Software Support for Creating Digital Health Training Materials in the Field

Maletsabisa Molapo
University of Cape Town
Private Bag X3, Rondebosch 7701
+27 21 650 2663
maletsabisam@gmail.com

Gary Marsden
University of Cape Town
Private Bag X3, Rondebosch 7701
+27 21 650 2663
gaz@cs.uct.ac.za

ABSTRACT

In this paper, we present the design, implementation, and deployment of a tool developed to help rural health trainers to create digital training content for low-literate Community Health Workers (CHWs) in Lesotho, the digital content being mobile videos created from combining images, voice over, and/or video clips. Our results show that when health professionals who are based in rural areas were empowered by the tool to create their own content, they were able to supplement nationally and globally produced health training materials with more locally relevant content that addresses unique information needs within their communities. We discuss other lessons learned from an eight-months deployment of this tool in Lesotho, and conclude with recommendations on how a similar project can be implemented in other developing regions.

Categories and Subject Descriptors

K.3.1 [**Computing Milieux**]: Computers and Education – *Computer Uses in Education*. *Computer-assisted instruction (CAI).*

General Terms

Design, Human Factors.

Keywords

ICT4D; training; low-literacy; software.

1. INTRODUCTION

Many developing countries are still battling with high rates of maternal mortality, HIV/Aids prevalence and tuberculosis infections [19,24]. The many deaths (maternal and otherwise) that occur (especially in rural areas) could be avoided if people were taught on health concepts, as health education has the potential to provoke change in behaviour and attitude towards lifestyle and medicine [4]. Because of this opportunity, health information content is continually being produced at global and national levels to be distributed in rural areas. ICTs are also being used in several developing countries to augment the dissemination of such health information content. However, not many ICT tools that empower trainers to create their own local content to supplement the general-use content exist. The work we present in this paper attempts to meet this need. We discuss how we developed software that permits trainers of low computer proficiency to create non-textual (multimedia) health content and distribute it to rural Community Health Workers (CHWs), who are active agents for disseminating health information and encouraging behaviour change in rural communities.

In many rural areas of developing countries, CHWs assist the formal healthcare system, wherein they provide basic and maternal healthcare, counselling and health education in their villages. Most CHWs are low-literate members of society who are selected for these roles but have not undergone formal education in the health sciences. Though low in literacy, their services are still needed in many developing countries due to limited heath facilities, especially in rural areas [19,24]. CHWs need to be trained on different health concepts to help them perform their healthcare duties. However, most CHWs cannot read text-based training materials, so it becomes challenging to train them effectively.

Given this, we started our research with the high-level question of investigating if ICTs could be used to support the training of CHWs with community-level content, and in turn, promote health education with locally produced training materials. To refine this aim, we considered three metrics: *relevance*, *usefulness* and *accessibility*.

- On the question of *relevance*, we focused on content origin, and learned that most of the materials that exist for training CHWs are produced at global and national levels; so we set one of our objectives as finding ways of using ICTs to empower professionals based in rural areas to create health education content for CHWs from within the communities they serve.
- *Usefulness* is defined as "the ability to be used for a practical purpose,"[1] so having established the need for health training content to be produced locally within the community, the next question would be how to design a model of content creation such that the locally created content can be useable for the practical purpose of training CHWs and furthering health information in villages (i.e., can the content produced locally be of any practical use in the CHWs training process and for general health education?).

---

[1] Oxford Dictionary: British and World English

- In terms of *accessibility*, we considered the fact that 1) most CHWs have low levels of textual literacy, so we wondered how ICTs could be used to convey training information effectively for them in non-textual forms), and 2) many in the developing world still live in impoverished circumstances, so we also desired to focus on how this digital, locally created, useful, non-textual content would be delivered at low to no cost to CHWs and across the rural health system.

As discussed in the next section, significant work is being done on the use of mobile phones and multimedia to distribute health information in rural villages, but not much has been done to provide ICT tools that health trainers can use on their own to create and distribute content. So the main contribution of this work is how software can be used to empower trainers based in rural areas to create non-textual digital training materials *independently* from within their communities.

2. RELATED WORK

Related work is analysed in two-fold, first by looking at the use of multimedia in training and health education, and then general content authoring in the developing world.

Video has been used with success in different projects in the developing world for purposes of training and information dissemination. The nature of videos vary from narrative lecture-style videos [8,12]; step by step instructional videos [12]; dramatization videos for demonstrating the skills [12,16], and testimonial videos used for motivation [19]. The Digital Green project [8] uses participatory video to train Indian farmers on recommended farming practices. Videos are recorded in the field and shown to farmers in public gatherings in the presence of an agricultural extension officer, who elaborates on the content and answers to farmers' questions. Video content that is produced in this manner is consumed by a group of people in what are commonly called video viewing clubs [2], where people gather in one place to watch training videos. Though these projects are a great success in improving the knowledge and perception of farmers as intended, the videos are watched in public televisions, and not distributed to individuals for later reference and concept reinforcement.

Mobile phones present a mobility advantage over video viewing clubs when used to disseminate video content, the major advantage being that content can be possessed by more people (can be easily shared across devices), and can be easily carried from place to place. This advantage is exemplified in the following projects, which use mobile multimedia to disseminate health information in rural areas: Ramachandran et al. [19] used mobile videos in India to motivate and train rural health workers and persuade pregnant women to adopt recommended health practices, where the mobile videos were created by weaving pictures together and annotating them with voice-over. The health workers would then carry the mobile content with them in as they visited their patients. CommCare is another application that uses multimedia on mobile devices [25]. CommCare is used for collecting data and assisting the visits CHWs pay to mothers in their communities. When CommCare was transformed to include images and accompanying voice, positive results were wrought, including mothers changing behaviour and CHWs being more motivated. The work of Treatman and Lesh on CommCare [25] confirms the benefit of mobility that mobile phone content enables. In [4], mobile videos were also used by midwives for one-on-one patient visits in India. Three videos were created beforehand in the field and then deployed on an Android application that the midwives used to collect patient information and disseminate health information.

