Sangoshthi: Empowering Community Health Workers through Peer Learning in Rural India

Deepika Yadav[1], Pushpendra Singh[1], Kyle Montague[2], Vijay Kumar[4], Deepak Sood[1], Madeline Balaam[2], Drishti Sharma[3], Mona Duggal[3], Tom Bartindale[2], Delvin Varghese[2], Patrick Olivier[2]

[1]IIIT Delhi
India
deepikay, psingh*,
deepak15013@iiitd.ac.in

[2]Newcastle University
UK
kyle.montague, madeline.balaam,
tom.bartindale, d.varghese2
patrick.olivier@ncl.ac.uk

[3]PGIMER
[4]SWACH
India
monaduggal2, 1940kumarv,
drishti.sharma@gmail.com

ABSTRACT

The Healthcare system of India provides outreach services to the rural population with a key focus on the maternal and child health through its flagship program of Community Health Workers (CHWs). The program since its launch has reached a scale of over 900000 health workers across the country and observed significant benefits on the health indicators. However, traditional face to face training mechanisms face persistent challenge in providing adequate training and capacity building opportunities to CHWs which leads to their sub-optimal knowledge and skill sets. In this paper, we propose *Sangoshthi*, a low-cost mobile based training and learning platform that fits well into the environment of low-Internet access. *Sangoshthi* leverages the architecture that combines Internet and IVR technology to host real time training sessions with the CHWs having access to basic phones only. We present our findings of a four week long field deployment with 40 CHWs using both qualitative and quantitative methods. *Sangoshthi* offers a lively environment of peer learning that was well received by the CHW community and resulted into their knowledge gains (16%) and increased confidence levels to handle the cases. Our study highlights the potential of complementary training platforms that can empower CHWs in-situ without the need of additional infrastructure.

Keywords

CHW; ICT4D; IVR; mHealth; Peer Learning; mLearning

1. INTRODUCTION

Since 1990, India has made considerable progress in improving the child health with a remarkable reduction (61%) in the mortality rates of under-fives [29]. However, India missed its Millennium Development Goal 4 that aimed for two-third reductions by 2015 [21]. One of the primary causes is the relatively slow decline in the deaths of newborns (46%) occurring in the neonatal period (first 28 days of life) [25]. The neonatal period is the most vulnerable period for the child survival and contributes to 45% of the global under-five child deaths [33], with even higher proportion (56%) in India [25]. Hence, accelerated progress in reducing neonatal mortality rates (NMR) is critical to improve the child survival overall.

A significant proportion of these neonatal moralities occurs in developing countries particularly rural areas due to high rates of home deliveries and a lack of skilled care during the first few weeks of childbirth. WHO recommends provision of home based care with the help of Community Health Workers (CHWs) [33] for such countries. CHWs are the local people from the communities selected and trained to improve the access to basic healthcare services and provide health education [28]. In this regard, the Government of India, under the program Home Based Post-Natal Care (HBPNC) mandates a key cadre of CHWs known as Accredited Social Health Activists (ASHAs) to make regular home visits to newly turned mothers to promote globally approved newborn care practices [23]. These home visits have been found to be effective in improving the health indicators of newborns. For instance, a study in Uttar Pradesh, India targeted behavior change management through community based intervention of health workers and observed 54% reduction in neonatal moralities [16]. Still, there is a huge scope of improvement in terms of quality of care delivered. The same remains affected by the sub-optimal performance of ASHAs. One of the main causes of this poor performance is the limited amount of training and supervision provided. Studies evaluating the performance of ASHAs highlight the need of regular refresher training courses and innovative strategies to equip ASHAs with the requisite skill sets [1] [17].

Technology enabled health education has been identified as a viable method to train ASHAs and the community. However, challenges remain, particularly in rural settings such as financial limitations, low-literacy, poor infrastructure and low-connectivity. This leads to slow adoption of technology. For example, in India, the rural Internet subscribers account for only 9% of the total population [26].

*corresponding author

WWW 2017, April 3–7, 2017, Perth, Australia.
ACM 978-1-4503-4913-0/17/04.
http://dx.doi.org/10.1145/3038912.3052624

Internet environments are largely intermittent and offer low-bandwidth services in rural areas. A recent study on the mobile Internet service reports significant differences between the advertised and the actual values of throughput, latency, and availability of 2G and 3G cellular services [13]. Further, the Internet penetration gets hindered by low English literacy as 64% of these subscribers browse web in their local languages [8].

To provide information under these constraints, a rich body of research has been exploring simple interventions using technologies such as Interactive Voice Response (IVR), SMS, video etc. [30, 16, 9]. In the similar direction, we recently proposed a system that used Internet and IVR technology together [11] to provide an interaction platform to the community members for self-management of chronic illnesses. It highlighted the potential of this mixed approach to foster structured and real time discussion among users who cannot afford Internet enabled smartphones. So far no mobile based system has been proposed to train CHWs in constrained environments. In this paper, we propose *Sangoshthi*[1], a low-cost training and learning platform for CHWs working in low resource settings. *Sangoshthi* builds on the work proposed in *Sehat ki Vani* [11]. The *Sehat ki Vani* code-base has been revamped to make it more robust and is now renamed as *Citizen Radio*[2]. Considerable modifications have been made to the original code-base [11] to provide a stable communication platform for the contexts with low-bandwidth Internet connectivity. We deployed *Sangoshthi* for four weeks in the Haryana state with the help of an NGO to understand its acceptability and feasibility. In this paper, we present our qualitative and quantitative findings, and show how *Sangoshthi* complements traditional face to face training mechanisms for CHWs, and has potential to develop into a platform that can be used in rural settings to deliver training without needing additional infrastructure.

2. BACKGROUND

The government of India delivers health care services to rural populations through National Rural Health Mission (NRHM). The NRHM identifies one literate woman in every village as Accredited Social Health Activist (ASHA) covering a population of 1000 [27] people. The main functions of an ASHA include providing health education to community members, promoting awareness about health services, escorting pregnant women for hospital-based deliveries, making regular home visits for antenatal and postnatal care and participating in various other programs. An ASHA is a honorary volunteer and receives performance based monetary incentive. For example, under the Home Based Post-Natal Care program, an ASHA is supposed to make home visits to mothers post-delivery on specific days as: 1 (in case of home delivery), 3, 7, 14, 28 and 42 and receives a remuneration of 250 INR (3.6 USD) for each such visit[23]. The ASHA program is now a cornerstone strategy of NRHM, with a total of 942786 ASHAs placed well across the country [24].

