Video Consumption Patterns for First Time Smartphone Users – Community Health Workers in Lesotho

Maletsabisa Molapo
University of Cape Town
Cape Town, South Africa
mmolapo@cs.uct.ac.za

Melissa Densmore
University of Cape Town
Cape Town, South Africa
mdensmore@cs.uct.ac.za

Brian DeRenzi
University of Cape Town
Cape Town, South Africa
bderenzi@cs.uct.ac.za

ABSTRACT
There is already strong evidence that mobile videos are a good vehicle for public health information dissemination, but there remain open questions around sustainability, appropriate target users, consumption patterns, content, and usage models. We analyse log and interview data of 42 community health workers (who were first time smartphone users) from a longitudinal 17-month deployment to better understand how the utility of mobile videos played out over time in rural Lesotho. During the study period, videos were viewed at an average of 170 times per month, for a total of 2898 views. Through this data we draw these primary findings: a) pausing is not contextually necessary, b) age is not a barrier to usage, c) the primary predictor of popularity of a given video is topical relevance and national campaigns, d) there is no apparent relationship between video length, popularity and completion rates, and e) new videos have only a short-lived novelty effect. Furthermore, we affirm that regular engagement with CHWs has an impact on continued usage, in addition to being important for reducing attrition due to technical issues.

Author Keywords
Community Health Workers; Lesotho; Mobile Health Video; Consumption Patterns; Understanding Users.

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

INTRODUCTION
There continues to be an alarming number of preventable deaths in rural areas in sub-Saharan Africa. The problem is complex and multifaceted, but one primary cause continues to be limited health knowledge [25]. 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. These challenges are more pronounced in rural areas that do not have adequate access to healthcare professionals who provide health education, diagnosis and support.

Health education and health promotion efforts targeting these areas have been shown to reduce misconceptions, encourage citizens to access healthcare facilities, and educate the rural public towards leading healthier lives [1,5,11]. One such project is the Bophelo Haeso (BH) project in Lesotho [18]. BH supports the creation of local multimedia content to address health challenges faced by youth, men and women in hard-to-reach rural areas. In the BH model, rural-based nurses create health education content in the form of mobile videos that Community Health Workers (CHWs) use in their communities to help educate the public. The BH project has found that health education content delivered in video formats can reach patients who cannot read in these areas, changing behaviours and influencing health decisions [18]. Beyond the BH project, there are several studies that have reported improved community health education when CHWs are equipped with mobile videos for dissemination in rural areas [11,17,21,27].

However, despite reported successes of mobile videos for public health education, most studies are short term, and we still have limited understanding of critical questions around the sustainability of these programs. In this paper we analyse the logs generated by 17 months of usage in the BH project, supplementing this data with interviews with the CHWs. This longitudinal study enables us to look at patterns of usage: whether video views are sustained and how viewing rates are affected by researcher visits, introducing new content and other factors. We consider natural and technical attrition, seeking to understand underlying causes of decreased usage of the videos over time. We expect that this study will contribute to understanding the factors and design choices that are entailed in similar projects. The remainder of this paper presents background on Lesotho CHWs and what we have already learned from other video-based health education initiatives. From there we detail the BH project and describe the app used for viewing the videos. We then present our research methodology, findings, and conclude with discussion and implications for design.

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RELATED WORK

Our work forms part of a growing area of research that explores the use of mobile multimedia for community health education in low-resource settings. Initially, mobile multimedia had been used as an educational resource even outside community health education, such as in the Digital Green Project [8], Digital Study Hall [22] and the Story Bank Project [7]. These works 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 supporting low literate information consumers in locating and managing media on mobile devices [2].

The ASHA Assist [21] project first provided evidence that videos on phones could be used by CHWs as a counselling tool with their clients, often expectant mothers. However, this study was only done in an experimental setting over a period of 8 weeks. The Projecting Health project has seen much longer real-world evidence for the benefits of video for health education [11], including a further study that demonstrated that CHWs are the most effective channel for disseminating health videos for community education [28]. Building on this work, we sought to understand how, over a longer period of time, the trends of CHWs' video dissemination and consumption would change.

BACKGROUND

Community Health Workers

In remote villages in the highlands of Lesotho, the nearest health centre (clinic) can be up to a four-hour walk away. People who live in these communities do not have regular access to mainstream radio, television, or the Internet; they are 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. To help alleviate this problem, public health facilities employ CHWs—residents of rural villages who receive monthly training to serve as the face of healthcare in their home villages. They provide basic healthcare services in the villages when needed, and are responsible for motivating people in their communities to adopt healthy lifestyles and make use of freely available services at health facilities. CHWs in Lesotho serve on an almost voluntary basis, with the majority receiving a stipend of about 22 USD per month. In some cases, CHWs are paid only once yearly, and there are CHWs who have never been paid at all. Despite little financial rewards, the CHWs in Lesotho continue to serve in their communities and attend monthly training meetings at the health centres.