The main distinction that our work brings against these mobile multimedia solutions is the providence for trainers to create content independently from a dedicated computer application. This means that in our solution, mobile videos are not pre-loaded on handsets, nor created by external experts; instead local trainers are equipped with software that allows them to author mobile multimedia content independently and distribute it to CHWs at no cost.

Though not much work has been done in developing tools that specifically assist health workers in creating local health content, there are other authoring tools that have been developed and deployed in the developing world. These systems are not tailored specifically for creating training content, but for digital storytelling, which in their different applications have been used to author and share different categories of information, including health information. Some of these tools include Mobile Multimedia Presentation Editor (MMPE) [10], the mobile digital story telling application reported in [22,23], the Storybank project in [5,6,7], and a PC based digital story telling application named iTell [13]. Of all these projects, the Storybank project is the only one that includes a content sharing or distribution option as part of the same solution, a feature we sought to build into our own solution.

In our work, we decided to develop a computer application that produces and is able to share mobile videos via Bluetooth. The decision to go with PC instead on mobile was based on the observation that trainers have access to computers, and that though low in computer proficiency, they can use computers for basic operations. Additionally, the solution discussed in this paper produces content that is specially formatted to play on even low-end feature phones and can be shared across multiple devices.

3. CONTEXT
3.1 CHWs in Lesotho

This work was conducted in partnership with a rural health centre in Mafeteng, Lesotho – The Emmaus Health Centre. The work started with understanding users, wherein the first author spent three days at Emmaus for the first qualitative needs assessment visit. In these three days, she took time to explain the initial goal of the research project to the health centre staff, while also building working relationships with them. Also during the stay, she conducted Contextual Inquiry [1] to build a detailed knowledge and understanding of the health trainers' work and the context within which the CHWs training process occurs, as recommended in [26]. The chief nurse and another nurse (both of whom take part in training CHWs) took the first author through the halls in which CHWs are trained, explaining the materials and other artefacts used for training the CHWs, the functions of CHWs, and the entire process of training and monitoring them – a typical Artefact Walkthrough [21]. This walkthrough included an account of the infrastructure available at the health centre; for example we learned that there is constant electricity supply at the centre, and a computer that is used mainly for compiling and submitting monthly reports.

At the end of the first visit, we had learned that Emmaus Health Centre brings together 35 CHWs from 16 neighbouring villages every month, who are trained on maternal health, sexual and reproductive health, HIV/Aids, TB, etc. Content shared with

CHWs is extracted from books published by Lesotho's Ministry of Health and other international health organisations. During the artefact walkthrough, the nurses mentioned that since CHWs cannot read, they are not given copies of the written materials; instead they are given graphical flyers, flash cards, and posters. The posters used in training are mainly composed of images with lines of text written in Sesotho (the only local language in Lesotho) or in English. Most posters and flyers are produced at the national health printing by the Ministry of Health and are distributed across health centres in the country. However, not all content needed by the CHWs is contained by the posters. Sometimes the trainers have to consult external sources (e.g., the web) to find content to communicate to the CHWs, according to the need at hand.

To get a closer understanding of the CHWs' training, on another visit, the first author sat through a series of training sessions, where she observed how the CHWs are taught, how they take the training, and how they relate with the nurses at the health centre, and chatted to them casually afterwards. In this session, only one of the 35 CHWs took notes.

**Figure 1 - CHWs in a training session - only one taking notes**

The chief trainer explained that most of the CHWs (all but two) can read and write in Sesotho (though not fluently), but their writing is so slow that it would affect their attention if they attempted to take notes. To overcome this challenge, she said, they try to use interactive methods of teaching (like role-playing and singing) to get the content across. Even with these methods, she indicated that most of the content communicated to the CHWs is still lost, because they forget what they were taught and do not have effective ways of reminding themselves of the content learned. For instance, she mentioned that CHWs had made a number of mistakes in the past, where they were given certain instructions on how to deal with patients in villages, but then due to forgetting some of the details in the instruction, ended up doing the wrong or opposite thing. The nurses expressed the forgetfulness of the CHWs as one of their greatest challenges, saying,

> *"We can teach them something in March, but by October most of them will have completely forgotten about that. Due to this, sometimes deadly mistakes happen in the villages."*

3.2 The Rural Health System

Figure 2 illustrates the rural health system as we learned it from the interviews, contextual inquiry, and artefact walkthrough conducted at Emmaus Health Centre. The figure shows that the health centre serves many villages that surround it, where every village has a representative CHW, who is an ambassador of the health centre in her community. The CHWs visit the health centre on a monthly basis to receive training and instructions to execute in their respective villages.

With the grounded understanding of the rural health system and the process of training CHWs, the next question for us to tackle was: how can ICTs be used to assist the existing CHWs' training program to overcome the challenges that are currently associated with it?
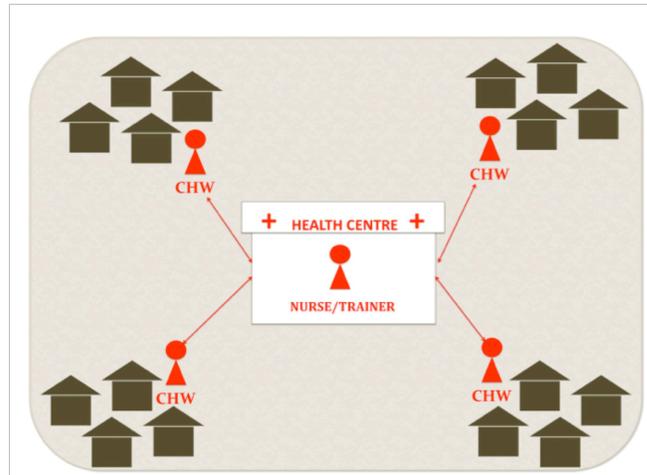
**Figure 2 - The rural health system, as at Emmaus Health Centre**

