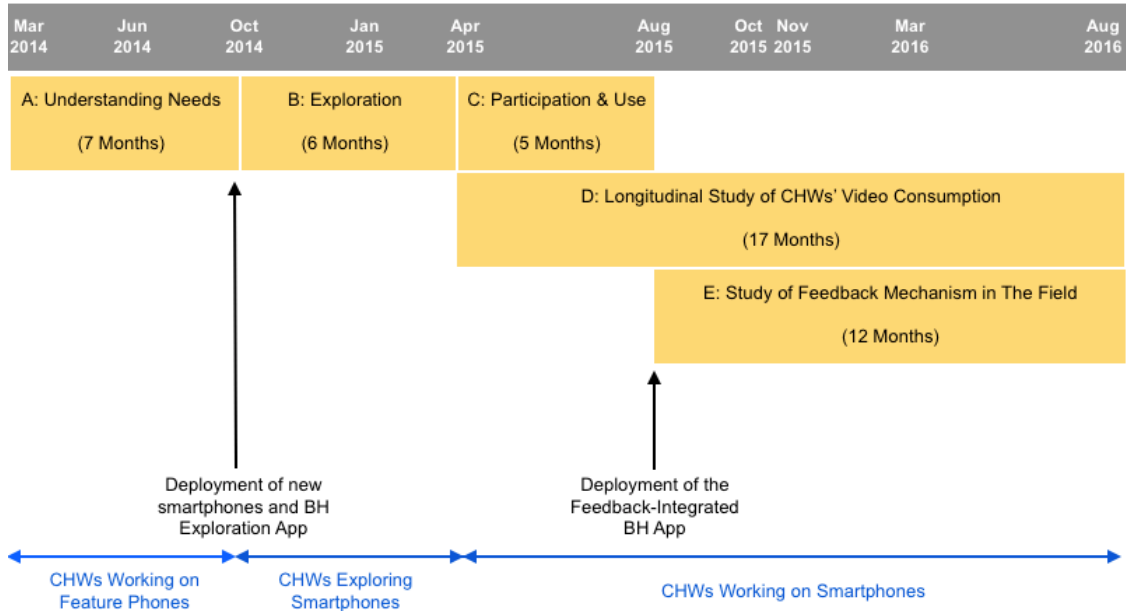
The study reported in this thesis ran for 30 months and started with 54 CHWs. During the research period, the primary researcher went into the field ten times, at a frequency of almost every three months throughout the 30-month period, to run workshops with CHWs and to hold meetings with nurses. The first 18 months were a design period. We engaged in a PAR journey comprised of three cycles (reported in Chapter 3), during which we co-designed the BH feedback mechanisms with CHWs and in association with the nurses. In the 18 months of shaping the BH feedback mechanism, the first six months (0-6) were used to identify and define the problems we wished to solve in the remainder of the study. During this period, we engaged with CHWs and nurses to help them articulate the needs that they wanted us to meet over the rest of the process.

The next six months (6-12) were designated for progressively improving the CHWs' experiences with new digital technologies—including apps—to prepare them for active participation in the design stages of the months that would follow. In the final six months (12-18), the CHWs, drawing upon their improved empowerment, agency, and exposure to technology, began to participate in the co-design of the next BH feedback mechanism. Their experience with the technology grew with increased use over this last six-month period and, from months 18 to 30, they continued to define and redefine the BH solution with increased use of the BH content and the BH feedback mechanism.

In months 18 to 30 (12 months), we studied the use of the BH feedback mechanism, comprised of an asynchronous voice solution and other non-technological approaches to feedback that we used (reported in Chapter 4). We logged usage of the BH video content from month 12 until month 30 (total 17 months) – the analysis of which is reported in Chapter 5.

The approach we chose demonstrated the importance of participatory workshops such as roleplaying and brainstorming. When paired with frequent and supportive engagement, these workshops give users the *time* necessary to develop confidence and

experience around the concept being designed. We describe these results in detail in the three chapters that follow.



**Figure 1 - Overview of the 30-Month Study.**

## 2.6 CHAPTER SUMMARY

This chapter introduced the Bophelo Haeso project—the project within which we conducted this research. It addressed the feedback gap within the Bophelo Haeso project, then described the context and participants discussed throughout the thesis. There is emphasis in this chapter on the significance of prioritising the voices of CHWs in the design process and within the rural health education model more broadly. We also discussed the methods we applied to make this work possible. The chapter then concluded with an overview of the 30-month study described in this thesis.

## 3 DESIGNING WITH COMMUNITY HEALTH WORKERS: THE POWER OF EXPLORATION

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In this chapter, we describe the PAR process followed in our research, sharing experiences and outcomes from three PAR cycles of about six months each. These research periods were themed: 1) Understanding Needs, 2) Exploration, and 3) Participation and Use. In the sections that follow, we articulate both what we learned about co-design and the outcomes of our activities concerning the design of the BH feedback mechanism. We argue that our choice of methodology has helped us co-articulate new, more refined, and more appropriate design requirements with the CHWs than we could have with more traditional approaches. We also suggest that deeper and more prolonged engagement in the field is an essential requirement for Human Computer Interaction for Development (HCI4D) research.

### 3.1 RELATED WORK

Outside of mCHW research, ongoing studies are investigating how to involve people of low literacy and limited technical experience in the process of technology design. Maunder *et al.*, (2007) have found that for groups that have limited prior exposure to technology, conventional design activities need to be altered, or localised. At the onset, such users will not be able to envisage the use of technology in their contexts or to give any productive feedback as they have no experience against which to judge a technology. They recommend, therefore, to first seek to develop the user and improve their knowledge and understanding of the technology. Ramachandran *et al.*, (2007) demonstrate that one way to do this is to introduce simple artefacts early in the design process and progressively grow the experience of the user over time. These studies show that when we employ *progressive* design techniques, users' technical experience and

expertise build to a point where they can envisage the use of technology in their work or life. Hence, they begin to contribute ideas about how it can be used to further meet their needs (Hartswood *et al.*, 2000; Ramachandran *et al.*, 2007).

This chapter builds upon, and contributes to, this growing body of knowledge. We demonstrate how, by employing different forms of communication and expression and by giving CHWs time to explore new technologies, we enabled them to find their voices and to productively participate in the process of co-designing a technology with which they were initially entirely unfamiliar. Our goal for empowering was to provide the CHWs with initial technical experience and to develop their understanding of digital solutions before engaging in the design process. In doing so, we progressively gave them the freedom and confidence to articulate their needs and to devise or propose technical solutions of their own (Dearden and Rizvi, 2008).

### 3.2 CYCLE 1: UNDERSTANDING NEEDS (MAR 2014 – OCT 2014)

The focus of the first cycle was for the CHWs and nurses to discover and express their immediate needs based on their use of BH in previous years. The cycle was meant to foster discussion about the existing solution (nurse-produced videos consumed from CHWs' phones) and possibilities for future improvement. By March 2014, we were already working with one health centre on the BH project (HC1). CHWs at this centre used the Nokia C2-01 devices to show nurse-authored videos in their villages. From March 2014 onwards, the second group of CHWs (HC2) joined the project. All CHWs from then on used Nokia Asha 201 phones (we discuss these device changes in Chapter 6). The CHWs watched and showed BH videos using the phones' native media players, with video files residing in the phones' default media galleries. This phone model (Nokia Asha 201) is an advanced feature-phone with a QWERTY keyboard and support for apps from the Nokia store. March 2014 marked the beginning of the 30-month study reported in this thesis.

In June 2014, after a few months of the CHWs' consumption of BH multimedia on the Nokia Asha devices, we held consultation meetings with nurses and CHWs to discuss the future of the project. First, we had a meeting with the nurses—one of whom started with

the BH project in 2011, and two new nurses who had recently joined the project. After this meeting, we then held focus group meetings with CHWs.

### 3.2.1 Consultation Meetings

The project name “Bophelo Haeso” was coined at the first CHW consultation meeting at HC1 in June 2014. The Sesotho phrase *Bophelo Haeso* means *Good Health for My Home Village* (or my home community, or where I come from). It emerged as CHWs emphatically expressed their passion for the work they do. They all asserted that even with little to no pay, they do their work because each one wants good health outcomes for her home village.

In observing the CHWs’ use of the videos and phones, as well as through discussions with them, we discovered that they struggled to find the BH videos in the phones’ galleries, where they were stored amongst the music videos, personal recordings, and other entertainment multimedia which was also stored on the phone. In collaboration 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 decided instead to explore how to build a ‘place’ on their phones that would be dedicated to BH. We investigated various simple solutions based on the nurses’ confirmation of what other researchers had already found: that CHWs work better when they have easy and quick access to the content during a viewing session (Kumar *et al.*, 2015). At this point in our study, we determined that one of the most straightforward options would be 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 too. At the inception of the project in 2011, nurses used to create multimedia content for CHW consumption only; however, the CHWs used the same content to educate their patients. In response, the nurses began creating videos targeted at the rural public. One of the early requirements that the nurses presented was that the BH media player should list CHWs’ videos separately from public videos. This separation would make it even easier for the CHWs to identify and distinguish between the two types of videos.

The nurses also mentioned that they were curious to know how often and in what scenarios the videos were played. As a result, we discussed the ways in which it might be possible to record usage logs showing the consumption patterns of different videos using a mobile application (app). The nurses also asked if it would be possible for the app to know what happens when a video is being played – if the audience is confused, if they have questions, etc.

The possibility of this was presented to the CHWs by the nurses in their combined meeting, and the CHWs then contributed another aspiration. As a group, they confirmed that they could benefit from being able to bring difficult questions they receive from the public to the nurses (as well as some of their own).

From here, we jointly decided with the CHWs and nurses to pursue a *'feedback mechanism'* that would enable the recording of questions about the videos as well as more general questions from the CHWs and their patients. Furthermore, we decided through consultation with the nurses and CHWs that the new app (the BH gallery/media player which records usage logs and captures questions) would be delivered on a smartphone instead of a feature phone. We then chose a low-end smartphone: The Nokia Lumia 520. The reasons behind this choice and the details of the resulting process are reported in detail in Chapter 6.

At this point, the CHWs' participation in framing the next steps in the project went only as far as expressing their struggles with their current 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 or detailed suggestions on what could be done to solve their challenges and the need for feedback elicitation. To amplify their voices 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.

### 3.2.2 *An Exploration Artefact*

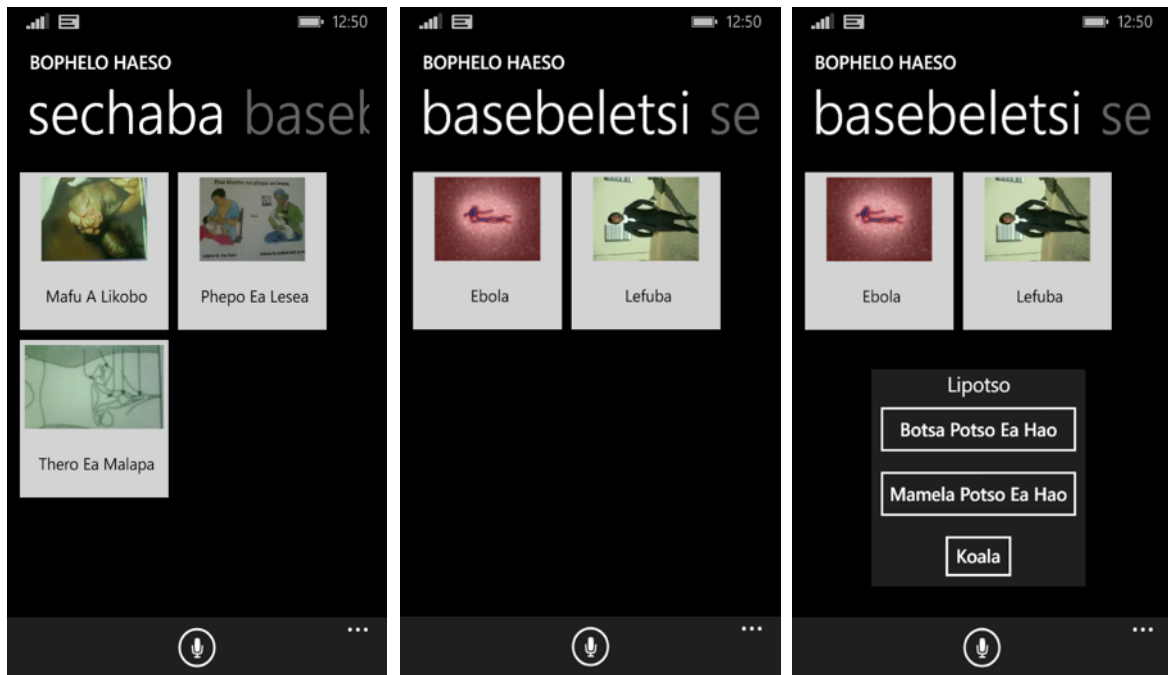
Our methodology was one that said: we do not start by immediately co-designing an artefact (in this case, a gallery/media player app) with the CHWs and the nurses. Instead, after consulting with each of them and discovering their aspirations, we develop a simple

artefact (Ramachandran *et al.*, 2007). This simple artefact is an *exploration artefact*, an app that implements the CHWs’ fundamental aspirations as a starting point. We hypothesised that as they began to learn the app by using it, their understanding of an app as a tool for work would grow. Consequently, they would begin to identify how the app works for them, how it does not work, and what else they need to know about it, among other things. This initial app was thus to be created solely for *exploration* and as a *starting point for discussion*, building them toward a state of *co-design readiness*.

The exploration artefact—the app—was fully developed by the end of September 2014. At that point, it captured the most important basic needs for the nurses and CHWs. The app included:

- 1) A media gallery and video player dedicated to BH videos only, which listed and played only BH videos and made them easily accessible;
- 2) The BH gallery allowed the separation of CHW-focused videos and public-focused videos by displaying them in different lists;
- 3) The app allowed CHWs and their clients to record questions; and
- 4) The app logged the consumption and use of the BH videos on each of the CHWs’ phones.

Features 1 and 2 of the app were designed to make it easier for CHWs to access the BH videos, while features 3 and 4 were to be used to implement the first attempt at the feedback mechanism. The app (the custom media gallery) included two ‘pages’: one listing the videos meant for the CHWs and the other listing the videos meant for the public. The user could swipe left or right to move from one ‘page’ to the other. At the bottom of the listing screen (gallery) on both pages, there was a record button present on the application bar (Figures 2a and 2b). The purpose of this record button was to allow CHWs or their clients to record any general questions—that is, questions not related to a specific video. Clicking on that button brought up a dialogue box atop the gallery (Figure 2c), which allowed the user to ask a question, preview the question asked, and then re-record or confirm. The record dialogue 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/Confirm”.



**Figure 2 - From left: (a) List of Public Videos, (b) List of CHW Videos, and (c) 'Record Question' Dialogue Box.**

When a video was selected to play from either of the video 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 3a). Pressing this button would cause the video to pause and then bring up the question recording dialogue box. At the end of the recording session, the CHW could resume the video playback the same way as they would after regular pausing (using the resume button). Since the goal, identified by requests made at previous workshops, was to make the app as simple as possible with minimal buttons, a stop button was not included. The CHWs were taught to press the back key on the phone to exit the video playback.



**Figure 3 - From left (a) Video playback and (b) 'Record Question' Dialog Box.**

All the buttons available during video playback were placed on the application bar. In Windows Phone, the icon bar displays icons-only by default; however, 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 Your Question,” and “*Tsoela Pele*” meaning “Resume.” The recorded audio files would be stored in the device’s music library for easy extraction via USB/Bluetooth onto the nurses’ laptops.

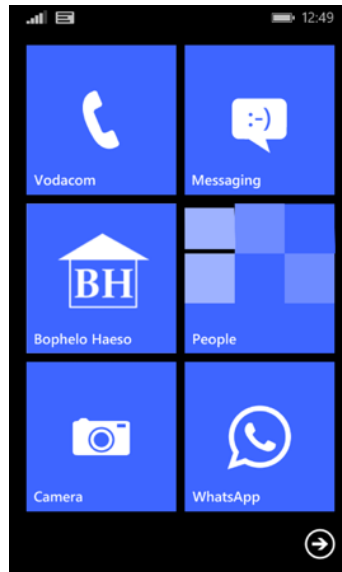
The recorded audio files were not listed in the app. The reason for this decision was that we did not want to have too many features in the exploration app, to avoid overwhelming the CHWs, as agreed upon in our initial discussions with the nurses. We wanted the exploration app to do only three things: 1) list videos, 2) play videos, and 3) allow questions to be recorded. However, the record question dialogue box would allow the CHW to preview the audio before confirming the recording.

### 3.3 CYCLE 2: EXPLORATION AND OWNERSHIP (OCT 2014 – APR 2015)

#### 3.3.1 *Deployment and Training*

The exploration artefacts—the exploration version of the BH app on the new Nokia Lumia smartphones—were deployed in October 2014 to all 54 CHWs (24 at HC1 and 30 at HC2). At that time, only five CHWs had ever interacted with a touchscreen device, though barely. To give the CHWs a chance to explore and learn about the devices at their own pace, they were given six months with the phones and the app in the field. During

this time, they were encouraged to *play* with the devices (Chirumamilla and Pal, 2013; Schwartz *et al.*, 2013). At launch, the devices were simplified for the CHWs by removing unnecessary apps from the home screen (e.g., maps, games, etc.), leaving only the BH app and five of the most useful functions (dialler, phonebook, messaging, camera, WhatsApp). The settings on each of the devices were also altered to make the phones easier to use and more efficient on battery usage.



**Figure 4 - The Simplified Home Screen for the CHWs.**

At the beginning of the deployment, training workshops were organised to introduce the 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 giving them a chance to explore 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!” This meant that the CHWs were being introduced to both the phone and the app, and that they would learn one through the other—that is, they would learn the phone by using the app, and learn the app while exploring the phone.

We considered first allowing the CHWs to learn the devices as is, and then later introduce the BH app. However, according to the exploration methodology we were trialling, we did not want the CHWs to receive the smartphones and use them only to call and text (which many already knew how to do). We wanted them to see the full utility of the

smartphone from the beginning (especially the utility of apps). We wanted them to appreciate the concept of an app, and of all the apps they could use during exploration, the most relevant was the BH app, which performed an action with which they were already familiar. We wanted them to learn the phone more by actively using the app for practice and exploration.

The CHWs were then given six months to get familiar with the phones and the app by 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 app. By allowing independent exploration, we were building *co-design readiness*.

### 3.3.2 *Encouraging Exploration*

At the mid-cycle workshop in January 2015 (three months after the exploration artefacts were deployed), a new version of the BH app was installed. There were no changes visible to the CHWs in this new version of the app, but improvements were made to its robustness and logging capabilities. The primary purpose of the workshop was to encourage further learning and exploration of both the smartphones and the BH app. New additional BH videos were released to the CHWs: four from the nurses and two created by us (the researcher). The videos from us were created in response to CHW requests—one video covered the use of WhatsApp, data bundles, and Internet settings on the smartphones, and another described the features of the BH app. The workshop in January 2015 was not meant to re-design the feedback mechanism or the app implementing the mechanism yet. Instead, it was intended to give the CHWs a chance to share their general experiences and to give us all (CHWs, nurses, researchers) an idea of how far they had come on their journey of learning and gaining familiarity with the new technology in their hands.

Since receiving the new phones, the CHWs at HC1 were instructed by their nurse to submit written reports both as a way to encourage CHWs to use the phones and because of the growing need among the nurses to deeply understand the use of the videos. These reports were tables that included the details of the people to whom the videos were shown, the content of 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 adequately express the viewers' comments in one narrow column on a sheet of paper.

NO	NAME	VILLAGE	SEX	DATE	COMMENT
1	Malebana Japane	Mpatane	F	24/10/14	Na kea unta fela nako ea ho marasa e nyane
2	Masena Sena	Mpatane	F	24/10/14	lefu ke la li wats ke fihla kepa chee
3	Senu Nephoka	Mpatane	M	24/10/14	ke thabo ho na haka Vidio ana e tisa ke ho
4	Mokane Selike Ha Chake		M	24/10/14	Na ke ile kapa ke lefuta Me ka fota ke
5	Mafela Molekei	Ha Chake	M	24/10/14	ke rata ha ho bapalisa Vidio te kee ka litso
6	Mankobo Moim	Musa-Pelo	F	24/10/14	ke lebaha boiphikela bona e mang le emang a
7	Mataniet Mepet	Mosang	F	03/11/14	Ha ke fihla Lienta ke ea boria ha li sheba bu
8	Matebello Selibe	Ha Likhama	F	03/11/14	Ekapa rona basebetso ba rona batla fua Vidio
9	Mothoang Selibe	Ha Likhama	F	03/11/14	che na ke gale ho itoa ka li wats ha hana ke
10	Manthati ntoi	Ha Likhama	F	03/11/14	Pele-ea-Pele bohle re itlhooka leng
11	Majela Majela	Ha Majela	M	03/11/14	Mafu a mangata a na a bakoa ke buka hantso
12	Maleboko Majela	Ha Majela	F	10/11/14	le sehloko lefu lena ha kholea Motho haka khone
13	Liketetseng Pateche	Ralequaka	F	10/11/14	Ekare lefu lena la likoba lena le msho le khutua
14	Makobe Letele	Ralequaka	M	30/10/14	Joale rona re hote le li tsebetso Motho e ee
15	Lebohang Letele	Ralequaka	M	28/10/14	Re kopa khahlametsa ha hahle ka moe ho ka

Figure 5 - Example of CHWs' Hand-Written Reports.

By January 2015, only 10 of the 54 CHWs had asked health-related questions in the BH app, amounting to 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 recordings, such as a recording of a child singing or playing (10 CHWs), of a radio program (15 CHWs), or CHWs practising the use of the recording feature by themselves (24 CHWs). Our joint analysis of the CHWs' experiences was that all of them were using the phones (albeit learning at different paces). Some of them were beginning to have suggestions for changes they would like to see in the feedback mechanism or the app and were already requesting support for different issues that affected their work with the smartphones.

### 3.4 CYCLE 3: PRODUCTIVE PARTICIPATION AND USE (APR 2015 – AUG 2015)

April 2015 marked the end of the explorative PAR cycle—the moment when we would collaboratively reflect over the last six months and plan action for the next cycle. This

was the beginning of real participation. The CHWs had been given six months in the field with old and new educational videos that were consumed from the BH exploration app on new smartphones. It had been made clear to the CHWs that the previous six months were for learning, further exploration, gaining familiarity with the technology, and identifying what was relevant and useful to them.

#### 3.4.1 *Reflection and Planning Workshop*

In April 2015, at the end of the Exploration Cycle and the launch of the Participation and Use Cycle, we held a workshop. The goal of this workshop was to create a space where we could all work together productively (Dray *et al.*, 2012) and where each member of the group would feel empowered (Marsden, 2008) to articulate their needs and to contribute their knowledge and experiences from the last six months. We sought to understand the dynamics of the interactions between the CHWs and the patients in the villages, to best support the capturing of feedback in those interactions.

To enable this space for productive participation and collaborative thought, we used:

- 1) Roleplaying to give the CHWs a platform to simulate 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 through participation in CHW training sessions over the years, roleplaying had traditionally been used extensively as a training method by nurses and other trainers.

At each health centre, the CHWs were divided into four groups. Each group was tasked with coming 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 of the participants would act as CHWs and the rest as the village people. The groups then staged dramatised scenarios, demonstrating how (if at all) they used the phones to show multimedia content and capture feedback in the middle of their interactions. CHWs imitated the behaviours and words of their patients. By acting in this way, they were indirectly reporting their experiences from their daily CHW-patient

interactions (Jacobs and Mazé, 2004; Marsden, 2008). We all observed the skits by each of the groups. General group discussions were held after the presentations where CHWs discussed the future of the current feedback mechanism and the BH app. More details on these skits are presented in Chapter 4.

We then followed up with a brainstorming session. This brainstorming was guided by two statements: “*Ke ne nka thabela ho...*” (meaning “I wish I could...”), and “*Hoja...?*” (meaning “What if...?”) (Muller and Druin, 2012). “I wish I could...” was used to encourage CHWs to express changes they wished to see, and to identify new ways in which they sought the BH technologies to support their work. “What if...” was used to encourage 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 exploratory approach to feedback.

#### 3.4.2 Outcomes of Co-Design Sessions

The skits gave the nurses and the researchers a new view into the CHWs’ work (and life) in the villages. While the CHWs usually narrated their experiences during meetings, the finer details of their interactions with the public, and the issues they faced had never been as clear as they were in the drama simulations. For example, we learned that most 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. The CHWs confirmed this to be true even in practice—it is not often that they engage with only one person at a time. 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 in and relevant to the progress of the project. One CHW even stood up at the beginning of the discussions at HC2 and encouraged 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. Some 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.” - CHW 24, HC2<sup>3</sup>*

Discussions after the simulations touched on the experiences that the CHWs had with the BH exploration app. All of the CHWs confirmed that they had no difficulty launching the app and playing the videos. However, many were confused by a button in the question-recording dialogue box that read, “*Mamela Potso Ea Hao*”—“Listen to Your Question.” This button was intended to give the CHWs an option to preview a question after recording it, but to many, it read as a binding command to listen to the recording. In one of the simulations, a CHW paused a video in the middle of playback and recorded her discussion with a patient (discussion lasted 4 minutes, 17 seconds). She then played the whole discussion back to the patient before confirming it and resuming the video playback. The CHW said she thought the app would not allow her to resume the playback if she did not “follow all the steps.”

Talks about the feedback mechanism dominated the discussions. The main issue that emerged from these discussions was that the current feedback arrangement—where CHWs had to pause videos during playback to record questions and discussions—was not working well. Most CHWs agreed that this process did not come naturally because of the nature of conversations they have while showing videos. They said that most people do not ask one short question, but instead have long arguments or discussions, before or after watching the video. Even in the simulations, only in one of the eight was a recording of a question done in the middle of the video playback. In this instance, the recording seemed forced and interruptive of the flow. One CHW attested that recording in the field made her look absurd to her clients, because she would pause a video for

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<sup>3</sup> **Note:** *all workshops were conducted in Sesotho by the researcher who is a Lesotho native, and for whom Sesotho is the first language. During the sessions, notes were captured both in English and Sesotho and later collated into English by the researcher. Direct quotes were captured or transcribed in Sesotho and later translated to English by the researcher.*

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.” – CHW 15, HC1*

The brainstorming exercise at both centres allowed CHWs to propose alternative methods for feedback capturing. The most prominent suggestions at the two health centres were:

**At HC1:** *What if we stopped 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 say so much more (orally) than we do with writing.*

**At HC2:** *What if when I am with the people, I do not focus on any recording, but instead 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.*

### 3.4.3 Insights to Ideas to Designs: The Concept and The Artefact

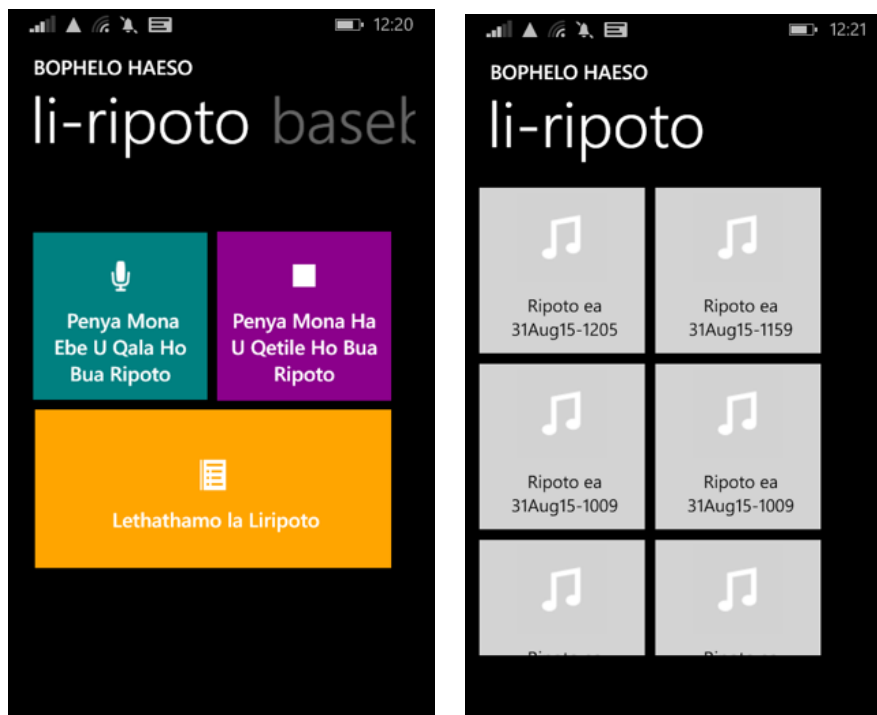
The shared resolution regarding the feedback mechanism that emerged from the co-design activities and brainstorming sessions was that the next feedback mechanism would be CHW *Audio Diaries*—spoken reports done by the CHWs. In the reports, the CHW would state the number of people she met, describe the discussions that they had, identify the video she showed, and then report on any questions or comments her clients had before or after watching the video. This idea or concept was decided upon even before discussing how the new system would look on the mobile phones. We found that it is essential for the CHWs that this distinction is made. This method enabled us to discuss the solution as a concept and then to discuss the implementation of the technology afterwards.