The BH project works with two groups of CHWs, operating out of two separate health centres, designated in this paper as Health Centre 1 (HC1) and Health Centre 2 (HC2). At each health centre, there are one or more nurses responsible for training and monitoring CHWs. Nurses are in charge of identifying the information needs of the surrounding villages, and equipping CHWs to deliver the correct health education in their villages. At both HC1 and HC2, the nurses serve as the main healthcare providers – there are no doctors assigned to these centres, and this is the case for the majority of the rural clinics. Nurses are therefore seen as the 'doctors' of the community, and are greatly respected in the villages surrounding the health centres.

The BH Learning Model

BH uses a feedback-integrated multimedia health education model with emphasis on local content creation and elicitation of village-to-clinic feedback. CHWs are equipped with educational videos on mobile phones to assist with health education. The videos are authored by the nurses based at the rural health centres using the computer-based authoring tool developed by Molapo and Marsden [18] and are loaded onto the CHWs' devices offline using USB cables or Bluetooth. The BH project includes a feedback mechanism that allows CHWs to capture and submit feedback in the form of audio reports to give nurses insight into the status of people's health practices in the villages, and to inform the creation of future videos.

The BH Mobile Application

For the project phase reported in this paper, CHWs consumed (watched, showed to patients, shared with others) the health content from the BH app on Nokia Lumia smartphones (running Windows Phone OS Version 8.1). The BH app serves as a dedicated gallery for BH videos, a customized video player, and a feedback collection tool. The main benefit of having a mobile app for all BH activities is that it helps separate the BH multimedia from the rest of the personal files on CHWs' devices, for easy and quick access in the field; and that it enables the logging of CHWs' usage of the BH content. Deeper rationale for the design and features of the BH app is well-documented by Molapo et al [15], and outside the scope of this paper.

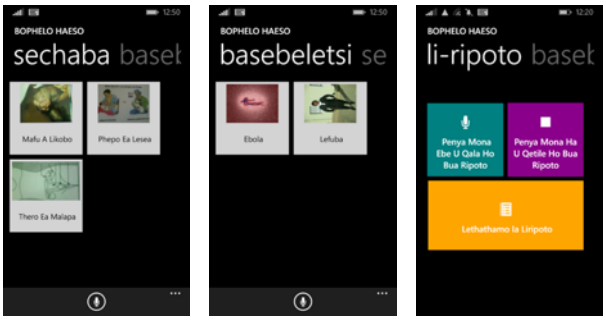

Figure 1 - Screenshots of the BH app showing the CHW Video List, Public Video List, and Reporting Page

The BH app has three pages, which users swipe left or right to cyclically navigate between. The first two pages are the BH gallery: videos meant for public consumption on Page 2, and videos meant for CHWs only on Page 1. In the period reported in this paper, however, the videos on the CHWs' list were also applicable to the public. The videos

are displayed in a grid using thumbnails. Below a video thumbnail is the name of the video in Sesotho (the native language in Lesotho). The third page of the app is used for recording feedback, where CHWs record 'audio diaries' of their experiences and interactions in the villages.

The BH Project Timeline

The BH project consisted of three sequential phases. In the first phase (six months), CHWs consumed BH videos on Nokia Asha feature phones, and starting from Phase 2, CHWs used Nokia Lumia smartphones. Phase 2 (six months), the Exploratory Phase, allowed CHWs to acclimate to the smartphone devices through exploration Following exploration, the CHWs entered into Phase 3 (17 months), consuming BH content from the smartphone app.

In October 2014, when smartphones were deployed, none of the 54 CHWs had used a smartphone before. To give them the opportunity to explore and learn at their own pace, the CHWs were given six months with the phones and the app in the field, during which they were encouraged to *play* with the devices [24]. The devices, at launch, were simplified for the CHWs by removing unnecessary apps from the devices' home screen (e.g., maps, games, etc.), leaving only the BH app and five of the most useful tiles. While unnecessary apps were disabled from the home screens, we did find that approximately 20 CHWs (48%) installed custom applications of their preference (e.g., the Bible, radio, and meme-creating apps). A detailed analysis of this use is beyond the scope of this paper. Midway through the exploration period, the researchers released two videos to further encourage CHWs to explore the devices. The first video focused on the basic understanding of how the Internet, data connections, data bundles, and WhatsApp work on the devices, and the second on the navigation of the BH app.