3.3 Proposed Content Creation Model

Having thoroughly studied and analysed the rural health system and the people involved in it, we then designed a content creation/distribution model that would fit into the system. Our task was to build a model of digital content creation atop the rural health system, i.e., a model that would support the existing process of CHWs' training with the use of mobile digital content. The objective was to align the design with the principles "Goals in Promoting Rural Education using ICTs" [18], which help in guiding the design of appropriate content creation solutions by ensuring,

- Locally relevant content,
- Accessibility of content beyond the bounds of literacy,
- Affordability of accessing content, and
- Design that fits existing community eco-systems.

The core of our model of content creation is that the content shared with CHWs and the community at large is created locally within the community by a trusted member of the society who is already involved in health training, i.e., a professionally educated health officer who is based in the community and is already involved in the health training process. The trainer uses the content s/he learns from the web, the national health department, and from health education resources to create mobile digital content for CHWs to be disseminated to their mobile handsets; using this locally created content to supplement the existing

monthly training sessions. We were careful to come up with a model that does not disrupt the normal operations of the health centre or the CHWs. The only added variables are that health trainers have to create content and the CHWs have to receive it as they come in for training every month. This model is demonstrated in Figure 3.
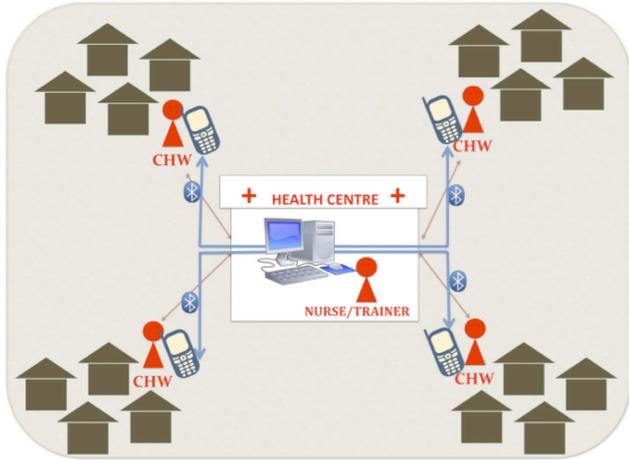
Figure 3 - Proposed Content Creation Model

The nurses/trainers who are based at the central health centre create the digital content that they distribute to the CHWs' handsets via Bluetooth as they come in for their monthly training sessions. The CHWs then carry the content with them on their mobile phones from the health centre into their villages. The process of meeting every month at the health centre for training is still maintained, the digital content is used to support the current process of human-mediated training, not to eliminate it. An important aspect to this model would be the consideration that the health trainers in question are not highly proficient computer users; so whatever technology would be deployed to implement this model would have to consider this factor carefully.

3.3.1 Introducing The Content Creation Model

To introduce this proposed model of digital content creation, we used an approach recommended by Ramachandran et al. [20] and Maunder et al. [15], which is to introduce simple technology artefacts with instant utility, in order to stimulate initial discussions on the possibility of using technology in training, without overwhelming the users with technology prototypes that they do not understand or cannot conceptualise.

To achieve this, we created sample digital content, the kind that the trainers would produce in the proposed content creation model. The sample content was created using Microsoft PowerPoint, where images were extracted from the existing posters, and placed on separate slides, then voice-over was recorded over each slide, being the recital of the text which was used in the original posters. When one played the PowerPoint show, they would get an idea that the content on the poster (images + text) has been transformed into digital format (images on slides + voice over each slide). The mocked up content did help to get trainers interested in creating similar content, and even helped to give the CHWs an idea of the work that was being planned. This is an approach that we termed "Content Prototyping" and is discussed in detail in previous work [17].

3.4 The Need for New Software

Following the discussions on the mock-up content, we moved on to the stage of providing software that would make the content creation model possible, i.e., software that would enable the trainers to create similar content to the one we had mocked up on PowerPoint. This task included deliberation on whether or not the best solution was to train the health trainers on how to use existing software (e.g., Microsoft PowerPoint, mobile digital story telling tools) to create similar content, or to build a new application.

According to the model that we had designed and agreed on with the trainers and CHWs, the content creation and distribution would involve the following steps:

- Adding images, recording voice over and/or including moving pictures (video clips),
- Transferring the created content to the mobile phones of CHWs at no cost (e.g., Bluetooth).

Microsoft PowerPoint can perfectly perform the first task as we had used it to create the mock-up content, but 1) even as we created the mock-ups, the process was found to be tedious on PowerPoint, and having learned of our trainers' computer proficiency levels, that option didn't appear to be the best, and 2) PowerPoint slides that contain multimedia content are normally large in size and only a selection of smart phones can play PowerPoint slideshows. So the use of PowerPoint as a tool that implements our content creation model was ruled out.

In a project with similar goals to ours, Ramachandran et al. [19] used four different applications to generate their mobile content (Adobe Photoshop for drawing the images, Microsoft Movie Maker and Photo Story for sequencing the pictures and adding voice-over, and a converter software to convert the produced videos into .3gp format to play on mobile handsets). Again, these are applications that we could not expect the trainers we had interacted with to use (the trainers are familiar with basic usage of Office applications and web browsers, but have no experience with photo or video editing tools). Furthermore, we aimed at providing in-built support for easily sharing the content to handsets via Bluetooth.