Once we had agreed that the *idea* of keeping audio diaries as reports could work with the CHWs’ preferred workflows, we proceeded to design how it would work on the phone and the app. We agreed that regarding the BH mobile app, the next version would be one

that implemented this new feedback mechanism (audio diaries) and incorporated all the needs expressed by the CHWs. We had found that it was not ideal for the CHWs to record anything during video playback, and that the small microphone icon on the application bar was not easy to use. Therefore, in the new app, we would remove the initial features of question recording: removing the recording feature from the video player and eliminating the recording icon on application bar on the video listing page.

Additionally, the CHWs had expressed that they felt they had to press too many buttons to get a recording done, and that they wished for a more straightforward way to record their reports in the next app. They also requested that the new app would give them access to their previously recorded files, but still in an easy-to-find, easy-to-use manner.

The new app was developed as the point of entry into the next PAR cycle. In this version of the app, the video player and the listing of the videos (with the CHWs' kept separately from the public's) remained the same, because all of the CHWs confirmed these were easy and convenient for them to use. However, the small question recording icons were removed from the video list page and the video player. A new page dedicated to reporting was introduced (Figure 6a). The CHWs could now cycle through all three pages (CHW videos, public videos, and reporting) by swiping to the left or to the right.



**Figure 6 - From left: (a) The new reporting screen (b) The listing of recorded reports (Li-ripoto).**

The reporting page included three big buttons: “*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, the second one upon completion, and the recording would be done in two clearly visible steps.

The last button was labelled “List of Reports.” This button was now presented in a manner that indicated to the CHWs that it was optional to view the list. The wording was chosen carefully so that it did not say “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 and arranged according to the date and time of recording, was displayed in the same wide thumbnail holders as those displaying the videos (a style which the CHWs confirmed was easy for them to use).

The second app was released onto the CHWs' phones five months later, in September 2015 (I took two months off development and fieldwork on maternity leave). This new version of the app implemented the new feedback mechanism based on the 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 the Conceptual Model Extraction style (Jones and Marsden, 2006). These tasks included prompts like “Can you try to start a recording?”, “What would you do when you were done speaking?”, and “Try to find the recording you just made.” Most (all but about four) of the CHWs at both health centres understood how the recording on the new app worked without any problems.

#### 3.4.4 *Continued Use*

As in previous cycles, a mid-cycle workshop was organised for check-in in November 2015 (about 2.5 months after the new app was released). In 2.5 months with the new feedback mechanism, a total of 89 relevant audio reports, recorded by 21 of the 40 CHWs who attended the meetings where the reports were collected, had been made. Ninety percent (90%) of the CHWs had some form of recording on their phones that had been recorded using the BH reporting feature. These recordings included relevant health reports, music playing on the radio, a CHW singing, and a church service, among others. This showed that while not all CHWs were recording reports, they did know how to use the recorder in the app purposefully.

At both health centres, we held focus groups to discuss the CHWs' experiences with the new feedback mechanism and the new version of the BH app. The discussions were led by CHW representatives. Most of the CHWs who had not submitted any audio reports said they knew what was required of them, but that they had just not started reporting. We followed the discussion with roleplaying, as we had done in the previous cycle. This time, the CHWs who had begun using the app to generate audio reports played out scenarios to demonstrate to their peers how they used the app to report various in-village experiences. They then explained the different ways in which they could use the recording feature, noting how easy and useful it was and citing examples that made the other CHWs excited to begin reporting.

We held another follow-up workshop a month later, in December 2015. A total of 98 relevant audio reports had been collected in one month since November 2015, received from 25 of 31 present CHWs. This meant that three months after launching the new feedback mechanism, 41 of 54 CHWs across both health centres had submitted at least one report, and a total of 187 reports had been received. Both in numbers and quality of content, the feedback received in this co-designed feedback mechanism greatly surpassed the feedback attempted on the earlier explorative feedback mechanism (where only a total of 32 audio files were collected in six months from 21 of the 54 CHWs).

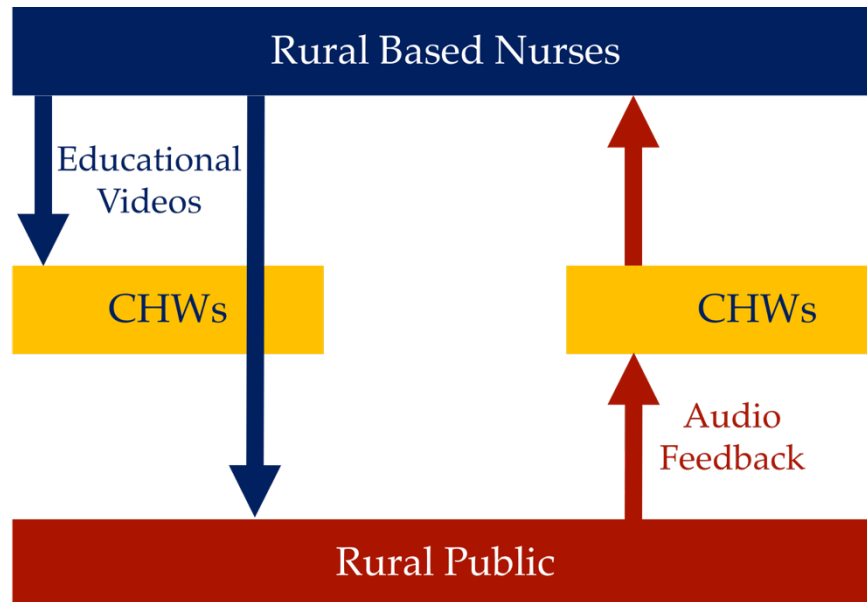
	Understanding Needs (Mar – Sep 2014)	Exploration and Ownership (Oct 2014 – Apr 2015)	Productive Participation and Use (Sep 2015 – Apr 2016)
Design Process Activities	<ul style="list-style-type: none"> <li>- Consultation meetings</li> <li>- Focus groups</li> <li>- Observations of phone use</li> </ul>	<ul style="list-style-type: none"> <li>- Workshops to encourage learning and exploration</li> </ul>	<ul style="list-style-type: none"> <li>- Drama workshops to report experiences and express ideas</li> <li>- Brainstorming sessions</li> </ul>
BH Activities	<ul style="list-style-type: none"> <li>- CHWs consume BH videos using Nokia Asha native gallery and media player</li> </ul>	<ul style="list-style-type: none"> <li>- CHWs consume BH videos using the BH exploration app on Nokia Lumia</li> <li>- CHWs produce written BH reports</li> </ul>	<ul style="list-style-type: none"> <li>- CHWs continue to consume BH video using the BH gallery and player app</li> <li>- CHWs record diaries (audio reports) in BH app</li> </ul>
CHWs' Experiences, Needs.	<ul style="list-style-type: none"> <li>- CHWs struggle to find BH videos among many individual multimedia files</li> <li>- Need for village-to-clinic feedback</li> </ul>	<ul style="list-style-type: none"> <li>- CHWs getting more familiar with smartphones and apps</li> </ul>	<ul style="list-style-type: none"> <li>- CHWs find it easier to record reports, and reports come in a myriad of styles</li> </ul>
CHWs' Participation	<ul style="list-style-type: none"> <li>- CHWs report challenges</li> <li>- CHWs can't contribute new ideas</li> </ul>	<ul style="list-style-type: none"> <li>- CHWs contribute new ideas</li> <li>- CHWs can better articulate their challenges and needs</li> </ul>	<ul style="list-style-type: none"> <li>- CHWs are increasingly vocal about what works for them</li> <li>- CHWs initiate and propose new ways of using the BH app</li> </ul>
Cycle Outcomes	<ul style="list-style-type: none"> <li>- BH exploration app, implementing: BH gallery/media player</li> <li>- BH logs and audio questions as feedback</li> </ul>	<ul style="list-style-type: none"> <li>- CHWs' increased personal experience with smartphones and apps</li> </ul>	<ul style="list-style-type: none"> <li>- A new feedback mechanism</li> <li>- A new BH app co-designed with CHWs</li> <li>- New methods of capturing further feedback, identified by CHWs through increased use</li> </ul>

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

### 3.5 THE CO-DESIGNED BH FEEDBACK MECHANISM

The three PAR cycles resulted in the creation of 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 co-designed a feedback mechanism which the CHWs have moulded to fit their work and life needs. There was not one prescribed way of capturing audio reports. CHWs employed different

styles of reporting, which they discovered by themselves through increased use of the app (discussed in detail in Chapter 4).



**Figure 7 – High-Level of the Feedback-Integrated BH Model.**

### 3.6 DISCUSSION AND IMPLICATIONS FOR DESIGN

In this section, we present the lessons and implications for designing with, and building for CHWs, which we learned in the time that we worked with CHWs—especially while co-designing the feedback-integrated BH platform.

#### 3.6.1 Co-Design Readiness

In the activities and discussions held to co-design the new feedback mechanism, we observed the CHWs' significantly increased ability to articulate their needs and opinions. Importantly, having had time with the exploration artefact, we found that even their *technology vocabulary* had improved, making them capable of expressing their opinions on different aspects of the app and the smartphone. The CHWs had spent time understanding what an app might be able to achieve and what a smartphone can do. As a result, they developed confidence talking about these things and using their own interpretation of what a phone can do, including developing their own wording for app,

icon, home screen, etc. This is a phenomenon that we termed *co-design readiness*: a state where someone who was initially completely unfamiliar with a technology has explored it enough (independently and with assistance) to develop a personalised vocabulary and opinion of its use and utility to the point that they are able to confidently and creatively suggest changes in how it might serve them better in the future. Exploration allowed the CHWs to truly and productively participate in the design process by expressing their innate creativity and using their unique experiences to shape the outcome of the technology with which they were previously completely unfamiliar.

### 3.6.2 *Productive Participation by Exploration and Frequent Engagement*

Our approach was to introduce the CHWs to the idea of an app for use in their work context and to 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 (Jacobs and Mazé, 2004; Marsden, 2008). The artefacts were not deployed as prototypes in that they were not meant merely to elicit responses or early feedback on a proposed solution. The artefacts were also not just technology probes (Hutchinson *et al.*, 2003) in that they were not only meant to gather information about the CHW user group. Instead, they were an *exploration artefact* employed for 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 new ideas.

At the end of the explorative PAR cycle, we engaged in roleplaying activities that enabled the CHWs to report their experiences of exploring the BH app and the new smartphones. The outcomes of the roleplaying exercises shaped the next versions of the BH app and the feedback mechanism. The contributions that the CHWs made were possible because they had been given sufficient *time* with the technology to build cases of use, to observe struggles, and to begin to imagine what else might 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 had engaged in the design activities too early. In the

first few months of Cycle 2, the CHWs were still familiarising themselves with the technology. It would have been difficult for them to talk about the ways in which the technology did or did not integrate into their ways of life and work when they did not yet fully understand the technology itself. The CHWs attested to the benefits of this progressive exposure to technology. At the end of PAR Cycle 2, one CHW said:

*“I am very grateful that the BH team gave us 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.” – CHW10, HC1*

The six-month acculturation period with the mid-cycle checkpoint workshop further confirmed 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-in on their progress gave them the motivation to learn more and ask questions.

The work discussed so far has covered three six-month long PAR cycles, over which time the CHWs’ experiences, confidence and technical competences improved. Based on these experiences, we argue that allowing a more extended deployment of the technology in the field while accompanied by frequent engagements increases capacity for people to participate productively in co-design. We recommend 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.”*

Instead, we encourage an approach that says:

*“Here is an example of an artefact (e.g., app). It is imperfect, but it attempts to solve problem X. Its purpose is to introduce you to what might be possible with an artefact of this nature in your work context. Go and use it, and after a few months, if you think this kind of thing can help you in solving X, then we will have a discussion on how a more appropriate and useful artefact could be designed for you.”*

### 3.6.3 *Conceptual Design: The Concept vs The Artefact*

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

Similarly, decoupling the concept and the artefact meant showing the CHWs that if the concept itself was not worthy or relevant, then it could be cancelled without necessarily killing the artefact—especially in cases where the artefact implemented other concepts too. In the case of the BH app, if the feedback mechanism were to be cancelled, only the features of the app that implement the mechanism would be cancelled with it. The features of dedicated video listing and playing could be kept. We argue that it is essential to begin the design process by preparing people to fail a concept or a technology (the artefact) where *they* find it necessary (Densmore, 2012).

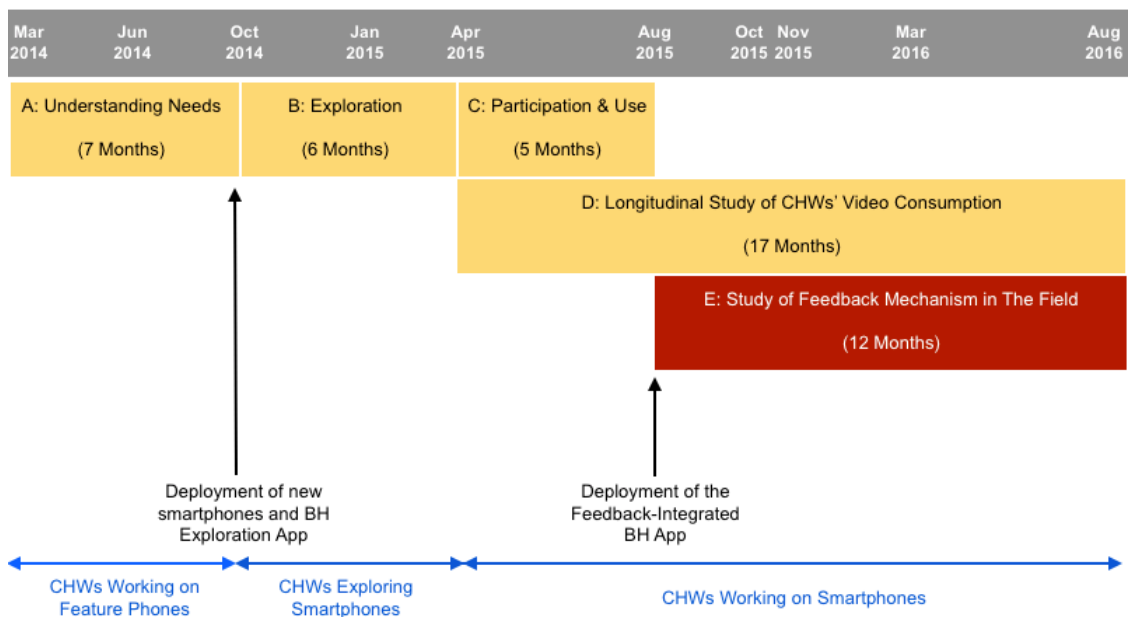
## 3.7 CHAPTER SUMMARY

In this chapter, we described three PAR cycles of six months each. The purpose of these cycles was to co-design a feedback mechanism for the rural health system with nurses and CHWs. We engaged the CHWs in the participatory process from the beginning with the premise that increased use and exposure to mobile technologies would allow them to become 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 precisely because they were given *time to explore* new technologies in their own work, life, and play spaces. With improved familiarity, they were then able to engage in productive talks about how such technologies could be used in their work. Alongside the CHWs and the nurses that train them, we designed a mechanism for collecting feedback

from rural villages regarding different health issues using the CHWs' phones. The details regarding the deployment of the feedback mechanism are discussed in the next chapter, Chapter 4.

## 4 APPS AND SKITS: CLOSING THE FEEDBACK LOOP

Chapter 2 discussed the need for feedback in the BH project, and Chapter 3 introduced the mobile-based BH feedback mechanism and the process followed to design it with CHWs. In this chapter, we discuss the deployment of the feedback mechanism in the field for 12 months.



**Figure 8 – Process Overview with Emphasis on the 12-Month Feedback Study.**

We also demonstrate how, in addition to the mobile BH application, we employed user-created drama to supplement the technologically-sourced feedback. This roleplay model opened a new avenue for expressing valuable village-to-clinic feedback. Roleplay was

used extensively as a design tool throughout this research process, but it also proved useful as a tool for feedback. We discuss how these two approaches effectively enabled feedback elicitation from distributed CHWs to centralised nurses as part of the BH health education model. Additionally, we provide evidence that this feedback is beneficial in bringing previously-unknown health challenges to the attention of the nurses, thus leading to more relevant future health education content and improved service delivery. We will begin by describing the research related to feedback elicitation with CHWs.

## 4.1 RELATED WORK

While there is need to give CHWs a voice because of the integral role they play in the rural health system (Campbell *et al.*, 2014), not much work has been done to open appropriate communication channels that enable them to contribute to shaping the technologies and content used in their work. Perrier *et al.*, (2013) built a web-based tool to be used for analysing the questions asked during screenings of Digital Public Health videos to generate feedback to content creators. Beyond this, we have found no technological interventions that have been developed to assist CHWs in bringing the health challenges and realities in their remote rural villages to the forefront and to the attention of those who provide health services and education in these areas. This study aims to fill this gap using asynchronous-voice and roleplay approaches. We, therefore, examine related research from the two bodies of work: asynchronous voice and roleplay used to generate general feedback.

While not directly related to CHWs, several ICT4D projects have used asynchronous voice to gather information in rural areas using mobile devices. Some of these tools, such as Our Voices (Bidwell and Siya, 2013), allow rural citizens to record voices and listen to those of others in their communities. Similarly, in projects like CGNet Swara (Mudliar, Donner and Thies, 2012a), Avaaj Otalo (Patel *et al.*, 2010), and AppLab Question Box (Futterman and Shuman, 2010), local voices are also forwarded to authorities who are able to respond with relevant information or improved services. Grover *et al.* (2012) developed a voice-based service for obtaining feedback from school children and found a strong preference for the use of speech as input.

Our work built upon the results of these projects. However, our goal was to move beyond creating a solution for recording voice and transmitting it offline and asynchronously. We sought to find ways to situate the new asynchronous voice solution within the CHWs' current life and work routines and to integrate it atop existing tools they already use, as recommended by Bidwell & Siya (2013). This strategy included focusing on offline transmission of voice from rural villages to centrally-located clinics, because the costs of uploading voice over the web or calling over an Interactive Voice Response (IVR) system is not feasible or affordable in rural Lesotho. Additionally, we wanted to explore the complementary power of non-technical approaches to feedback generation—that is, roleplay. We wanted to explore both approaches in combination.

In chapter 2, we discussed the extensive use of role-play in HCI and other fields where alternative forms of self-expression are desirable. In most HCI cases, designers and researchers play the roles of the users. They act out usage scenarios and user-life depictions as the next step following extensive user studies with the aim of deeply understanding users, their needs, and their contexts (Burns *et al.*, 1994; Buchenau and Suri, 2000; Oulasvirta, Kurvinen and Kankainen, 2003). In cases where people play themselves, such as in therapeutic sessions (Brandt and Grunnet, 2000), they are typically given a plot to act out (Matthews, Gay and Doherty, 2014). Likewise, in design contexts, they are given a product or idea to act upon in their dramatisation.

In the BH project, on the other hand, we allowed the CHWs to design and direct all aspects of the roleplay – they decided which scenarios to act out and which aspects of their experiences to demonstrate. The nurses and researchers accepted that they know little about the settings in the rural villages where CHWs live and work. We used an open-ended approach to roleplay as a tool for reporting on health phenomenon experienced in CHWs' work and on experiences with the technology.

## 4.2 'APPS': ASYNCHRONOUS VOICE AS FEEDBACK

The technological implementation of the BH feedback mechanism was comprised of an application that allowed CHWs to record audio diaries of their work easily. The concept behind the mechanism was that CHWs could report the different phenomena that they experienced and observed in their own spaces as soon as (or shortly after) they happened.

Each CHW could then submit all her voice files in a single bundle to the nurse during the monthly meeting. The nurse and her assistants could then listen to the recordings to identify health issues from the villages that were previously unknown, that warranted action or response, or that were simply noteworthy or interesting. For instance, a CHW's report might be about a meeting she had with a group of village men, the lessons she taught them, the videos she showed them (if any), and the issues and arguments they posed to her. Also of interest to the nurses were the demographics of the people with whom the CHWs had contact and the contexts in which the encounters happened, as well as the comments and questions they received.

#### 4.2.1 *New Voice Recorder or Native Recorder?*

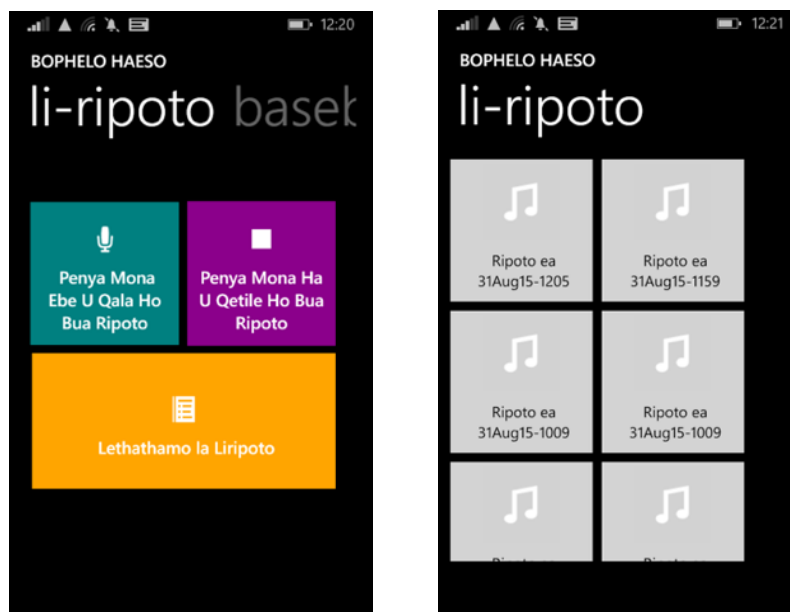
When it was time to implement this feedback concept, the nurses and CHWs agreed that a voice recorder module would be built into the BH application. Doing so would ensure that the recorder could be tailor-made to meet the needs of the project as well as the preferences, experiences, and language abilities of the CHWs. During the participatory workshops, the CHWs emphasised the importance of having the BH app. Its large buttons and the dedicated “place” on their devices to go for all BH activities made it easy for them to access videos. As a result, the CHWs had specifically requested that the new feedback feature be included in the app with which they had all become comfortable. One of the CHWs explained her opinion, saying:

*“Bophelo Haeso has made it very easy for us with the introduction of this app. It is comforting to know that there is one dedicated place on my phone where I can go for everything related to the project. It will be difficult to forget anything.” CHW33, HC2*

Since the CHWs used their phones for non-project activities, their phone galleries contained many personal recordings. As a result, if we had used the native voice recorder on the devices, it would have been much harder for the nurses to identify relevant health recordings among the clutter of their personal recordings. All BH activities also needed to happen within the app to enable usage logging that was not available within the native smartphone recorders. These logs help us to further understand CHWs' interactions and interaction needs. Lastly, the BH recorder interface was in Sesotho, which was useful for the CHWs.

#### 4.2.2 *The Bophelo Haeso Feedback Feature*

The feedback recorder feature was integrated into the Bophelo Haeso app that already housed the CHWs' content gallery, media player and sharing tools. No new application was developed, thus enabling the CHWs to continue using a familiar environment which they did not struggle to learn. The same large button theme was maintained with non-ambiguous labels that were agreed upon with the CHWs. The feedback page was added as an additional page or tab that allowed the CHWs to begin a recording, stop a recording, and view the list of recorded reports. Simplicity was the goal in this design. The CHWs were trained on this feature when it was first launched in August/September 2015, and further training was done in October 2015 and March 2016 to ensure that all the CHWs could use the feature.



**Figure 9 – From left: (a) The Main Feedback Reporting Page and (b) The List of Recorded Files.**

In August 2016, at the end of the 12-month period in which CHWs engaged with the recording feature, we conducted usability tests with 36 CHWs to determine how many of them could use the feedback feature. The CHWs were tested one-on-one. Each was asked to launch the app, to make a recording, to find the recording, and to play it. Of the 36 CHWs, 81% (n=29), launched the app without any struggle, navigated to the reports

page, pressed the green button to begin the recording, made the mock recording, and completed the recording by pressing the purple button. Another 8% (n=3) managed to complete their recordings, but not as swiftly. This group of CHWs easily navigated to the reports page but seemed unsure of where to press at first. When guided by the Sesotho labels on the buttons, however, they could perform the actions correctly. The rest of the CHWs (n=4, 11%) admitted to being unfamiliar with reporting and sought further assistance and guidance. All the CHWs who managed to make a recording also managed to open the list of recordings. However, 30% of them were not aware that they could scroll further down to access more recordings—they thought that the six recordings they saw on the list were all the recordings on the phone. One CHW even complained that some of her recordings had gone missing.

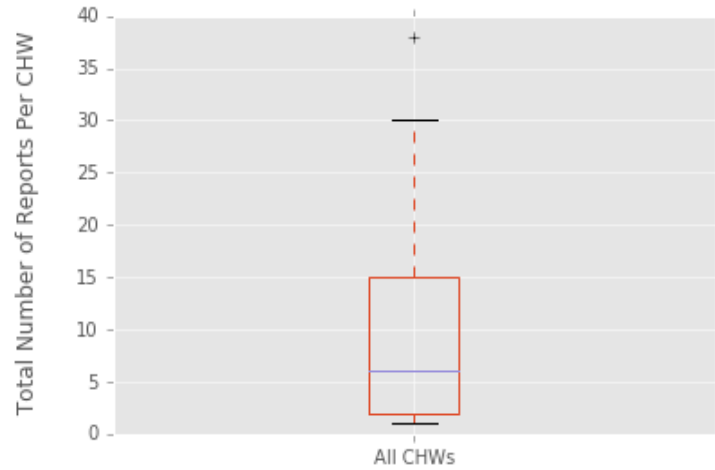
In the following sections, we discuss the details of how the audio recording feature was used in the 12-month study period from September 2015 to August 2016.