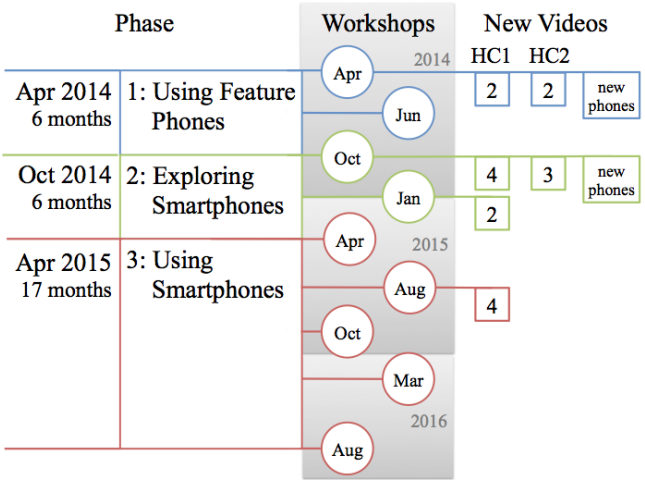

Figure 2 - Timeline of BH Activities

Most CHWs (70%) said they learned how to use the smartphones by a combination of personal exploration and receiving guidance from children and grandchildren, typical of older first-time smartphone users [9,20,23]. Only 20% said they learned entirely on their own, and 10% said they learned by exploring the devices with friends. Following the exploration phase, CHWs entered the active usage phase reported in this study. Throughout exploration and into the active use phase, all CHWs showed excitement and pride regarding the new devices, and that led to their enthusiasm to learn and explore.

BH Multimedia Content

By April 2015 when the evaluation of CHWs' consumption patterns began, the HC1 group had eight nurse-authored videos released to the CHWs, and HC2 had five. The dates for initial release per video are included in Table 1 and Table 2. 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	Duration (mm:ss)	First Released	Created By
Tuberculosis	04:44	Jun 2014	HC2 Nurse
STIs	03:15	Jun 2014	HC2 Nurse
Infant Nutrition	03:07	Oct 2014	HC2 Nurse
Family Planning	04:37	Oct 2014	HC2 Nurse
Ebola	01:55	Oct 2014	HC2 Nurse

Table 1. Videos released at HC2

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

Table 2. Videos released at HC1

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, asking the following research questions.

Research Questions

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

We expected to see a novelty period, as reported in related work [3], where the initial introduction of the application and subsequent new content causes a spike in the number of plays, which decreases over time (RQ1). We sought to understand three things: (1) the duration of the initial spike in 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 when the decay stabilizes. Additionally, we anticipated an increase in video usage after researchers met with the CHWs. We also sought to understand the properties of health videos that make them more or less popular among CHWs and their communities, and 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). Our assumptions were that CHWs would pause videos often during playback to engage with patients (RQ3). Looking at individual CHWs, we sought to understand how CHWs compare to one another, looking at attributes or attitudes that affect individual usage rates (RQ4). Lastly, to interpret the trends observed, we aimed to further understand the scenarios where BH content is used and the interactions between CHWs and the public (RQ5).

Participants

We began with 54 CHWs during the exploration phase in October 2014. There were 24 CHWs from HC1 and 30 from HC2. The 54 CHWs ranged from 29 to 70 years old, with the mean age of 55.1 (*SD*=11.7). All but one CHWs are female. 7 (12%) completed varying levels of high school, 31 (58%) have primary school education only, and 16 (30%) did not complete primary school. All CHWs can read and write in Sesotho—the national language in Lesotho—although the older CHWs generally write very slowly. About 11 (20%) can read basic English with difficulty.

CHWs did not receive regular financial compensation from the project during the study, but were given $3-5 USD for transport and lunch during workshops with the research team. The smartphones, however, served as incentives for the CHWs, as they were also used for personal purposes. None of the CHWs had previously owned a smartphone, with only four having had some exposure to smartphones because their children owned smartphones. However, all CHWs had owned feature phones (provided by the project and self-acquired) and used the phones for SMS and calling, and 25 (60%) had also used their Nokia Asha feature phones for WhatsApp.

Procedure

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

To complement the usage logs, qualitative data around the CHWs' experiences were collected multiple times during the study. This 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 [16], all conducted in Sesotho. All quotes included in this paper have been translated from Sesotho to English by the first author, a native Sesotho speaker.