To become an ASHA, a woman receives modular training which is delivered in five parts over 23 days. In addition, states are directed to pro-actively conduct refresher training for continued improvement of skills [22]. However, in practice there exist numerous challenges which impede the successful implementation of this training and re-skilling program. This results in ASHAs working within communities with limited opportunities for capacity building. Problems related to infrastructure broadly include acute shortage of skilled trainers, insufficient funds, inadequate training space and lack of training aids such as equipment, tools etc [27]. Further poor management disrupts training schedules incurring delays and considerable loss in retention of the training content by the trainers in the cascade model of training [27]. After the delivery of the training, states struggle to provide field level support to ASHAs and to conduct systematic evaluations. Refresher training has been identified to be very important and states conduct it using forums of monthly meetings or separate programs [27]. However, challenges remain in ensuring that all ASHAs achieve requisite competencies or at least enable novice ASHAs to repeat training rounds until they reach a minimum level of required skill sets [27].

A number of studies have found issues related to sub-optimal performances from ASHAs. For example, a cross-sectional study on 130 ASHA workers by Mahyavanshi et al. [17] found a considerable portion 86.2% to have sub-optimal knowledge on newborn care. Another study [4] found a lack of competence in classifying infant's illness and diagnosing critical signs. Bajpai et al. [1], evaluated various aspects of the ASHA program in five states and found under performance of ASHAs. The authors attributed it to the weak processes of the current authorities and highlighted that the existing training procedures are inappropriate in giving optimal education to ASHA. They also emphasized regular refresher training for the ASHA community.

3. PROPOSED SYSTEM

3.1 Need Assessment

To understand the needs better, we collaborated with a non government organization SWACH located in the Haryana state, India. SWACH works in the field of maternal and child health having a presence in 100 villages. Our discussion with the head of SWACH identified two key components of conducting a face to face training as: creation of a standard content and its delivery to the ASHAs timely and uniformly. Traditionally, this is achieved by calling batches of ASHAs at their nearest health centers. Three prominent factors of consideration here are cost, time, and transportation. The Cost for the organizers to arrange for the training space, trainers fees, incentives for ASHAs for attending sessions and other logistics. Time management for ASHAs, who in addition to their duties are overloaded with the household tasks. Since, a single day of a training session, on average spans over 6-7 hours, the frequency needs to be planned carefully. Further, commuting to the training center is not a trivial task for some ASHAs who live in areas having infrequent and inconvenient mediums of public transport.

Another forum of capacity building of ASHAs are the monthly meetings with their supervisors to cover agendas such as payment vouchers, new directives, drugkit replenishment and problem solving [22]. We conducted a focus group with 15 ASHAs to collect their thoughts and experiences of the monthly meetings, training and existing training materials. We found that although the ASHAs liked the

[1]Sangoshthi - a conference or other meeting for discussion or training

[2]https://.citizenrad.io

training material, they considered that better understanding would come from discussion of these materials. They also reported that the allocated time for meetings is not sufficient to address all their queries individually. As a result, 'peer ASHAs' become the first point of contact for discussion. These peer discussions were sometimes face-to-face, when ASHAs encountered one another in the field, but were also mediated through phone calls. Phone call communication among ASHAs happens actively, also because they are given a dedicated SIM by the government with a monthly free recharge of 100 INR talk-time. The following quote from one of the ASHAs supports the fact that peer discussion is a primary source of their learning.

"Most of the times in the delivery cases, it is our responsibility to take the woman to the hospital and bring her back. During these cases, we are at huge risk because if anything happens to her, we can be held responsible. We are not given training on how to handle such situations, how to carry the woman, what type of food to give etc. All of these we learn by consulting our senior ASHAs."

3.2 Design Rationale

In the light of the aforementioned challenges in traditional face to face training methods, there is a need for innovative solutions which can complement existing training mechanisms. One such solution is distance learning, which allows learners to learn in their personalized settings. The distance learning approach is cost-effective, scalable, and appropriate for the decentralized model of community health workers. The advent of affordable electronic devices with increasing penetration of the Internet has opened unprecedented opportunities of training and learning e.g. online learning. In rural areas where computer access is limited, mobile phones become a potential medium due to their high penetration. In the context of community health workers, mobile job aids have been showing encouraging prospects [6, 5, 2, 9]. Yet, they do not serve the purpose of education. One of the main barriers in building a mobile based learning platforms in low-resource settings is the limited access to smartphones. Existing studies targeting user base of feature phones have been limited to provide information exchange services using tools such as IVR and SMS [30].

We propose a training and learning platform based on the architecture proposed in [11] that allows trainers and learners separated geographically to exchange information in a class like environment. The system architecture combines Internet and IVR technology in a way such that trainers via an Internet enabled smartphone application can host a live talk show with the learners having access to basic phones only. The show is a conference call session amongst three kinds of participants: a host, who could be an individual with facilitator skills, an expert of the field, and the listeners who are learners. The purpose of a show is to deliver the training content and have interaction between the learners and the expert. The interaction design attempts to incorporate pedagogical aspects of distance learning viz instructor-learner, learner-learner and learner-content [19].

3.3 Architecture

Sangoshthi follows a client-server architecture (see Figure 1). The client is an android application built upon a beta-version of *Citizen Radio* and is adapted for the Indian

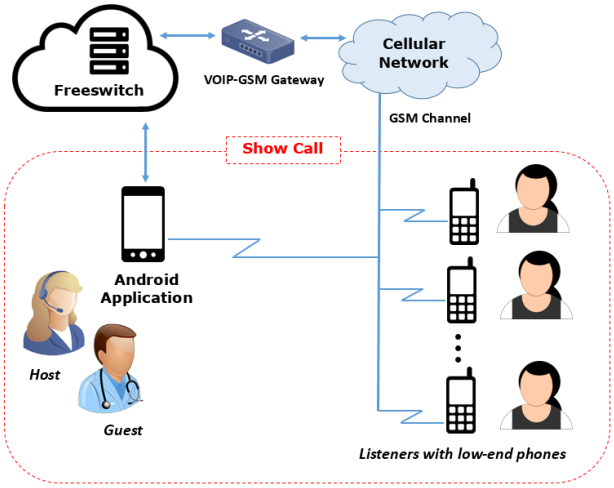

Figure 1: System Architecture

deployment. The app allows the host to create, prepare and manage shows as explained earlier. The server is a software built upon Freeswitch, an open source telephony platform to achieve call related functions. The communication between the android app and the server requires Internet either through Wi-Fi or mobile Internet for exchanging request/reply data packets.