#### 4.2.3 *Audio Reporting Trends*

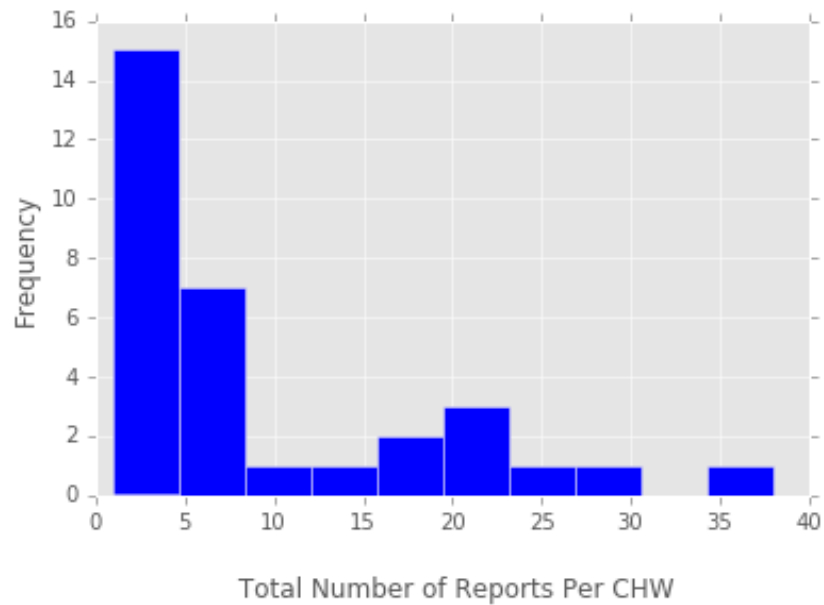
During the 12-month study period, a total of 298 reports were collected across the two health centres (218 from HC 1 and 80 from HC2). The recordings reported here are “relevant recordings,” meaning recordings in which health-related content was present. A few non-relevant recordings also made using the BH report recorder (a total of 64 recordings) were found in some CHWs’ phones. Some of these audio files included blank recordings seemingly the result of pressing the record button by mistake. Others were of a CHW demonstrating to others how well she can use the app and the feature. Still, others contained CHWs’ recordings of personal activities including a community council meeting, a village women’s group meeting, a church session, random family conversations, a CHW singing, or a song or favourite programme playing on the radio.

Of the 298 relevant reports, the average report length was 1 minute 31 seconds; the minimum length was 5 seconds; and the maximum length was 6 minutes, 18 seconds. In the period reported in this chapter, 42 CHWs were actively involved with the BH project. Among the 42, 32 submitted at least one report during the study period. Of the CHWs who submitted reports (n=32), the total number of reports collected per CHW ranged from 3 to 38, with a mean of 9.3, a median of 6.8, and a standard deviation of 9.7. Figures

10 and 11 show the distribution of the total number of reports collected from each CHW over the 12-month period.



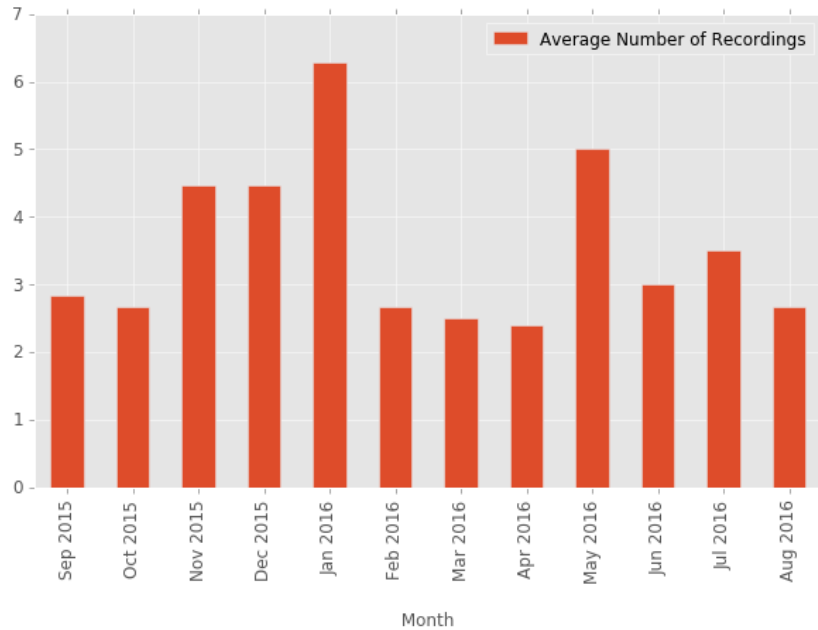
**Figure 10 - Distribution of Total Number of Reports Collected Per CHW.**



**Figure 11 – Histogram Showing the Distribution of the Total Number of Reports Collected Per CHW.**

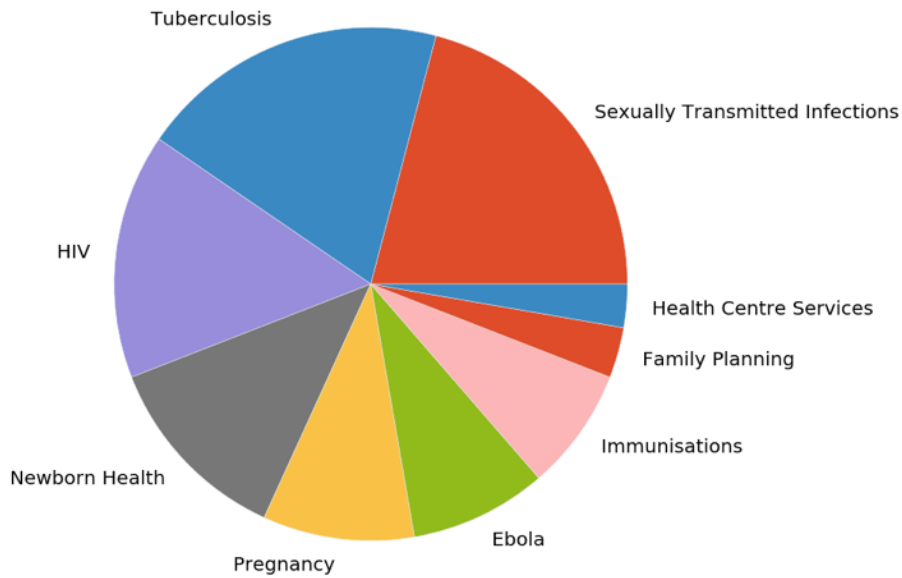
Sixty-six percent (66%) of the CHWs (n=21) submitted less than 10 reports in 12 months while 16% (n=5) submitted between 10 and 20 reports, and 18% (n=6) submitted more than 20 reports. Figure 12 shows the average number of reports received based on the

number of CHWs who submitted reports in that month, showing how the number of reports submitted over the months varied. On average, when individual CHWs reported, they submitted between two and seven reports a month. The highest number of reports received from one CHW in one month was 18.



**Figure 12 - Average Number of Recordings Received Per CHW Per Month.**

The most-mentioned topic in the audio feedback was Sexually Transmitted Infections (STIs) (21%), followed by Tuberculosis (TB) (20%), Human Immunodeficiency Virus (HIV) (16%), new-born health (12%), pregnancy (9%), Ebola (9%), immunisations (7%), family planning (3%) and health centre services (3%).



**Figure 13 - Proportions of Health Topics in Audio Reports.**

#### 4.2.4 Approaches to Feedback Capturing

While the initial agreement was for the CHWs to personally report on their experiences by making recordings by themselves, we discovered that a variety of other recording types were useful a few months into the deployment of the feedback mechanism. While some of these methods of “reporting” were not envisaged during the co-design sessions, the CHWs used them in ways that enriched the feedback and opened the possibility of important discoveries. In the typical, expected approach to reporting (71% of all reports), the CHWs recorded themselves narrating the reports of their engagements with the public. These reports included their observations about the interactions, the people’s challenges, and the arguments and complaints the people posed. In another approach, 16% of CHWs directly recorded their conversations with individuals or groups. Some of the conversations were arguments that the CHWs and clients had after a video showing; others were discussions on various health-related issues that led the CHW to play the video to clarify concepts to the person or people with whom she was engaged.

In 6% of the reports, CHWs quizzed a group of people on record, as a way to report to the nurses how little or how much the people knew on the topic at hand. The members

of the CHWs' communities also took advantage of the reporting platform to pass specific requests to the nurses or other health professionals. Reports of this type were found in 5% of the audio files. Another 2% of the recordings were voluntary testimonials—CHWs recorded people who are practising proper healthcare (e.g., adhering to TB treatment) to play the recordings to others who have doubts on the topic.

#### 4.2.5 *Feedback Elicited from Asynchronous Voice*

**The audio reports helped nurses to understand why certain groups did not seek timely medical attention as was recommended.** For example, four CHWs' audio reports indicated that in some villages, women are thought to be weak if they begin antenatal care at the health centres at the beginning of their pregnancies. The belief is that a “real woman” must use only traditional herbs and wait until she has started to feel the movements of her foetus (well beyond four months of pregnancy) before going for antenatal appointments. This is an issue of concern to the nurses because antenatal visits at the beginning of pregnancy are essential, especially for the timely prevention of mother-to-child transmission (PMTCT) of HIV in cases where the mother is HIV positive.

**Some reports revealed emerging, dangerous practices that required immediate attention from the nurses.** Two of these reports revealed a new type of herb that supposed “traditional herbalists” were selling to pregnant women. This herb was potentially dangerous to the mother and even teratogenic to their embryo or foetus. A report from one of the villages said that young people were being led to believe that taking drugs in high school could help them improve their grades. In other villages, men were planning to beat and chase away people from Central, West and East Africa if any of them ever set foot in their village because they believed everyone from these countries carried the Ebola virus. These are examples of misleading misconceptions that nurses could correct in future videos.

Six of the CHWs' reports included **complaints where individuals pointed to the poor handling of patients at health centres** (clinics) and the frequent absence of medical equipment (e.g., HIV testing kits), which discouraged many from visiting the facilities. This is valuable feedback for nurses, as they are always looking to identify the reasons that prohibit people from visiting health centres. One of the nurses' priorities is to ensure

that the public makes use of the facilities and services offered at health centres. This is because most of the HIV/TB/maternal/neonatal mortalities and morbidities in rural areas could be easily prevented by people taking timely tests and receiving and adhering to treatment and support guidelines. An additional seven reports included requests from community members and suggestions for ways in which service delivery methods could be redesigned to make health services more accessible to everyone. Among these was a request that anti-retroviral (ARV) therapy be made available closer to the villages for those who are too weak to walk or travel to the health centres.

**The nurses learned of other concerning issues that affect the way people make health choices.** For example, they found through 22 of the CHW audio diaries that some people in Lesotho’s rural villages were unable to take up recommended health practices because of poverty and hunger. There were reports of people who stopped ARV therapy because the treatment increased their appetite significantly, but they did not have access to enough food to meet the demand of the induced appetite. CHWs also reported cases of women who, despite the recommendations in the videos for exclusive breastfeeding and proper infant nutrition, fed unhealthy food to their infants early in their lives due to limited access to healthy food options. A direct request included in one of the reports from an elderly village woman called for health professionals (nurses) and other authorities to intervene in the life of a young pregnant teenager who, in the speaker’s words, “*is worryingly underweight and weak for a pregnant woman.*” Additionally, nurses continue to discover that young mothers still give birth in their villages due to poverty, even though they are aware of the recommendations to give birth in hospitals.

From the audio reports, **nurses also identified several knowledge gaps among the people**, and these discoveries improved their understanding of the reasons for resistance towards certain healthcare practices. The following comments are examples of opinions contained in the reports:

*“Condoms are against the will of God!”*

*“The ministry of health contributed to bringing these strange diseases into our country so that they can benefit at our expense. First, they bought HIV from overseas, and introduced it in Lesotho via these unending injections you want us to take (vaccinations). So now they are doing it again—they have brought Ebola, just so that*

*they can find new ways to make money and control our lives. None of my family members will go to those clinics, we will stick to traditional remedies.”*

From more than 30 reports, **the nurses also learned of the need for special health education for men.** These reports showed how men refused to cooperate with their wives in planning and living healthy lives, especially with regards to HIV, other STIs, TB, and planned parenthood. For example, three reports included information on women who told the CHWs that their husbands clearly had TB symptoms; however, the women had stopped trying to convince their husbands to go to the health centres to get tested because the men beat them every time they talked about TB and testing. In one of the stories, the woman sadly mentioned that her husband eventually infected her three children, who were now receiving treatment secretly while their father remained untreated. In more than five reports, CHWs carried enquiries from young women who sought advice on how they could be best supported to protect themselves from HIV and STIs in marriage. Many women begin marriage without these infections but end up infected because of their husbands' extra-marital affairs. Several of these reports showed that men physically abuse their wives when they suggest the use of condoms in their marriages.

Sometimes, **one type of question indicating the public's misinformation is frequently repeated** from the reports originating from the same village or area. These repeat questions indicate that specific attention must be paid to that specific village to address the misinformation or misconception.

Resulting from all this feedback, the clinics are re-designing some of the services they offer to the communities, and nurses are creating new videos that address the needs that the reports helped to identify. For example, nurses have created new videos on pregnancy complications and the use of traditional remedies in pregnancy in response to the knowledge gaps identified through the audio feedback.

### 4.3 SKITS: ROLEPLAY AS FEEDBACK

In addition to using asynchronous voice feedback, we explored the use of drama for CHWs to report in-village experiences to the nurses and the researchers. CHWs used two

artefacts in their work: the BH application (developed by the researchers) and the BH content (created by the nurses). Contextual details of where and how the content and the app were used were valuable in informing both the nurses and the researchers about the iterative design of the application and the creation of future content.

Roleplay allowed CHWs to:

- 1) Simulate their interactions and relationships with the public in their villages, and
- 2) Report on **actual** experiences that had happened at some point in the past.

‘Skit workshops’ were held three times in the 12-month feedback deployment period. Before the BH project, roleplay had been used to reinforce concepts during CHW training. Drama (skits) were initially used to open alternative channels of communication and expression, focusing on design and exploration. We hoped that the skits would illustrate CHW-patient interactions, and hence would inform the design of technologies that supported such interactions. However, it evolved into roleplay as a supplementary feedback mechanism: roleplay for experience reporting. The thinking behind this choice was that roleplay would enable the CHWs to deeply explore their experiences and interactions and to report those rich findings in the form of drama to the nurses for further discovery of the state of affairs within the villages

#### 4.3.1 *Scenario building by CHWs*

During the workshops, the CHWs were divided into groups of five to seven individuals. They were then asked to discuss among themselves the different experiences they had with the public in their communities. Following this, they would develop scenarios and act them out to demonstrate their experiences in an embodied manner. Each group independently picked its own setting and then assigned CHWs to their respective roles. Some CHWs played themselves (a CHW) while others played different roles representing the various members of their village communities—chiefs, men, women, mothers in law, youth, and entertainers, among others. In their skits, the CHWs attempted to capture the true picture of village life. They put much thought into presenting as much detail as possible regarding the settings where they met with patients and the ways they

communicated with them. After brainstorming and agreeing on a scenario to stage, the CHWs rehearsed for a few minutes and then presented their dramas.

The core principle of the CHW skit reporting is that the CHWs created their own scenarios and decided on the storyline to be staged. They were not told what to act, or what to focus on. They decided among themselves to combine their experiences into one act lasting between three and five minutes. They designed the entire script for their skits, assigned actors to parts, and self-directed the play. The skits were truly CHW-created and CHW-directed. Each CHW had the chance not only to be an actor but also to sit in the audience watching the performances of others. Discussions among the larger group with the nurses and researchers followed the performances.

#### 4.3.2 *Examples of CHW-Created Roleplay Scenarios*

At every roleplay workshop, the researchers and nurses were taken away by the dramatic creativity of the CHWs, the ways they could capture detail in their delivery, and the way they immersed themselves in the moment in drama. For example, one of the shyest CHWs played the character of a loud, aggressive, argumentative village man. In doing so, she used the true depth of the character to demonstrate her experiences of dealing with difficult male figures in her village. Because she's extremely shy in her own persona, some of these experiences would never have emerged in a focus group or interview setting or in the audio reports. Stepping out of her own self and acting someone else allowed her to report much deeper details.

Below are three examples of the scenarios the CHWs staged:

##### **Scenario 1:**

*A CHW visits a sick patient whose house is also a beer-selling spot. The spot operator is also the caregiver for the sick woman. Upon the CHW's arrival, she starts by advising the drunken women to reduce the rate at which they drink. They make fun of the CHW as she turns to the sick woman and her caregiver privately. The CHW is discontented with the situation in which her patient lives and is doubtful that she gets enough attention and food. As the CHW discusses the patient's health status with her, the patient discloses that she has been hiding from her caregivers that she has been having unusual symptoms in her*

*genitalia. The CHW immediately says: “it sounds like a bad STI.” The caregiver is angry that the patient has divulged this information to the CHW, saying that a woman must keep certain things to herself. The CHW tells the patient that the symptoms she is experiencing are of a condition called genital warts, and that she has a video on her phone that describes STIs. The CHW holds the phone showing the video out to the patient, who listens and watches. The caregiver listens too, but doesn’t see the images, as the screen is not visible to her. Midway through, the patient requests to ask a question. The CHW pauses the video, allowing the patient to ask. Once the patient has asked her question, they resume playback and watch the rest of the video. The woman, convinced by the video, eventually agrees that she will go to the health centre to get herself tested and treated.*

**Scenario 2:**

*A group of women are preparing food for a funeral. The women are expressing disbelief over the death of the person to be buried the next day, in part because they are aware that this woman’s death means an addition to the many orphans that already live among them. The CHW joins in the discussion with the intent to also join in the food preparation process. As they all work and chat, they continue to talk about how no one really knows what caused this death. One woman says that all that is known is that the deceased woman had chest pains at some point. The CHW comes in and says, “You all know that everywhere I am, I am your CHW, and will take advantage of any situation to talk about good health. I will do that even as we work now—especially because I have information that is directly relevant to the dilemma behind our friend’s death.” The CHW tells them that to make her work even better, she has just received a new phone from the health centre to help her. All the women are excited to learn of this development and comment on the phone’s advanced look. The CHW then brings out the phone and says she will play one video for them as they continue to work. It is a video on TB. One woman then picks up the phone and looks at the images accompanying the voice. The phone is then passed around for others to see the changing images as they all continue to listen. The women comment in joyful surprise that the person teaching in the video is the nurse from the health centre, whom they appear to respect very much. The CHW then takes the phone, places it on the floor, and they listen to the rest of it as they continue to chop the vegetables in silence. When the video ends, the women are appreciative of how much they have learned. One, seeming scared, rises to her feet and tells*

*the CHW that after hearing the TB symptoms being mentioned in the video, she thinks she, too, might have TB. The CHW encourages her to go and get tested, and promises to support her through her treatment. A long discussion on TB and many other topics follows as they work, with the women frequently thanking the CHW for the video that ignited such a useful discussion.*



**Figure 14 - Examples of CHWs performing their skits.**

**Scenario 3:**

*A CHW runs into a heavily pregnant woman in the village who is on her way to dig traditional herbs to heal some pains and discomforts she has been feeling. She says that her grandmother taught her which herbs to dig. The CHW then begins to discourage the use of such herbs because of the dangers they have caused in the past, and encourages the woman to visit the health centre where all her discomforts will be addressed by professionals. The CHW even recommends that the woman make plans to give birth at the health centre. The woman says she would like to give birth at the health centre, but her mother-in-law is adamant—she will not allow it due to her belief that new-born babies can be bewitched if born outside the home. The CHW then talks to the woman at length about the dangers of giving birth in the village, and concludes by showing her a video on good health for the mother and the new-born. They watch the video silently until the end. The woman appreciates the truths in it, and requests that the CHW visit her family urgently to present these matters to her mother-in-law.*

CHWs enjoyed expressing their experiences in this manner, and the rooms were normally filled with energy, new ideas and lively discussions.

#### 4.3.3 *Learnings Elicited from Skits*

The skits allowed the CHWs to "report" their experiences, struggles, and other issues related to their work with people, their use of the videos, and related comments. Several contextual details emerged from the CHWs' skits. These details give useful feedback to the nurses and the researchers as well. For example, from only the three scenarios summarised above, we learn of:

- The settings in which some patients are treated;
- The external influences within families that go against good health practices;
- People's habits of preferring to hide health challenges;
- General knowledge gaps related to basic health issues like the symptoms of TB;
- The way the CHW asserts her authority to her fellow community members;
- The way CHWs provide necessary customised support 'in the moment';

- Examples of scenarios in which CHWs showed BH videos—to groups, to individuals, and at different points within a conversation;
- Reasons why certain groups do not use health facilities (for example, most women are controlled by their mothers-in-law);
- Misconceptions that originate from beliefs related to witchcraft; and
- People’s faith (or lack thereof) in CHWs.

For these purposes, roleplay is about opening new channels of communication where CHWs can express themselves better. It is about affording them an opportunity to say:

*“This is what my day looks like. These are the issues I deal with. These are the questions I hear. These are the most common struggles for the people I serve. These are the tools I use and this is how I use them. This is how I behave in my natural context. This is how people perceive me. This is how I incorporate Bophelo Haeso technology into my work. This is how others react to the technology and content I present to them. These are the settings in which I use Bophelo Haeso videos. This is what happens when we watch a Bophelo Haeso video.”*

## 4.4 DISCUSSION

### 4.4.1 *New Revelations – True Feedback Mechanism*

The feedback mechanism confirmed our hypothesis that tools which support new forms of expression would enable us to elicit deeper details about the CHWs’ work, the people they serve, and the health challenges they experience in their villages. The audio reports included such details as the descriptions of the individuals or groups that the CHWs met. The skits then enlightened us about such details as the contexts in which CHWs meet patients for care and education and the scenarios in which videos were played. Interviews with the nurses confirmed that the feedback mechanism (voice logging and the skits) significantly improved the number of issues reported by CHWs and the depth of the contextual details they revealed. One nurse said:

*“I have worked with some of these CHWs for more than three years, and yet I am learning for the first time about some of the struggles they go through. I think these*

*new opportunities to give feedback encourage them to speak even more. So many village experiences remained untold in the past.”*

The primary benefit of the increased number of reports is the feedback itself. It allows new types of information to be revealed to the nurses which would never reach them otherwise. Having the information from the feedback allows nurses to discover the topics which are the most urgent to address in their educational videos. It also helps them to identify the groups that need more attention or help. Additionally, the nurses said that by listening to the reports, they could gauge the competence and growth of their CHWs and to learn more about the confidence and sense of urgency with which they addressed different health issues. The nurses also reported that they could use the direct recordings to observe the CHWs’ growing confidence of expression and ability to articulate experiences. This growth was made possible by the fact that CHWs made the recordings in the absence of nurses and other health professionals, where they had the freedom to express themselves and to explore different ways of reporting.

#### 4.4.2 *Improved Expressions and Reduced Biases Through Roleplay*

For the first three years of the BH project, the primary method of feedback elicitation from CHWs was check-in meetings where CHWs would go around in a circle and state their experiences with the BH videos in their villages. Up to four meetings would be held a year. Over the three years, the typical response from the CHWs was:

*“People love the videos. We love the phones. They make our work so much easier.”*

There were a few examples of how people received content that was shared with them by the CHWs. This information came mostly from a few outspoken CHWs, but there were few details about the contexts in which the videos were shown.

In some cultures, as was the case for the CHWs, women can be reserved in their speech—especially in formal focus group or interview setups. For a project like BH where the opinions and voices of the CHWs are integral to the design process and to the village-to-clinic feedback, this can be a real limitation. Additionally, our experiences, like those of other researchers (Dell *et al.*, 2012), have been that participants can be biased when asked directly about their experiences. This is especially the case when reporting to people of

authority like their nurses and the researchers who developed the technologies and content under review. In these contexts, the CHWs tended to give responses that would give more appraisal to the researcher and nurses than true reflections of their own experiences.

We discovered that roleplay and the skits did a great job in getting the CHWs out of their reserved, non-articulate states. Being forced to be a different person than the reserved woman a CHW is acculturated to be, the CHW can be more expressive and demonstrate struggles that would not be easy to articulate in a discussion setting. We found that drama opened new forms of communication and expression that could not be as thoroughly expressed either verbally or visually otherwise (Matthews, Gay and Doherty, 2014). The CHWs commented that they enjoyed expressing themselves through play, saying:

*“Some things are not easy to describe in words, but easy to demonstrate in play...”*

We, therefore, recommend roleplay activities in which participants can report their experiences through self-created scenarios, especially in research and design cases where deeper expression is preferred but the natural culture is to be less expressive. Roleplay is also useful in cases where descriptions of experiences are not easy in words.

#### 4.4.3 *Simple, In-Situ Reporting*

Because of the ubiquity of the mobile phone, reporting from within the BH app can be done anywhere, and at any time. For the CHWs, knowing that they have a chance to report frequently makes them more vigilant within the community, and they can observe and report issues that they would otherwise overlook. In-situ audio reporting also presents new benefits for capturing many community issues which would have remained unspoken or would have been forgotten when the primary platform for feedback exchange was the discussion at the monthly CHW meetings. Our work demonstrated the importance of giving CHWs feedback tools in their hands, in-situ, where they do their work and live their daily lives. These tools promote quality feedback.

The approach to feedback through the BH app was easier to use than other previously-explored methods like writing. When speaking of voice reporting, the nurses noted that:

*“Speaking is the easiest thing for CHWs... all they need to know now is where to press on their phones, and they seem well-adept at that.”*

Unlike on paper, there is no limit of expression with voice recording. The CHWs and the public can express themselves to a point where they are convinced they will be understood. The availability of the mobile BH audio recorder in the field also enables direct recording of the public when preferred or necessary. The presence of the technology in the field has led to even richer expressions and discoveries of the state of health in the villages.

#### *4.4.4 Complementing Tech with Non-Tech*

In-situ reporting and roleplay reporting complement each other. Each offers different affordances. Mobile phone reporting that happens in the comfort of a CHW's home soon after her interaction with members of her community enables her to articulate a fresh experience, including useful details and demographics. In group skits, on the other hand, we observed that in-group reflections allowed collaborative reporting and integration of experiences into a single performance, thus enabling easier peer-to-peer communication and sharing of experiences among CHWs. Drama also gives CHWs greater imaginative space due to the embodied experience that might spark creativity in ways that may not occur otherwise (Burns *et al.*, 1994). Looking at the results of both approaches as we employed them in this study, we realised the benefits of leveraging them together (Densmore *et al.*, 2013). Our work has confirmed previous research that demonstrated that while mobile technologies are powerful and ubiquitous, sometimes a complete solution requires more than a technological intervention (Densmore, 2012).

#### *4.4.5 Methods Matter*

Methods are an important component of what made the BH feedback mechanism intervention work. The 18-month PAR journey allowed CHWs to fully participate in the conception and design of both approaches to feedback. Additionally, we attempted to take advantage of the CHWs' current ways of speaking, and situated the designs and activities accordingly. It was important to take advantage of the different ways of learning and communicating that preceded the intervention.

In our workshops, we used techniques including role-playing and local approaches for encouraging discussions, all of which were techniques with which the CHWs were already familiar. These techniques allowed richer expression from CHWs than we could have achieved with verbal articulation alone. During the roleplaying sessions, CHWs designed simulations (skits) with a level of creativity that surprised all the researchers and nurses. They injected many of their experiences into the process of defining the plot, characters, themes, and settings of their simulations. These exercises enabled further discussions and led the CHWs to know that they are legitimate contributors to the design process. As we learned from their comments, they felt that their experiences were a valued component of the process.

#### 4.5 CHAPTER SUMMARY

This chapter presented the first attempt at using asynchronous audio diaries and user-created drama to enable feedback generation to support rural health education and service delivery. It demonstrated that these approaches can disseminate new information one or two levels up the health system. We developed and deployed a mobile, asynchronous voice application supplemented by roleplay to successfully give CHWs a voice in Lesotho. This process enabled them to generate valuable village-to-clinic feedback. Our results indicate that when CHWs are equipped with a mobile tool that they can use in their own space, they are able to report more experiences and articulate more of the challenges that their communities face than they were when old approaches such as check-in meetings were used without supplementation.

Further, we argue that while technology artefacts such as the BH feedback-integrated mobile application are useful in enabling communications, further forms of reporting can be opened by encouraging bodily forms of expression like roleplay. In the Bophelo Haeso project, roleplay enabled deeper feedback that supplemented what was captured by the asynchronous voice solution alone. We showed how the incorporation of village-to-clinic feedback communicates the real challenges of rural communities. We also confirmed that CHWs, as the core players in the rural health system, can assist the education process substantially when given a voice. Thus, we hope to demonstrate that while clinic-to-village health education initiatives are impactful, effective feedback

mechanisms driven by CHWs are essential not only for fostering community engagement, but also for bringing the voices of the public to the forefront.

