



# LEAP: Scaffolding Collaborative Learning of Community Health Workers in India

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Despite a crucial role in providing public health services, Community Health Workers (CHWs) remain disadvantaged in receiving effective skill-building opportunities. Due to the lack of health experts and appropriate infrastructure, it becomes challenging to provide training on a regular basis. Our aim is to investigate opportunities for designing technology-supported collaborative learning to compensate for the limited availability of instructors. We designed a mobile learning-based peer-led educational intervention, and conducted an eight week long between-group study with 120 CHWs across four districts of Delhi, India. We found that CHWs were able to participate and use the system on their own leading to significant knowledge gains and increased desire to learn. With little guidance, CHWs exhibited benefits of collaborative learning in terms of positive interdependence on each other and use of interpersonal skills. The informal peer learning environment encouraged CHWs to have discourses on deeper societal aspects e.g. their role in society.

CCS Concepts: • **Human-centered computing** → **Human computer interaction (HCI)**; **Empirical studies in HCI**;

Additional Key Words and Phrases: CHW; ASHA; HCI4D; ICTD; mHealth; India

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## 1 INTRODUCTION

Considering the global crisis of health experts in low and middle income countries (LMIC), which is estimated to reach a deficit of 18 million by 2030 [66], global foundations advocate mobilization of low-skilled community health workers (CHWs) [2]. The CHWs work at the interface between primary health care and the communities to provide basic care and improve awareness [52]. Research indicates that CHWs contribute significantly in improving maternal and child health in under-served populations [7, 70]. They have helped in the uptake of immunization, institutional deliveries, and breastfeeding [50, 53]. However, CHWs face challenges in delivering quality services. One of the primary causes is inadequate training [28]. The other factors include low incentives, poor work recognition, ineffective supply-chain etc. [46].

In India, inadequate training is primarily due to the shortage of skilled trainers, infrastructure to provide training, and the cascade nature of training [64]. Because of the lack of sufficient training,

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their performances are reported to be sub-optimal [28, 54]. Though it is mandated to provide them with refresher training at regular intervals, it does not always happen regularly. Combined with overburdened medical doctors, the community health workers do not find a channel or forum to get answers to their queries and often rely on each other to conduct their duties [81]. Due to the lack of structured platform of knowledge exchange, either some queries remain unanswered or misconceptions continue. Recent studies suggest that in order to meet the WHO recommended ratio of one doctor to 1000 people in India, there is a need for an additional 1.4 million doctors by 2030[71].

Given the lack of experts, in the healthcare systems, technology-based solutions that can supplement existing methods in cost-efficient ways are much needed. Research has shown that equipping CHWs with appropriate tools of assistance, also known as job aids, helps improve their performance. A variety of job aids for facilitating decision making, counseling mothers during household visits, data collection, and tracking targets have been designed and evaluated in developing countries [1, 16, 17, 72]. However, improvement on the subject matters and regular exchange of knowledge through educational interventions are very few. In particular those which do not increase the burden on trainers.

Recently, we proposed a platform *Sangoshthi* [81] that facilitates experts in connecting with CHWs in real time (through a conference call) and conducting interactive sessions. With the combination of a smartphone and telephony application, experts stream audio lessons and conduct questioning-answering activity with CHWs. However, the *Sangoshthi* model requires the availability of experts to conduct these sessions; hence, while it solves the problem of reaching out to CHWs, it may not scale given the lack of experts.

It has been found that CHWs leverage peer knowledge for performing their duties [28, 81]. CHWs, belonging to an area, closely discuss their work, often accompany each other during various field visits, and help in decision making [81]. Thus, CHWs actual learning happen informally through peer to peer interactions on-field. However, efforts to support peer learning that do not increase burden on trainers are missing.