Of the 54 CHWs originally enrolled in the study, data from 42 (21 from HC1 and 21 from HC2) was used for analysis. 12 CHWs were excluded from analysis because they had missing or incomplete logs because either the CHW died (1), moved to another country (1), the CHW's phone was stolen (1), the instrumented version of the app was not installed at the start of the study, i.e., they worked with an old version with no logging feature (4), or the CHWs were moved from active CHW duty in the villages to work full-time as assistants at the health centres (5).

At the beginning and end of the study (April 2015 and August 2016), we conducted user tests and interviews with CHWs to understand how they used BH content and to assess their proficiency of 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 user tests conducted both at the beginning and end of the study, we sat with CHWs one-on-one. For each, 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 Tuberculosis video), etc. In the workshop held at the end of the study, we also asked the CHWs to each tell us the video they played the most during the 17 months, and give reasons why that video was the one they played the most.

Data Cleaning

Firstly, 10% of the raw records were removed: we removed all records with invalid timestamps (8% of total raw records), which was the result of the phone battery being removed and the clock being reset to the default time of a January 2014 date. 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 no health message would have been heard. For all the videos, at 10% into playback, the nurse has covered at least one main point on

the topic at hand, 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.

RESULTS

In this section we report on our investigations into each of the research questions posed earlier.

RQ1: Consumption Patterns

For this research question we used the logs to identify patterns of how often videos were played by the CHWs, and we hypothesized that researcher visits and new videos would cause increased use that would decay quickly.

Frequency of Play and Effect of Researcher Visits (RQ1)

Figure 3 shows the mean number of BH video views per CHW by health centre over the 17-month period. The means are based on the number of CHWs who viewed videos that month.

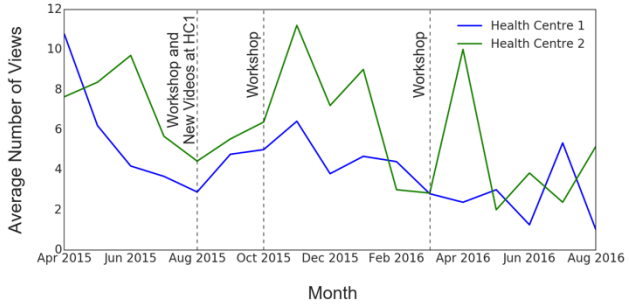

Figure 3 - Average number of views over 17 months

In the 14 of the 17 months, HC2 had more video views than HC1. Over the months, usage rates at both centres went up by 33% - 72% in the months following workshops with researchers, with the exception of HC1 after the March 2016 workshop, where instead a slight decrease in usage occurred after the workshop. In all other cases, after the workshop-induced spike in usage, a decline was seen until the next workshop when usage spiked again. When workshop 'excitement' subsided, usage settled at approximately 2-6 views per CHW per month. By the end of the study period, the average number of views 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, RQ2)

At HC1, four new videos were introduced five months into the study. Figure 4 compares the usage of the four new videos against the eight old videos at HC1. This graph depicts the mean number of views per video in each set 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 release, reaching a peak on the third month after release. For two months, starting a month after the release of the new videos, new video usage surpassed old video usage; but in the next month after the usage rate of the new videos peaked, it declined by 81%. After the initial peak and decline, the new videos then joined the standard usage pattern of occasionally increasing and declining usage, but never rising as high as in the three months after initial release.

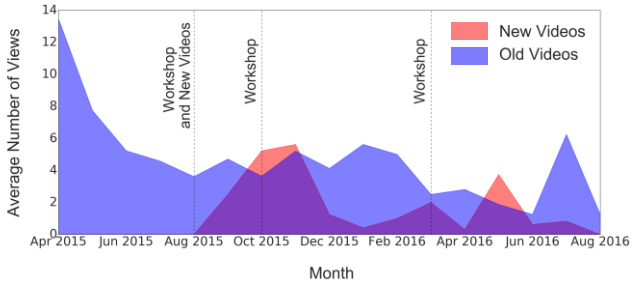

Figure 4 - Newly released videos vs old videos at HC1

RQ2: Video Popularity

As shown in Figure 4, video popularity due to novelty wears off after three to four months. In this section, we further examine factors that lead to sustained popularity.