## 5 LONGITUDINAL STUDY

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There is already substantial evidence that mobile videos are a good vehicle for public health information dissemination. However, open questions remain about sustainability. Most studies are short-term, and we still do not have a good understanding of critical questions for the long-term, including consumption patterns, relevant content, and usage models. Multiple researchers in HCI4D and ICT4D have called for more long-term qualitative and quantitative evaluations that extend beyond initial experiments and deployments that often last a few hours to a few weeks (Heeks, 2002; Vaughan and Courage, 2007; Ho and Smyth, 2009; Wyche and Murphy, 2013). There are significant benefits in observing use, evolving behaviours, attitudes, and interpretations over time.

For the BH project, we ran a longitudinal, 17-month study where we collected log and interview data from 42 CHWs. We aimed to better understand how the utility of mobile videos changes over time. We considered problems of natural and technical attrition, and sought to understand the underlying causes of decreased use of videos over time.

Over the course of this study, videos were viewed an average of 170 times per month with a total of 2898 videos views for the entire 17-month period. Using this data, we drew some preliminary findings:

- Pausing is not always contextually necessary;
- Age is not a barrier to use;
- The primary predictor of the popularity of a given video is topical relevance and national campaigns;
- There is no apparent relationship between video length, popularity, and completion rate;
- New videos have only a short-lived novelty effect;

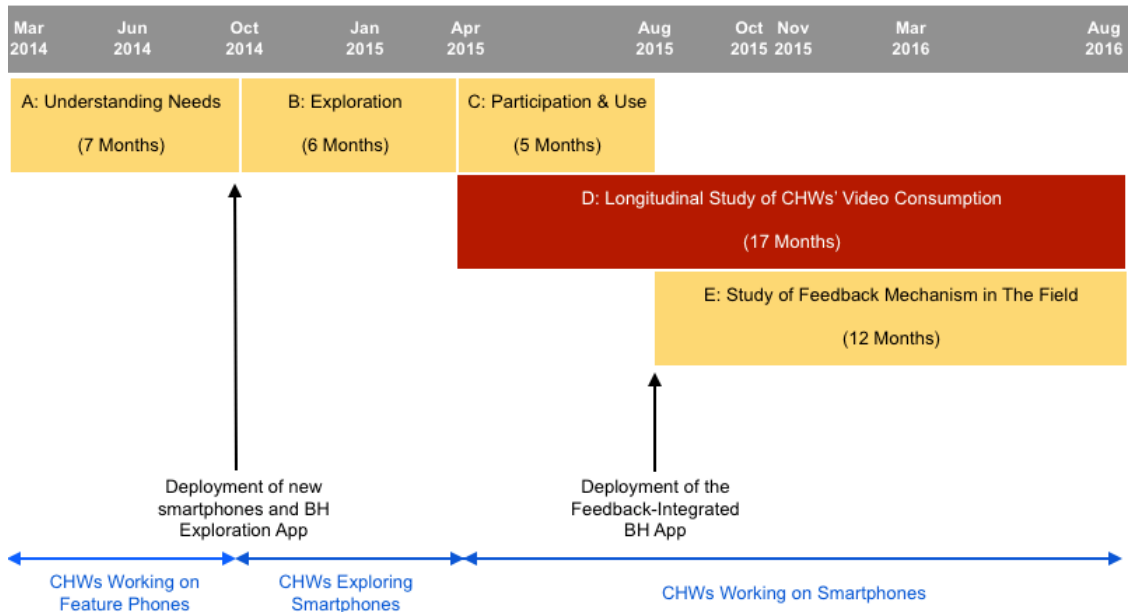
- Regular engagement with CHWs has an impact on continued video use and is important for reducing attrition due to technical issues.

## 5.1 RELATED WORK

The Accredited Social Health Activists (ASHA) Assist project (Ramachandran *et al.*, 2010) first provided evidence that CHWs could use videos on phones as a counselling tool with their clients, who were often expectant mothers. However, that study was only done in an experimental setting over a period of eight weeks. The Projecting Health project (Kumar *et al.*, 2015) has provided much more enduring, real-world evidence for the benefits of video for health education. A further study demonstrated that CHWs are the most effective channel for disseminating health videos for community education (Vashistha and Anderson, 2016). Building on these studies, we sought in the BH project to understand how the trends of CHWs' video dissemination and consumption would change over a more extended period.

Extensive research has been conducted on the performance of CHWs considering factors such as motivation, supervision, and workplace limitations (Ramachandran *et al.*, 2010; DeRenzi *et al.*, 2012; Pinzon and Iyengar, 2012). In most cases, CHW performance is normally measured from the lens of effective reporting. Our work built on this research by looking further into CHW performance in terms of the effectiveness with which they use mobile videos provided for community health education.

The 17-month-long longitudinal study began at the end of the exploration phase in April 2015. By then, all the CHWs had explored and learned their new smartphones and the BH app.



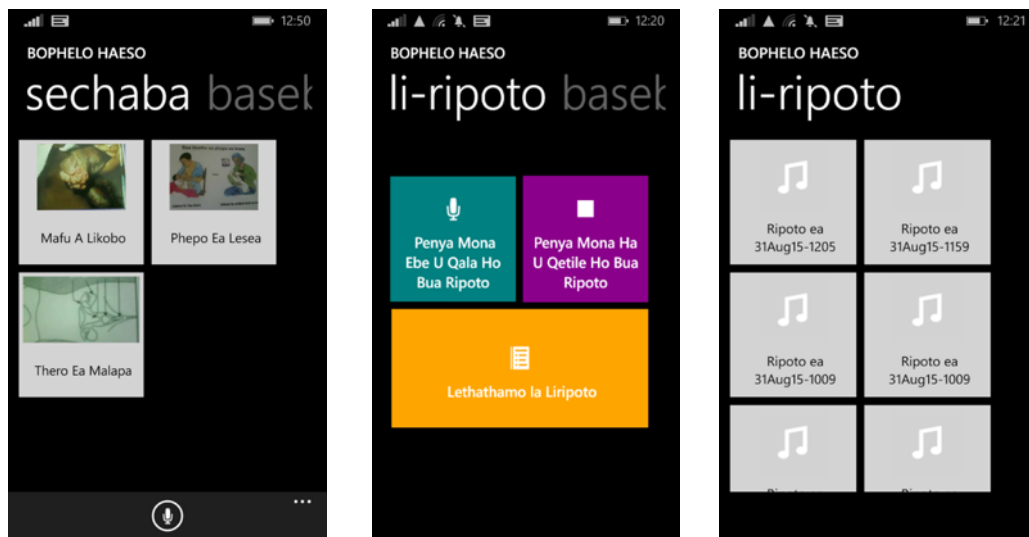
**Figure 15 - Process Overview with Emphasis on the 17-Month Longitudinal Study of Video Consumption Patterns.**

## 5.2 RECAP: THE BH MOBILE APPLICATION

For the duration of the study, CHWs consumed health content (watched it, showed it to patients, and shared it with others) using the BH app on Nokia Lumia smartphones running Windows Phone Version 8.1. The BH app served as a dedicated gallery for BH videos, worked as a customised video player, and functioned as a feedback collection tool. The main benefit of having a mobile app for all BH activities was that it helped separate the BH multimedia from the personal files on the CHWs' devices, and thus enabled easy and quick access in the field. The app also enabled the logging of CHWs' use of the BH content. A more detailed rationale for the design and features of the BH app is well-documented in Chapter 3, but an overview is presented below.

The BH app has three pages, and users swipe left or right to cyclically navigate between them. The first two pages are the BH gallery. Videos meant for public consumption are located on Page 2 and videos meant for CHWs only are located on Page 1. During the period reported in this thesis, however, the videos on the CHWs' list could also be shown

to the public. The videos are displayed in a grid using thumbnails. Below each video thumbnail is the name of the video in Sesotho. The third page of the app is used for recording feedback. This is where CHWs record the 'audio diaries' of their experiences and their interactions in the villages.



**Figure 16 – From left: Screenshots of the BH app showing (a), CHW Video List, b) The Reporting Page and c) The Report List page**

### 5.3 BH MULTIMEDIA CONTENT

By April 2015 when the evaluation of the CHWs' consumption patterns began, the HC1 group had eight nurse-authored videos released to the CHWs, and the HC2 group had five. The dates for the initial releases of each video are included in Table 2 and Table 3. At HC1 only, four new videos were released in August 2015. HC1 videos with the same names as some HC2 videos were indeed the same videos created by HC2 nurses but also deployed at HC1.

Title of Video	Page in App	Duration (mm:ss)	First Released	Created By
Tuberculosis	1	04:44	Jun 2014	HC2 Nurse
STIs	2	03:15	Jun 2014	HC2 Nurse
Infant Nutrition	2	03:07	Oct 2014	HC2 Nurse

Family Planning	2	04:37	Oct 2014	HC2 Nurse
Ebola	2	01:55	Oct 2014	HC2 Nurse

**Table 2 - Videos Released at HC2.**

Title of Video	Page in App	Duration (mm:ss)	First Released	Created By
Tuberculosis	1	04:44	Jun 2014	HC2 Nurse
STIs	2	03:15	Jun 2014	HC2 Nurse
Ebola	1	01:55	Oct 2014	HC2 Nurse
Overall Family Health	2	04:20	Oct 2014	HC1 Nurse
Maternal and New-born Health	2	05:20	Oct 2014	HC1 Nurse
Pregnancy Health	2	13:22	Oct 2014	HC1 Nurse
HIV Status	2	07:45	Jan 2015	HC1 Nurse
HIV Testing	2	06:06	Jan 2015	HC1 Nurse
Immunisations	2	10:50	Aug 2015	HC1 Intern
Traditional Remedies During Pregnancy	2	06:20	Aug 2015	HC1 Intern
Pregnancy Warning Signs	2	04:39	Aug 2015	HC1 Intern
True Signs of Labour	2	05:27	Aug 2015	HC1 Intern

**Table 3 - Videos Released at HC1.**

#### 5.4 BH USAGE OVER 17 MONTHS

Our objective from April 2015 to August 2016 (17 months) was to study how CHWs would use the BH videos in their respective villages. To this end, we asked the research questions that are outlined in the following section.

### 5.4.1 *Research Questions*

- RQ1: How frequently do CHWs play BH videos, and how do consumption patterns change over time?
- RQ2: What video content is the most popular, looking at sustained frequency of play?
- RQ3: How common is it for CHWs to pause and resume video playback when engaging with patients?
- RQ4: What CHW attributes and attitudes affect individual use rates?
- RQ5: In what scenarios is the BH content used?

We expected to see a novelty period similar to that reported in related studies (DeRenzi *et al.*, 2012). In those studies, the initial introduction of the application and subsequent new content caused a spike in the number of plays which decreased over time (RQ1). In our study, we sought to understand three things: (1) the duration of the initial spike of interest when the videos were introduced, (2) the rate of decay in video plays, and (3) the frequency of video plays during the steady-state period once the decay had stabilised. We also anticipated an increase in video usage after researchers met with the CHWs.

Additionally, we sought to understand the properties of health videos that make them popular among CHWs and their communities, as well as to measure the ratio of partial to complete plays (RQ2). We hypothesised that short videos (less than 2 minutes) would be watched to completion more frequently than long videos (over 5 minutes). We assumed that CHWs would pause videos often during playback to engage with patients (RQ3). Looking at individual CHWs, we sought to understand how the CHWs compared to one another. We accomplished this by looking at the attributes or attitudes that affected individual usage rates (RQ4). Lastly, to interpret the trends that we observed, we aimed to further understand the scenarios in which BH content was used as well as the interactions between CHWs and the public (RQ5).

### 5.4.2 *Participants*

We began with 54 CHWs during the exploration phase in October 2014. There were 24 CHWs from HC1 and 30 from HC2. CHWs' demographic and literacy details were reported in Chapter 2.

The CHWs did not receive regular financial compensation from the project during the study. However, they were given 3-5 USD for transport and lunch costs when attending workshops with the research team. The smartphones served as incentives for the CHWs, as they could also be used for personal purposes. None of the CHWs had previously owned a smartphone, and only four had had some exposure to smartphones because their children owned them. However, all the CHWs had owned feature phones (provided by the project or self-acquired) and could use the phones for SMS and calling. Twenty-five of the CHWs (60%) had also used their Nokia Asha feature phones for WhatsApp.

#### 5.4.3 Procedure

During the 17-month research period, the BH app logged CHWs' use. The app generated logs that recorded the date and time when every video was opened, the length of play and all details of the pause activity (whether the video was paused, if the playback was resumed and, if resumed, the length of the pause). The analysis was limited to nurse-authored videos only. The app also recorded actions such as sharing a video with another device via Bluetooth. The usage logs were collected throughout the 17-month period and quantitatively analysed to answer the research questions outlined above.

To complement the usage logs, qualitative data related to the CHWs' experiences were collected multiple times during the study period. This data collection included semi-structured interviews with CHWs, focus groups, observations where CHWs would be asked to demonstrate how they use the BH app, and skits where CHWs demonstrated scenarios of BH use in their villages using drama (Chapter 4). These data-collection methods were conducted in Sesotho. All quotations included in this chapter have been translated from Sesotho to English by the author who is a native Sesotho speaker.

Of the 54 CHWs initially enrolled in the study, data from 42 of them (21 from HC1 and 21 from HC2) were used for analysis. Twelve CHWs were excluded from analysis because they had missing or incomplete logs for a variety of reasons. One CHW passed away, one moved to another country, one CHW's phone was stolen, four CHWs did not have the instrumented version of the app installed on their phones at the start of the study (i.e., they worked with an old version with no logging feature), and five of the CHWs were

moved from active CHW duty in the villages to work full-time as assistants at the health centres.

At the beginning and end of the study (April 2015 and August 2016), we conducted baseline and end line user experience tests and interviews with CHWs to understand how they used BH content and to assess their proficiency with the BH app. In April 2015, all 42 CHWs were tested and interviewed. However, in August 2016, only 36 of the 42 CHWs attended the workshop and were tested and interviewed. In tests conducted both at the beginning and end of the study, we sat with CHWs one-on-one. For each session, the CHW was asked to find the BH app, launch it, play a specified video on page 2 of the app (e.g., the STIs video), abort the video playback, return to the gallery, play another video on page 1 of the app (e.g., the TB video), etc. In the workshop held at the end of the study, we also asked each CHW to tell us about the video they played the most during the 17-month period and to state why that video was the one they played the most.



**Figure 17: One-on-One User Experience (UX) Testing with CHWs**

#### 5.4.4 *Data Cleaning*

Ten percent (10%) of the raw records were removed. We removed records with invalid timestamps (8% of total raw records). We also removed all records for play events recorded on training and workshop dates (2% of total raw records). For the quantitative analysis, a “video view” means that the video was played for at least 10% of the video length, and “barely opened” means the video was played for less than 10% of the video length. We wanted to exclude records where the video was opened for only a few seconds (e.g., for demonstration purposes rather than content consumption), during which time no health message would have been heard. For all the videos, by 10% into playback, the nurse had covered at least one main point on the topic at hand, thus indicating that a message was heard. The average length of the videos is 05:23 (323 seconds), meaning the average 10% of video length is 32.3 seconds.

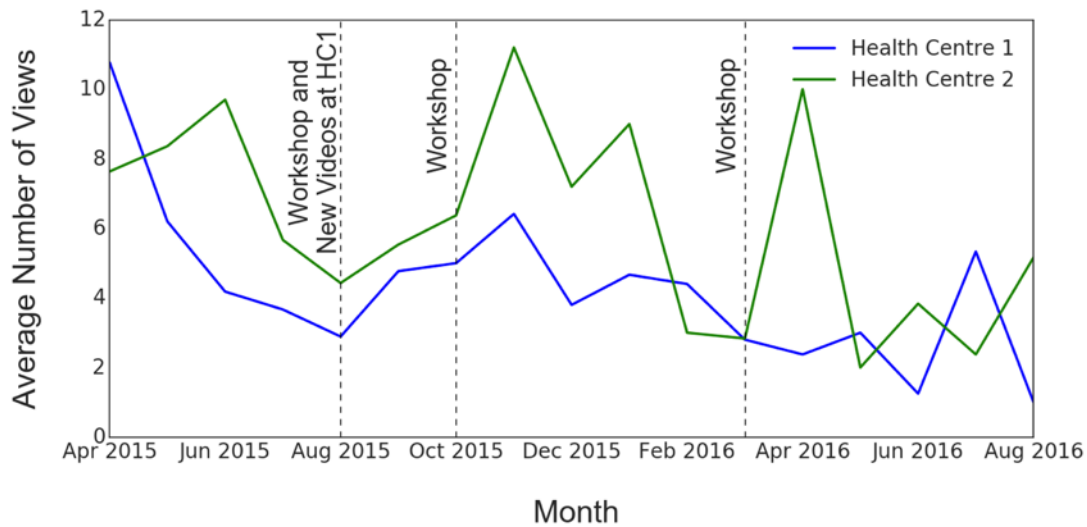
## 5.5 RESULTS

### 5.5.1 *Consumption Patterns*

For RQ1, we used the logs to identify patterns of how often videos were played by the CHWs. We hypothesized that researcher visits and the introduction of new videos would cause increased use that would diminish quickly.

#### *Frequency of Play and Effect of Researcher Visits (RQ1)*

Figure 18 shows the mean number of BH video views per CHW by health centre over the entire 17-month period. The means are based on the number of CHWs who viewed videos each month.



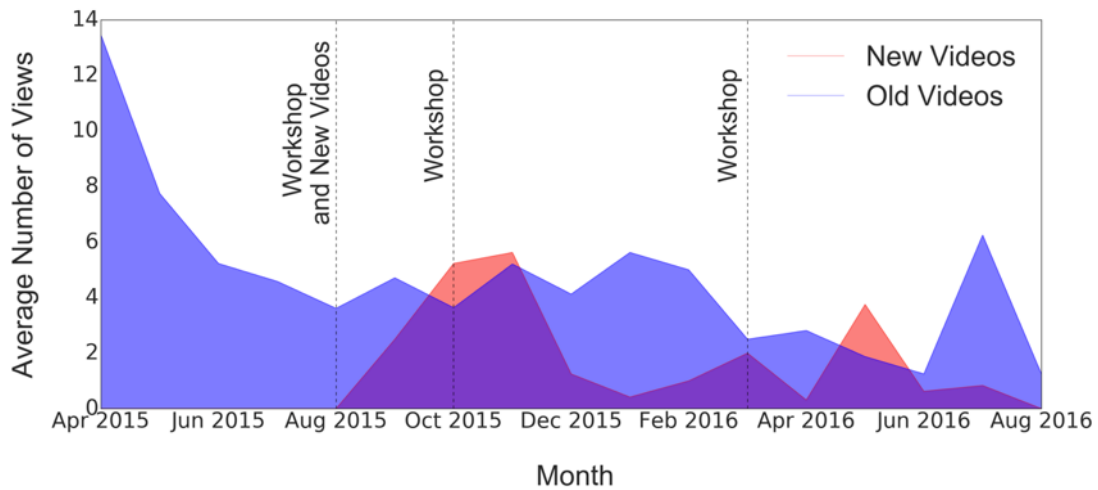
**Figure 18 - Average Number of Views Over 17 Months.**

In the 14 of the 17 months, HC2 had more video views than HC1. Overall over the 17 months, use rates at both centres went up by 33% to 72% in the months following workshops with researchers. One exception was HC1 after the March 2016 workshop, where a slight decrease in usage occurred following the workshop. In all other cases, after the workshop-induced spike in video use, there was a decline until the next workshop when use spiked again. When workshop ‘excitement’ subsided, video use settled at approximately 2-6 views per CHW per month. The average number of views per CHW per month had declined from 11.9 (HC1) and 7.6 (HC2) in April 2015 to 1.5 (HC1) and 5.8 (HC2) in August 2016—declines of 87% and 24% respectively.

#### *Newly-Released Videos vs. Old Videos (RQ1 and RQ2)*

At HC1, four new videos were introduced five months into the study. Figure 19 compares the use of the four new videos against the eight old videos at HC1. This graph presents the mean number of views per video for the old and the new videos for CHWs that viewed at least one video in each given month. For the new videos, a steady increase in use was seen in the three months following their release, reaching a peak in the third month after release. For two months starting a month after the release of the new videos, the new video use surpassed old video use. However, in the month after the use rate of the new videos peaked, it declined by 81%. After the initial peak and decline, the new videos then

joined the standard use pattern of occasionally increasing and declining usage, but they never rose as high again as in the three months after their initial release.



**Figure 19 – Newly-released Videos vs. Old Videos at HC1.**

### 5.5.2 Video Popularity

As Figure 19 shows, video popularity due to novelty wore off after three to four months. In this section, we further examine factors that led to sustained popularity.

#### *Factors Affecting Popularity According to CHWs (RQ2)*

When we asked CHWs which video they showed most often, 31 (74%) of them identified the TB video, 5 (12%) identified the STIs video, 4 (9%) identified videos relating to pregnancy and new-born health, and 2 (4%) identified HIV-related videos. The primary reason for the high use of the TB video is that CHWs view TB as an epidemic in their communities due to the number of TB-related deaths and rates of infection among the young and old. CHWs said many patients display TB symptoms, yet remain reluctant to test for TB and dismiss the symptoms as the flu or common cold. CHWs believe this reticence to seek treatment is caused by a lack of knowledge and understanding about the disease.

Additionally, the TB video is the only video in which the nurse from HC2 can be seen. Seven HC2 CHWs mentioned that the appearance of the nurse helped them in their persuasion. One CHW reported that a client said:

*“We thought you were lying to us, but now we can see this is true. The nurse is here talking about this matter **in person**.”* – Reported by CHW 24, HC2

HIV is as much a crisis in rural Lesotho as TB. We asked CHWs and nurses why HIV videos were not as popular as the TB video. The nurses explained that as part of the national fight against TB, CHWs were tasked with identifying suspected TB cases, encouraging infected people to visit health centres for tests, and assisting them through treatment to ensure adherence. Nurses believed that because of this specific mandate for TB, CHWs used the TB video more often. With HIV, they were expected to teach and support the public, but national campaigns were no longer as rigorous. Additionally, CHWs mentioned that HIV is now better-understood than TB.

Indeed, national campaigns in which CHWs get involved affect video consumption in cases like this. Similarly, during the Ebola outbreak in West Africa in 2015, the Ebola video was used at high rates because there was a national campaign launched to educate communities on the virus. Much of the rural population did not know about Ebola, and community members were frightened by the rumours of its deadly nature. As a result, they relied on CHWs to educate them on the state of Ebola prevalence in Southern Africa, and to give them information on prevention measures. CHWs were instructed to discuss Ebola widely in their communities, to educate people thoroughly, and to correct any misconceptions. CHWs, therefore, showed the Ebola video frequently in that period. However, once Ebola had been managed in West Africa, and it seemed there would be no outbreaks in Southern Africa, the national top-down push for Ebola education subsided, as did the CHWs' frequency of showing the Ebola video.

The video on STIs was popular among other CHWs, who stated that the video was known for its explicit graphic imagery of STI-infected genitalia. Many people in the CHWs' villages had never seen such images or been exposed to the reality of STIs, so CHWs reported they preferred to show the video to demonstrate that STIs are real. Some CHWs said they also showed the video to teach people that there is no reason to hide when one has symptoms, since they learned that many people in their villages were infected with STIs but were either afraid to disclose symptoms or embarrassed to seek medical assistance.

Figure 20, which compares videos at HC2, confirms the use patterns described by CHWs, with TB being the most-viewed video, followed by STIs.

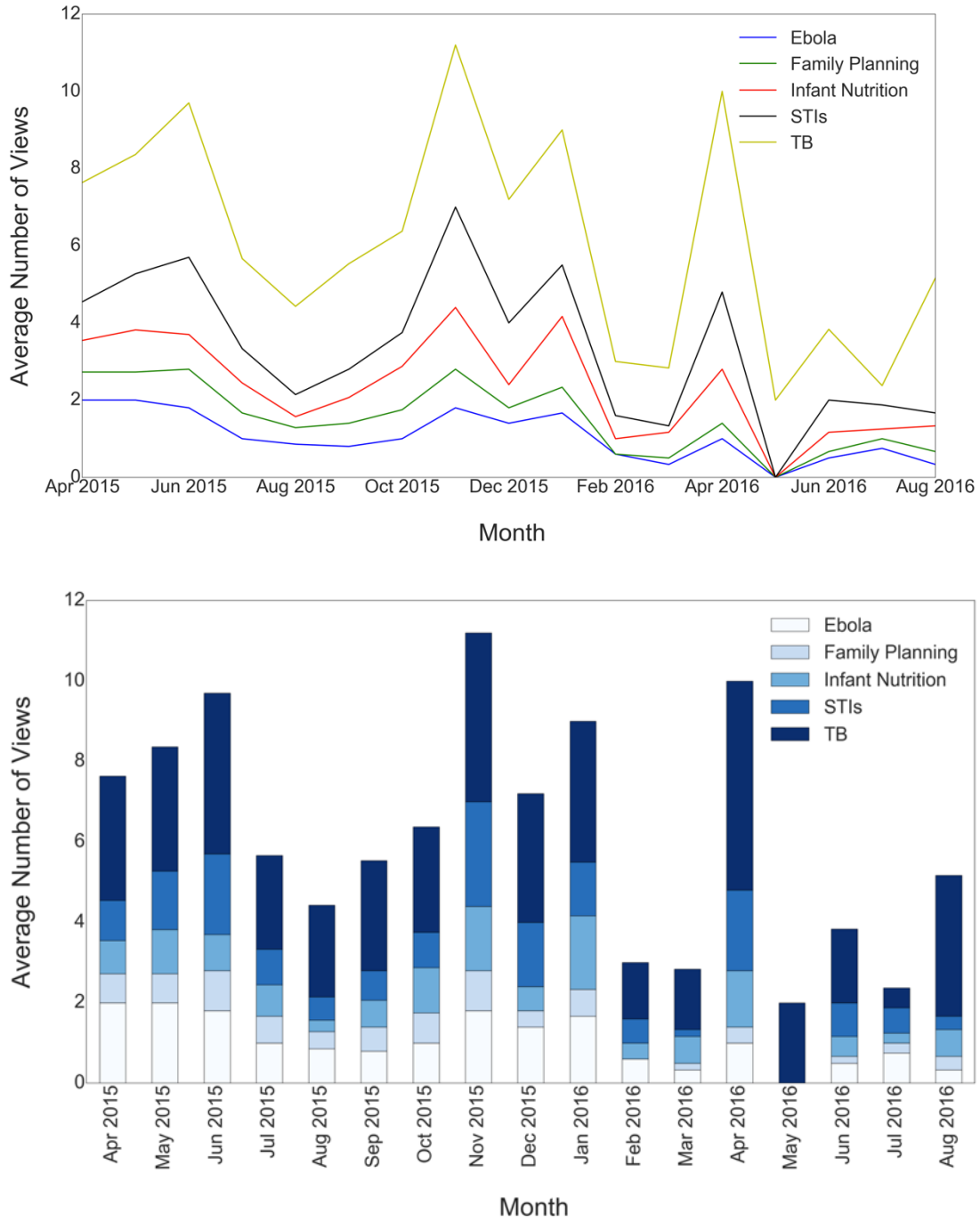
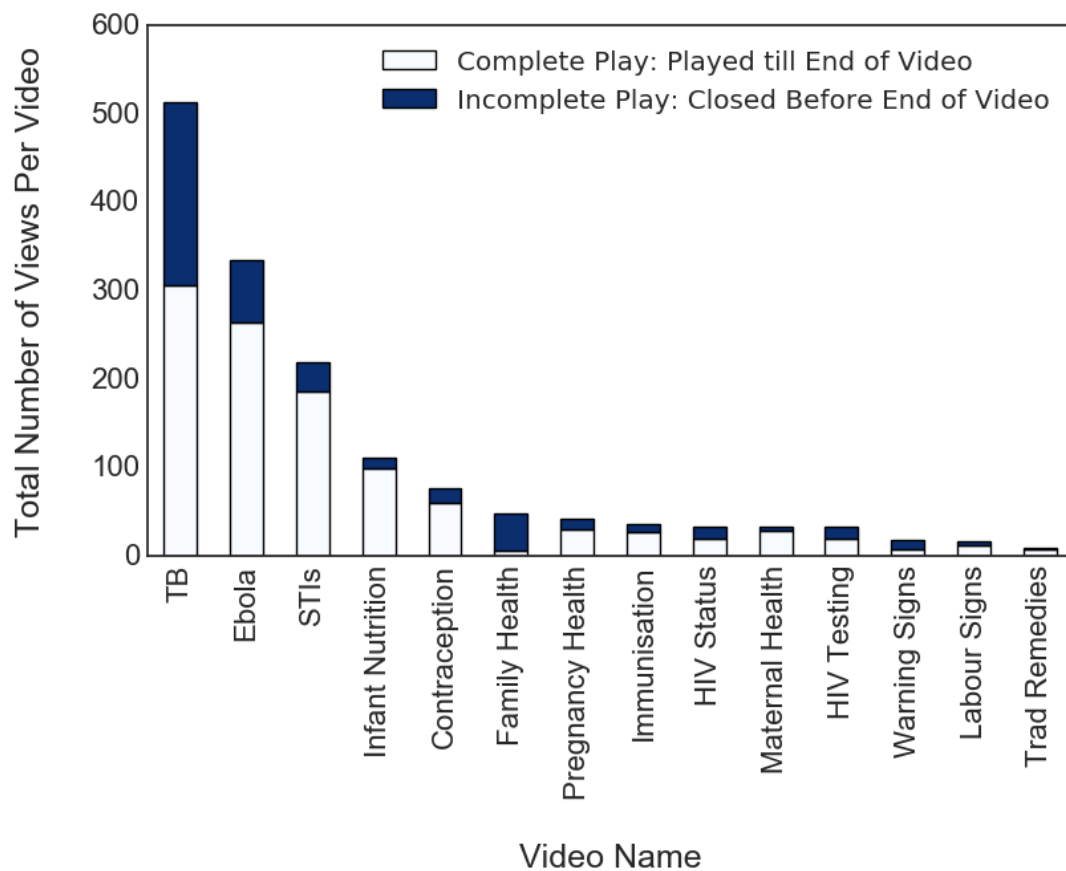


Figure 20 (a,b) - Comparing Per-Video Performance at HC2.