To host a show with the learners, the host through the app, first registers the phone numbers of the interested listeners, creates a show id for the specific day and time and then broadcasts a trailer to inform the registered listeners for the upcoming show. The trailer, here is a phone call the frequency of which can be set by the host depending on the number of trailers to be broadcasted. Thereafter, on the scheduled day and time of the created show, when the host sends a start show request, the Freeswitch based server connects all the listeners and the host in a conference call over the GSM cellular network. In this conference call, by default all the listeners are made to enter in *mute* mode and can only hear the host's voice. The host, after the delivery of the content invites listeners to interact with the expert by expressing their opinion. To be able to speak, the listeners have to press "1" in their phone keypads which generates a DTMF event. On occurrence of these DTMF events, the Freeswitch captures the phone numbers of the listeners who pressed "1" and then sends them to the android app in the order of first come first serve. The android app then displays the last 3 digits of these phone numbers using which the host can select listeners and send unmute request to the server one after the another. This way the show allows structured interactive session avoiding overlaps of voices happening in usual phone based conference calls.

In our previous system [11], the voice channel of the host initiated through a SIP (Session Initiation Protocol) account configured with the Freeswitch using VOIP (Voice Over Internet Protocol) and thereby, consumed significant network bandwidth. *Citizen Radio* has removed that limitation and supports audio communication via both VoIP and GSM, to address the challenges of low-bandwidth. It separates out the transfer of voice from the Internet to GSM channel and uses Internet only for non-voice data packet transfer. The

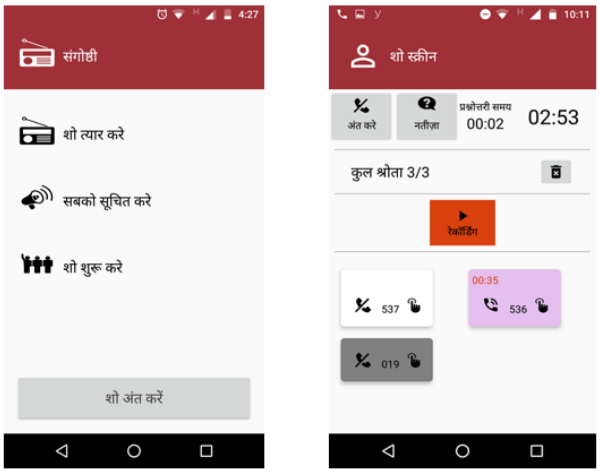

Figure 2: User Interfaces of the *Sangoshthi* Android Application

Sangoshthi app, building on top of *Citizen Radio*, uses this feature to minimize the dependence on network bandwidth.

4. GOAL

The main goal of our study follows four research questions:

- **Feasibility**

  RQ1: Can *Sangoshthi* host training sessions successfully?

- **Efficacy**

  RQ2: Is the interaction environment offered by the *Sangoshthi* able to enhance the knowledge levels of ASHAs?

- **Usability**

  RQ3: What are the attitudes and experiences of the hosts, experts and the ASHAs towards the *Sangoshthi* platform?

  RQ4: How do the stakeholders perceive the usefulness of *Sangoshthi*?

5. FIELD DEPLOYMENT

SWACH identified ten topics on Home Based Post-Natal Care that aligned with the NRHM training course material. The distinguishing feature of the content prepared by SWACH was that it focused on important elements of day to day care which are often missed in ASHA training. The ten topics identified were: (a) Exclusive breast feeding; (b) Play & communication with newborn; (c) Excessive crying in newborn; (d) Danger signs in newborn; (e) Danger Signs in mother; (f) Hand hygiene; (g) Temperature control in newborn; (h) Mother child protection card; (i) Depression in mother after child birth; (j) Health, happiness & contentment in mother.

Participants

SWACH selected 40 ASHAs from two districts of Haryana state, India. All these ASHAs belonged to the pool who were already associated with SWACH for a period of at least one year under a different project and had regular conversations over phone calls with the employees. All ASHAs were tenth grade pass. Further, eight of them were graduates and one was pursuing her under-graduation course. The median age was 36 years and the age ranged from 26 to 50 years. 11 of the ASHAs owned smartphones and 29 had low-end feature phones. Two SWACH employees both females selected as hosts had experience of over two years and the head selected as the expert is a pediatrician with an experience of 45 years.

We randomly allocated the selected ASHAs (n= 40) into two groups: treatment group and control group. The treatment group received the training intervention consisting of 12 shows on the 10 chosen topics in a period of 22 days. Around 3 shows were hosted in a week within a fixed time slot from 2 pm to 3:30 pm. The timing was selected based on the preferences of majority of the ASHAs. All the shows were hosted from the SWACH office, having both the expert and the two hosts physically present together. In addition, a dummy listener was also recruited from the SWACH staff to signal in case of any voice related problem during the live shows.

5.1 Design Process

User Interaction for Host

A series of workshops were conducted with the SWACH team over a period of eight weeks to discuss the current features of the app and to build on these to create an appropriate platform for delivery of training to a community of ASHAs. Feedback on the interface of the android app was taken at each step to make it easily usable by the two hosts. Figure 2 illustrate the Main Menu screen (left), and a 'live show' screen (right) of the *Sangoshthi* android app. The three blocks at the bottom of the 'live show' screen indicate callers who have pressed "1" to express opinion. The colors indicate three statuses associated with the listeners: white for waiting, pink for currently speaking and grey for already spoken. Timers detail the length of the 'show', the wait time for any listener waiting to speak, and the air time for a currently unmuted listener.