There is a rich literature showing significant pedagogical benefits of peer-learning approach [21, 41, 42, 65] when instructors availability is low. It has been found that through positive interdependence on one another, learners improve in their subject knowledge, problem solving skills, critical thinking skills and overall morale [20, 41, 51]. CSCW research has both investigated and proposed theories and interaction framework of peer learning in variety of settings. However, it largely remains oriented towards learning environments or work contexts where learners are technology users e.g. online settings. CHWs working in constrained environment such as rural areas or slums in developing countries represents an important user group to study because of the challenges such as low education (8th std), limited or no exposure to digital devices, inadequate training and limited infrastructure. We base our research around the questions of investigating how might technology-supported peer learning help CHWs in skill building and what kinds of peer-learning design should be adopted in their particular contexts, nature of work and technology use. We also show the challenges faced by for their skill advancement and the role that mobile-based interventions can play.

We designed a mobile-based collaborative learning platform—*LEAP*— that facilitated conversation and exchange of knowledge around a given topic with access to learning material. We evaluated the effectiveness of the design by conducting a between-group studies across four health centers (120 CHWs) in slum areas of Delhi, India. Through our qualitative and quantitative analysis, we found that, with minimal scaffolding, CHWs were able to participate and use the *LEAP* platform and achieved significant knowledge gains. Further, CHWs exhibited benefits of collaborative learning in terms of positive interdependence on each other and use of interpersonal skills. The informal

peer learning environment also encouraged CHWs to have discourses on deeper societal aspects e.g. their role in society.

We contribute to CSCW research by expanding its focus towards new groups in low resource settings, who need innovative ways of collaborative tools for improving their skill sets.

## 2 BACKGROUND AND RELATED WORK

Understanding and designing innovative ways to support collaboration and learning in the social and under-served contexts has been a focus within CSCW and HCI communities since long. We situate our work by discussing the background: peer-learning, context of the study, literature study of the approaches proposed for CHWs so far, the research gap, and opportunities for collaborative learning: theory and practice.

### 2.1 Collaborative Learning: Theory and Application

Peer learning or collaborative learning is based on the foundation of social constructivism and postulates that learners learn more actively when they engage socially with their peers as compared to individual classroom learning [73]. By sharing individual experiences, understandings and reflections, learners positively depend on each other and contribute towards enhancing each others' mental models [41, 78]. The rich literature on collaborative learning provides strong evidence in terms of substantial gains in problem solving and critical thinking skills [8] [20, 41, 51]. Further, CL research emphasize that in order to achieve successful peer learning, learners must be socially supported through scaffolded opportunities [25]. There exists many studies proposing methods to design group activities combined with pedagogical techniques such as Peer Instruction, Problem-based Learning [31, 32], the Cognitive Tools and Intellectual Roles [67].

CSCW research around peer learning covers a variety of contexts ranging from online settings, workplaces to informal groups. In particular, online learning platforms e.g. MOOCs have gained traction in the past few years due to the unique opportunities it offers in terms of diversity and scale. In the light of limited interaction between instructors and students, design approaches based on peer learning are being explored increasingly. For instance, the work leverages the geographic diversity in improving learners engagement and learning through a video chat environment called as Talkabout [48]. Likewise another work found positive outcomes by introducing synchronous peer discussion in online settings for crowdworkers and MOOC students [12]. Through an interaction framework that included creation of on-demand groups for performing a sequence of tasks, overlaid with mini-lessons, the study found significant gains in groups ability to converge at correct answers. Synchronous model of learning where lectures are watched together in small groups has been an effective strategy to facilitate peer learning. Many universities like Stanford, MIT implement through distributed tutored video instruction model and have found positive outcomes in terms of scalability, learning gains and time flexibility for students. The study addresses two issues, first, how the system of collaborative video watching can be easily developed and how different channels of communication e.g audio conferencing, chat text, video conferencing affect students learning and interactions [9].

Further, the following studies lay good examples of peer mentoring efforts. The paper proposed a socio-tech system for expanding research training opportunities without increasing orchestration challenge on faculty mentors [83]. A different work demonstrate the potential of distributed mentoring by analyzing online communities of Fanfiction series[23].