In terms of providing integrated support for content creation and sharing, the StoryBank project is the best solution that has been developed, wherein users can create multimedia content comprised of images and voice on mobile handsets and share the created content through a situated display via Bluetooth or USB. For users who do not have access to computers because of affordability or literacy limitations, the mobile phone serves as a perfect device for the creation of multimedia content; and the work of Reitmaier et al. [23] and Frohlich et al. [6] have shown the feasibility of using mobile phones for multimedia content creation. However, there is a limitation to what can be achieved on a mobile phone interface compared to that of a PC [10]. Therefore, for a target audience to whom the use of a computer is possible, the content authoring tool can be developed for PC to harness the computing advantages that a PC has over a mobile phone. Even in the StoryBank project, it is reported that some of the users who were computer literate requested that the mobile digital story telling application be made available for PC [6].

Our solution was therefore to develop a PC-based application that would address all these issues in one complete piece of software, one that would:

- Allow for easy insertion of images and recording of voice-over on a PC,
- Convert the multimedia content into mobile video format and to a size that can play on even low-end feature phones,
- Allow the transfer of the created content to the mobile phones of CHWs easily via Bluetooth, from within the application.

4. THE SOFTWARE

4.1 Technology Probing

We sought to design a simple-to-use and flexible tool that would produce content similar to what we had mocked up with PowerPoint, and produce content in a format that would play on mobile phones. The idea behind building a working computer application was to deploy it in Lesotho as a technology probe that would help us explore the process of digital content creation within a community to support the training of CHWs. By definition,

> "A probe is an instrument that is deployed to find out about the unknown - to hopefully return with useful or interesting data…Technology probes are a particular type of probe that combine the social science goal of collecting information about the use and the users of the technology in a real- world setting, the engineering goal of field-testing the technology, and the design goal of inspiring users and designers to think of new kinds of technology to support their needs and desires." [9]

We would then learn from the deployment how the content creating application is used and adopted into the rural health system by the users involved (trainers, CHWs), monitor the technical performance of the software during the deployment (does is work? Does it produce videos? Is it useable?), while also observing the unique ways in which the users use the technology to fulfil their daily tasks. At the end of the deployment, these observations would be reflected upon and used to inspire and inform the next level of design for expanding the use of the tool into other places in developing countries.

4.2 Software Design

We built the tool as a Windows Presentation Foundation (WPF) application. We describe below how the application works, stating reasons behind our design choices, which were informed and inspired by the interviews, contextual inquiry and the feedback from the mock-up content.

- The application produces videos by combining images and voice, and/or video clips.
- A video is made by combining one or more 'frames'/ 'slides'. This is to give the trainers a platform to create the exact content that was modelled in the mock-ups, i.e., a series of images (one image per slide) with voice over.
- Each 'frame' is composed of an image and a voice recording or a video clip (one of the comments that came out of the discussions on the mock-up content was that it would be useful to allow for inclusion of moving pictures in the content creation process).
- The trainer can save the project, close the application and modify it later.
- Modifying a project, the trainer can delete or add a frame. S/he can also delete voice on a frame, leaving the image; and vice

versa. This was done based on our experience when creating the mock-up content, sometimes we did record voice that we wished to delete and re-record.

- When the trainer is done with the project s/he can save the project and export it as a mobile phone format video (.mp4). We chose to export videos as mp4 because the format is supported on most mobile handsets (including low-end feature phones), and mp4 files are smaller in size than other video formats for the same quality [18].
- When s/he chooses to export the media, a file named FileName.mp4 is saved to a folder "Completed Videos" folder in the computer user's documents folder. During the artefact walkthrough session we had at Emmaus, we learned from the chief trainers' computer that they save most of their files in the "My Documents" folder, so we chose to place the completed videos in the "My Documents" folder.
- When s/he wants to share completed videos, clicking on "Share Videos via Bluetooth" enables her to share any videos s/he selects via Bluetooth to every device in the room which has Bluetooth enabled.
- When the trainer has loaded all the required images, recorded corresponding voice, and has inserted video clips (if any), and the export option is selected, the media is then combined into one video file using FFmpeg[2].

4.3 The Graphical User Interface

The aim was to develop a simple application where every function would be available on first click level (i.e., such that every available feature is immediately available and one does not need to go through more than one button to get to access a function). The left pane of the main workspace comprises of only three buttons: one for inserting an image, one for recording voice over, and one for inserting a video clip. Corresponding on the right side of the workspace are three buttons for deleting an image, voice recording, or a video clip from the current frame. The lower pane of the interface shows frames that have been inserted into the project by using thumbnails. This display is used in a manner similar to how Microsoft PowerPoint shows existing slides using slide thumbnails.

Figure 4 - Screenshot of the main application workspace

---

[2] http://www.ffmpeg.org

4.4 Software Testing: Conceptual Model Extraction

When the application was developed and fully functional, we took it to our first layer of users – the producers of content – the health trainers, for Conceptual Model Extraction (CME). The role of the CME session was to discover if the users would see the interface as the designers thought they would [11], and be able to use it.

We played the mock-up videos to the thrainer again to remind them of the kind of content the application was built to produce. Then we asked the trainer to launch the application, and asked her to explain what she thought the different interface elements meant and how she would perform given tasks. Some of the issues we observed were: 1) she did not recognize the play, stop and pause icons (for the recording module) when used without labels, 2) she did not understand a button we had that read, "Re-Use Existing Frame", which we later replaced with the "Copy" and "Paste" buttons. 3) Where we had implemented a tooltip to give an explanation for what a button does, she did not hover the mouse over all four instances where we had hoped she would (e.g., during voice recording, hovering over the "stop" button would read the tooltip "Click here to stop recording").

Regardless of these ambiguities, she was able to create a four-image video, which she exported and then saw the video file she had created in the "Completed Videos" folder. In the discussion we had after the CME session, she indicated that she understands the application more because she knew what she was building – making reference to the mock-up videos. Following this exercise, the software was refined, ambiguities removed, and the CME session repeated. The same chief trainer was observed to navigate the system with increased ease in the second CME session with the application.