*Video Popularity – Frequency of Play and Play Completion Rates*

Looking at the total number of times all the videos were played in the 17-month period (2898 total views), 37% of the time (1081 times) the videos were watched until the end; 15% of the time (448 times) the videos were not completed, but were watched beyond the 10% threshold; and 47% of time (1369 times) the video playback was terminated before reaching 10% of the video length. Figure 21 presents the total views per video for all views longer than 10% of the video length. It focuses on the ratio of complete to incomplete plays per video.



**Figure 21 – Video Total Views Comparing Proportion of Complete Plays vs. Incomplete Plays.**

We also wanted to determine whether the most frequently-viewed videos were more likely to be watched until the end, or if shorter videos were more likely to be watched

until the end. We found a very weak correlation between number of video views and completion rate (Figure 22, Pearson's  $r(12) = 0.09$ ,  $p = 0.75$ ) and between video length and completion rate (Figure 23, Pearson's  $r(12) = 0.03$ ,  $p = 0.91$ ). In these plots, video popularity is the mean number of views for the video, and video completion is the ratio of completed plays to total plays for each video.

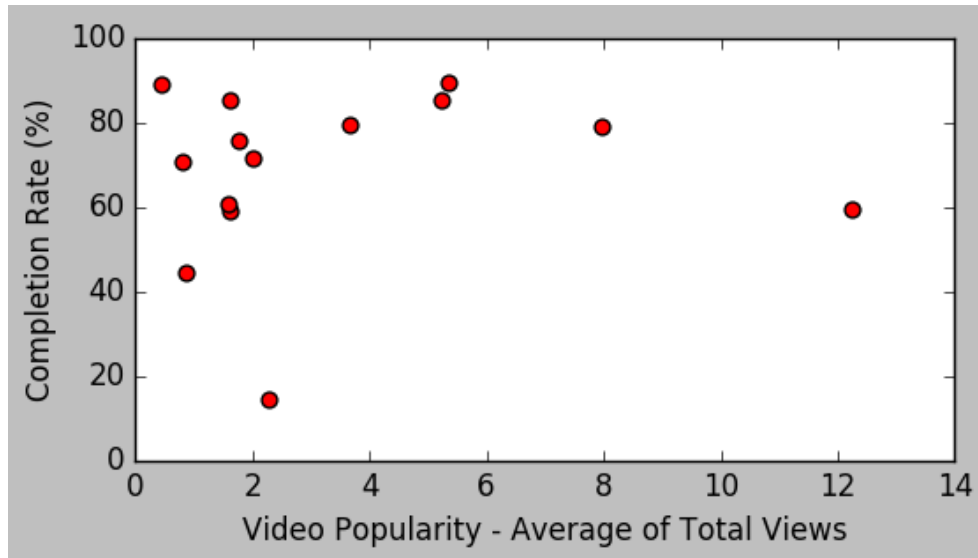


Figure 22 - Video Popularity vs. Video Completion Rate.

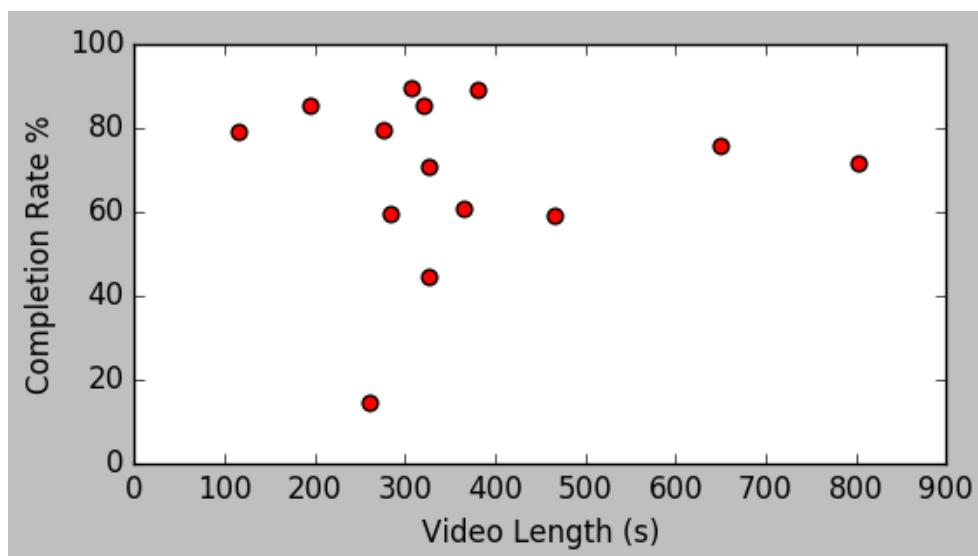


Figure 23 - Video Length vs. Video Completion Rate.

### 5.5.3 *Pausing and Conversations*

Ramachandran et al. (2010) suggested that active pausing and discussion during a video would lead to greater behavioural change. Indeed, in early versions of the BH app, we implemented a feature that allowed CHWs to pause and add audio annotations at points in the video playback. This feature was later removed because the CHWs found it to be confusing and largely unused (discussed at length in Section 3.3.2). Throughout the 17 months of the study, playback was paused during only 14% of video views. Of the paused sessions, playback was resumed only 25% of the time. The remaining 75% of the time, the app was closed, or the user returned to the video gallery after pausing. Where playback was resumed, pauses lasted an average of eight seconds; the longest pause was 27 seconds. In interviews with the CHWs, 90% confirmed that they rarely paused the videos when they showed them to the public or individual patients. They explained that they preferred to let a video play until the end, and then discuss it afterwards. When asked what they did if the audience had a question as the video played, one CHW said:

*“I tell them to watch the rest of the video, and then we’ll discuss. If they seem impatient and not willing to wait for the video to play until the end, I just close the app and allow them to talk.” – CHW 9, HC1*

### 5.5.4 *Characterizing Community Health Workers*

We recognise that not every CHW used the application in the same way. In this section, we examine some of the factors that we hypothesised might lead to different individual usage rates and styles.

#### *CHW Smartphone and BH App Competence (RQ4)*

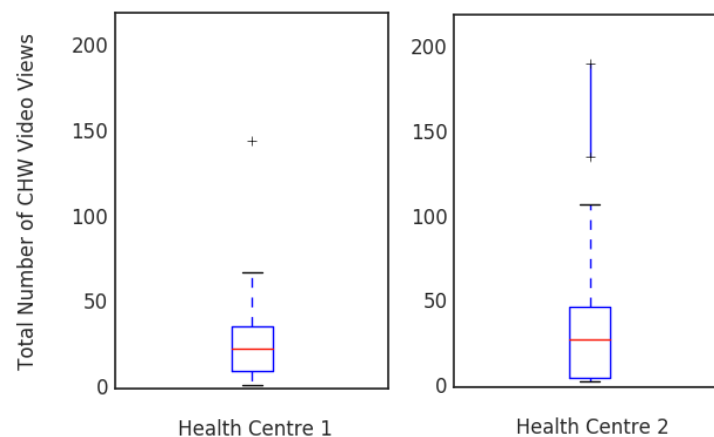
As we launched into the 17 months’ period of the study, user tests and interviews were held with 42 CHWs to determine their familiarity and competence with the devices after the exploratory phase. The same tests and interviews were conducted with 36 CHWs at the end of the 17-month period. In user tests done at the beginning and end of the study, all the CHWs could easily find the BH app, launch it, and arrive at page 1 of the video gallery. In both workshops, all CHWs could play a BH video from the BH gallery.

However, at the beginning of the study, four CHWs struggled to understand how to play a specific video; they appeared to play any video without first looking at the thumbnail or label.

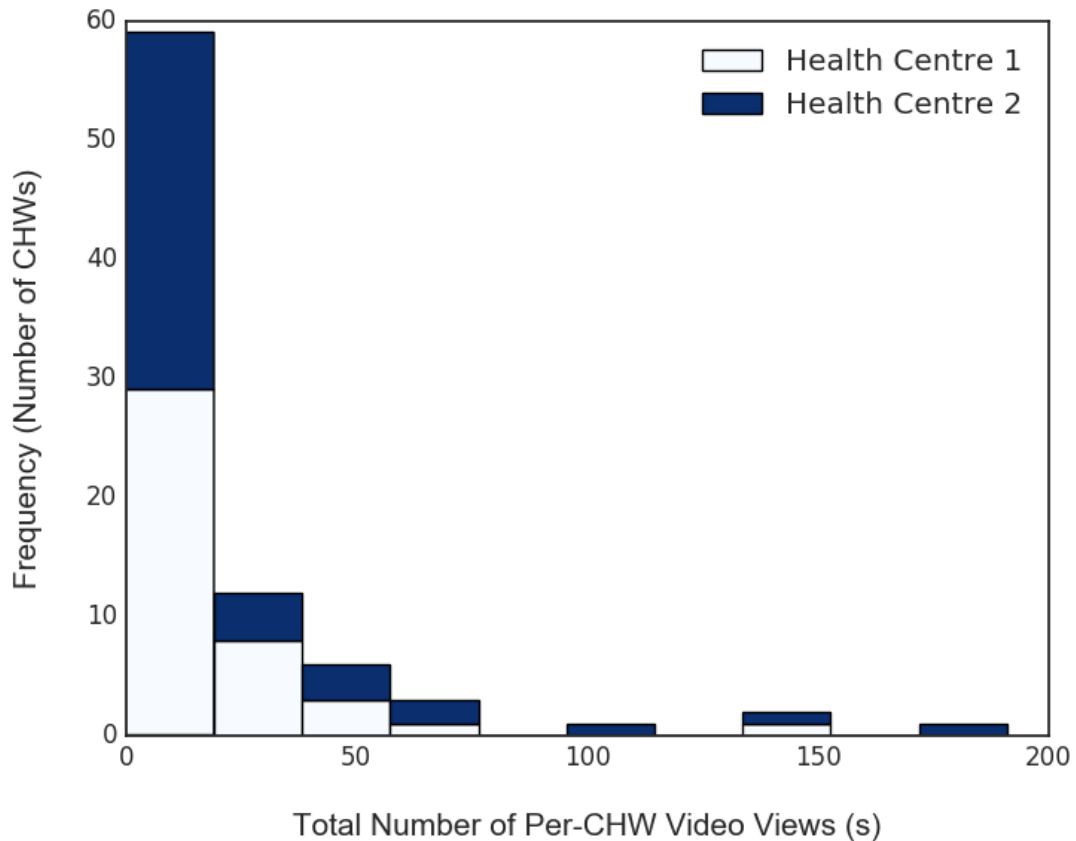
The four CHWs who struggled at the beginning of the study were present at the tests conducted at the end of the study. Two of them still struggled with finding a specified video after 17 months, though they could now navigate easily between the two pages of the app. One said she usually played all the videos sequentially for a few seconds each until she found the one she was looking for. The other two of the four CHWs who struggled at the beginning had improved by the end of the study and could navigate the app and play correct videos as effortlessly as the rest of the CHWs. The rest of the CHWs correctly found the videos by reading the names of the videos and using the thumbnails to guide them. The struggling CHWs received further training and guidance after both sessions.

#### *Total Views Accumulated Per CHW (RQ<sub>4</sub>)*

At HC1 (N=21 CHWs), the mean number of total accumulated views in 17 months per CHW was 31.0; the median was 23.0 views; ranging from 2 to 145; and the standard deviation was 31.6. At HC2 (N=21 CHWs), the mean number of total views in 17 months per CHW was 41.9; the median was 28.0 views; ranging from 3 to 191 views; with the standard deviation of 49.7.



**Figure 24 - Distribution of CHWs' Accumulated Total Views Over 17 Months.**



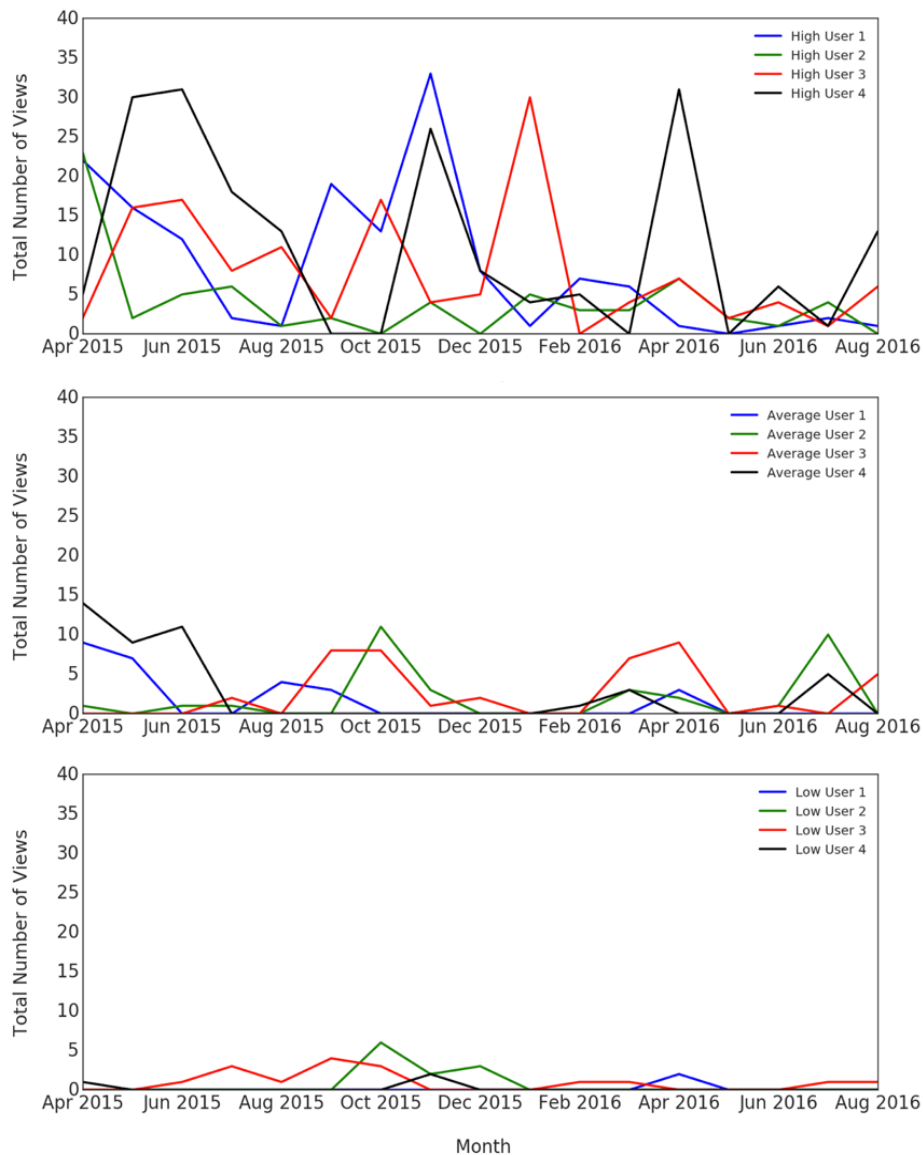
**Figure 25 - Histogram of the CHWs' Accumulated Total Views.**

Figures 24 and 25 show the distribution of the total views accumulated per CHW in each of the CHW groups. Most CHWs (80% at HC1, 67% at HC2) viewed less than 50 videos in the 17 months; 13% at HC1 and 13% at HC2 viewed between 50 and 100 videos; and 7% at HC1 and 20% at HC2 viewed over 100 videos in 17 months. HC1 had one outlier with a total of 145 total views—more than double the views of the next-highest CHW who had 68 total views. HC2 had three similar outliers, with total views of 191, 136, and 108. The next-highest CHW in HC2 had 74 views.

#### *Usage Patterns of Individual CHWs (RQ4)*

To further understand the patterns of use of the BH videos, we looked at the use patterns of a subset of individual CHWs. From each health centre group, we picked two CHWs with the highest number of total views, two with the lowest number of total views and two at the median of total views. In total, we closely examined 12 CHWs, as reported in

Figure 26. High-use CHWs did not necessarily watch videos at a steadily high rate across all the months on record. For each of the high-use CHWs, there were one to two months within the 17-month period when the CHW did not show any videos (6% -12% of the time). However, each CHW had spikes of high use in varied months, going as high as 30 video views a month. Three of the four high-use CHWs were some of the oldest CHWs (aged 70,66,62).



**Figure 26 – From the top: (a) Usage Patterns of Four 'High Users', (b) Usage Patterns of Four 'Average Users', (c) Usage Patterns of Four 'Low Users'.**

Average-use CHWs consumed BH videos in 6 to 9 of the 17 total months of the study, with usage peaks going up to between 10 and 12 video views a month. During the user tests in August 2016 (at end of the study), Low User 1 and Low User 2 (one originating from each of the centres) were the only two CHWs (out of the 36 tested) who could not find the required video by opening the app, swiping to Page 2 and playing the specified video. Our conclusion from watching their interaction with the app was that they used it rarely. The logs confirm this suspicion. Low User 1 played only two videos (beyond 10% of the video length) during the entire 17-month period, and Low User 2 played only 11 videos (in only 3 of the 17 months). Low User 3 and 4 could easily navigate the app, made no errors and were able to perform all given tasks. We do not have an explanation for Low User 3's low-usage rates; because while she showed few videos per month, she logged usage in nine of the months of the study period. Low User 4 only had 29 video views at the end of the study. She was one of the youngest CHWs. When asked about her performance, the nurse at her health centre said:

*"I am not surprised. This CHW is only interested in entertainment multimedia and she uses the BH-provided phone for personal use only. She always has headsets on - playing music, funny videos, etc." – HC2 Nurse*

#### 5.5.5 Scenarios of Use

We wanted to further understand the scenarios in which CHWs showed videos, both as a means of helping us understand their usage patterns and to discover how to best support them in the future. From interviews with the CHWs, we identified eight different scenarios in which CHWs used the BH content.

#### **1) CHWs take advantage of being among a group of people and show several videos for the general education of the group:**

*"As we sit and chat with friends or neighbours, I normally bring out the phone and choose a video, or multiple videos, to show to them... normally I will begin with TB or STIs." – CHW 11, HC1*

*“During family events with my extended family, I will play one video to my relatives. They get amused and ask for more... At our family’s Christmas feast, we watched all the videos in my phone.” – CHW 26, HC2*

*“While waiting to fetch water at the communal water source, or when the village men and women are gathered doing communal work, I take advantage there and show two or three videos.” – CHW 15, HC1*

**2) When engaged with a specific user group, CHWs select a topic or topics of most relevance to the group:**

*“When I am with young mothers (for example, when they gather at my place for monthly weigh-ins for their infants), I show them the Family Planning and Infant Nutrition videos.” – CHW 34, HC2*

*“When I come across a group of young people, I show them the STIs videos.”  
– CHW 5, HC1*

*“My daughter-in-law has a hair-dressing salon. I go there sometimes and make the girls waiting in the queue watch a few videos... I often show them the Family Planning video.” – CHW 9, HC2*

**3) Members of the public occasionally request that CHWs show videos, without specifying a topic:**

*“Sometimes when we have just dispersed from a village meeting, one person will ask me to show them ‘my interesting videos’ and then I will choose one to play. Then people will gather and watch. I may end up showing three of four in a sitting.”  
– CHW 12, HC1*

**4) Some members of the public request a specific video:**

*“At times, I meet someone and they say, ‘Hey, please show me that scary STIs video again!’” – CHW 26, HC2*

**5) A CHW responds to a person’s or people’s insufficient knowledge on a subject by playing the relevant video on the topic:**

*“Sometimes I listen to someone talk about a topic like Ebola or STIs and realise how far from accurate their knowledge or assumptions are. Then I just pull out the video and show them what is correct.” – CHW 2, HC1*

**6) CHWs also use videos as tools to directly convince patients to pursue recommended healthcare practices, using the voice of the nurse in the video to increase the credibility of their teachings.**

*“This is especially true for TB. I see someone with TB symptoms. I go and try to encourage him to go for a TB test. When he doesn’t believe what I am telling him, I produce the TB video so the nurse can back up what I am teaching.” – CHW33, HC2*

**7) CHWs use videos as counselling material during home visits.**

*“When I have gone into a home to check on a patient, I will choose a video that I know will either persuade him or her to seek medical help, adhere to treatment, or be assured that their condition can be treated... In home visits, sometimes I play videos to caretakers more than to the patient.” – CHW 30, HC2*

**8) At the instruction of the village chief, sometimes the village population gathers for the CHW to address them.**

*“Addressing the public at a Pitso is very common. I talk to them about any relevant topic, based on my observations, or because the nurse has instructed us to teach people on a certain topic. Sometimes at the Pitso, I will play a video and let the population listen to the nurse directly.” – CHW 14, HC1*

*Pitso* is a gathering of the village adults called by the chief. The *Pitso* scenario was one of the first that we learned about from the CHWs. Halfway through the 17-month study, we provided each CHW with a portable loudspeaker that she could connect to her phone via audio jack or Bluetooth. We thought that the loudspeakers would help CHWs in those outdoor settings when playing a video for large crowds. At the end of the study, however, only five of the 36 CHWs we interviewed confirmed that they had used the speakers.

## 5.6 DISCUSSION

The data collected and analysed in this study have helped disprove some of our initial assumptions. They have also opened new areas of understanding for us and other researchers to better support CHWs in their community health education mandate in the future by designing more appropriate tools suited for their context and work culture.

The discussion in this section is divided into two parts: the first addresses our improved understanding of CHWs as a result of this longitudinal study, and the second details our observations and analyses of usage trends as observed from the CHWs' logs.

### 5.6.1 *Improved Understanding of CHWs*

#### 5.6.1.1 *Community-Based Health Education in Practice*

We found that CHWs used BH content in varying contexts and scenarios, many of which went beyond what we initially imagined. Due to the varying contexts of use beyond traditional house visits, CHWs have periods of high use followed by low use. For example, a CHW might show all the videos on her phone in one day at a family gathering, and then not show another video until two weeks later when she is working with new mothers when they bring their infants to her house for growth monitoring. We also found that CHWs play videos to large groups more often than to individuals—a phenomenon that was also observed with ASHAs in India in a study by Ramachandran et al. (2010).

However, in contrast to Ramachandran's findings, our CHWs preferred to play videos to completion and to discuss the content afterwards, rather than pausing to comment and clarify concepts in the middle of the playback. CHWs felt that by pausing to engage, they would be interrupting the nurse speaking in the video; it was more respectful to let the nurse finish. Pausing for discussion before playback was complete had the added effect of reducing interest in watching the rest of the video after a lengthy discussion. While the first version of the app was designed to encourage pausing and engagement, CHWs found the pausing to be inconsistent with their preferred natural flow. In their interactions with villagers, CHWs and their clients often engaged in lengthy discussions that could not be easily incorporated into a brief pause, confirming findings by Kumar et al. (2015) and Fiore-Silfvast et al. (2013).

### 5.6.1.2 *Simplicity for Confidence*

Apart from their preferred flow, CHWs expressed a preference for simplicity as a reason for not pausing during video playback—they preferred this approach so that they could confidently manage viewing sessions. They felt that they wanted to conduct as simple a play session as possible to avoid ‘pressing so many buttons’ that they would end up confused and look incompetent in front of their community members. It is for this reason that 60% of the CHWs did not seek video new positions using the slider during playback, and why those who did only moved the video forward, never backwards.

We also observed that this preference for avoiding errors led to the CHWs’ reluctance to use the supplied portable audio speakers. All but five CHWs did not use the speakers at all. They did admit that they saw their utility, but they preferred not to carry any extra equipment that could potentially fail and embarrass them. Looking confident and technically competent was important to the CHWs. It is a means of maintaining the elevated status they received in their communities when they began using mobile phones for their work.

### 5.6.1.3 *The Effect of CHW Attitudes and Attributes in Usage Patterns*

We interviewed the nurses to discuss the varying consumption patterns of the CHWs, and found that the common attribute of all high-use CHWs is that they were generally highly committed to their community work, even outside the BH project. For these CHWs, the new technology was just an amplifier of prior intent (Toyama, 2011). Most of these CHWs happened to be older, and many had worked as CHWs for more than 20 years, with commitment. One of the nurses said:

*“At the end, we found that far beyond this project, what is important is to have CHWs who are truly committed to their work. The ones who have high usage rates in BH are already very active CHWs. Even if the task is to follow up on patients who have defaulted on treatment, or to conduct community teachings on a given subject, these top users are the ones who will always go out of their way to complete the task and report accordingly. Their performance in the BH project is a direct reflection of their general commitment to their CHW duties.” – Nurse at HC2*

However, not all the committed CHWs were high users in the BH project, but only those who were also open to learning and leveraging technology for their work. We also identified some previously inactive CHWs whose commitment to community work was ignited by their excitement for the technology. Commitment to community work and openness to learning and exploring the technology were attributes and attitudes of CHWs that seemed to affect their usage rates.

#### 5.6.1.4 *Age Is Not a Limiter of Use*

At the beginning of the BH project, nurses suspected that old CHWs (over the age of 60) would not be effective in the project because it would be harder for them to become accustomed to using mobile phones in their work. However, based on previous work in studies addressing technology for the elderly and low-literate (Muller and Druin, 2012), when participatory and empowered design principles are applied (Marsden, 2008; Rogers *et al.*, 2014), older people can become empowered and interested enough to learn and use technology. We decided to work with all CHWs to study if CHWs of all ages and literacy levels could be empowered to learn to the point of fluently using technology in their work.