To support aforementioned pedagogical goals, various tools have been investigated. For instance, the study provides a workflow to summarize long discussion threads into an expandable summary tree allowing students to search distinct subtopics at multiple levels of detail [82]. Another study presents the effectiveness of supporting peer assessment in computer science education through a

visualization tool of code history [68]. Clickers have been effective in stimulating peer discussions in classrooms and giving real-time feedback to instructors [38]. Further a set of studies are also directed towards users having special needs like children [79], age old [76] etc.

However, largely CSCL research is around users who have access to technology. There are contexts in which users have challenges pertaining to education, technology access and infrastructure. Shifting focus from regular classroom settings to informal settings where the demand of learning or skill improvement is critical is valuable for CSCW research. Understanding effects of environment on peer-led education, social constructs and barriers of low-resource environments is important for developing CSCW interventions. This potential paradigm shift would contribute in making CSCW more inclusive and expanding its spectrum of technology use in real-world scenarios.

## 2.2 Context: CHW Training Practices and Challenges in India

We now describe the training practices for CHWs in India and underlying challenges. The information we provide is compiled from our meetings with officials of three organizations : National Health Mission of Haryana [57], Delhi State Health Mission [58], an NGO working with CHWs for the past 30 years, and study of available reports and documents.

ASHAs are female workers recruited by National Rural Health Mission to serve as health educator and promoter in rural and marginalized regions [56]. An ASHA works at village level that covers a population of 1000 approx [56]. The primary focus of ASHA work is on improving maternal and child health, including institutional-based deliveries, immunizations, identifying danger signs and making referrals. As a cadre of CHWs, ASHAs are the largest, more than 8 million ASHAs have been recruited and placed across India. The other two cadres are Auxiliary Nurse Midwife (ANM) and Anganwadi worker (AWW). Almost all functions of ASHAs are associated with ANM, the salaried employees working at sub-centre level that covers a population of 3000-5000. ASHAs report their task details to ANM and receive performance-base monetary incentives on monthly basis. Broadly there are three roles associated with ASHA: link workers (bridge communities with health centres), service extension workers (provided with a kit containing condoms, delivery commodities, drugs etc. ) and health activists (create awareness on health, mobilize community towards local health planning.

ASHAs are selected from the communities they serve, based on the criteria as education up to eight class, age group 25-45 years, marital status as married/widow/divorcee/separated and leadership skills. Their training is divided into two parts : initial modular training for providing the necessary skills and knowledge to start performing the duties (23 days) and then regular refresher training for upgrading of skills (12 days every year) [56, 64]. There are numerous studies which report gaps in the training process to be one of the determinant in the sub-optimal performance of ASHAs [28, 64, 77]. Main challenges that have been identified are as follows. Necessary infrastructure for conducting training is poor. The health centres are inadequate in terms of sitting space, and teaching aids [64]. There is acute shortage of skilled trainers, thereby affecting the training frequency and process overall [64].

Furthermore, the training strategy has also come under criticism. The cascade model, under which training is delivered through layers of trainers leads to a considerable loss in retention of the training content as a result of delays in training roll-out [64]. Finally, after the training period, organizations face challenges in providing field support to ASHAs and then in conducting systematic evaluations. They face challenges in ensuring that all ASHAs achieve requisite competence or at least identify incompetent ASHAs to repeat the training rounds until they reach a minimum level of required skill sets [64].

For this work, we use CHW and ASHA interchangeably.

### 2.3 Where We Are: Technology-Based Assistance for CHWs

Since CHWs get operational into the field after receiving basic training exposures, designing effective job aids has been of interest to the research communities. Keeping in the view the state of technology penetration and feasibility of implementation in different contexts, applications have been explored.