5. DEPLOYMENT

After the rounds of initial testing of the software, we started a deployment in Lesotho between March 2012 and October 2012. To assist the deployment, we provided Emmaus Health Centre with 10 phones to be used by the CHWs in this period (so ten CHWs were selected by the trainers to be the ones to receive the phones and use them in the course of the deployment). Apart from these 10, five other CHWs who already had phones that could play videos joined the group of 10, bringing the total number of CHWs who would receive digital content to 15.

5.1 Objectives

The evaluation of the software's usability was conducted through CME, so the focus of the technology probe deployment was on the implications of using the digital content in the training process. From the deployment, we sought to answer the questions:

- Are the trainers able to use the software to create and share the content?
- Does the introduction of digital content bring any improvement to existing processes?
- How is the technology adopted, appropriated, domesticated?
- For what needs and goals is the technology used?
- Is there real need for locally produced content?
- What attitudes emerge from the use of the technology?
- What can be learned from this deployment that can be useful in future deployments?

5.2 Method

Because of the nature and focus of the study we collected only qualitative data, using the following approaches:

- We analysed application-generated logs and examined the actual content produced, i.e., the images used in content creation, the voices recorded, the length of recordings, the number of 'slides' used, etc., in order to understand the use of the software and the content creation patterns.

- We held informal meetings and interviews with the CHWs every two months to discuss their experiences with the digital content in their communities. In these meetings (which were sometimes held during lunch over a shared meal), the CHWs would take turns to discuss their challenges, opinions, and experiences. Meetings with the CHWs alone were possible as the first author speaks the Sesotho language. In more formal meetings, the trainers would ask each of the CHWs to stand and share their experiences in a lecture style.

- We also asked the nurses and other staff members of the health centre to chat with CHWs casually about their experiences with the videos and the phones in their communities. Though we needed to hear from the CHWs about their experiences, we still acknowledged that they could withhold feedback (especially if negative) from the researchers [3]; This process was made possible by the fact that every CHW spends a week working at the health centre once in three months, so during the times when a certain CHW was on duty at the health centre, the nurses would start conversations about the videos and probe the CHWs opinions in a conversational style.

- Our last set of interviews was with the nurses, mostly with the main training nurse, finding out their experiences with creating the videos, what constraints were being experienced, and the impact the digital content was having on their jobs and on the learning effect of the CHWs.

- *First-hand Observations:* We targeted some of our visits to the health centre to be in times when the CHWs were due to gather at the health centre for their monthly training; so we would sit through the training sessions, observe the process of created content being shared to CHWs' phones, watch the CHWs interact with the phones and the content, listen to them chat to one another about the content, etc.

6. RESULTS AND DISCUSSIONS

In this section we discuss the results of the questions asked in section 5.1, being observations made during the deployment period.

6.1 Content Creation Patterns

During the eight months deployment, the researchers did not play any role in determining which topics to cover in the videos that were being created, which images to use or what to record for voiceover. The nurses created the content independently based on their judgment on the needs of the community and their expertise in the field of health.

According to the examination of the videos and application logs, the first four projects created appear to have been "practice"

projects, which included random photos and recordings. We found this interesting, as we did not indicate to the trainers that they can "play around" to get used to the software before using it to create content, but they did it anyway and hence got comfortable with the tool.

Since tuberculosis (TB) is still one of the causes for most deaths in rural communities, the chief trainer decided to create the first video on TB, explaining in the video the basics of the disease, how it is transmitted and its common symptoms. The TB video consisted of 13 images and had an overall length of 1 minute 42 seconds. To understand further how she interacted with the software in creating this first official video, we studied the content she had used in the application files and logs and we also interviewed her about the process. This is how the video was created: Firstly, she (the lead trainer) wrote on paper the main

points of what she was going to talk about in the video, then she downloaded supporting images from the web, and placed them in a folder, numbering them '1' to '13', in the order in which she was going to use them. She mentioned that it is easier for her to plan a narration first because that is how she teaches in a normal training session, saying,

"Images are just visual supplements in the lesson."

When the videos had been created, any of them could be sent to the CHWs' phones via Bluetooth when they came in for monthly meetings. Table 1 below presents each of the videos that were created during the deployment period, with reasons that the trainers gave for creating each of them.

Table 1 - Summary of the videos created during the deployment period

Video Title	Month Created	Nō of Frames	Total Length	Notes
1. Tuberculosis	March 2012	13	00:01:42	Created in response to the high TB infection rates and deaths in rural areas of Lesotho
2. Adhering to HIV Treatment	May 2012	9	00:01:59	Created because of the realization that many HIV positive patients do not adhere to their prescribed HIV treatment, and end up dying of Aids.
3. Immunization for Babies	June 2012	7	00:02:00	Created to assist CHWs in remembering the details of which immunization injections children must go to at different stages and ages.
4. Love, Sex and Fidelity	July 2012	11	00:01:02	Created in support of the national HIV Reduction Campaign, using the lessons on love, sex and fidelity to reduce HIV infections.
5. Human Papillomavirus (HPV)Vaccination	September 2012	6	00:00:55	Created for the general patient community to address the concerns that parents have against having their children vaccinated.
6. First Aid in the Community	October 2012	13	00:02:05	Created to teach CHWs and community members on first aid skills applicable within the community. *Specially requested by CHWs.*
7. Working at the Health Centre	October 2012	14	00:01:48	Created to help CHWs cope with the work they do at the health centre. Every three months, one CHW works fulltime at the Health Centre to assist the staff at the health centre and to learn from the nurses at work. Video was created to address such issues as hygiene.