The SWACH office was chosen for hosting the sessions. Multiple hands-on sessions were organized for the hosts at this office so that they become comfortable with the app usage. The objective was to make the SWACH capable of hosting the shows independently without the need of assistance from the authors through their physical presence. The Internet speed available was quite slow which often made the two hosts frustrated as the app events took time in processing. The hosts exhibited impatience towards such scenarios by pressing app buttons multiple times, without waiting for the effect of the previous clicks, leading to erroneous actions at the server side e.g. multiple broadcast of trailers, multiple initiations of show calls, abrupt show end etc. To safeguard from such situations, the app was made robust by adding more warning pop-ups, wait-time progress bars, and making the buttons with critical operations unaffected for multiple clicks.

Structuring the Show

The core idea of *Sangoshthi* is to support learning through interaction and experience sharing between ASHAs and the expert. Hence, the timeline of the show was simplified into two distinct segments: an initial shorter segment for delivering the topic information succinctly; and a second longer

segment to allow interaction between the listeners and the expert. The longer segment could be divided into multiple rounds of interactions known as Q& A. We also designed *Sangoshthi* so that a listener could get only one chance to speak in a given Q & A round. Every show, started the proceedings dedicated a Q&A to the previous show topic.

Our previous study [11], highlighted the role of hosting skills in the success of a show. In order to make the task of hosting easy for the two hosts who had no prior experience of hosting a talk show, *Sangoshthi* incorporates a feature which allows the presenter to use pre-recorded materials. In our deployment, this feature enabled the SWACH team to prepare the content of all the topics in advance. A total of six weeks were spent on the preparation of the content. For each topic, the content was prepared by following the best practices of Home Based Post-Natal Care and converted into a script of conversation between two individuals: host and the guest. The structure of these content was designed in form of Q&A, recorded by two actors, who were the employees of SWACH after series of rehearsals. In all the shows, the hosts after greeting the listeners directly played the content recording and handled the coordination part mainly.

6. DATA COLLECTION

We adopted a mixed-method approach to analyze the qualitative and quantitative data collected through the deployment of *Sangoshthi*. We collected the following data:

1. Call Logs - our system logged call related activities to understand the interaction pattern of the hosts and ASHAs. Main events captured includes show call answer/drop timestamps, mute/unmute action timestamps, DTMF events, and their timestamps etc.

2. Questionnaire - to assess the impact of the training intervention, an open ended questionnaire on the topics of the training was developed by the expert.

3. Interview Data - recordings of the interviews and shows were transcribed for data analysis. In total 103 interviews were conducted : 80 telephonic interviews of the 40 ASHAs before and after the intervention, 20 telephonic exit interviews of the treatment group and 3 face to face interviews of the doctor and the two hosts. In addition 12 show call recordings were also transcribed.

7. SYSTEM FEASIBILITY

We were able to complete all the shows but observed some network related issues:

Call Drop

One of the main challenge while running the shows in rural India is frequent call drops of the listeners. This is mainly caused by poor network infrastructure in the villages of the listeners. To deal with the issue, the dropped listeners are called back immediately on detection of their hung-up event in an ongoing conference call. A maximum of four redial attempts were made in case of no successful response. Despite call drops occurring during the deployment (12 shows), we experienced only two incidences where call drops had a duration of more than five minutes.

On average in a show of greater than 60 minutes, 19 call drops were experienced from 11 unique listeners (see Table 1). Our analysis of log-data shows that the average listener experienced only one disconnection per show. One listener had a persistent problem of connectivity, and experienced 30 call drops in 12 show calls.

We also observed poor network coverage on a specific day. The show on the topic *danger signs in mothers* was postponed due to difficulty in connecting to all the listeners and had only 12 stable connections. Another problem observed in the initial 5 shows was abrupt loss of the host voice in an ongoing show. This break of voice transfer would result in the host having to restart the show. We resolved this by changing the host device from a tablet to a smartphone. A minor bug related to the show end procedure also incurred the loss of logs in a show which was later rectified.

Table 1: Call Drops Summary

Name	Min	Median	Max
per show	5	19	32
unique listeners per show	4	11	17
per listener per show	0	1	9

8. MEASURES OF LEARNING

To address our second research question of whether *Sangoshthi* was able to successfully improve the knowledge levels of the ASHAs who received the training, we present our quantitative and qualitative data analysis.

8.1 Evaluation Methodology

To assess the knowledge levels of ASHA, a questionnaire containing 20 questions covering the 10 topics was developed by the expert and an individual blind to the participant allocation was recruited to conduct the interviews. We wanted to gain deeper insights into the knowledge levels of the AHSA, hence, the questions followed an open-ended format [12]. For these the ASHAs had to respond to questions of type - what, when, where, why, and how. The questionnaire was administered via a telephone call. This was considered the most practical approach, since residences of ASHAs were distributed over an area of 100km.

Following the standard guidelines of administering the questionnaire over telephone [32], we prepared a script and a protocol to guide the interviewer with a systematic procedure of asking the questions. To test the understanding level of the questionnaire from ASHA point of view, a pilot interview was administered on three ASHAs unknown to the study. As a result, some questions were re-ordered and others were simplified using the local jargon. All selected ASHAs were briefed about the questionnaire at least one day before its delivery and explicit consent was taken for recording of the call conversation. The questionnaire was administered to ASHAs at two stages, before and after the treatment condition. To evaluate the questionnaire responses of the ASHA, an answer key was developed by the expert. The answers given by the ASHAs were assessed by matching against the answer key. Each correct answer in the key is composed of responses ranging from 2 to 9. Each matched response for an answer gets a score as 100/n, where n is the number of correct responses and 100 is the maximum score of the question. For example, a single correct response for a question having total 4 correct responses is assigned a

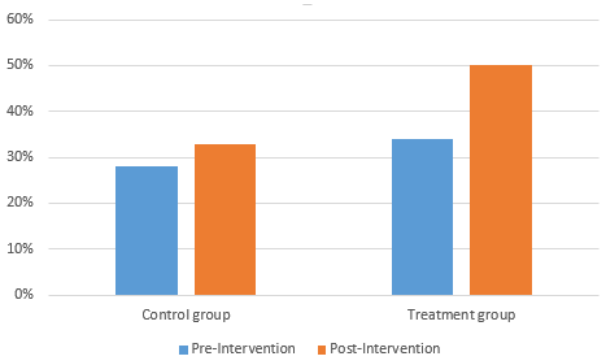

Figure 3: Treatment group test scores

score of 25 out of 100. For questions having more than 5 responses, evaluation is done on the presence of any five. Two authors evaluated the responses independently following a rubric. After the first round of independent evaluations, evaluation results from the two authors were compiled and compared in order to produce final scores. The two evaluators substantially agreed with each other (Cohen's Kappa: mean kappa = 0.71, standard deviation = 0.11) with some conflicts which were resolved through mutual discussion.