Factors Affecting Popularity According to CHWs (RQ2)

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

> *"We thought you are 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 said that as part of the current national fight against TB, CHWs are tasked to identify suspected TB cases, encourage them to visit health centres for tests, then assist them through treatment to ensure adherence. Nurses believe that because of this specific mandate on TB, CHWs use the TB video more often. With HIV, they are expected to teach and support the public, but national campaigns are not as rigorous. Additionally, CHWs mentioned that HIV is now more accepted, whereas many people still deny the existence of TB as a medically treatable disease and blame witchcraft for deaths caused by TB.

Similarly, during the Ebola outbreak in West Africa in 2015, the Ebola video was used at high rates because there there was a national campaign launched to educate

communities on Ebola. CHWs showed the Ebola video frequently in that period, but when it appeared 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 also popular among other CHWs, who stated that the video was known for its explicit graphic imagery of STI infected genitalia. Many people in CHWs' villages had never seen such images, or been exposed to the reality of STIs, so CHWs said they preferred to show the video to demonstrate that STIs are real. Figure 5 compares videos at HC2, confirming the usage patterns described by CHWs, with TB being the most used video, followed by Ebola in 2015 and early 2016, and then by STIs.

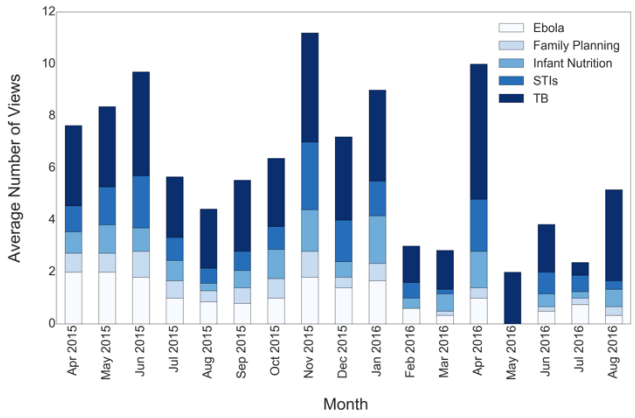

Figure 5 - Comparing per-video performance at HC2

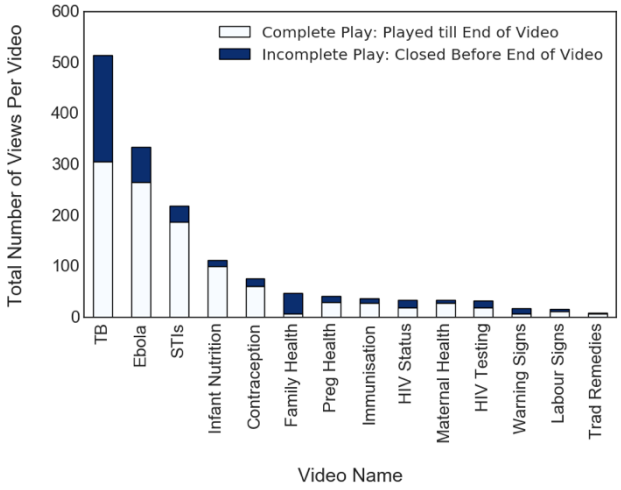

Figure 6 - Video Total Views Showing Completion Rates

Popularity, Frequency of Play and Completion Rates (RQ2)

Looking at the total number of times all videos were played in the 17-month period (2898), 37% of the time (1081 times), the videos were watched till the end, 15% of the time (448 times), the videos were not completed, but were watched beyond 10%, and 47% of time (1369 times), the video playback was terminated before reaching 10% of the video length. Figure 6 shows the total views per video for views longer than 10% of the video length, showing the ratio of complete to incomplete plays per video. Further, we wanted to understand if the most frequently viewed videos were also more likely to be watched till the end, and if shorter videos were more likely to be watched till the end. We found very weak correlation between number of video views and completion rate (Figure 7a, Pearson's r(12)=0.09, p=0.75) and between video length and completion rate (Figure 7b, 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 video plays to total video plays for each video.