6.2 Improvement to Existing Processes

In our meetings with the CHWs, we discussed their experiences with the mobile videos in their communities. In most meetings, they stressed the value of the videos in helping them remember the concepts they usually forget easily. In one comment, they likened carrying the phones with the health content to having access of the trainers' knowledge with them everywhere they go. One CHW mentioned that due to repeatedly watching the content, she remembers most concepts more easily that she did before. Overall, we observed that the presence of the mobile videos helps address the main challenge that the trainers experienced with CHWs: forgetfulness.

Additionally, CHWs revealed that some of the videos help them communicate content that they are normally uncomfortable discussing in their villages (e.g., sexuality). During the first month

of the deployment period, we sat through a training session on "One Love", which taught on issues of sexuality, fidelity and HIV/Aids. After the training series, the CHWs had to teach members of their communities on these issues, and one of them expressed that she would be uncomfortable discussing such a sensitive topic, especially with male members of her village, out of the respect for her husband. However, as it was pointed out in [25], multimedia becomes the third person in the conversation between the CHW and the person watching the content. Recorded multimedia gets to do the talking which the CHW may be uncomfortable doing. We observed the similar effect on the CHWs, who mentioned that when they show the sensitive videos to their patients, the content is taken as originating from the nurse communicating the content, not the CHW herself.

6.3 Use, Adoption and Appropriation

Table 1 shows that the chief trainer created around one video per month, based on the needs she observed in the community, and amongst the CHWs. This showed us that she took ownership of the software, and started to visualise how it would help her in achieving her work goals. On the fourth month into the deployment, the CHWs themselves started making requests to the nurses about what content to create for them in the months to come (they requested for the video on First Aid). This is another benefit of locally created content – it was easier for the CHWs, who are the ones who spend the most time in the villages, to request for content that will directly address the issues they face on a daily basis. They had taken ownership of the technology and saw it as an opportunity for doing their jobs at a higher level of excellence.

Interestingly, the CHWs did not only use the videos for building their own competence, but they used them to teach other members of their communities as well. They mentioned that part of their job is to encourage people to adhere to treatment, visit the health centre and to lead healthy lifestyles. In their different communities, they said, people gather in groups to watch the mobile content from their phones. They mentioned that unlike other health education methods that they used before (posters, flash cards, flyers), their patients understood the audio-visual content more clearly. We quote below one of the CHWs who said:

> *"we learn more when we watch than when we are told. The presence of pictures helps us understand more than when we just listen"* (translated to English by the first author)

One of the CHWs mentioned that once, she was working in the fields with five other women and three men when she mentioned to them that the nurses at Emmaus had been giving them (CHWs) educational videos, showing some of the videos to everyone who was present there. Following this instance, she said people started coming to her home, sometimes in groups, to watch some of the videos from her phone. So in the end, health information was shared to even those who did not have mobile phones of their own. Another CHW mentioned that the video on sex and fidelity was enjoyed with a lot of laughs by a group of village women at a community tap, where they were gathered, waiting to fetch water; and out of the humour generated by the content and the comments that arose, the information was disseminated to this group of women.

6.4 Need for Locally Produced Content

Our idea of promoting locally relevant content was enabling the creation of content locally, by a health professional who knows the community that will consume the content; her decisions for which videos to create and what to say were specifically influenced by the needs of the society she serves. Since nursing sisters train CHWs and counsel patients on a daily basis, they are able to communicate content in the simplest manner, in the language that people in the community would understand. The flexibility to create content allowed for creativity and appropriation, as discussed above, not only for the trainers, but for the CHWs as well. The main lesson from this is that locally relevant content, especially when produced locally by a trusted member of society, can effectively educate CHWs and other members of their communities.

Figure 5 - Left: Nursing Sister sharing a video form her laptopn. Right: CHW receiving a video on her handset

6.5 Observed Attitudes

Trust and Credibility: In the second video that she created, the chief trainer at Emmaus used a picture of herself for the introduction page to her lesson, i.e., when the video started, her picture, dressed in her health apparel, showed as she spoke the Sesotho equivalent of the words:

> *"In this video, I am going to teach about the importance of adhering to ARV treatment – which means to take medication as per the directions given by your doctor"*

This added credibility to the content, from the people's point of view. One of the CHWs mentioned that when her patients saw this video, they recognized the face and the voice of the nurse (she is the chief nurse for the whole community, who is known and respected for her health expertise), and suddenly developed interest in the content.

Willingness to Participate: Over the deployment months, we observed among the CHWs an increasing willingness to participate in the project. Some of the CHWs who did not have multimedia-capable phones borrowed the capable phones for a week or so to go and use the mobile videos in their own communities. Many ICT projects have failed because of people's unwillingness to participate in the technology. Reasons for this are not that people find the technology to be non-useful per se, but sometimes because of other cultural or contextual issues which were not properly identified and addressed from the beginning of the project [15]. We believe that the paths we followed in designing the content creation model and the software (Initial technology-less visits, Contextual Inquiry, Mock-up Content, using Human Access Points [14], Technology probing as an approach to deployment) helped us to properly situate our designs into the rural health system in a manner that was appropriate to the community's culture and context.

Pride: The CHWs also shared that the possession of the videos brought them an element of pride, making them appear more important in the community. The CHWs felt that by having the videos they were respected more in the villages, and that more than any time before, people listened to them and gave heed to what they said. One of the CHWs even expressed the desire to hold a public gathering in her village and play the mobile videos to her patients off her handset.

Figure 6 - Some of the CHWs as they watch and listen to the content with eagerness

6.6 Lessons for Future Deployments

6.6.1 Challenges

Though the model of creating mobile health education content from within the community has major advantages as discussed above, there are some challenges to the process, discussed below:

Image Sources: At the beginning of the deployment, we encouraged the nurses to search for images online, to use in creating the videos. In the course of the deployment, they used images from the web, images captured by camera, images extracted from existing posters at the health centre, and from PowerPoint presentations they collect at the health professionals' workshops that they attend. However, even with these sources in place, the chief trainer mentioned than there are times when she wished she had an image appearing or coloured in a certain way, and she would struggle to find an image that perfectly fits her imagination online.