CHWs often work in low-resource environments e.g. rural areas in developing regions, which are remote and have infrastructural challenges e.g. unreliable transport, limited technology support. In such isolation, mobile phones offer a good way to improve communication amongst health workers, vision super and providing assistance in the work. For instance, DeRenzi et al. [16] used SMSs for administering routine home visits of CHWs by sending repeated reminders and escalating to supervisors in cases of overdue visits. The study observed improvement in terms of 86% drop in the overdue visits. Jones et al. [43] studied the effectiveness of such SMSs by qualitatively analyzing health workers' perceptions and highlighted the value in improving networking and communication amongst CHWs. While the aforementioned studies concentrate on one-way communication, providing performance data of CHWs to their supervisors, another study by DeRenzi et al. [18], investigate the effectiveness of closing the feedback loop through a system, ASTA, that provides comparative performance data over web-based and voice-based application. By being able to self-track progress, CHWs could significantly improve (21%) house visits.

Considering the limited training exposure of CHWs, the use of multimedia content to assist in client counseling has been an emerging line of research. Ramachandran et al. [72] studied the impact of short instructional videos on motivating expectant mothers to adopt healthy practices during home visits. The two month deployment highlighted the value of videos in engaging mothers in dialogue and increasing the motivation of CHWs. Fiore-Silfvast et al. [24], demonstrated the use of such videos by nurse-midwives in their postnatal examination and the perceived impact on their workflow. It discussed in detail the complexity of the experiences of nurse midwives in their working environment, pedagogical aspects of video showing and issues of authority and patient trust. The project by Kumar et al. [49] studied the model of community-led video education in promoting healthy behavior through the creation and public dissemination of locally filmed videos. The study helped in highlighting the factors pertaining to involving CHWs as the communication channel and their use of tools. Molapo et al. [61] further conducted a longitudinal study to understand consumption patterns of videos, attrition causes, and the role of CHW engagement on long-term usage. They also designed a tool to help trainers create digital content for CHWs [62].

Audio-visual job aids have been found to be impactful and have been adopted in various large-scale mHealth projects [1, 26, 34]. One of the notable projects in India is Mobile Kunji [1] which is deployed in eight districts of Bihar, India. It provides an audio-visual job aid for CHWs to be used in family visits for providing information on nine life-saving maternal and child health behaviors. The interface has two components: a deck of 40 cards with illustrations and messages and unique codes imprinted on each card. During home visits, the CHWs dial these codes which play audio messages spoken by a doctor.

To aid CHWs in decision making, researchers have studied the use of PDA (Personal Digital Assistants) or mobile based applications that provide electronic checklists to arrive at the right decisions while examining clients. There exists a significant body of literature and deployments in this direction [4, 17, 55]. CommCare is one of the most popular platforms that has been used in various studies and projects in multiple countries [22].

While the works [49, 61, 72] aim at improving community education by creating and disseminating informative content which also helps in improving knowledge of CHWs, projects directly targeted towards training CHWs are limited. Javaid et al. [39] experimented the use of animated

videos in teaching CHWs in Pakistan and found significant knowledge gains over regular methods. Some interventions have been explored in countries where the education levels of CHWs are high or technology resources are good [33, 74, 84], there are not many deployments in marginalized regions. The research gap is of particular concern given that the governments, global foundations, and policymakers are looking promisingly towards ICT-based interventions. Recently, the government of India launched a project, Mobile Academy, to upgrade CHWs knowledge and skills on life-saving healthy behaviors. The project provides an audio-based training course through an IVR service such that ASHAs can dial a given number from any handset and listen to audio lessons. At the end of the program, ASHAs get a certificate of merit. From the perspective of learning, the project only facilitates passive learning by providing content through one way communication.

To fill the gap, we proposed *Sangoshthi* [81], a mobile-based training and learning platform for CHWs, which is interactive and stimulates active learning. It enables trainers to connect with CHWs remotely to conduct live, audio training sessions. However, it is hierarchical in nature and needs experts to conduct and organize training sessions which is difficult to scale given the shortage of trainers. Moreover, *Sangoshthi* does not explore peer-to-peer learning and knowledge flow remains one to many.

#### 2.4 Collaborative Learning Aspects in ICTD Applications

While there is a rich body of collaborative learning research in formal education settings, considering our low-resource settings, it is relevant for us to understand how and to what extent collaborative learning has been practiced in real-deployments particularly ICTD applications.