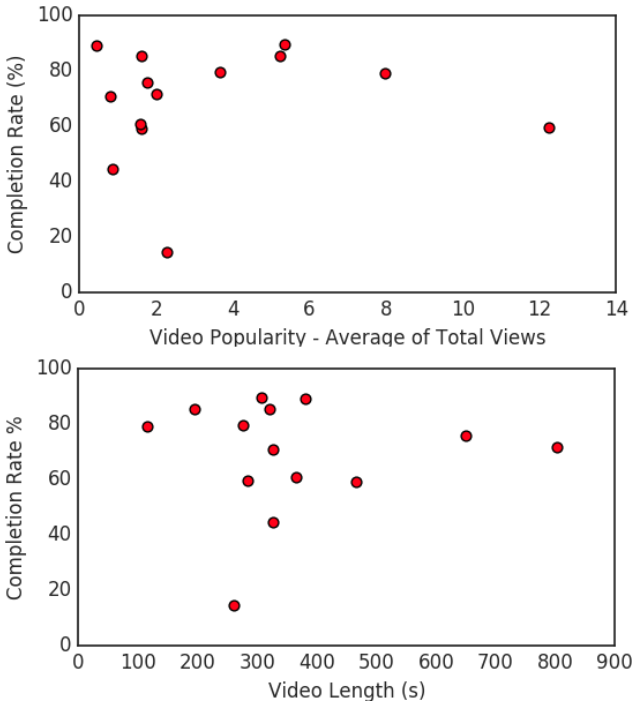

Figure 7 – (a) Video Popularity vs Video Completion Rates, (b) Video Length vs Video Completion Rate

RQ3: Pausing and Conversations

Ramachandran et al. [21] suggested that active pausing and discussion during a video would lead to greater behaviour change. Indeed, in early versions of the BH app, Molapo et al. [15] implemented a feature so CHWs could pause and add audio annotations at particular points in the video. This feature was later removed because it was found by the CHWs to be confusing and largely unused [15]. In the 17 months of the study, playback was paused during only 14% of video views. Of the pauses, 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. Where playback was resumed, pauses lasted an average of 8 seconds, with the longest pause being 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, saying that they preferred to let a video play till the end, and then have a discussion about it afterwards. When asked what they do if the audience have a question as the video plays, and 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 till the end, I just close the app and allow them to talk." – CHW 9, HC1

RQ4: Characterizing Community Health Workers

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

CHW Smartphone and BH App Competence (RQ4)

As we launched into the active study phase, user tests and interviews were held with 42 CHWs to determine their familiarity and competence with the devices after the exploratory phase, and the same were held 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 done at the end of the study, and 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 normally played all the videos for a few seconds, sequentially, until she found the one she was looking for. Two of the four CHWs who struggled at the beginning had improved and could navigate the app and play correct videos as easily as the rest of the CHWs. The rest of the CHWs correctly found the videos by reading the names of the videos and being guided by the thumbnails. The struggling CHWs received further training and guidance after both sessions.

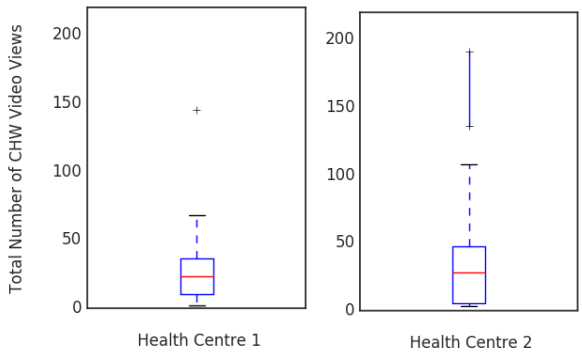

Figure 8 - Distribution of CHWs' accumulated total views

Total Views Accumulated Per CHW (RQ4)

At Health Centre 1 (n=21 CHWs), the mean number of total accumulated views in 17 months per CHW is 31.0, Median 23.0, Range 2 to 145 views, and SD = 31.6. At Health Centre 2 (n=21 CHWs), the mean number of total accumulated views in 17 months per CHW is 41.9, Median = 28.0, Range 3 to 191 views, and SD = 49.7. Figures 8 and 9 show the distribution of the total views accumulated per CHW in each of the CHW groups. The majority of 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, followed by 74.

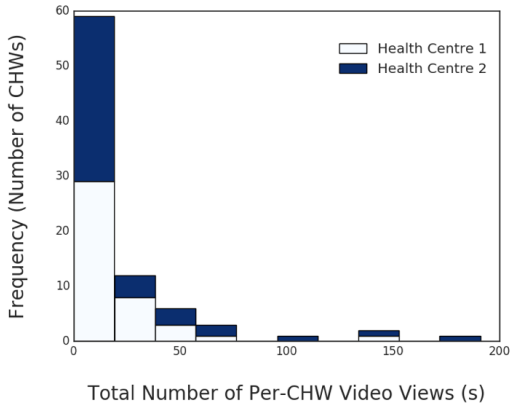

Figure 9 - Histogram of the CHWs' accumulated total views

Usage Patterns of Individual CHWs (RQ4)