For instance, she mentioned that when she was creating the ARV Adherence video, she wished to have an outline picture of the human body filled with different coloured dots to represent the HI-virus and the CD4 cells in the human body, then use variations of these dots to explain how the body's immune system is strengthened by proper administration of the ARV treatment. She had a clear idea of what she wanted the images to look like, and what she wanted the video to communicate, but she could not find images that fitted her description at any of her usual sources. This is a hindrance to our vision of giving the health trainer the control to create content in a manner that she feels is appropriate.

As a way of moving forward and addressing this challenge, an option is to use the method employed by Treatman and Lesh [25], which involved recruiting a local illustrator. This is someone who the trainer can explain her ideas to, and then he/she would draw illustrations according to the trainer's requirements. Though this approach introduces an extra person in the content creation process, the power of what content should be created would still remain with the trainer.

Mobile Phones and Battery Life: Even though mobile phones have widely spread in many rural African communities, the challenge of where and how to charge the phones is still a major one as most villages are still without electricity. However, people find their way around this limitation in that they do not use their phones for battery-consuming tasks, hence the phone charge lasts longer.

In the case of the Emmaus CHWs (none of whom have electricity at home), saving the phone's charge by not using it was not possible given the intensive use of the phones – they mentioned that when people watched the videos off their phones regularly, the batteries on their phones would deplete quickly. For instance, one of the CHWs shared that with normal use her phone goes for over a week without a need for charging, but when she plays videos often she needs to charge it every two days. Because of this, they have to regularly charge the phones at a local retailer at a cost of M5.00 ($0.50) per charging, an amount they cannot always afford. Some CHWs mentioned that they know people who have solar panels in their villages so sometimes they charge for free at those people's homes, but generally phone battery life is a concern.

When they do come in for training and for those who live close enough to walk to the health centre – they charge at the health centre, which has regular electric supply, as seen in Figure 7 (a). On the other hand, with the rapid increase in adoption of mobile phones, people are coming up with innovative ways to charge mobile phones in places of scarce electric supply, such as solar chargers and the Hatsuden-Nabe Pot[3] (a pot fitted with a USB port that is used to connect a charger and can charge a mobile phone as one cooks with the pot, pictured in Figure 7 (b). Innovations such as these give hope that even in the limitation of access to power, the mobile phone still remains a useful candidate of choice for sharing health information.

Figure 7 - (a) Charging phones at the Health Centre During Training, (b) The Hatsuden-nabe pot, charging while cooking

6.6.1.1 The Typicality of the Lesotho Trainers

Looking back at the involvement of the health professionals at Emmaus in this project, especially the chief trainer, we asked ourselves: "how typical was the set of trainers in Lesotho? Would this content creation model and supporting software work with other health trainers in other developing countries?" At the end of the technology-probing period, reflecting on this question helped us consider closely how to recommend our model of content creation and the use of our software for other public health projects that may be interested in duplicating our solution. This is an important exercise as, in the past, technologies deployed in the rural health system have failed to be well received by health professionals because they were seen as extra work or as spy tools [15].

Upon reflection, we realised two attributes about the chief trainer in Lesotho that made her committed to this project and this process, namely:

---

[3] http://techcrunch.com/2011/06/14/hatsuden-nabe-pot/

- As a person, she is passionate about making a difference in the health system of Lesotho. She is determined to change the status quo and has realised that health education is a powerful tool to make this change.
- She quickly learned and embraced the potential of the mobile video to simplify her work and magnify her impact. This was especially encouraged by the mock-up videos, which showed her the possibility of digitising her existing content and making it widely available on mobile phones.

Now, of the many health trainers in developing countries, how many can possess these attributes? How many can take interest in using this tool in their jobs?

On the question on passion, there are many health professionals in developing countries who are moved by the current health situation in rural areas, and would happily take on a useable technology if it would help them make their impact possible. But then, what about the other nurses who don't see nursing or health education as a passion but merely as a job? Can they be willing to use this model and technology? Probably not. This brings back the lesson that a technology, whether being newly developed or being brought in from a previous deployment, must not be imposed on people or onto their work. Making use of a Human Access Point [14] during exploratory stages of the project can help reveal these issues and then an appropriate solution can be devised; for example, by introducing a model of content creation that does not bring in much extra effort on the trainer's part, even if the resulting technology would be less 'techy' than designers had perceived. Lastly, we reiterate the value of using 'simple technology artefacts with instant utility' [20], like our mock-up content, to elicit nurses' opinions early and to show them the potential benefit of the technology in a manner that they are able to relate to.

7. CONCLUSION

This work had one main research question: Can ICTs be used to empower health trainers to easily and independently create useful, non-textual digital training content to be disseminated to CHWs at low cost in developing countries? In addressing this question, we started by first looking into previous work that is related to our question, and then used recommended HCI for Development (HCI4D) approaches to understand the rural health system and to build relationships with stakeholders in the CHWs' training process. We then designed, with a clear understanding of the rural health system, a content creation model that pivots on health professionals independently creating training materials for CHWs. We used mock-up videos to introduce the idea of this model to the trainers and the CHWs, and followed by developing a computer application that allows even users of low computer proficiency to create training videos out of images and recorded voice over.

Following this we set out an eight months technology probe deployment at Emmaus Health Centre, Mafeteng, Lesotho. In this time, the local health professionals were able to successfully create mobile digital content for CHWs using the software we provided. The selection of topics for the content created was the trainers' discretion based on their own information need analysis and their knowledge and experience working in the rural health system. Our results from the deployment indicate that health education using this locally created content helped address community-specific health issues and promoted local creativity, engagement, and empowerment.