From the usage logs collected during the 17-month study period, we found that 72% of the high-end users were CHWs over the age of 55; the highest users at the two health centres were 70 and 66. While the data does not suggest that old CHWs are more effective at mobile-supported health education than young CHWs, we found that old and committed CHWs can nevertheless be effective with technology when given the opportunity to learn and when the design of the mobile application is considerate of limitations such as literacy, prior exposure to technology and failing eyesight. Our results also point to the importance of intermediaries like children and younger peers. Similar results have already been discovered in other contexts in ICT4D work (Parikh and Ghosh, 2006; Sambasivan *et al.*, 2010; Kumar and Anderson, 2015; Katule and Densmore, 2016). Lessons from our study also highlight the importance of allowing self-exploration. Some of the older CHWs preferred to explore and learn by themselves.

### 5.6.1.5 *Regular Engagement with CHWs*

We found that after BH-focused workshops, CHWs remained motivated to use BH videos at increased rates. However, the initial enthusiasm after meetings eventually wore off and caused the frequency of plays to return to a lower, more stable rate. We recommend regular engagement with CHWs, not only to keep them motivated to use the content, but also to encourage exploration of the technology and to counteract technical attrition (Schwartz *et al.*, 2013). Engagement with CHWs does not have to be performed by the researchers alone; discussions and activities about CHWs' digital content use can form part of their monthly meetings. In BH workshops, for example, we used roleplay exercises where CHWs staged their experiences using BH video in their villages, and this spiked enthusiasm in them. We also learned that when CHWs were frequently encouraged to explore the BH app and content, it improved their confidence, and thus their usage.

## 5.6.2 *Analyses of Usage Trends*

### 5.6.2.1 *Topical Relevance Begets Video Popularity*

Our expectation was that interest in videos would decay over time, with older videos losing popularity in favour of newer ones (Meeyoung Cha *et al.*, 2009). However, after 17 months, the two most-watched videos were those on TB and STIs. The CHWs found these to be the most relevant to their work based on their assessments of their clients' health information needs. TB remained the most-viewed video because it assisted CHWs in their primary mandate under the current national TB campaign. The STIs video was popular because it facilitated discussion on a highly-prevalent issue that was otherwise taboo for discussion. Thus, the primary retrospective indicator of a video's popularity is not a feature such as length, authorship, style, or novelty. Instead, its topical relevance to the community, as perceived by the CHW or indirectly depicted by the community through the questions they ask and the conversations they have with CHWs, is the prevailing factor.

### 5.6.2.2 *Novelty Usage Spikes*

Our results show an initial use spike for all videos that the CHWs had at the beginning of the study, and another spike in usage when new videos were introduced. These spikes show the temporary initial excitement over new content; however, this excitement lasted

no longer than three to four months. Novelty spikes can be leveraged for introducing new topics to the community, as was the case with Ebola in this study. However, in the absence of sustained interest or extrinsic motivation, as with the TB videos, new videos must be introduced every few months.

### 5.6.2.3 *Engaging Imagery: Explicit Content*

Of all the BH videos, the STIs video has the most explicit imagery, in part because it contains images of genitalia which are not commonly seen in public, but also because it shows scary images of untreated genital warts in males and females. The nurses wanted to communicate the importance of seeking medical attention as soon as one observes signs of an STI, emphasising that treatment is easily accessible, but also showing how dire the infections can be if left untreated. Of all the videos deployed in the 17 months in which we ran this study, the STI video was the most “talked about”. It stimulated great interest and initiated dialogue among many people in the CHWs’ villages. Those who saw the video and were frightened by the images referred their friends to the CHWs so that they, too, could watch the video. Those who requested to see the video would end up watching several others. The use of this graphic video confirms the role of engaging or provocative imagery in health education (Leshner, Bolls and Thomas, 2009).

## 5.7 CHAPTER SUMMARY

We worked with 54 CHWs who were first-time smartphone users and studied their use of multimedia content for community health education over 17 months. We enquired about the diffusion and use of the content over this period and sought to understand the attributes of the content itself and the practices of the CHWs that affected patterns of consumption. We demonstrated that CHW engagement and topical relevance of health videos affect rates of use the most. We also presented lessons applicable to projects seeking to deploy multimedia content in rural settings over long periods of time. The long-term nature of the deployment of the BH systems in the field allowed a rigorous evaluation of the BH multimedia learning model, giving insight into the way that content is consumed by CHWs. Lessons learned from this deployment and study are useful in

understanding what makes a video health education platform successful in a rural CHW-led context.

## 6 SMARTPHONES IN THE FIELD: DOES THE SMARTPHONE NEED REDESIGN?

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In this chapter, we first discuss lessons learned from previous work regarding the choice of devices in ICT4D projects—lessons that informed our choice of devices in the BH project. We then present the rationale behind choosing smartphones for CHWs to use for the multimedia health education work within the BH project. Further, we look at how CHWs, as first-time smartphone users, adopted the project-provided smartphones and other hardware. We focus specifically on their process for learning the devices and how they integrated the devices into their homes and communities. We present the results of interviews and focus groups with CHWs that were conducted to discover the people who got involved as intermediaries in the CHWs' processes of learning, use, and exploration. Finally, we discuss the use of smartphones in rural villages by the old and low-literate and then present a call for the redesign of the smartphone to achieve contextual relevance in low income areas.

In the previous chapters, we discussed the design and evolution of the BH platform, focusing on how CHWs used the mobile phones and other tools provided for their work. However, the devices became part of the ecosystem of their lives as individuals, in their homes, and in their communities. It is, therefore, necessary to examine not only how the CHWs used the devices given to them for the project, but also how the devices affected their lives outside the project (Donner, 2015). In other words, it is imperative to understand the external factors that influenced their use and adoption of the technology.

## 6.1 RELATED WORK / LESSONS FROM LITERATURE

### 6.1.1 *Choosing A Mobile Phone for An ICT4D Project*

Many ICT4D projects leverage the widespread availability of mobile phones to achieve their development goals. Mobile phones are often used in interventions not only because they are familiar to many potential beneficiaries but also because they incorporate a multitude of capabilities including communications, internet access, multimedia, and games. However, all ICT4D projects ultimately face the same decision: what phone or mobile platform should the project use? Should researchers buy and deploy new devices for the project or should they leverage the devices that their participants already own?

We reviewed 50 ICT4D-related papers published at ICTD, ACM DEV and CHI conferences between 2012 and 2016 with the goal of understanding the choice of mobile phones and platforms used in each project. For each paper, we sought to identify the nature and objectives of the study, its technical requirements, the applications and features that the project developed or deployed, the study location, the identities of the users or participants, the type of mobile phones used, the mobile platforms they supported, the reasons for choosing a specific phone or platform, and the lessons learned from the use of the chosen phone or platform.

The next section discusses the factors to consider when choosing devices and platforms for an ICT4D project based on the lessons we gleaned from these papers. These lessons formed the basis of our device choices for the BH project.

### 6.1.2 *Assessing Project Needs*

#### 6.1.2.1 *Purpose and Feature Requirements*

When selecting a device, a team must ask several questions to identify the expected purpose(s) of the devices to be used in a project. Will the device be used to run a new mobile application, to browse the web, to make phone calls to an Interactive Voice Response (IVR) system, to consume multimedia content, or to receive notifications via SMS? What phone features (e.g. camera, GPS, WLAN) will be required to achieve the desired solution? Will a mobile application be developed? What computing resources

and capabilities will be needed for the application? What interactions (e.g. swipe, typing, etc.) are envisioned or preferred? Reflecting on these requirements is the first step in determining device and platform choice.

#### 6.1.2.2 *Funding and Project Nature*

The second central decision that must be made for determining the device and platform to use in a project relates to whether the project team will buy handsets to support the new project or leverage existing devices that project participants already own. This decision depends on the nature of the project, the envisioned purpose of the project, and the funding available. Where there are funding limitations or where the objectives do not call for new devices to be purchased, researchers can decide to use phones that participants already own (Joshi *et al.*, 2014). Depending on the devices the participants own, it is not ideal to develop native applications in these cases. Instead, solutions that support multiple platforms, versions, and phone types should be adopted. These solutions can employ Unstructured Supplementary Service Data (USSD), Short Message Service (SMS) (DeRenzi *et al.*, 2012), IVR (Mudliar, Donner and Thies, 2012b), or mobile web technologies (Brown, Marsden and Rivett, 2012). The challenge with web, SMS, and IVR applications in most low-income regions, however, is the costs involved in data, calls, and SMS (Ssekibuule, Quinn and Leyton-Brown, 2013). Researchers using these options would have to plan upfront whether the charges will be borne by the project for its duration, or whether people will be expected to pay to access the services. Such decisions require researchers to consider the sustainability of the project beyond its initial funding cycles.

When researchers plan to take advantage of devices already in people's possession, it is important to thoroughly identify the variety of phones that are owned by the target group. Smartphone prices are declining and more people in rural areas will own them in the years to come. In reality, however, many people still own feature phones rather than smartphones (Mathur, Agarwal and Jaiswal, 2013; GSMA, 2016). As a result, in many areas, feature phones may still be the devices to target when designing ICT4D solutions. Even when designing for smartphones (in instances where the majority of the user base owns smartphones), it is important to understand the limitations of the devices owned by the target group. For example, low-end smartphones often have lower computing resources

and run older versions of the mobile operating systems (OS). Applications developed for users of such phones must thus be compatible with a variety of smartphone versions.

It can be that smartphone capabilities are needed to reach project goals but the people participating do not yet own or cannot yet afford to buy their own smartphones. In such cases, the implementing organisation or research team can provide the phones to the participants for the duration of the project (Motlhabi *et al.*, 2013). Another reason to buy phones for the project is the desire for uniformity, especially in cases where the project requires all participants to have similar phones or a common mobile phone platform for experimental validity.

### 6.1.2.3 Context

Understanding the context in which devices will be used allows the project team to discover the aspirations of the user group, to properly identify the problem to be solved, and to devise the right solutions for the problem. Not every development challenge needs a new smartphone application. Sometimes simple solutions prove to be most effective (Densmore, 2012). Selecting the right device for a project depends on understanding the environmental and infrastructural factors of the project context. In most rural areas, the factors to consider when choosing a phone or mobile platform include device durability, visibility of the screen outdoors, audio quality for use in noisy environments, and battery life (especially in contexts with intermittent power supply). A few smartphones and feature phone models exist, that have been specially designed to survive rugged environments (e.g. dust, humidity) which teams might consider (Vitos *et al.*, 2013).

### 6.1.3 Advantages of Smartphone Deployment

Feature phones have historically been preferred in ICT4D projects because for many years they were the most affordable, had the best battery life, and were the most prevalent in rural communities. As some of these variables have begun to change, more ICT4D projects have started choosing smartphones for their experiments and deployments. Sixty-nine percent (69%) of the 50 ICT4D projects published between 2012 and 2016 that we reviewed used smartphones for their deployments and experiments. A larger analysis by Dell and Kumar on HCI4D projects published between 2009 and 2014, found that the number of smartphone-based projects in the HCI4D related conferences

they reviewed (ICTD, CHI, DEV, ITID, Interact, CSCW, MobileHCI, DIS, NordiCHI, Ubicomp, UIST) rose from four in 2009 to 23 in 2012-2014 (Dell and Kumar, 2016). There are advantages to smartphone use that motivate their selection in recent ICT4D projects. However, there are also challenges associated with them that must be well understood, which will be discussed in Section 6.1.3.

#### 6.1.3.1 *Higher Specification Needs*

Some implementations necessary for executing research objectives require devices that are more powerful than the traditional feature phone. When compared to feature phones, smartphones provide significantly greater memory, larger screens, larger storage, and faster and more fluid interactions. In cases where the research context and other project factors permit the choice, these factors impact researchers' preference for smartphones in their ICT4D projects. Taking advantage of the processing power of smartphones gives project teams more opportunities to create innovative features and solutions that were not easy to achieve with the computing constraints of feature phones (Mathur, Agarwal and Jaiswal, 2013; Vitos *et al.*, 2013). Many developers find it less strenuous to develop Android applications because of the free and open nature of the operating system. Additionally, with Android, the development experience has fewer restrictions than on many other platforms (Dell and Borriello, 2013; Vitos *et al.*, 2013).

#### 6.1.3.2 *Decreasing Prices and Increasing Aspirations*

While research projects have aspired to take advantage of the resource offerings of smartphones in the past, the high costs of the phones in previous years prevented them from being considered in many typical ICT4D projects. However, smartphone prices have recently begun to decline to the point of competing with the prices of feature phones that were once considered affordable. In the last few years, we have seen Moore's Law at play: the processor speed of mobile phones has begun to double every 18 months, yet costs have remained the same or even decreased (Robinson, Marsden and Jones, 2014). This price decrease is encouraging many individuals to buy smartphones. Consequently, many ICT4D project planners have begun researching smartphone solutions in their work (Motlhabi *et al.*, 2013).

While smartphone prices continue to decline, challenges to adopting the phones in rural areas remain. These challenges are discussed in more detail in Section 6.1.4. Even with

the contextual challenges, however, many rural-based individuals find smartphones more desirable. People aspire to own and to be seen with more sophisticated phones (Friscira, Knoche and Huang, 2012; Motlhabi *et al.*, 2013).

### 6.1.3.3 *Improved Interactions*

Touchscreen phones are easier to use for data collection, for multimedia consumption, and for feedback generation than feature phones are. It is easier to touch and swipe than to navigate menus with keys and a much smaller screen. Vitos *et al.* (2013) observed among their test subjects in the field that sliding a finger across a touchscreen interface to draw out a pattern for access control seemed easier and quicker than typing a complex password on a feature phone.

While we have learned from the literature that there are benefits to adopting smartphones for ICT4D projects, some challenges that affect their adoption still exist.

### 6.1.4 *Considerations and Challenges for Smartphone Deployment*

Smartphones are certainly attractive for all the reasons outlined in the previous section. In rural Africa, however, the majority of people still own low-end phones due to battery life limitations, repair infrastructure requirements, and other challenges associated with smartphone ownership (Wyche and Murphy, 2013). This section discusses these challenges, which every ICT4D project deploying for or on smartphones should consider.

#### 6.1.4.1 *Battery Life*

When smartphones are used in rural projects, plans for charging the devices must be considered upfront. The reality is that many people still struggle to charge their mobile phones. In rural Lesotho, for example, the cost of charging a phone at homes or business establishments with electric or solar power is around 0.50 USD per charge. Most people cannot afford to pay this price several times in a week. Other projects are already exploring different methods for charging devices in areas with no power. These solutions include solar charging kits, solar charging stations, bicycle chargers, and the *Hatsuden-Nabe* - a thermoelectric cookpot that can charge phones while cooking (Bidwell *et al.*, 2008; Vitos *et al.*, 2013; Wyche and Murphy, 2013).

#### 6.1.4.2 *Cost of Use*

Even though smartphone prices continue to decline, researchers must consider what is referred to as the “fully loaded” price that accompanies the device. Beyond the purchase price, the “fully loaded” price includes SIM cards, data costs, repair and maintenance, peripheral devices, and charging costs (Tulchin, 2011; Schwartz *et al.*, 2014). These prices are higher for smartphones than for most basic phones, and should be considered in advance during project planning. Researchers must make decisions about whether certain costs will be borne by the project or by the device custodians (Schwartz *et al.*, 2013).

#### 6.1.4.3 *Liability and Security*

For device custodians (project participants), the pride of using a smartphone for an ICT4D project is accompanied by fearful caution—the fear of liability in the case that the device breaks or is stolen. In projects where devices store sensitive data like patient records, participants might feel more concerned about the financial and legal implications of losing such a device (Anokwa *et al.*, 2012). It is thus recommended that plans for data backup and encryption should also be provided for cases of device loss or theft. Also, people can be allowed to use the phones for their own personal uses outside the project, because with increased use comes increased comfort and a decline in fear of breaking the device (Schmid *et al.*, 2013).

## 6.2 CHOOSING SMARTPHONES FOR THE BH PROJECT

When the BH project started in 2011, the project provided Nokia C2-01 phones for the CHWs involved in the study (Figure 27). In 2013, we changed the CHWs’ phones to the Nokia Asha 201, and later in 2014, to the Nokia Lumia 520. The reasons for these choices and changes are discussed in this section.



**Figure 27 - BH Phone Choices, from left: (a) Nokia C2-01, (b) Nokia Asha 201, and (c) Nokia Lumia 520.**

At the beginning of the BH project, the role of the phones was merely multimedia consumption. The videos were consumed using the native video players installed on the phones. The Nokia C2-01 was selected because of its price (60 USD in 2011), its good battery life, its durability, and its outdoor usability. We supplied the devices because while 80% of the CHWs owned mobile phones at that time, only 25% of the phones were multimedia capable.

In 2013, we had the opportunity to procure more devices, and we chose the Nokia Asha 201. The Nokia Asha 201 was preferable because in 2013 it cost the same as the Nokia C2-01, but was a slightly smarter device with a bigger screen. It was also just as durable and suitable for outdoor use. As we continued our iterative co-design and development process, however, we learned that our future applications would require more computing resources than the capability of the Nokia Asha 201 allowed. To meet our resource needs, we changed the deployed devices to Nokia Lumia 520 smartphones in 2014.

When making this choice, our objective was to find a “budget smartphone” that could work in the field. We considered a variety of factors including the phones’ robustness, battery life, outdoor screen visibility and speaker loudness. We found several devices that met most of our criteria, including the Nokia Lumia 520. There were cheaper options (starting at 40 USD), but since our funding restricted us to use Nokia devices only, we

chose the Nokia Lumia 520 (running the Windows Phone OS). It was the cheapest Nokia smartphone at the time at 80 USD.

One of the questions we asked when selecting a smartphone and affiliated mobile platform was: *does the platform have a future in emerging markets?* We wanted to build applications that could be adopted by other organisations and researchers by the end of the project. We did not want to design applications for a platform so uncommon that it could not be duplicated in other settings without complete redesign and development for other platforms. We were aware that the Android OS had more potential in emerging markets, but we were limited to Windows Phones due to our funding restrictions.

Three years after this decision was made, the Windows Phone has become much less popular in Africa. For any organisation to adopt the BH application, they would need to re-build the application for Android, as many organisations prefer the Android OS. Despite this, it is still easier to port the BH application we built from Windows Phone to Android than it would have been if the app had been built for a feature phone platform.

### 6.3 STORIES AND LESSONS FROM SMARTPHONE USE

This section focuses on the BH deployment of smartphones with CHWs in rural Lesotho. It focuses specifically on how we supported the deployment with charging support, and examines the CHWs' overall experiences with the smartphones and support hardware.

#### 6.3.1 *The Solar Charging Solution*

We were aware when we deployed the Nokia Lumia 520 devices that many CHWs would have more challenges charging the devices than they did with the Nokia Asha 201. Of the 54 CHWs who received the smartphones, only 14 had electricity at home; the rest struggled to charge the devices. The CHWs reported that the Nokia C2-01 would last for up to two weeks without need for charging; the Nokia Asha 201 would last up to one week; but the Nokia Lumia 520 would last only four to five days with strict battery saving settings turned on, or one to two days without. For all three devices, the battery depleted much more quickly when the phone was used to play videos several times a day (the primary purpose of the devices). The Nokia Lumia 520 has the same battery as the Nokia

Asha 201. As advertised, it offers longer battery life during video/music playback. However, on standby, the battery depletes faster than that of the Nokia Asha 201.



**Figure 28 - Solar Charging Kit.**

For these reasons, we procured solar charging kits for all the CHWs who did not have electricity at home. We wanted to ensure that the CHWs were all able to charge their devices as often as necessary for them to use the phones at a pace of their choice and to avoid any downtime. Forty GDLite solar charging kits were deployed to the CHWs, each of which cost about 21 USD. Each kit included a 1W/6V solar panel, a 3.7V/800mA lead-acid battery, three light bulbs, a multi-port USB cable for mobile phone charging, and a torch (flashlight).

The GDLite battery (the charging station battery) could be solar charged or AC charged. On solar, it took 6-8 hours to fully charge the charging station battery in sufficient sunlight. When the charging station battery was fully charged, it could charge up to three mobile phones and provide up to five hours of light using the light bulbs. However, the torch uses more power than all other functions. For this reason, the manufacturers recommend that the torch should not be used for too long. The manual states that

leaving the torch on when the (charging station) battery charge is low could affect the longevity of the battery. While the product was not designed entirely for phone charging, it was the most affordable and effective solution we could find—there were no affordable, effective “phone-charging-only” solutions available when we began the project. All completing solutions combined lighting with mobile phone charging.

#### 6.3.1.1 *Use and Value*

The solar kits were received with great excitement by the CHWs’ families, mainly due to the lighting feature, but also for the new charging option they provided. The CHWs reported that the units allowed them to not only charge their project-provided phones, but also those that belonged to their families and friends. We asked the CHWs to submit pictures of the solar kits in their homes to show how they had set them up. A collage of some of their submissions is presented in Figure 29. We learned that the husbands of two CHWs got involved in setting up permanent solar wiring. They set the panels up on the roofs of their homes and used them to power the light bulbs inside their houses. For others, the light bulbs hung loosely on the railings of their thatch or corrugated iron roofs. Many CHWs said that the safest setup was to place the battery unit near the window inside the house, with the cable running through the window and leading to the solar panel outside. In other cases, the CHWs put both the panel and the battery outdoors and protected the battery from the sun by creating a shade. Three cautious CHWs said they never put any of the items outside, even the solar panel. Instead, they placed the solar panel on the inside of a sun-facing window to gather energy that way.



CHWs' health education work tools. CHWs observed increased respect from their community members. One said:

*“Now they see that I am part of a big project, an important project. It shows them that if I qualify to receive such high-level equipment from ‘overseas’ to help me with my work, then my work is really important.”* – CHW 36, HC2

Other CHWs, however, felt that the BH incentives invoked jealousy in their villages, which could put their families at risk:

*“I am also worried of the jealousy from some of the women in my village. Lately, I have stopped using the bright solar lighting because I worry that the light might invite jealous people to bewitch me and my family.”* – CHW 32, HC2

#### 6.3.1.2 Challenges with Durability

While the solar kits provided most CHWs with a reliable alternative for charging their devices, 13 of the CHWs saw the kits fail within the first six months of use. In nine cases, CHWs did not follow manufacturer use and care instructions. For example, the manual included the warning that the torch should not be left on for an extended period. Yet some CHWs used the torch extensively, which affected the battery unit. Other CHWs used solar panels that were outside the recommended voltage range for the unit batteries. Almost all the CHWs admitted that they did not look at the manuals or the instructions on the boxes. One said:

*“No one reads manuals. They are in English!”*

We did conduct a training session when the CHWs first received the solar kits. During this training, the charging and care processes were explained to them. However, many forgot the details from that training session. We realised later that it would have been useful to create a short video manual to explain the use and care of the solar kits. The CHWs could have watched this video on their phones in the villages and showed it to their families, with whom they shared the charging kits.

Apart from the charging kits that malfunctioned due to improper use, seven reported damage caused by placing the solar panels outside with a cable connected back to the

battery unit inside the house. These damages were caused by dogs, horses, or children tripping on the cables and causing them to break off the solar charger or battery units. Three more CHWs reported that they left the battery units covered outside because it was safer to charge them at a secluded outdoor location away from animals and children. In some cases when they chose these options, the chargers were destroyed by sudden rain or heavy winds.

In general, we learned that the solar kits were not designed for the contexts in which we deployed them. This problem had already been discussed by other researchers. All of our findings emphasize that there is a need to design appropriate and affordable alternative charging options for these contexts (Bidwell *et al.*, 2008; Wyche and Murphy, 2013).

### 6.3.2 *Smartphone Loss, Theft and Damage*

We thought the theft of BH smartphones and other hardware would have been a concern for CHWs in the villages, but this was not the case. Instead, it was witchcraft that concerned many CHWs. They were concerned that people would bewitch them out of jealousy for their BH-provided devices. They mentioned that in most of their villages, no one would get away with stealing from a CHW. There is communal unity against crime, and it is not common for theft to happen within the villages—especially to someone as well-known as a CHW. As a result, they did not feel unsafe using the devices in the villages, but they had to be more cautious when they left their villages and went into towns or rode on public transport where criminal activity is more pronounced.

In the 24 months in which the CHWs used smartphones, only two of the 54 phones were stolen or lost. The first was stolen in a public taxi. It was later found with help from the community and the police and returned to the CHW. In the second case, the CHW forgot the phone at a public gathering and the community members identified it and returned it to her.

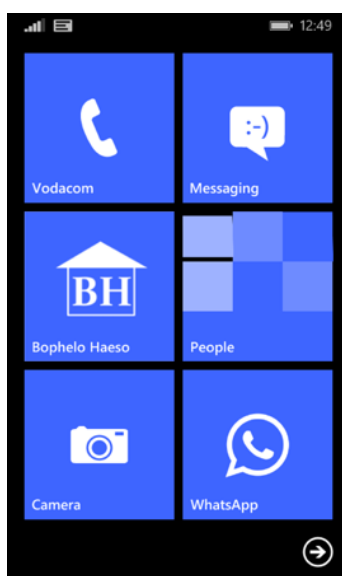
Technical issues with the phones were more problematic and common. These issues impacted the study in the months when the affected CHWs did not have working phones with which to do their BH work. In these instances, we missed important logs for learning continuous usage patterns. Of the 54 phones deployed, 11 had battery problems and had

to have the batteries replaced; 4 had software issues and had to have the OS reinstalled; and 6 fell and the screens shattered. When the CHWs could find a trusted repairer, they arranged for the phones to be fixed themselves (about 60% of the cases). In the remaining cases, the researchers took the responsibility for phone repairs.

### 6.3.3 *Training, Exploration and a Non-Intimidating Start*

Our experience, like that of other researchers who have worked with groups of low digital literacy users, was that while most CHWs did not have any experience with smartphones before the project, they became comfortable with the phones after they were trained and encouraged to use the devices often and independently (Bali *et al.*, 2013; Schwartz *et al.*, 2014).

We also learned that it is important to simplify the appearance of the device before releasing them to the participants to remove intimidating applications and widgets from the home screen. Most phones come with many irrelevant applications installed and placed on the home screen(s), which can contribute to making the device feel foreign and difficult to use. When Nokia Lumia devices were deployed, we only kept the following tiles on the home screen: the BH app, the dialler, the phone book, messages, camera and photos, and WhatsApp (Figure 30). During the training session when the devices were deployed, we demonstrated to the CHWs how they could access the rest of the applications when needed. We found that many CHWs benefitted from the option of hitting the Windows key to easily return to the home screen, especially when they were feeling lost at any point while using the phone or a specific application.



**Figure 30 - The Simplified Home Screen on BH Devices at Deployment.**

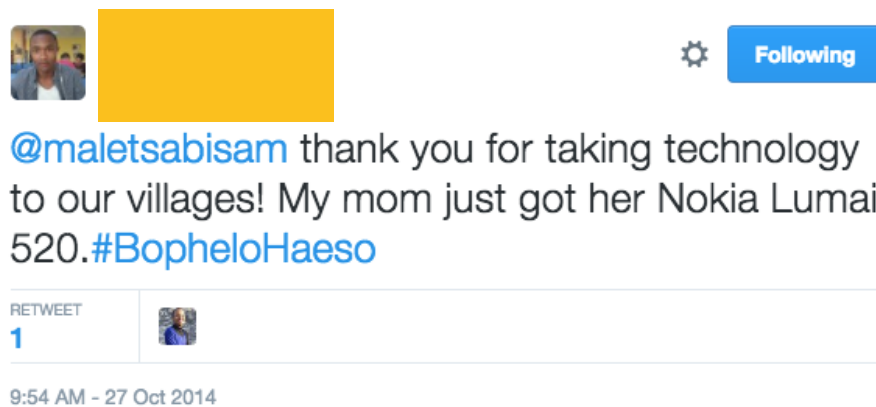
We also observed the importance of training at the beginning of a deployment, especially for people who are new to touchscreen devices. Beyond the initial training, we observed that the comfort level of many CHWs increased month after month as they used the devices in the field. They were encouraged to explore the devices on their own without fear of breaking them. This helped them to get used to the new touch-based interactions. As discussed in Section 3.5.1, having the time and flexibility in the villages to explore the devices (and being deliberately encouraged to do so) increased the confidence and comfort of all the CHWs within six months. They moved from being intimidated by the devices to co-designing BH solutions for their smartphones in this time.