To further understand the patterns of CHWs' use of BH videos, we looked at the usage 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, closely examining 12 CHWs as seen in Figure 10. High-use CHWs did not necessarily watch videos at a steadily high rate across all the months on record. For each of the CHWs, there are one to two months in the 17 months when the CHW did not show any videos (6% - 12% of the time), but each had spikes of high usage in varied months, going as high as 30 video views a month. Three of the four high-use CHWs are some of the oldest CHWs (aged 70,66,62). Average-use CHWs consumed BH videos in 6 to 9 of the 17 months, with usage peaks going up to 10 - 12 video views a month. During the user tests in August 2016 (end of the study), Low User 1 and Low User 2 (they originate from both centres) were the only two CHWs (out of 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, and the logs confirm this as 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, but while she showed few videos per month, she logged usage in nine months. Low User 4

was only 29 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 one CHW is only interested in entertainment multimedia and using the BH-provided phone for personal uses only. She always has headsets on - playing music, funny videos, etc.*" – HC2 Nurse

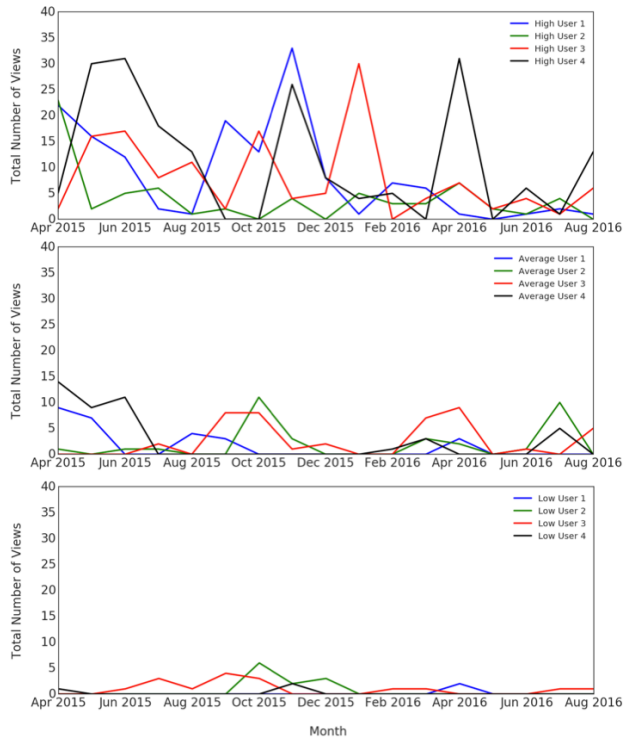

Figure 10 - (a) Usage patterns of four 'high users', (b) Usage patterns of four 'average users', (c) Usage patterns of four 'low users'

RQ5: Scenarios of Use

From interviews with CHWs, we discovered eight scenarios in which CHWs use 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 my 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

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

"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 on 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 specific topic:

"Sometimes when we have just dispersed from a village meeting, one will ask me to show '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 that sitting." – CHW 12, HC1

4) Some members of the pubic 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 perceived 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 convince patients to pursue recommended healthcare practices, using the nurse's voice 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 in 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 the patient 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 is gathered for the CHW to address.

"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

A *Pitso* is a gathering of the village public called by the chief. The *Pitso* usage scenario was one of the first that we learned from CHWs, and halfway through the 17-months study, we provided them each with a portable loud speaker that they could connect to their phones via audio jack or Bluetooth. We thought that the loud speakers 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 they used the speakers.

DISCUSSION

This discussion is structured into two sections: first our improved understanding of CHWs as a result of this longitudinal study, and secondly, our observations and analyses of usage trends as observed from CHWs' logs.

Improved Understanding of CHWs

Community-Based Health Education in Practice

We found that CHWs use BH content in varying contexts and scenarios, which are beyond what we initially imagined. Due to varying contexts of use beyond the traditional house visits, CHWs have periods of high use followed by low use, e.g., when a CHW shows all the videos on her phone in one day at a family gathering, and then shows the next video two weeks later to 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 has also been observed with Accredited Social Health Activists in India in a study by Ramachandran et al. [21].

However, in contrast to their findings, our CHWs preferred to play videos to completion and discuss the content after, rather than pausing to comment and clarify in the middle of playback. CHWs felt that by pausing to engage, they would be interrupting the nurse speaking in the video and 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 long 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, CHWs and their clients often engage in long discussions that cannot be easily incorporated into a brief pause, as found by Kumar at al. [11] and Fiore-Silfvast et al. [6].