8.2 Results

The questionnaire test scores were used as the primary metric for evaluating the knowledge level of the ASHAs. There were two types of scores : 1.) pre-treatment scores generated before the start of the training period and 2.) post-treatment scores generated after the training period. The knowledge levels of the two groups at baseline were not comparable. The pre-treatment scores of the treatment and the control group calculated as 34%and 28% respectively and the difference was statistically significant (Wilcoxon sum test, $p < 0.05$) (see Figure 3).

Following intervention, the treatment group showed an improvement of 16%. The control group on the other hand also showed some improvement (5%). Knowledge of both the groups was found to increase statistically (Wilcoxon signed-rank test, $p < 0.05$). We postulate that since many of the ASHAs knew each other, ASHAs in the treatment group might have shared their knowledge with those in the control. The is corroborated by some of the ASHAs, who reported in the exit interviews. Finally, significant differences were found between the post-treatment scores of the treatment and the control group (Wilcoxon sum test, $p < 0.05$), with scores 50% and 33%, respectively.

8.3 Learning Aspects

Interaction

Total 12 shows were conducted. The 10 topics of the training were covered in the first 11 shows; where a topic corresponded to a show with an exception that was completed in 2 shows due to the network problem. The last show was dedicated for collecting the feedback of ASHAs and their remaining queries. Table 2 summarizes the interaction logs of 11 shows leaving out the show which experienced the network problem. Interaction is the core component of the learning environment offered by the *Sangoshthi* evident by the fact that in a show (average duration: 1:08), 46 minutes

Table 2: Show Summary

Name	Min	Median	Max
Show Duration (hh:mm:ss)	00:44:13	01:08:03	01:30:25
Content Delivery Duration (hh:mm:ss)	00:12:23	00:14:34	00:18:40
Show Q&A Duration (hh:mm:ss)	00:26:33	00:46:16	00:53:24
Interaction Count per Show	10	20	22
Interaction Count per ASHA in 11 shows	2	10	23
Interaction Count per ASHA per show	0	1	3
Repeat Speakers per show	1	5	7
Unique Speakers per show	9	12	18

were dedicated to the Q&A segments. On average, a show had 3 Q&A segments, 4 repeat speakers (listeners who expressed their opinion in more than one Q&A.) and 12 unique speakers. In each show 1 Q&A was dedicated for discussion on the previous show topic.

Our data analysis of the interaction between the ASHAs and the expert highlighted the importance of *instructor-learner* interaction component. We defined interaction score in our context as the total number of times an ASHA expressed her opinion in the shows. To understand better, we segregated the ASHAs into two groups (size 10) of high and low pre-treatment scores (threshold test score = 35%), and then further categorized into two sub groups of high and low interaction score (threshold of interaction count was 12 in each group). Positive impact of actively contributing in the shows got reflected in the performance of ASHAs irrespective of their initial test scores, as shown in the table 3. In addition, 3 ASHAs who had low pre-treatment scores managed to reach to the group of top 5 ASHAs who attained maximum improvements. The statement from one of the ASHA goes with the finding:

"I used to enjoy the shows so much that I always wished them to extend beyond their duration so that I could ask more questions."

Table 3: Impact of Interaction

Pre-Treatment Score	Interaction Score	Improvement Rate
low	low	17%
low	high	19%
high	low	9%
high	high	17%

Peer learning

The prominent feature of *Sangoshthi* was its ability to foster peer learning. The act of listening and sharing was found to be fruitful by both the ASHAs and the two hosts. The following quote from an ASHA exemplifies the value of peer learning:

"The problems in my area are different from those of the others, so when other ASHAs used to put forward their questions, we got to know about the new problems in advance, thereby increasing our knowledge."

Similarly, a host described her learning experience as:

"This was the first time we got an opportunity to connect to 20 ASHAs simultaneously and listen to their varying levels of issues and concerns. In addition, we were able to

deliver our messages to all in one go instead of repeating in separate one to one calls."

The benefit of peer learning expanded to few community members also. 11 ASHAs reported events of attending the shows with their family members or friends. Some ASHAs even recorded the show call in their mobile phones and made written notes which they later shared with their friends, mothers, and one ASHA showed it to her supervisor also.

9. USABILITY

We attempt to understand the usability of the system on the following parameters:

9.1 System Usage

Initially, we had apprehensions about the interaction environment offered by *Sangoshthi*. We were concerned that an oral conversation over a call between 21 participants may not lead to fruitful learning interactions, and instead become overwhelming for the listener and host. We were also concerned that interactions to contribute to the show would be confusing and hard to remember. For example. to contribute opinion in a show, an ASHA needs to press "1" in her phone keypad and then later identify her chance to speak by recognizing the last 3 digits of her phone number. We anticipated the task of remembering the last 3 digits of a phone number would be difficult for the ASHAs, but surprisingly all of them remembered and reported it to be a simple and useful technique.

"The procedure of pressing "1" was very simple and this way all of us used to get chances uniformly."

Both the expert and the host appreciated this functionality for maintaining synchronicity in the communication. The expert highlights by saying:

"The biggest advantage of this system was that we were able to converse systematically without any overlaps."

In a single Q&A, an ASHA could press "1" only once. Some ASHAs exhibited their eagerness to talk by pressing "1" before the host invited participation from the ASHAs in order to come first in the queue. The system log also captured events of DTMF input other than "1". On average, the system log captured 22 such events per show out of 9 shows and 6 per ASHA for all 9 shows leaving out an outlier who happened to do for a total of 62 times in 9 shows.