#### *6.3.4 Pride, Gratitude and Validation*

In the BH project, CHWs often remarked on the pride they felt in the villages when they were seen with touchscreen devices. We observed increased zeal in the project because of the new Nokia Lumia devices. This finding confirms that even amidst the constraints that they experience, people still aspire to own better phones (Marsden, Maunder and Parker, 2008). We found that this zeal was further sustained when the CHWs were allowed to use the phones for personal activities that were not related to the project. In fact, we believe that personal use can also advance project objectives because when people are allowed to enjoy the wider benefits of the smartphone, they ascribe higher

value to owning the phone, take better care of it, and feel more motivated to keep it charged (Schwartz *et al.*, 2013; Vitos *et al.*, 2013).

In the CHWs' families, the phones and solar kits were received with great pride. One CHW mentioned that her husband finally began to approve of her work as a CHW after she received the BH devices, and that the devices validated her worth. The son of another CHW tweeted:



**Figure 31 - Tweet by a CHW's Son.**

### 6.3.5 CHWs and Smartphone Proficiency

After just the first six months of exploring their smartphones, 95% of the CHWs agreed that accessing the BH videos from the easily-accessible BH app on the smartphone was much quicker and simpler than navigating the menus on the feature phones. The CHWs felt that interactions on touchscreen devices were easy and fitted their type of work, especially for the BH app where they did not have to type anything but could simply *swipe and tap* the icons. One said:

*"With these phones, it's a quick tap, swipe, tap and the video is playing. It's so easy. I think touchscreen devices were created for old people like us who need things to be right there when you open your phone, easily accessible and not hidden." – CHW 15, HC1 (Top User, Aged 70)*

We held focus groups with 40 of the CHWs after they had been using the smartphones for 18 months to discover their proficiency with the devices. One-hundred percent (100%) of the CHWs confirmed that it was easy to open the BH app and play videos (a finding

which was later confirmed by formal user tests). All could make phone calls by dialling a phone number and 89% could easily call a number saved in the phonebook. Twenty-five percent (25%) of the CHWs struggled with text messages because of the typing experience on a touchscreen interface. Of these, five mentioned that it was easier to use voice notes on WhatsApp to avoid typing. All the CHWs confirmed that they could take photos, while ten said they needed help from children if they had to shoot a video.

As discussed in Section 5.6.1.4, intermediaries like CHWs' children and grandchildren played a significant role in assisting the CHWs with learning and exploring their smartphones. However, we also found evidence of peer learning, wherein CHWs engaged other women their age to explore and learn together.

### 6.3.6 CHW Struggles with Smartphones

CHW experiences with smartphones were not without struggles. Most of them were related either to data services, typing on a touchscreen interface, or interacting with the devices in English.

At one of the workshops, a 66-year-old CHW arrived very early to request assistance because she was confused by the process of buying data bundles necessary to restore the WhatsApp service that she relied on to communicate with her children in South Africa. She arrived frantically saying:

*“A K’u Nkenyetse Li-Megabiti Ngoanaka!” - “Please Help Me Load the Megabytes, my child!” - CHW<sub>5</sub>, HC<sub>1</sub>, (Aged 66)*

Her data bundle had been depleted and she had received many messages from the network service provider about data bundles and special offers. Most the messages were in English and confusing to her; all she knew was that someone told her to load something called *Li-Megabiti*—Megabytes—and then her WhatsApp would work again. CHWs had received a short video in the BH app that described the internet in a simple manner that clarified terminology including megabytes, data bundles, etc. Nevertheless, the CHW was still confused. As Medhi and Toyama, (2007) also found, technical instructional videos like these are difficult to follow for people with low digital literacy, especially when the instruction is high-level and is not contextualised for improved

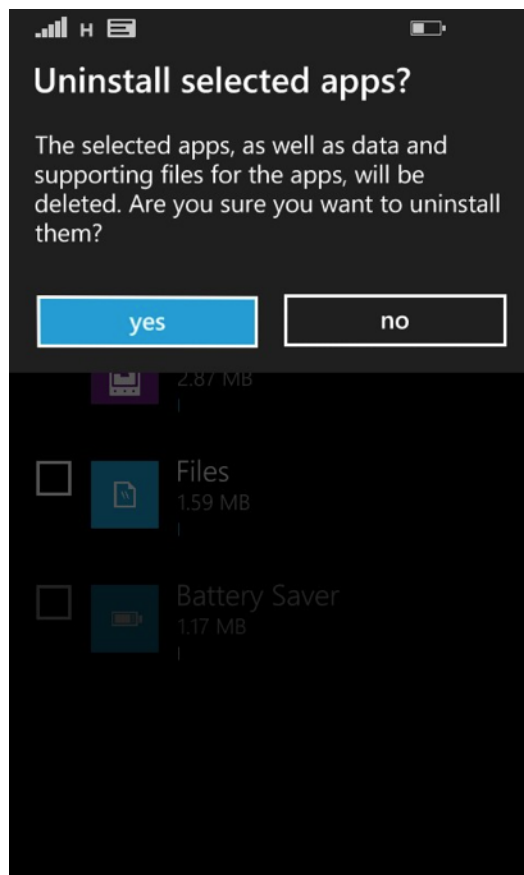
understanding and relatability. In this case, we assisted the CHW with purchasing data bundles and showed her to do it in the future. We used examples related to cooking to make her understand the concept of buying data bundles using prepaid airtime.

The entire data cost management system was foreign and confusing for many CHWs to understand. Additionally, most of the CHWs could not afford enough data bundles to stay constantly online. For example, CHWs liked to use WhatsApp, and the app was installed on all their devices. For many, though, the cost of data bundles often forced them to remain offline. When asked how much they could afford to spend on airtime and calling, CHWs' responses ranged from LSL 30 to LSL 100 a month (2-8 USD). The average they could afford (LSL 40) only buys about 200MB of data a month.

Some CHWs mentioned that they periodically switched off mobile data services on their phones because the phones would “eat up the data” otherwise. Wyche et al. also found that Zambian farmers faced the same challenge (Wyche, Densmore and Geyer, 2015). As a result, the CHWs would only switch data services on a few times a day to check WhatsApp messages. We often helped CHWs to switch off any background updates and data-consuming processes on the phones, but most still could not afford to have data services running constantly. About 40% of the CHWs actively used WhatsApp, while others said they gave up because it was “too hard”. What frustrated CHWs about WhatsApp on the Windows Phone devices was the frequent need to update the app. This process was not straightforward for the CHWs. To update the app, it is necessary to go to the app store and enter a Microsoft email address and password. These steps had to be taken every time an update was required. On setup, the password had to be a ‘strong’ password with alphanumerical and special characters—which some CHWs struggled to input.

Another challenge with smartphones (and smartphone services) for CHWs was limited English literacy (Doke and Joshi, 2015). At different times in the study, CHWs uninstalled the BH app and when asked, admitted that:

*“Sometimes the phone brings up English messages I do not understand [asking to confirm an uninstall, for example], so I just press whatever I can press to remove that English message [then uninstall unintentionally].” – CHW 30, HC2*



**Figure 32 - Uninstall Prompt in English.**

On the devices used by the CHWs, there was no Sesotho language option. Even if there had been, we had previously found that the Sesotho translations on phones are incomprehensible and confusing. The feature phones previously used by the CHWs had a Sesotho language option, but CHWs preferred to use English (even with their limited English literacy) because the Sesotho version was too confusing. To fit within the existing menus and labels of the mobile interface, translations from English to Sesotho were often too short and thus incomprehensible. If the translation were to be comprehensible, the Sesotho equivalent would be too long to be accommodated within the existing interface. Native OS translations often go with the former (short, direct translations that are not immediately understandable). In the BH Sesotho app that we designed, however, we designed buttons and labels with this challenge in mind. We were sure to provide the necessary space in the designs for long Sesotho phrases. We did not directly map English words into Sesotho equivalents (as described and demonstrated in Section 3.4.3.).

Instead, we allowed for long phrases that captured more comprehensible meaning. For example, a button that could have been labelled “Start Recording” in English had to be labelled “*Penya Mona Ebe U Qala Ho Bua*” in Sesotho, to be understood – which literally means “Press Here and The Begin Speaking”. A shorter, more direct translation would not have been easily comprehensible to the CHWs.

#### 6.4 PERSONAL AND NON-PRESCRIBED USES OF PROJECT-ISSUED DEVICES

In their study of how CHWs in India used project-issued devices, Schwartz *et al.*, (2014), explored the tensions between instructed/prescribed device use and how the CHWs appropriated the devices in their personal lives and workplaces. The study examined how varying degrees of freedom and control over the devices affected empowerment and the advancement of the project’s mission. They explored how deploying organisations or teams can balance the benefits of the issued devices with the burden and sacrifice to the project and to the device custodian. Following a burden versus benefits analysis across multiple deployments with varying formal/informal and explicit/implicit rules, their recommendation was that “*project managers counter instincts to completely control a device and its uses and instead embrace the potential benefits that can accrue from relatively unrestricted and unplanned appropriation by frontline workers.*”

We sought to build on this work, particularly by exploring the effect of explicitly-permitted exploration and use. In our study, CHWs were given explicit permission to explore and use the devices for personal purposes. Schwartz *et al.* recommend that research teams or organisations deploying project devices make the decision about whether the use of the devices outside the prescribed project work would be allowed or encouraged. From there, they can determine and set freedom limits where applicable. In the BH case, the CHWs were given permission to use the phones (and their full suite of features) widely and freely for personal use as part of the exploration methodology described in Section 3.3. We believed in equipping CHWs with the devices not just as tools for work, but also as tools that they could integrate into their normal lives. Community health work was only one part of their lives. Additionally, we reflected on a variety of personal and non-prescribed uses when CHWs were issued smartphones

instead of feature phones: did smartphones (and their extra features) introduce new challenges or further incentives to propel the project’s mission?

Over the 24-month period, we studied the ways in which CHWs used the project-issued Nokia Lumia smartphones for uses outside of the prescribed BH work. Those uses are described and discussed in the following subsections.

#### 6.4.1 *Media: Music, Videos, Recordings*

The first time we examined the phones (three months after deployment), all the CHWs had captured private photos and videos using the Nokia Lumia phones. The CHWs said the devices allowed them to capture important occasions and celebrations in image and video. We found images of daily life in the CHWs’ homes and villages, including various family photos (mostly photos of children); selfies taken by CHWs themselves (we recorded up to 18 CHWs who had taken a selfie within the first three months of using the phones, and 33 within the first six months); and photos taken at community events and political rallies, graduations, initiation ceremonies, among others. Image galleries also included funny, religious, and motivational memes received from others, mostly via Bluetooth or sometimes via WhatsApp. There were also CHW-created memes or photos where CHWs had annotated their own images. One such meme was a photo of a CHW’s children with the caption “Mi Life”. CHWs mentioned that they could print “important photos” taken using their Nokia Lumia devices at a kiosk in town (Mafeteng), and were impressed by the quality of the printed images.

Most captured videos were of ceremonies or events, children playing, women singing and dancing, church services, and, in one, a CHW’s son captured her practising a health talk she would deliver later. In the early months, some CHWs (8) did not figure out how to use the phone’s voice recorder; they ended up using the BH app recorder to record music playing on the radio. They said they found it easier to use the BH app recorder than to try and find a native recorder on the devices.

Another common use was playing music. CHWs had a range of music genres on their devices. Some songs clearly belonged to them (Macecilia, IPCC, Paul Mashaba). Others were more typical of teenagers (DJ Fish, Beyonce, Heavy K, Akon). These songs most

likely belonged to their children and grandchildren. By the end of the 24 months with the devices, only two CHWs had no music at all on their BH phones.

#### 6.4.2 *Phone Sharing and Permissions*

We observed that most CHWs (about 65%) shared their phones with the members of their families. CHWs, their husbands, their children, and their grandchildren used the devices sometimes. For example, there were two phones that had active Facebook accounts. The CHWs said that these accounts belonged to their children, but noted that they only allowed the children to use the phones in the evenings. They said statements like:

*“I allow my kids to use the phone when I am around and then they help me by teaching me and showing me certain things. But the phone is still in my control.” –*

*CHW 7, HC1*

*“I don’t forbid my kids from using the phone because they are the ones that teach me how to use it.” – CHW 34, HC2*

The remaining CHWs, on the other hand, said they did not allow their children to use their work phones for their individual needs. They explained that they only allowed their children access to the phone when they were helping them or teaching them. They believed that by allowing their children access to the phones, the phones could be misused.

In a focus group conducted in April 2015 (at the end of the six-month exploration period), only 6 of the 54 CHWs confirmed that there were other smartphones in their households. These were owned by their children or other family members who lived with them. However, they commented that their own smartphones were often seen as superior and more “original”. In 2015, most budget smartphones purchased in rural villages were imported Chinese models which were considered unoriginal.

#### 6.4.3 *Installed Apps and Phone Settings*

We found that up to 20 CHWs had installed custom apps on their phones. Common among these apps were the Bible, radio apps, and meme-creating apps. Other apps that

were installed on a few of the devices included Skype and a variety of games. WhatsApp was installed by the research team on all of the CHWs' devices.

Beyond the media and apps installed on the devices, further evidence of rigorous personal use was evident in the way the phones' settings were changed throughout the 24-months period in which phone use was monitored. CHWs said the changes to phone settings had been done by or with the help of their children or, less frequently, by themselves as they explored the devices. Beginning as early as three months after deployment, 80% of the devices had changes in the colour scheme (theme) and the lock/home screen background images. Additionally, more apps had been added to the home screen—especially those that appeared to be used more frequently like the radio and Bible apps.

After 24 months, only one of the 42 phones that were working at the end of the period had the same look and settings as it did when it was deployed. The device had the same six tiles that had originally been set on the device when it had been deployed 24 months earlier. The colour scheme and lock screen images were not changed; however, there were some personal photos of the CHW and her grandchildren in the phone's image gallery. Looking at the usage logs, we found that this CHW had some of the lowest usage rates of BH videos, which means that she did not use the phone much, either for work or for personal reasons. We characterised this CHW when discussing "low-users" in Section 5.5.4. She was the CHW who recorded the least number of videos views during the study period.

#### 6.4.4 *Calling and Texting. Data and WhatsApp*

The CHWs used their phones liberally for calling and texting. At the end of the entire study (after having used the devices for 24 months), we found that all had saved at least ten phone numbers in the device's phone book, and some had up to 70 contacts. There was an even mix of incoming and outgoing calls and text messages. However, there were a few CHWs (6) who had received messages but had never written an outgoing SMS. On average across the four times we examined the CHWs' phones during the 24 months of use, we found that 78% of the CHWs had data services switched off.

#### 6.4.5 *Reflecting on The Implications of Allowing Personal Phone Use*

Our observations confirm the previous findings by Schwartz et al. (2014), that when participants who are equipped with organisational mobile phones as part of their work are also allowed to use the phones for personal reasons, there is an increased sense of ownership, mastery, and attachment to the devices. This increased attachment enables increased use for work. In general, the lesson that we learned from the 24 months of observing the CHWs' use of the smartphones was that the mobile phone is not just a tool that does a specific task for health work. Instead, it represents so much more to the CHW. It is a token of pride, a valuable incentive, a signal of appreciation, and a part of life that touches not only the custodian (that is, the CHW) but her entire family. In studies like the BH project, it is therefore important that we provide accounts and reflections (as we have done in this chapter) on the position of the mobile phone in the personal lives of the project participants beyond the project-specific studies and analyses.

### 6.5 RE-IMAGINING THE APPROPRIATE SMARTPHONE FOR LOW-INCOME REGIONS

Wyche et al. (2015) encouraged ICT4D researchers and practitioners to re-examine the mobile phone by looking at many understudied barriers that hinder the adoption of mobile services in areas of limited resources and differing abilities. Based on our experience with the CHWs' use of smartphones in rural villages, we reiterate this call. We argue that the smartphone, in its current form, requires re-examination if it is to be widely adopted and relevant for low-resource areas.

Smartphone penetration in Africa is on the rise. By the end of 2016, the sales of smartphones had begun to outpace feature phone sales across Africa (GSMA, 2016). Many argue that the new penetration of smartphones is what will drive the next digital revolution on the continent. The primary driving factor for the increasing smartphone penetration has been the decrease in smartphone prices. The emergence of budget smartphones in the same price bracket as feature phones makes them an attractive choice for many.

Affording a smartphone means one has access to exciting features not typically available on a feature phone, like a camera, GPS, improved storage, a multitude of apps, larger screens and easy touch-based interactions.

However, this is not a complete win—*yet*. Smartphones may be increasingly more affordable, but they are not necessarily relevant for those living in remote rural areas with limited or intermittent electric supply, limited literacy, limited data affordability, or for those who do not speak English and other major international languages. It is due to these limitations that, despite the fact that the phones are affordable to buy, many are deciding against relying solely on smartphones as their primary devices (Minter, 2017).

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- 1) *“Smartphones were not designed for us.”*
- 2) *“Touch-screen devices were made for the old, like us.”*

These two conflicting statements emerged from our focus groups with CHWs about smartphone use. The oldest CHW in our group (70) found touch-screen devices much easier to interact with than the old feature phones. On the other hand, this CHW and others like her agreed that smartphones were not designed for the limitations of power, literacy and affordability in which they live. Current smartphone operating systems are designed for the “always-online” user. Smartphone interfaces assume literacy in English and other major languages; their icons and abstractions assume literacy and understanding of concepts like hierarchy. Most smartphones consume computing resources at high rates, yet they run on hardware that requires frequent charging. Wyche and Murphy argued in 2015 that *“HCI4D/ICTD research is incomplete if researchers continue to develop software applications without acknowledging how access to electricity affects ICT use because the interface extends beyond the screen to include the socio-technical infrastructures that include access to electricity”* (Wyche and Murphy, 2013).

The smartphone that will be impactful and useful for these populations must be designed with sensitivity around these needs and limitations. This smartphone will focus on the user that is not primarily online, can afford only limited data bundles, has never used a computer, is unfamiliar with computing abstractions, and cannot afford to charge their

device every day. At the same time, this phone must still connect the user to the world in relevant ways (Facebook, WhatsApp, etc.), and provide the benefits of a large screen and touch-based interactions. Most importantly, this phone must allow for easy creation of relevant apps and content for local needs.

Wasan and Jain (2017), too, recently reported on the need for optimisation of mobile phones for rural areas throughout India, wherein they suggested changes in language, vernacular keypads, mobile content and overall mobile phone design for relevance in rural India.

## 6.6 CHAPTER SUMMARY

This chapter has discussed our decision to use smartphones in the BH project. We have drawn on lessons from other ICT4D projects that preceded ours, reported on our CHWs' experiences as first-time smartphone users, and explained how their usage experiences evolved over the 24 months of our research project. We described how the smartphones given to CHWs for the BH project work were integrated into their lives. We focused especially on the impact that the devices and the other equipment that we provided had on the CHWs' status and stature in their homes and villages, as well as how family and community dynamics supported or conflicted with the BH project because of the provided devices. Lastly, we discussed some of the challenges and the changes required for smartphone redesign, for people to have phones that would be useful and relevant for them in rural and low-income regions.

## 7 REFLECTION

*NB: This section is written in singular first person to directly reflect the personal views of the researcher, the author of this thesis.*

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### 7.1 RESEARCHER REFLEXIVITY

*“We find that many publications focus mainly on the analysis of results, or on the characteristics and performance of finished artefacts, rather than on the experience of gathering or producing those results.” – (Anokwa et al., 2009)*

In a qualitative research project such the one reported in this thesis, reflexivity is vital (Johnson *et al.*, 2012). The final results are as significant as the human and contextual factors that surrounded the study, and these factors have direct impact on the research outputs and the reproducibility of the work (Reitmaier, 2011). Additionally, as a qualitative researcher, the person I am and the role I played in the social system in which I conducted this research certainly had an impact on the outcomes and results (Rode, 2011).

First, I will reflect on my position as a researcher in this project, and on how being who I am influenced the nature and evolution of the study and the results that we obtained. I will then discuss the implications and differences of conducting qualitative research in an ICT4D context in the country where the researcher is a native, and reflect on the effects of building long-term relationships between the researcher/designer and the population on and for whom research and design are being conducted.

### 7.1.1 *A Mosotho Researcher in Lesotho*

Many documented and published accounts on immersed ICT4D and HCI4D research in low resource regions have been by researchers and designers who originate from countries outside the one in which the development work was conducted. In these scenarios, the researcher is often immediately seen as an outsider by the community being researched, and is seen to be of a significantly higher social status than the research participants. ICT4D researchers including Dell et al. (2012), Ramachandran (2010) and Kumar (2016) have reported on participant biases that resulted from these differences, often influenced by socially constructed lenses such as gender, class, and caste, among others. I wanted to reflect and account on my experience as an African researcher researching in Africa and, more specifically, in the country in which I was born and raised. In particular, I reflected on my experience as a researcher and designer of the same gender, who speaks the participants' language and is familiar with their ways and culture, building on the reflections of fellow native African researchers like Kapuire, Winschiers-Theophilus and Blake (2015).

#### 7.1.1.1 *Cultural and Linguistic Proximity*

I am a Mosotho, born and raised in Lesotho, with strong rural influence. I speak Sesotho, the language spoken by all the Basotho people, fluently as my first language. In manners, conduct, and speech, it is clear to all Basotho who interact with me that I was raised in a typical Sesotho household. I have first-hand, lived experience of the Lesotho village life as described in the sections that follow.

#### 7.1.1.2 *Deeper Understanding of the Context*

Throughout this study, there was very little that I had to imagine when the CHWs described their or their patients' challenges and experiences in the villages. I have had, or am familiar with, many similar experiences. In reflection, I find that this familiarity led to my deeper understanding of the general context in which the BH work was done. This, in turn, made it easier for me to design and make research decisions in this project with deeper understanding and consideration of the human factors at play.

### 7.1.1.3 *Increased Empathy*

I believe one of my strongest positions as an African-raised researcher is deep empathy for the rural public and patients with whom I work. Many of the challenges they experience hit very close to home for me. Many of the cases that CHWs worked through affected me personally. I have lost relatives to AIDS; I have observed maternal mortality and infant mortality strike people I love; I have struggled with getting a friend or a relative to test for TB/HIV or to adhere to treatment. I have seen poverty in my immediate and extended family, and understand how it affects the health choices that people make. I know the limitations of literacy that exist across generations in our villages. I have lived through changing perceptions towards western medicine (and technology) over the years. I believe that this position, which allows me to relate so closely to the needs, capacities, and aspirations of the populations with whom I worked, made me deeply empathetic in the research and design activities that I conducted during this project.

### 7.1.1.4 *Understanding ‘Local’ Ways of Innovating*

I was raised almost exclusively by Basotho women. To me, the model of strength, creativity, resilience, and brilliance is a Mosotho woman. Many of the women that raised me were not educated (like the CHWs with whom I worked on this project). Growing up, I saw them “innovating” to make ends meet and to build homes and families with few resources; “innovating” to feed families and to keep children healthy with little to no income. Upon reflection, I believe that my lived experience of what a Mosotho woman can be and do, her resourcefulness in the face of necessity, led me to begin this study with the confidence that **CHWs can and will innovate**. Many simply see CHWs as low-literate, but I saw them as the Basotho women by whom I had the privilege to be raised. I saw them as the women who can raise families, educate children, and take care of communities even in the most adverse circumstances. I came into this study knowing that a Mosotho woman is resourceful and intelligent, and that often, the limit of her education is not an indicator of her intelligence. Indeed, the CHWs in the BH project proved this time and again (see Chapters 3, 4, 5 and 6). When they were given a chance to learn, to explore, and to innovate in their own ways and in their own spaces, the results were astonishing.

### 7.1.1.5 *Insider-Outsider Positionality*

However, I also wonder: do my proximity to the CHWs in culture, language and nativity, and my close personal relationship to the context of this work make me a complete insider into the research setting? In reflection, I find that this is not the case. I reflected on the power relations that were at play in the duration of the study, and how these, too, affected my relationship with the CHWs, and enabled or prohibited equitable platforms for voice amongst us.

I was educated outside the village - in a town, at an English-medium school. I have attended higher-education institutions outside the country (which is considered a great honour among fellow Basotho). I have arrived at our meetings with CHWs driving vehicles that can be seen as ‘high-class’ by those living in rural villages. While I maintain a strong influence of my rural upbringing, these few examples demonstrate that I can be perceived to be of a higher social class than the CHWs. While I put deliberate effort to engage humbly with the CHWs and other research participants, this separation of status existed in our relationship, and understandably, added a bias in the way we related.

Admittedly, too, my position as the primary researcher in this project naturally placed me in a position of authority. Many CHWs saw me as the person who “gave” them the phones to do their work and personal functions, and immediately this became a donor-recipient relationship. While we have explained on multiple occasions that the phones were provided by the project from donor funds, I was still seen as the source of what they considered extremely “high-tech” gifts. This is a difficult reflection to process, since I sought equitable relations amongst us all, but it is useful to admit, for the sake of transparent scholarship.

I realise in reflection that because of these differences, there are matters that I did not get right and had to learn from CHWs through open engagement. For instance, when I first learned to run co-design workshops in Cape Town and other affluent locations, we would buy snacks for participants as an incentive for participation, expression of gratitude, or to enable fellowship after engagements. I did the same for the first few workshops I ran with CHWs in Lesotho, until during one workshop, a CHWs openly remarked:

*“Many of us live under extreme financial strain – often struggling to put food on the table. It feels somewhat uncomfortable for us to sit here and eat snacks that cost about M30 (~ 2.5 USD) per person, only to return home and face our hungry children who have not had snacks in months. Wouldn’t you rather give us the little money used to buy the snacks, and we can buy something for the whole family when the workshop concludes?”*

We started offering CHWs a small “lunch allowance” (3-5 USD) per workshop, from that day, that they could spend as they saw fit. I acknowledge this as an oversight that is a possible result of my separation, in socio-economic priorities, from the CHWs, regardless of my proximity to them in culture, language and previously lived experiences.

Kumar (in Kumar and Anderson, 2015), too, found while conducting research in her native country India, that while she was an ‘insider’ by linguistic proximity, as a researcher educated abroad and of a higher social status, she was an ‘outsider’ to her research participants. She reports that class and socio-economic differences were immediately discerned and thus affected the dynamics of the relationship between the researcher and the research setting.

What now, do we make of this combined initial proximity and the eventual social distance between native researchers and research participants? Hodkinson (2005) argues that holding a degree of ‘insider’ status can lead to successful and productive interactions with participants, but agrees that it is equally important to continue to seek commonality in other forms. While it is key to leverage any initial proximity to participants that a researcher may possess, it is important to note that gender, language and nationality are not the only cultural identity boundaries that one may need to cross to relate to their research participants (Song and Parker, 1995). Boundaries in the form of class, power and physical appearance, too, exist and may impact the research process. Native and Indigenous scholars, too, must continue to seek deeper immersion to develop deeper understanding of contexts in which they work, even if there is initial proximity. They must continue to navigate power relations consciously, and must continue to seek ways to achieve true and equitable participation by all, while acknowledging the inevitable biases from their evolving ways of being, doing and knowing (Soro *et al.*, 2016).

### 7.1.2 *Long-Term, Evolving Relationships*

I first started working with half of the CHWs involved in this project in 2011—three years before the 30-month study reported in this thesis began. In the 30 months that followed, I continued to build a close relationship with this group of CHWs, and began to forge a new relationship with the others who joined the BH project in 2014.

The relationships that I formed with these two sets of CHWs over the years have evolved far beyond the initial researcher-participant relationship. The mindset we developed was that CHWs are not just informants in a research project, but that we were working together towards creating something of value for the CHWs and the communities they served. The CHWs saw the research as an ongoing attempt to help them in the community work they had already been doing for many years. Overall, they never felt like mere informants of a scholarly investigation. We believe this perception played a role in forming less rigid relationships which, in the end, led to more fluid and free expressions in our workshops and meetings.