Looking back on the entire process, we assert that when socio-cultural issues of the rural health system are well identified and respected, when developing–world appropriate design methods are employed, when attention is paid to promoting local ownership of technology, ICTs, can, as in our case, successfully empower health trainers to easily and independently create useful non-textual digital training content to be disseminated to CHWs. While using health training materials produced for national and international consumption is beneficial and must not be nullified, we recommend that more emerging technologies should seek to empower trainers to create their own local content, even if such content is supplementary to the global- or national-level content, it is useful for addressing the unique information needs of each community.

8. REFERENCES

1. Beyer, H. and Holtzblatt, K. *Contextual Design: Defining Customer-Centered Systems*. Morgan Kaufmann, 1998.
2. David, S. and Asamoah, C. Video as a tool for agricultural extension in Africa: a case study from Ghana. *International Journal of Education and Development using ICT 7*, 1 (2011).
3. Dell, N., Vaidyanathan, V., Medhi, I., Cutrell, E., and Thies, W. "Yours is better!"*Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems - CHI '12*, ACM Press (2012), 1321.
4. Fiore-Silfvast, B., Hartung, C., Iyengar, K., et al. Mobile video for patient education: The midwives' perspective. *Proceedings of the 3rd ACM Symposium on Computing for Development - ACM DEV '13*, ACM Press (2013), 1.
5. Frohlich, D., Jones, M., and Park, S. Democracy, Design and Development in Community Content Creation : Lessons From the StoryBank Project. *Information Technologies and International Development 5*, 4 (2009), 19–35.
6. Frohlich, D. and Jones, M. Audiophoto Narratives for Semi-literate Communities. *Interactions Magazine*, 2008, 61–64.
7. Frohlich, D., Rachovides, D., Riga, K., et al. Storybank: Mobile Digital Storytelling in a Development Context. *Proceedings of the 27th international conference on Human factors in computing systems - CHI '09*, ACM Press (2009), 1761.
8. Gandhi, R., Veeraraghavan, R., Toyama, K., and Ramprasad, V. Digital Green: Participatory video for agricultural extension. *2007 International Conference on Information and Communication Technologies and Development*, IEEE (2007), 1–10.
9. Hutchinson, H., Hansen, H., Roussel, N., et al. Technology probes. *Proceedings of the conference on Human factors in computing systems - CHI '03*, ACM Press (2003), 17.
10. Jokela, T., Lehikoinen, J.T., and Korhonen, H. Mobile multimedia presentation editor. *Proceeding of the twenty-sixth annual CHI conference on Human factors in computing systems - CHI '08*, ACM Press (2008), 63.
11. Jones, M. and Marsden, G. *Mobile interaction design*. John Wiley and Sons, 2006.
12. Ladeira, I. and Cutrell, E. Teaching with Storytelling: An Investigation of Narrative Videos for Skills Training. *International Conference on Information and*

Communication Technologies and Development (ICTD), (2010).

13. Landry, B.M. and Guzdial, M. iTell : Supporting Retrospective Storytelling with Digital Photos. *Proceedings of the 6th ACM conference on Designing Interactive systems - DIS '06*, ACM Press (2006), 160.

14. Marsden, G., Maunder, A., and Parker, M. People are people, but technology is not technology. *Philosophical transactions. Series A, Mathematical, physical, and engineering sciences 366*, 1881 (2008), 3795–804.

15. Maunder, A., Marsden, G., Gruijters, D., and Blake, E. Designing interactive systems for the developing world - reflections on user-centred design. *2007 International Conference on Information and Communication Technologies and Development*, IEEE (2007), 1–8.

16. Medhi, I. and Toyama, K. Full-context videos for first-time, non-literate PC users. *2007 International Conference on Information and Communication Technologies and Development*, Ieee (2007), 1–9.

17. Molapo, M. and Marsden, G. Content Prototyping – An Approach for Engaging Non- Technical Users in Participatory Design User Centered Design. *Human-Computer Interaction–INTERACT 2013.*, Springer Berlin Heidelberg. (2013), 788–795.

18. Pennypacker, T. Which Is Better: MP4 or 3GP? | eHow.com. 2011. http://www.ehow.com/info_12160408_better-mp4-3gp.html.

19. Ramachandran, D., Canny, J., Das, P.D., and Cutrell, E. Mobile-izing health workers in rural India. *Proceedings*

of the 28th international conference on Human factors in computing systems - CHI '10, ACM Press (2010), 1889.

20. Ramachandran, D., Kam, M., Chiu, J., Canny, J., and Frankel, J.F. Social dynamics of early stage co-design in developing regions. *Proceedings of the SIGCHI conference on Human factors in computing systems - CHI '07*, ACM Press (2007), 1087.

21. Raven, M.E. and Flanders, A. Using contextual inquiry to learn about your audiences. *ACM SIGDOC Asterisk Journal of Computer Documentation 20*, 1 (1996), 1–13.

22. Reitmaier, T., Bidwell, N.J., and Marsden, G. Field testing mobile digital storytelling software in rural Kenya. *Proceedings of the 12th international conference on Human computer interaction with mobile devices and services - MobileHCI '10*, ACM Press (2010), 283.

23. Reitmaier, T., J Bidwell, N., and Marsden, G. Situating digital storytelling within African communities. *International Journal of Human-Computer Studies*, (2011), 1–11.

24. Sherwani, J., Ali, N., Mirza, S., et al. HealthLine: Speech-based access to health information by low-literate users. *2007 International Conference on Information and Communication Technologies and Development*, IEEE (2007), 1–9.

25. Treatman, D. and Lesh, N. Strengthening Community Health Systems with Localized Multimedia. *Proceedings of M4D 2012*, February (2012).

26. Wixon, D., Flanders, A., and Beabes, M.A. Contextual inquiry. *Conference companion on Human factors in computing systems common ground - CHI '96*, ACM Press (1996), 354–355.