The android app displayed the identities of interested speakers in order of who dialed "1" first in order to help the host in deciding who should speak next. We observed that the hosts over a period of time started to manage the speak priorities using an alternative method. For instance, the hosts used to shift the priority order of a particular ASHA who was very prompt in pressing "1" and had already interacted for the maximum number of times, in the interest of giving opportunities to other new listeners.

9.2 Show Experience

All ASHAs found the show duration of 1 hour to be appropriate and enjoyed the show proceedings. A supporting quote from as ASHA:

"The shows used to be so engaging that we never realized the time."

During the occasions when ongoing shows were interrupted and restarted due to issues related to voice transfer or connectivity, most of the ASHAs demonstrated patience, while a few mentioned their inconvenience :

"The problem I faced was the show call disconnection because of which my question was left unanswered once."

The process of successfully connecting 20 ASHAs, on average took 2 minutes. During the process of connecting to ASHAs, the host had the responsibility of making repetitive announcements about the waiting time. Events of show restart in case of network problem made this part of hosting quite frustrating at times. One of the host told us as follows:

"The most challenging part for us while initiating the conference was to get the successful connection from all the ASHAs. In this phase at times of comparatively longer connecting process, sometimes I would get upset by making repetitive announcements of - "keep patience while we connect to rest of the ASHAs." and worry about the show success"

10. SYSTEM USEFULNESS

In this section, we discuss the usefulness of *Sangoshthi* perceived by the stakeholders in the existing structure. We present three important factors that play an important role in understanding the future scope of *Sangoshthi*.

Cost

Estimation of the cost underlying the system use is necessary to understand its sustainability prospects. The main expense in our deployment was the call charges. We subscribed the VOIP-GSM gateway service of the company Doorvaani to establish the show calls over cellular network. Based on the airtime cost of an outgoing call of 1.68 INR (0.025 USD) per minute, the cost per minute for 22 parallel lines of the callers estimates to be 36.96 INR (0.54 USD), incurring the total cost for a show of 60 minutes duration to be as 2217.60 INR (32.61 USD). In our current set-up, the cost per ASHA computes to be 110.85 INR (1.63 USD) which could further be lowered down if ASHAs agree to bear their call charges by connecting to the show calls through outgoing calls. In this scenario, the estimated cost would then be 60 INR (0.88 USD) per ASHA per hour based on the standard call charges of the regular service providers which are much lower than that of Doorvaani. We solicited views of ASHAs on the system usefulness for this model and majority of the them (17) agreed in support of their knowledge gains. On the other hand, both the overall expenditures and per ASHA expense in a traditional face to face training session are quite high. We see a great potential in *Sangoshthi*to establish as a complementary training platform that can be deployed readily without the need of additional infrastructure.

We adopted an incentive approach towards ASHAs participation in this deployment. ASHAs in both the groups (treatment and control) were remunerated on the basis of 100 INR (1.5 USD) per interview (two interviews at pre and post-intervention stages). In addition, ASHAs in the treatment group were given 800 INR (11.8 USD)for participating in the shows. Therefore, each ASHA in the treatment group

received 1000 INR (14.7 USD) and 200 INR (3 USD) in the control group.

Impact on ASHA Routine

Since, generally the societies where ASHAs live follows patriarchal regime, they are responsible for majority of the household tasks and receive limited opportunities for leisure, it is important to understand the impact of our training intervention on their routine. Most of the ASHAs managed to take out time easily. One favorable reason was the time slot that was chosen according to their convenience. ASHAs acknowledged the cooperation from their family members during the training period. Following is the supporting quote from an ASHA:

"We used to finish our housework by that time and our kids used to take food on their own."

On being asked at what frequencies this form of training should be organized, majority suggested for every 5-6 months with two shows in a week.

System Benefit

SWACH expressed the benefit of the system on two parameters: usefulness of content production activity and system's ability to facilitate training sessions remotely. A quote of the expert:

"The system is very beneficial for us because it helped us in building the capacity of ASHAs on home based newborn care remotely which becomes difficult logistically in face to face training sessions. It also helped us to standardize the content which now can be used for reference purposes overcoming the problem of information loss due to the cascade model of training."

Sangoshthi also marked its benefits in the community using ASHA as the main vehicle. 18 out of 20 ASHAs who were able to share their knowledge in the home visits, declared the direct benefits to the families. For example, an ASHA shared her experience as:

"I had a delivery case in my area, in which the mother on discovering the birth of a girl child, cried a lot and went into depression. I pacified her patiently and explained in detail the value of breast feeding, play and communication and measures of reducing depression. Now she is happy and is also feeding her baby."

ASHAs found tremendous value of this training in their increased confidence to articulate the knowledge during home visits, an ASHA words are:

"Earlier we were not able to explain the content to mothers satisfactorily but now we explain better and are able to convince mothers."

Not only the knowledge empowered ASHAs in decision making but also helped them in earning respect in their society, as one ASHA mentioned:

"During my visits while conversing to the mothers when I made references to the training session to support the information, they trust me more."

10.1 Learning and Future Scope

The field deployment of *Sangoshthi* provided us valuable experience in understanding the design requirements for a platform which support the training of ASHAs in rural India. Everyone - ASHAs, NGO, expert - liked *Sangoshthi* and had a positive experience of using it. Literature suggests that providing synergy between all three types of interaction component viz, instructor-learner, learner-learner and learner-content, is important for learning [19]. In the present version, *Sangoshthi*, predominantly supports instructor-learner interaction, but does not provide support for learner- learner and learner-content interactions. In our interviews with ASHAs we found that some overcame this lack of functionality by recording the content and using it in different settings. This included sharing the content with other ASHAs, family, and friends. This gives evidence of the other two interactions which evolved organically around our system. We aim to improve *Sangoshthi* by further incorporating all three modes of interaction within the system. Our design for Sangoshthi included mechanisms to allow discussion among the participants and also to take a quiz. However, due to time constraints we were unable to implement these into the deployed system. In future, we would like to explore how more interaction modalities can be used to engage the listeners beyond the one-hour duration. Learning from other systems, such as *avaaj otalo* [30], we would like to incorporate questions, feedback, comments off-line before or after the show and then incorporate them in planning for the next shows. We also aim to make the content created/generated during a show available to ASHAs and community through regular IVR systems.