As the study went on, the BH workshops and meetings were filled with great enthusiasm, excitement, laughter, and an incredible sense of pride and community. This enthusiasm, much of which resulted from the strong relationships the CHWs built with me and the rest of the research team, certainly had an impact on the results that we observed. As discussed in Chapter 5, we observed spikes in usage of BH videos after most workshops or meetings. CHWs often left meetings feeling empowered and excited to make a difference in their communities. They exclaimed that we (the research team) helped them identify their purpose and made them want to have further impact in their villages. One can imagine, therefore, that where less enthusiasm-igniting relationships exist between researchers and participants, a similar effect may be seen to a lesser extent.

Upon reflection, I realise that this relationship with the CHWs was enabled largely by the fact that the project existed on a long-term basis, allowing an evolution from a formal research relationship to an openly collaborative one.

## 7.2 BEYOND THE TECHNOLOGY: REFLECTING ON BH AS A SOCIAL CHANGE PROJECT

It is well understood in ICT4D research and practice that technology does not achieve advances in social outcomes on its own (Schwartz *et al.*, 2014). Toyama (2017), has argued that “*there is no social change without a change in people.*” At the end of the 30 months running the BH project, we reflected on how much the BH project had enabled *human and social change* through the design and research process that we followed.

Toyama argues that as designers, we focus on designing for people as they are—hence our “human centred design” narrative. We address users’ current needs, designing for their exact context in the present moment. Therefore, our approach to design does not often include attempts to ‘change people.’ This significantly limits the impact of our development work because for true social change to occur, *people must change*.

Toyama further demonstrates how we often develop technologies in isolation of other social factors—for instance, designing interfaces that enable low-literate people to use computer systems or designing easy-to-use apps that enable people to share local content, among other things. While these technologies may be well-designed using a human-centred approach, sometimes they are limited in the social impact they have because they do not change people, nor do they address the myriad of other social issues that surround the lives of those for whom the technologies are built. Well-designed education apps still fail to educate children because more change in human thinking and education support structures are required for the education apps to be truly impactful.

The practice of looking beyond the technology and understanding that a technical solution alone is not enough to effect social change is critical in ICT4D research and practice.

### 7.2.1 *Feedback for Social Change*

In the case of the Bophelo Haeso project, we had to understand that digital health education in isolation is not enough. A well-designed app that gives CHWs an easy way to share useful health content is not sufficient to change behaviours and to have a lasting

impact on the way people make health choices. People do not need information only. For example, a young mother may be educated on the correct way to feed an infant, but there could be other factors in her family and community that lead her to choose an unhealthy or non-recommended approach to feeding.

Our solution of extending the BH model to include feedback elicitation was built on this premise. Feedback gathered in a continuous manner does not only capture knowledge needs, but also reveals other human and societal factors that affect how health decisions are made. Our feedback elicitation approach encouraged communal dialogue for people to reflect on and argue about their health choices with the CHWs while capturing these thoughts and arguments and exposing them to the health professionals who can take necessary action.

To change people, we need to know how they think and why they make different choices. This understanding is not a once-off requirement, since human thinking and reasoning is constantly evolving. Therefore, we proposed a feedback mechanism that allows researchers and stakeholders to continually understand the reasons for different choices and behaviours: to design relevant and timely interventions, both technological and non-technological. While the feedback received during the BH deployment informed the creation of new digital content, we also saw health centres introduce non-technological social interventions such as food donations, increased access to birthing centres, and more.

### 7.2.2 *Sustainability and The Exit Strategy*

Another critical question for HCI4D/ICT4D projects is sustainability. What happens when the research investigation is complete? What happens to the solutions that the community co-developed and to the technology to which they got accustomed? Do the artefacts immediately vanish when the research cycle ends? These questions speak to the sustainability of the social solution, but should also feed our reflection on how well we achieve genuine reciprocity and fairness for our participants (Brereton *et al.*, 2014).

In the case of the BH project, sustainability is one of the main limitations of this work as a social impact project. The weakness is two-fold. First, the project, through grant and

donor funds, procured smartphone devices for the CHWs, with no plan for the continuous replacement of phones that will malfunction due to natural wear and tear beyond the study period. We believe that this equipment was justified and necessary for the investigation reported in earlier chapters (such as the demonstration of the efficacy of mobile-authored feedback), but admittedly, it was too expensive for long-term sustained use (Dell *et al.*, 2014). Smartphones last for about two years on average, as opposed to feature phones that can last and work for up to ten (Dell and Kumar, 2016). However, we chose them (as discussed in Chapter 6) for the completion of the 2.5-year study that led to the results we have obtained. But what about the CHWs? What about their health education work that was thriving because of these tools? What about the important feedback they were eliciting in their communities through these tools?

As we closed off the research, the phones that were still functioning at the time were left in the possession of the CHWs, for them to continue using in their villages. The nurses continued to create videos and distribute them to CHWs, and she continued to ‘harvest’ audio feedback from CHWs’ devices. This is the part of the work that exhibits *some* sustainability, because the nurses and their assistants can independently manage the creation, sharing, and receiving of content to and from CHWs’ devices. The main limitation is that as phones wear and tear, there is no way to replace them, and the affected CHWs are then cut off from the continuing work. It is obvious that over time, only a handful of the CHWs will remain with the original BH-procured devices.

One of the exit strategies we are now employing at the University of Cape Town is to port the Windows Phone app into Android. This way, as more CHWs buy Android phones of their own, they can have the BH app installed on their devices. The feedback we received from both CHWs and nurses is that if there are devices to do the work, they are still interested in continuing with the BH content dissemination and feedback elicitation. One CHW whose project-issued device had malfunctioned by the end of the study, had already asked that BH videos be placed on the new Android phone she had recently bought for herself.

The second weakness of the study regarding sustainability is the way in which the feedback is processed and analysed. Nurses and their assistants listen to the audio

feedback, and then they transcribe and analyse it. Sometimes only important notes are taken while the audio files play. As suggested for future work in Chapter 8, one of the most high-potential next steps for this work will be to develop intelligent ways to process and analyse this feedback using Natural Language Processing (NLP). While we demonstrated the efficacy of collecting feedback in this study, the processing was conducted manually, which is not sustainable in the long-term. Automatic processing is the next step which the University of Cape Town’s students or other researchers can investigate.

### 7.2.3 *The Typicality of Participants*

Another useful question for reflection is “How typical or special were the CHWs and nurses involved in this study?” “Could similar results be expected with another group of CHWs?” Indeed, incredible passion accompanied the BH work and the research setting at large. The CHWs and their nurses were passionate and committed to the work as discussed in previous chapters. I do not think we stumbled upon “highly passionate CHWs and committed nurses.” I do not believe our participants were atypical in any way. As seen in Chapter 5 where we discussed the usage patterns by different CHWs, it was evident over the months that not all CHWs had the same intrinsic motivation for general community service and for participation in the BH project.

Instead, I believe that the passion and commitment we saw were cultivated by the deliberate empowerment approach we took, and enabled by the longitudinal nature of this study. Section 7.1.2 discusses this relationship in greater depth.

## 8 CONCLUSION

### 8.1 OVERVIEW

The work reported in this thesis built upon previous research that had demonstrated the potential of supporting CHWs' health-education work using mobile multimedia. Beyond this advancement in digital health-education research, a few gaps remained. As a community, we lacked deeper understanding of CHWs and the human factors that surround their lives and hence determine how to carry out their work with digital tools. There were also gaps in HCI4D literature on how to best design and research health technologies *with* and *for* CHWs, in ways that achieve truly productive co-design. Additionally, within health education using multimedia, current work had primarily focused on the creation and dissemination of content from professionals *to* rural citizens, with little known about the ways to implement a feedback loop that enables the flow of information *from* rural villages to the health professionals who design educational materials and other health services. Lastly, no other study had looked at the long-term offline consumption of digital health content, to understand the factors that affect use and adoption over time, beyond the initial months of a trial deployment.

In the research reported in this thesis, we conducted a longitudinal study of 30 months in rural Lesotho to research these gaps. First, we engaged in continuous user research comprising of 10 field visits and workshops to seek to deeply understand CHWs and the human and social factors within which they live and work. This deep understanding and integration into the CHW community enabled us to co-design with them, while employing a previously untested approach of technology exploration to achieve productive co-design with the CHWs. We used local ways of doing and saying (Bidwell and Siya, 2013) to deliberately engage CHWs, and enable their voice in the research and design process in ways that have never been reported in any other study in this area of research. Through the deep understanding of their position in rural villages, we identified with the CHWs, the valuable role they can play in coordinating continual collection of feedback from rural villages. We co-designed a village-to-clinic feedback mechanism

using asynchronous voice and roleplay techniques, and thus achieved a complete multimedia learning model for the rural health system.

This concluding chapter revisits the problem through a discussion of these results.

### 8.1.1 *Co-design Readiness*

The BH project contributes to the growing knowledge of co-design practice in contexts of limited digital experience. In this work, we presented a new concept that we term *co-design readiness*. An important aspect of practising co-design is that both parties must be able to contribute meaningfully to the process. Meaningful contribution, especially on the side of the prospective user, begins with the ability to fully articulate one's needs, the freedom and capacity to express one's own creativity, and the freedom and empowerment to critique and build on the ideas of others.

Enabling true co-design is more challenging when a participant has limited to no experience with technology (Batool *et al.*, 2016). In the process of designing a technology, we think about issues like offline vs. online access to content, data storage, and 'upload vs. download' options, among other things. We talk about connectivity, how certain buttons should look and what they should do, and what menus should look like. We discuss concepts for apps, browsers, etc. Those with experience can use this language because they have been previously exposed to it on computers and smartphones. But if the participant with whom we work has technology experience that begins and ends with calls and SMS, these words and concepts are foreign to her.

In a traditionally-run co-design process, her creativity would be curbed and her voice silenced because we would use a language in which she cannot express herself. She would be unable to express her needs because she would not know the utility of the tools being discussed. She would be unable to critique or build on any ideas because she would have no experience against which to judge what is good or bad technology (Maunder *et al.*, 2007). This is what we found in our research with CHWs that led us to coin the term "*co-design readiness*". It is also why we developed alternative approaches to prepare CHWs to fully participate in the research and design process.

We found that what works best is to give people the time and tools to explore unfamiliar technologies that are relevant to the design process, and to enable them to build a personalized experience around the language and the tools. This way, they too can meaningfully contribute to the process. This is what Marsden referred to as *empowered design*: getting people to a point where they can become their own innovators, even if using previously unfamiliar technology (Marsden, 2008).

We designed and deployed explorative artefacts and found that by increasing CHWs' technical, contextual, and linguistic capacity to contribute to the design process, they were empowered to unleash their innate creativity. This, in turn, led to more appropriate and highly-adopted solutions.

### 8.1.2 *A Continuous Feedback Mechanism*

Previous research had explored multiple approaches to assist rural citizens in receiving health education materials using digital channels. Many of these approaches have been significant breakthroughs for public health, as many who were previously unreached could now be informed, educated and persuaded to live healthier lives and seek medical assistance where relevant. We found this to be true in our own research, but also identified a need that only arose as digital content was increasingly disseminated into rural areas. We found that we (digital health researchers, nurses, professionals who design materials for rural education) do not have a deep-enough understanding of the underlying misconceptions, knowledge gaps and continuously-changing mindsets in the villages to which we disseminate content – a continuous feedback loop was necessary. We designed this loop with the CHWs in Lesotho using asynchronous voice on a mobile application and a non-technological technique of role play. These tools enabled us to give CHWs a voice, and best leverage their position and expertise as health providers in the villages.

We identify this model of continuous feedback elicitation using mobile tools as one of the main contributions of this work. It is the first attempt in digital health education, to use mobile technologies in-situ to enable health information to flow one or two levels up in the health system. That is, from the rural villages where citizens are often unheard and misunderstood to the level where decisions are made and interventions are designed.

Traditionally, to understand perceptions and to assess the depth of health knowledge in different populations, formal (and usually large) studies are conducted. There is rich health literature that reports on these perceptions, attitudes and knowledge gaps among different populations (Sorcar *et al.*, 2017). While these studies continue to be useful, they can only be conducted sparingly due to the costs involved. Also, such studies are not often followed up in the same regions to track short-term and long-term *evolving* trends of misconceptions and knowledge gaps. On the other hand, by taking advantage of the presence of CHWs in rural villages and leveraging the ubiquitous mobile phone, we can, as this study has demonstrated, achieve a continual learning of evolving perceptions, attitudes and varying depths of knowledge. This, of course, allows for more timely interventions and can, as well, inspire and inform the necessity for longer follow-up studies by researchers.

### 8.1.3 *Longitudinal Study of Offline Digital Content Consumption*

Another of the main contributions of this work is the insight generated from the longitudinal deployment of multimedia content in a rural setting over an extended period. There are lessons to be learned from long term-use of a technology that cannot easily be discovered in a brief pilot or study done within experimental settings. In digital health-education, not much work had been done to study how trends and patterns of content use change over time, or to isolate the factors that affect these changes. Kumar *et al.* (2015) ran a longitudinal study in the Projecting Health project. In their research, they provided a community-engagement perspective of how this model of health education diffuses into communities over time and analysed the powers at play in the process of content creation and dissemination. The study reported a 24-month-long deployment in which 38 films were produced and disseminated more than 4000 times. However, the study provided only limited information about the patterns of content consumption and how they related to the CHWs themselves, the content of the films, or the methods of delivery and community engagement.

Our close analysis of the use of the BH content not only provides lessons on what makes content relevant over an extended period, but also speaks to realistic methods of community engagement that gives new insight into how to engage with CHWs in a

manner that encourages sustained use. The longitudinal nature of the work also allowed us to understand to a deeper extent the behaviours, attitudes, and attributes of CHWs and how they influence participation in digital health projects over an extended period. While other researchers and practitioners also possess significant experience working and managing CHWs (Batoool *et al.*, 2016), we believe that this systematic affirmation of knowledge on their patterns of digital content use is an important contribution to the field. We also believe that the length of the study allowed us to provide empirical evidence that had not previously been available – the extensive data allowed us to characterise anecdotally-known phenomenon in greater depth.

## 8.2 LIMITATIONS AND SCOPE OF THE STUDY

Due to the scope and foci of this study, we did not measure the impact of the interventions we designed on health outcomes and learning outcomes among the CHWs and the rural public. A study of that nature could be run separately in future work. Because of the exploratory nature of the research process, no formal measurements were conducted, and most of the data collected were qualitative. We acknowledge this as a limitation of the study, and admit that it limits the generalizability of the results obtained. However, we hope that we have demonstrated alternative approaches and presented useful lessons that will shape future research and practice in future ICT4D, mobile health (mHealth) and co-design projects.

## 8.3 PROPOSED FUTURE WORK

### 8.3.1 *Intelligent Use of Feedback Data*

Having established the success of asynchronous voice in soliciting feedback, the next step in the feedback elicitation research is to find effective ways for the nurses to analyse the audio reports generated by CHWs. The use of Natural Language Processing (NLP) and other machine learning techniques for automated analysis of voice data (in Sesotho, in this case) will be imperative for extending this work. CHWs collect increasingly more data every day that can be used to build strong models to help us understand and characterise the rural public. Intelligent use of this data could help health departments

create more tailored interventions. An interesting use-case for this feedback data is in the introduction of personalised and targeted persuasive health messaging (Ikwunne and Orji, 2016), that considers individual and communal feedback.

### 8.3.2 *Increased Homophily in Content Creation*

The use of drama to communicate feedback proved useful, but it also has the potential to be incorporated into the content creation process. BH nurses expressed keen interest in using the footage of CHWs' skits in public videos. This use of CHW content could be extended by producing well-directed videos that are informed by CHW feedback. CHWs have the deepest understanding of the village contexts where they work. It will be important that they are given opportunities to directly inform the script for future videos — in which they are featured and where other members of the community are involved as actors. Increased participation of this sort will help address some of the most pertinent issues head-on. At the same time, it will also motivate CHWs, build their reputations (Ramachandran *et al.*, 2010; Kumar *et al.*, 2015), and increase adoption due to the increased homophily—that is, the degree to which two or more individuals are similar in certain attributes/interests (including culturally), and are likely to prefer those who are most like them (Rogers, 2010; Sorcar *et al.*, 2017). Additionally, it is useful not to completely overlook indigenous knowledge among CHWs and elderly members of rural communities (Awori, Vetere and Smith, 2015). As such, projects like the BH project can also play a role in capturing valuable indigenous knowledge on health practices, and incorporate such knowledge into the health education content delivered to citizens at large.

## 8.4 FINAL WORDS

We opened this chapter by reiterating the gaps in HCI4D and CHW-related digital-health literature that bore necessity for the research discussed in this thesis. These gaps were important to investigate, to deepen our understanding of CHWs and how to design with them, towards more relevant and useful digital health solutions in the future. Also, it was important to build new knowledge for the digital-health HCI community on how a feedback loop can be integrated to complete the process of health education using

digital tools and content. An understanding of what to expect long-term when deploying digital health content in rural villages, too, is useful knowledge that can guide future research and practice in digital health-education.

We hope that this research has advanced our understanding of CHWs' practice with digital tools and the multiple factors that influence their ways of working, and delivered practical lessons on how to design and research technologies with them in productively collaborative ways. Additionally, we have provided evidence on the importance and efficacy of continuous, effective feedback from rural villages and look forward to future research that will further advance the technical feedback mechanism using more intelligent technologies. Lastly, we hope that this work inspires fellow technology researchers and designers to rethink smartphone and web design with a focus on contextual relevance for users in low-income and emerging markets.

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Cape Town, South Africa. January 2018.

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## 10 APPENDICES

A total of 10 workshops were planned and conducted as part of the 30 months' study. Before each workshop plan was put together to outline to research questions and the tentative workshop activities. It would be impractical to list all workshop plans and workshop materials here, so a sample of workshop plans, focus group scripts, one-on-one interview scripts, etc.

### 10.1 WORKSHOP PLAN: APRIL 2015

#### **Background and Objective**

In October 2014, the Bophelo Haeso (BH) project entered a new phase by deploying Nokia Lumia devices to CHWs in Lesotho, with the mobile BH app installed. Details of all completed and planned phases here: <http://goo.gl/lk7FUU>

The deployment of the devices in October marked the beginning of several Participatory Action Research (PAR) cycles, throughout which we will co-design a multimedia learning platform with nurses and CHWs, on the premise that with increased use [9,12] of the devices, application and health content, we will collaboratively learn the needs in the rural health community that technology can address, and collaboratively design a complete and appropriate solution by the end of the project.

In April 2015, we will travel to Lesotho to hold workshops, meetings, trainings, and interviews as planned in this document. The goal throughout all PAR cycles is to enable a space where we (the researchers/designers) can interact and productively work together with the project participants (nurses, CHWs) [8]. We envisage building a space where all participants (including CHWs) feel empowered [11] to articulate their needs, contribute their knowledge and experiences, and participate in planning the solutions at

every phase, observing the outcomes of each action, and analysing observations alongside the researchers.

### **Anticipated Outcomes: Design Questions**

- To understand the dynamics of the interactions between CHWs and patients in the village. In similar projects, other researchers have seen the benefits of structuring the multimedia player to aid the interaction with CHWs (ASHA Assist, India [8]). Our goal is to support more than just the 'showing' of content to the patients and public, but also to support feedback capturing and more. To do this, we intend to understand the interaction between the CHWs and patients, and analyse all observations in the presence of the CHWs.
- To generate ideas for next actions with the Bophelo Haeso app, content creation and feedback. In the previous phase, the implemented feedback mechanism (recording questions during video playback) was not used. There is need to generate ideas for alternative ways of feedback generation from CHWs and the general public.
- To collaboratively critique current practice with the BH app and the process of content creation/use. Protocol is seen as part of design process [11].
- To test designer/researcher ideas/proposals.
- To further understand how to support nurses in improving CHWs' learning outcomes, and in creation, distribution and collaboration.

### **Techniques:**

- Role-play: observe use in simulated/dramatised interactions...CHWs familiar with role-play, as is a method often used in training [13].
  - Different patient-CHW scenarios (CHW to sit in groups and come up with scenarios to stage). CHWs using BH, CHWs not using BH?

- Observe different video types used: instructional videos, lecture-style videos, conversational videos, heavily graphical videos...
  - Two categories of patients in role-play activity:
  - CHWs acting as patients: a way of reporting experience, and Mediated design [8,11].
  - Non-CHWs acting as patients/general public, e.g., other staff at the HC, teachers, other people recruited (with understanding that a few variables are slightly different than pure CHW-patient interactions in the village)
- What if? I wish I could...? Brainstorming/Idea Generation [13]
    - Suggestions:
    - feedback by reporting, CHWs diaries (BH-Supported?)
    - feedback by picture/video capturing
    - real-time communication with nurses (WhatsApp?)
    - CHWs brainstorming in groups/
    - Prioritising generated ideas, (e.g., with sticky notes (preferred), chapatti diagrams [8])
    - Linking (current practice) role-play and brainstorming = Bodystorming Scenarios with Imagination?
  - Informal interview/discussion with CHWs on general use of the phones (looking at non-prescribed (personal) use, battery/charging struggles, exploration of phones owned by family members, pride associated with phone use, etc.).
  - Following the observation of each of the phones, looking at settings, content generated and downloaded on the phones (e.g., music, videos, photos, apps, etc.). Some of the non-prescribed uses observed and noted in January are here: <http://goo.gl/MpDbLu>

### **Meetings with nurses only:**

- Reflection of CHWs-inclusive workshop

- Interview-style conversation on future iterations of the authoring tool.

**Understanding and practising partnership [8] (to ponder):**

- How to enable CHWs and nurses to give voice to their concerns, to participate in decisions that affect them?
- What do we offer, what do we gain?
- Difference between researchers' and people's expectations and assumptions? And how to juxtapose the local idea/perspective of development with that of the researcher? (What does the local community consider progress?)

**Trip Dates:**

- Workshop at HC1: 9 April 2015
- Workshop at HC2: TBC (8 April tentative)
- Nurses' meeting: 10/11 April 2015

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## 10.2 ONE-ON-ONE INTERVIEW AND FOCUS GROUP SCRIPT

*Note: all interviews and focus groups were conducted in Sesotho. The initial scripts were written in both English and in Sesotho by the researcher. During the session, notes were*

*captured both English and Sesotho and later collated into English by the researcher who is fluent in both Sesotho and English.*

### **Understanding Experiences with The Solar Kit**

- What are your experiences with the solar kit?
- In relation to Bophelo Haeso, has your work improved? if so, how?
- Outside Bophelo Haeso, how has the kit helped you at home?
- Do you experience any difficulties with the solar kit?

### **Understanding Experiences with The Portable Speaker**

- What are your experiences with the portable loud speaker?
- Tell at least one story of a time when you have used the speaker. Explain the scenario. What happened?
- Do you experience any difficulties with the portable speaker?

### **Understanding Usage of The Bophelo Haeso App**

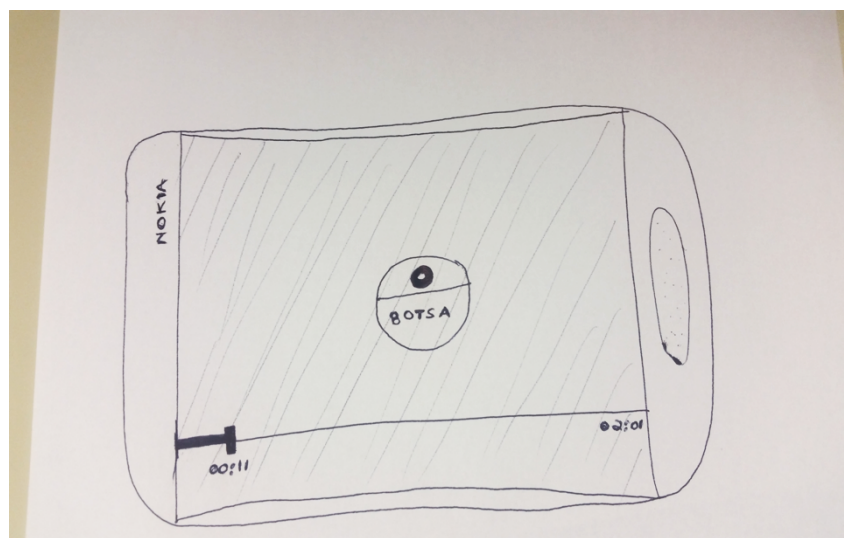
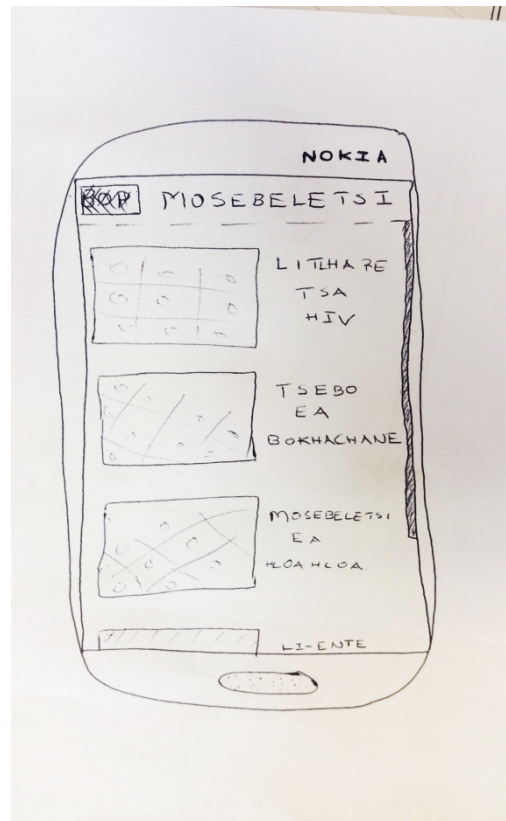
- Have you ever tried to share a video, what happened? (*Note to facilitator: Observe, Do they understand the Bluetooth Icon?*)
- We see many records of when a video was played but not to the end, in what scenarios do you abort the video playback before the video ends?
- Have you recorded any audio reports?
- Do you experience any difficulties while recording reports?

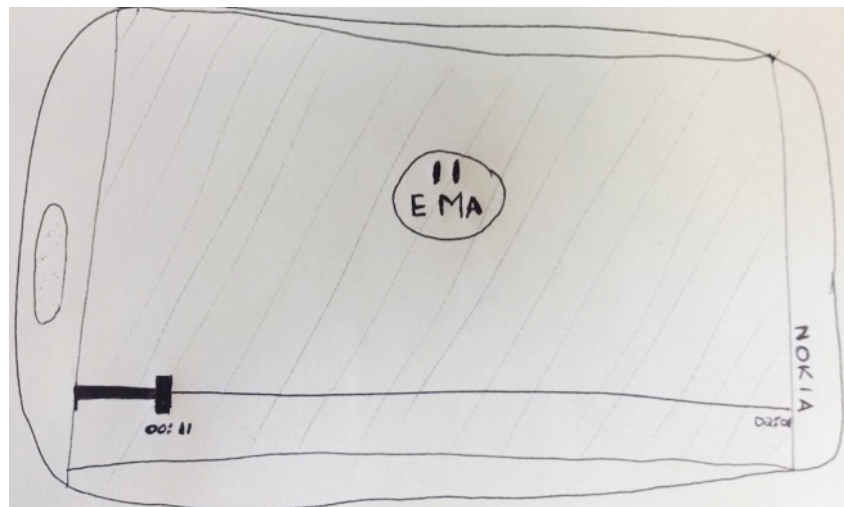
### **Reflecting on Phone Use and Ownership**

- Do you like having these phones?
- Why do you like having the phones?
- Apart from playing the videos, for what else do you use the videos?
- Do other family members (e.g., kids) use the phones?
- What other smartphones are there in the home? Have you used any smartphones yourselves?
- How much do you spend on airtime, and on what do you mostly spend the airtime?
- How do most of you charge the phones?

### 10.3 BOPHELO HAESO APP: EARLY PROTOTYPES

#### Paper Prototype





**Interactive Prototype Screens**