Simplicity for Confidence

Apart from their preferred flow, CHWs expressed a preference for simplicity as a reason for not pausing during video playback, in order to confidently manage the viewing sessions. They felt they wanted to conduct as simple a play session as possible, to avoid 'pressing so many buttons that they would end up confused and looking incompetent in front of their community members' [15]. It is for this reason that 60% of the CHWs did not seek video positions 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 CHWs' reluctance to use the supplied portable audio speakers. Many CHWs did not use the speakers. 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 CHWs, to keep up the elevated status they received in their communities when they began using mobile phones for their work.

The Role 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 are highly committed in general, even outside the BH project. For these CHWs, the technology was just an amplifier of prior intent [26]. Most of these CHWs happened to be the older CHWs, many of whom have done CHW work for more than 20 years, with commitment. One of the nurses said:

> *"At the end, we found that what is important is to have CHWs who are truly committed to their work. The ones who have high usage rates in BH were already very active CHWs…"* – 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 found previously inactive CHWs whose commitment to community work was ignited by their excitement for the technology. Commitment to community work and openness to learn and explore the technology are certainly attributes and attitudes of CHWs that seemed to affect their usage rates.

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 hard for them to get accustomed to using mobile phones in their work. However, based on previous work on the studies with technology for the elderly and low-literate [19], when participatory and empowered design principles are applied [13], older people can get 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 could be empowered to learn to a point of using technology in their work.

From the usage logs 17 months later, we found that 72% of the high-end users are CHWs over the age of 55, with the highest users at the two health centres being 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 still be effective with technology when given the opportunity to learn the technology 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, as already discovered in other contexts in ICT4D work [9,10,20,23]; but also include lessons of the importance of allowing self-exploration. Some of the older CHWs preferred to explore and learn by themselves.

CHWs on Touch-Screen and English Interfaces

At the beginning of the study, 95% of the CHWs agreed that consuming the BH videos from the easily accessible BH app on the smartphone was quicker and simpler than navigating menus on a feature phone. The CHWs felt that interactions on a touch screen device were easy and fitting for their type of work, especially for the BH app where they did not need to type anything. One said:

> *"...with these phones, it's a quick tap, swipe, tap and the video is playing. It's so easy,* ***I think touch screen devices were created for old people*** *like us who need things to be right there when you open your phone."* – CHW 15, HC1 (Top User, Aged 70)

The challenge with smartphones and CHWs is limited English literacy [4]. Six CHWs, at different times in the study, uninstalled the BH app by mistake and when asked, one 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 unaware]."*- CHW 30, HC2

On the devices used by CHWs, there was no Sesotho language option, and even if there were, we had previously found that the Sesotho translations on the phones are incomprehensible and confusing to CHWs. The feature phones previously used by CHWs had a Sesotho language option, but CHWs preferred to use English because the Sesotho version was too confusing. The difference between these native OS translations and the BH Sesotho interface, is that in BH we did not directly map English words into Sesotho equivalents: we made all Sesotho labels fully descriptive in a way the CHWs would understand.

Regular Engagement with CHWs

We found that after BH-focused workshops, CHWs remained motivated to use BH videos at increased rates, but that the initial enthusiasm after meetings eventually wore off and caused the frequency of plays to return to a lower, 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 [24]. Engagement with CHWs does not have to be by the researchers alone, but discussions and activities around CHWs' digital content can form part of their monthly meetings.

Analyses of Usage Trends

Topical Relevance Begets Video Popularity

Our expectation was that interest in videos would decay over time, with older videos losing popularity in favor of newer videos [14]. However, after 17 months, the two most watched videos were TB and STIs, which CHWs found 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 STI 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 its topical relevance rather than any other features such as length, authorship, style or novelty.

Novelty Usage Spikes

Our results show an initial usage spike for all videos the CHWs had at the beginning of the study, and a spike in usage when new videos were introduced, showing temporary initial excitement over new content, but lasting no longer than three to four months. Novelty spikes can be leveraged for introducing new topics to the community, such as Ebola. However, in absence of sustained interest or extrinsic motivation, as with the TB videos, new videos must be introduced every few months.

Engaging Imagery: Explicit Content

Of all the BH videos, the STI video has the most explicit imagery, in part because it has images of genitalia, which are not commonly seen by many, and 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," having stimulated great interest and initiated dialogue among many in the CHWs' villages. Those who saw the video and were frightened by the images referred their friends to the CHWs to also watch the video. Those who requested to see the video would end up watching several others. The usage of this graphic video confirms the role of engaging or provocative imagery [12] in health education.

CONCLUSION

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 on the diffusion and use of the content over this period, seeking 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 the health videos affect rates of use the most, and presented lessons applicable to projects seeking to deploy multimedia content in rural settings over long periods of time.

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