As a result of our initial design work, we pre-registered the hosts' devices. This meant that it was not possible to host multiple parallel independent training sessions. In addition, the design of Sangoshthi assumes that all the listeners have feature phones only and thus limits the interaction to pressing a key. However, we did find that around 2% of ASHAs has smart-phones with them. We would like to extend our system for smart-phone listeners by providing more interaction components on their devices. In future, as more ASHAs move to smart-phones, this will help in evolving the system.

Since the deployment of *Sangoshthi*, many additional features have been added to *Citizen Radio* which allow additional functionality that enable easy hosting and management of Radio Shows. *Citizen Radio* now includes several additional features to limit user errors during a live show. *Citizen Radio* also allows use of pre-recorded filler material to overcome the black hole problem reported in [11]. The *Citizen Radio* has also added an initial show set-up functionality to allow the hosts to prepare their show. The initial show set-up functionality allows to host multiple parallel independent training sessions.

11. RELATED WORK

In this section, we will discuss research studies focusing on improving the knowledge of community members living in low-resource settings on the topics relevant to them. The rural populations of many developing countries face serious information deficit due to lack of adequate literacy levels, access to information sources and its mediums. Therefore, simple forms of Information and Communication Technologies have been largely explored. For example, video has

been identified as an effective tool for the purpose of training and information dissemination because of its ability to engage larger audience overcoming literacy and language barriers. Digital Green by Gandhi et al. [7] was a popular work in the domain of agriculture that attempted to educate marginalized farmers about new farming practices by creating localized digital video content. They disseminated the content using TV and DVD players in public gatherings with the help of a mediator. Its remarkable feature was the involvement of the farmers in the creation of videos. A significant improvement (seven times) was observed on adoption of practices over classical extension approaches based on training and visit. On the similar line, Projecting Health by Kumar et al. [15] provided useful information to the mothers on child care by using the model of community-led video education. It also reflected upon the role of community power dynamics and patriarchal structure of the society on the flow of information. Ramachandran et al. [31] used videos in mobile phones of health workers as health messages for persuading women to adopt safe practices. Findings highlighted the impact on the motivation of health workers and strengthening of dialogue between the women and the health workers.

A substantial body of research exploited the power of cellular connectivity to reach the beneficiaries directly [30, 32, 20, 9]. Interactive Voice response systems (IVRs) gained much attention due to its ability to provide information in a more natural way. Avaaj Otalo by patel et al. [30], aimed to teach small-scale individual farmers in Gujarat, India, about the good farming practices using an interactive voice application. Its most popular feature was the voice forum for asking questions and browsing others questions and responses on a range of agricultural topics. CGNET Swara by Mudliar et al. [20] addressed the limited access to mainstream media of rural communities by building citizen journalism network through IVR. TAMA by Joshi et al. [10] presented findings on the use of IVR based system in providing treatment support to people living with HIV. A different direction of earlier work exploited the ordinary phone calls as a medium to make the web content accessible to the underprivileged. For example, TeleWeb [3] provided telephony service for web browsing and SpokenWeb [14] opened a new software development paradigm by allowing creation and navigation of VoiceSites over ordinary phone call interaction.

12. CONCLUSION

In this work, we described our evaluation of Sangoshthi, novel training and learning platform for ASHAs working in resource-constrained settings. While there have been tools to support individual learning or to improve the efficiency of CHW, no platform was available to train a number of ASHAs together. The field deployment of *Sangoshthi* showed its potential to support existing training mechanisms. *Sangoshthi* provided a lively environment of learning through structured interactions among CHWs and the expert. This interaction enriched the content created by the expert which can then be further used for training. Our system fully incorporates the four design principles [18], viz. locally relevant content, accessibility of content beyond the bound of literacy, affordability and fitment into the community ecosystem.

Our deployment highlights the potential of combining feature-phones, smart-phones, and available internet and mobile networks for delivering content in constrained environments for critical applications.

13. ACKNOWLEDGMENTS

This work was supported by ITRA project, funded by DEITy, Government of India, under grant with Ref. No. ITRA/15(57)/Mobile/HumanSense/01 and Visvesvarya Young Faculty Fellowship. The authors wish to thank all the ASHAs for participating in the study.

14. REFERENCES

[1] Nirupam Bajpai and Ravindra H Dholakia. Improving the performance of accredited social health activists in india. *Mumbai: Columbia Global Centres South Asia*, 2011.

[2] Molly Bogan, Jan van Esch, Gayo Mhila, Brian DeRenzi, Caroline Mushi, Timothy Wakabi, Neal Lesh, and Marc Mitchell. *Improving standards of care with mobile applications in Tanzania*. W3C, 2009.

[3] Yevgen Borodin, Glenn Dausch, and IV Ramakrishnan. Teleweb: accessible service for web browsing via phone. In *Proceedings of the 2009 International Cross-Disciplinary Conference on Web Accessibililty (W4A)*, pages 96–97. ACM, 2009.

[4] Emily Das, Dharmendra Singh Panwar, Elizabeth A Fischer, Girdhari Bora, and Martha C Carlough. Performance of accredited social health activists to provide home-based newborn care: A situational analysis. *Indian pediatrics*, 51(2):142–144, 2014.

[5] Brian DeRenzi, Neal Lesh, Tapan Parikh, Clayton Sims, Werner Maokla, Mwajuma Chemba, Yuna Hamisi, Marc Mitchell, Gaetano Borriello, et al. E-imci: Improving pediatric health care in low-income countries. In *Proceedings of the SIGCHI conference on human factors in computing systems*, pages 753–762. ACM, 2008.

[6] Jose F Florez-Arango, M Sriram Iyengar, Kim Dunn, and Jiajie Zhang. Performance factors of mobile rich media job aids for community health workers. *Journal of the American Medical Informatics Association*, 18(2):131–137, 2011.

[7] Rikin Gandhi, Rajesh Veeraraghavan, Kentaro Toyama, and Vanaja Ramprasad. Digital green: Participatory video for agricultural extension. In *Information and Communication Technologies and Development, 2007. ICTD 2007. International Conference on*, pages 1–10. IEEE, 2007.

[8] The Hindu. English preferred by urban net users: survey. `http://bit.ly/2l2fZRs`, 2013. [Online; accessed 23-October-2016].

[9] Caroline OH Jones, Beatrice Wasunna, Raymond Sudoi, Sophie Githinji, Robert W Snow, and Dejan Zurovac. âĂIJeven if you know everything you can forgetâĂİ: health worker perceptions of mobile phone text-messaging to improve malaria case-management in kenya. *PLoS One*, 7(6):e38636, 2012.

[10] Anirudha Joshi, Mandar Rane, Debjani Roy, Nagraj Emmadi, Padma Srinivasan, N Kumarasamy, Sanjay Pujari, Davidson Solomon, Rashmi Rodrigues, DG Saple, et al. Supporting treatment of people living with hiv/aids in resource limited settings with ivrs. In

Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pages 1595–1604. ACM, 2014.

[11] Konstantinos Kazakos, Siddhartha Asthana, Madeline Balaam, Mona Duggal, Amey Holden, Limalemla Jamir, Nanda Kishore Kannuri, Saurabh Kumar, Amarendar Reddy Manindla, Subhashini Arcot Manikam, et al. A real-time ivr platform for community radio. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, pages 343–354. ACM, 2016.

[12] Kate Kelley, Belinda Clark, Vivienne Brown, and John Sitzia. Good practice in the conduct and reporting of survey research. *International Journal for Quality in Health Care*, 15(3):261–266, 2003.

[13] Zahir Koradia, Goutham Mannava, Aravindh Raman, Gaurav Aggarwal, Vinay Ribeiro, Aaditeshwar Seth, Sebastian Ardon, Anirban Mahanti, and Sipat Triukose. First impressions on the state of cellular data connectivity in india. In *Proceedings of the 4th Annual Symposium on Computing for Development*, page 3. ACM, 2013.

[14] Arun Kumar, Sheetal K Agarwal, and Priyanka Manwani. The spoken web application framework: user generated content and service creation through low-end mobiles. In *Proceedings of the 2010 International Cross Disciplinary Conference on Web Accessibility (W4A)*, page 2. ACM, 2010.

[15] Neha Kumar, Trevor Perrier, Michelle Desmond, Kiersten Israel-Ballard, Vikrant Kumar, Sudip Mahapatra, Anil Mishra, Shreya Agarwal, Rikin Gandhi, Pallavi Lal, et al. Projecting health: Community-led video education for maternal health. In *Proceedings of the Seventh International Conference on Information and Communication Technologies and Development*, page 17. ACM, 2015.

[16] Vishwajeet Kumar, Saroj Mohanty, Aarti Kumar, Rajendra P Misra, Mathuram Santosham, Shally Awasthi, Abdullah H Baqui, Pramod Singh, Vivek Singh, Ramesh C Ahuja, et al. Effect of community-based behaviour change management on neonatal mortality in shivgarh, uttar pradesh, india: a cluster-randomised controlled trial. *The Lancet*, 372(9644):1151–1162, 2008.

[17] Darshan K Mahyavanshi, Mitali G Patel, Girija Kartha, Shyamal K Purani, and Sunita S Nagar. A cross sectional study of the knowledge, attitude and practice of asha workers regarding child health (under five years of age) in surendranagar district. *infection*, 72:55–38, 2011.

[18] Maletsabisa Molapo and Gary Marsden. Health education in rural communities with locally produced and locally relevant multimedia content. In *Proceedings of the 3rd ACM Symposium on Computing for Development*, page 25. ACM, 2013.

[19] Michael Moore and Greg Kearsley. Distance education: A systems view (belmont, california: Wadsworth). 1996.

[20] Preeti Mudliar, Jonathan Donner, and William Thies. Emergent practices around cgnet swara, voice forum for citizen journalism in rural india. In *Proceedings of the Fifth International Conference on Information and Communication Technologies and Development*, pages 159–168. ACM, 2012.

[21] United Nations. Mdg 4: Reduce child mortality. `http://bit.ly/2mBytER`, 2015. [Online; accessed 20-October-2016].

[22] Ministry of Health & Family Welfare. Support mechanism for asha. `http://bit.ly/2mBlzqt`, 2013. [Online; accessed 25-January-2017].

[23] Ministry of Health & Family Welfare. Home based newborn care operational guidelines. `http://bit.ly/2lfkEe1`, 2014. [Online; accessed 20-October-2016].

[24] Ministry of Health & Family Welfare. Quarterly nrhm mis report. `http://bit.ly/2aZZqMA`, 2016. [Online; accessed 20-October-2016].

[25] Public Health Foundation of India. State of india's newborn 2014. `http://bit.ly/2mlezSh`, 2014. [Online; accessed 20-October-2016].

[26] Telecom Regulatory Authority of India. The indian telecom services performance indicators. `http://bit.ly/2cy0yLy`, 2016. [Online; accessed 20-October-2016].

[27] Updates on Asha Programme July 2013. Ministry of health & family welfare. `http://bit.ly/2l2ftDO`, 2015. [Online; accessed 20-October-2016].

[28] World Health Organization. Community health workers: What do we know about them? `http://bit.ly/1vkzmDZ`, 2007. [Online; accessed 11-February-2017].

[29] World Health Organization. World health statistics 2016: Monitoring health for the sdgs. `http://bit.ly/1TgXpQO`, 2016. [Online; accessed 10-February-2017].

[30] Neil Patel, Deepti Chittamuru, Anupam Jain, Paresh Dave, and Tapan S Parikh. Avaaj otalo: a field study of an interactive voice forum for small farmers in rural india. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 733–742. ACM, 2010.

[31] Divya Ramachandran, John Canny, Prabhu Dutta Das, and Edward Cutrell. Mobile-izing health workers in rural india. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 1889–1898. ACM, 2010.

[32] Aditya Vashistha, Edward Cutrell, Gaetano Borriello, and William Thies. Sangeet swara: A community-moderated voice forum in rural india. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, pages 417–426. ACM, 2015.

[33] WHO. Newborns: reducing mortality. `http://bit.ly/1pG8smq`, 2016. [Online; accessed 23-January-2017].