Digital green [27] was one of the pioneering works that aimed at educating rural communities of India on farming practices using digital media. It used the approach of participatory process in digital content production and human mediation in training and dissemination. Active farmers were involved in the creation of instructional videos and managing the screening of these videos on public forums. The study highlighted the value of learning from and with peer farmers in small groups. The intervention was simple yet effective as it showed six times more uptake of the farming practices than the traditional approaches.

Another notable project in early 1999 was Hole-in-the-Wall [59, 60] which examined the effect of unsupervised learning among children from slum areas in India by placing freely accessible computers. Over the next decade through further research and deployment in various settings, the project exemplified the role of peer learning in enabling children to construct their own learning environment and learn skills with minimal or no assistance.

To understand how information technology can benefit the education environment of schools in under-served communities, the group—Technology for Emerging Markets [15] has explored both software and hardware modalities. As a solution to the limited affordability of computers in the schools, they proposed a product—Multipoint, which is a multimouse input to single computer display. Their experiments showed that learning among children multiplied due to gain of more control in collaborative learning scenarios [15].

In the late 2000s, as the penetration of mobile phones (basic phones) proliferated in developing countries, researchers and practitioners increasingly used them to provide knowledge exchange forums to rural communities. Avaaj Otalo [69] is one of the seminal works that used IVR-based voice forums to build a social network of farmers for exchanging knowledge on farming practices. With simple touch-tone inputs and voice messages, farmers could submit their queries, listen to those of others' and get responses from peers and experts. Likewise, later on, other works and socio-tech companies emerged on the similar idea for addressing various social issues e.g. Gram Vaani [29], CGNET SWARA [63]. The qualitative analysis of the forum users in these studies

supports the effect of peer learning, acknowledged that their knowledge improved by learning from the innovations and experiences of other.

Given the lack of channels for discussion with experts, CHWs rely on sharing advice and experience from one another for learning[81]. Leveraging their peer network in form of collaborative learning practices holds great potential and is the main theme of our study.

### 3 DESIGNING LEAP PLATFORM

We envisioned a system design that would allow small peer-groups of ASHAs to conduct their group learning sessions remotely. ASHAs spend a significant amount of time on field work which has been found to hinder their domestic responsibilities [28]. Therefore, it is necessary that they have tools that allow them to manage learning activities at their convenience without having to travel. The learning tool should be mobile based which is the primary digital device that ASHAs use, thus requiring a minimum learning curve. The majority of ASHAs in India use feature phones with primary purpose of calling; however, in recent times, some have also started using smartphones [36, 81]. For these smartphone users, Whatsapp has been found to be the most popular application; used for purposes such as coordination of work, communication and social media [36]. In our userbase, a health centre (30 ASHAs) had only 25% (7-8) of the ASHAs owning smartphones. Using innovative designs for learning environment, smartphone users and feature-phone users can be engaged in collaborative learning activities.

Thereby, we have three central aspects in our design of collaborative learning system 1.) Use of mobile technology 2.) Efficient utilization of user capabilities—leveraging smartphone users and feature phone users and 3.) Live interaction to enhance learning experience.

To meet our design requirements we draw upon the technical platform of our *Sangoshthi* system [81]<sup>1</sup>. *Sangoshthi* is a mobile based tool that is designed to enable health experts to remotely train ASHAs. With a smartphone application and a back-end of telephony application it connects feature phone users—ASHAs, a host, and the medical expert (smartphone user) in a conference call such that the expert streams audio content and the host controls ASHAs participation and interaction by selectively muting and unmuting their channels. More technical details can be found in the paper [81]. We conducted a pilot deployment that has shown positive outcomes in terms of feasibility, acceptability, and knowledge gains.

We built *LEAP*—Learning with Peers—on top of the codebase of *Sangoshthi* by adding several new features. We enhanced the core platform to remove the explicit role of the expert and the host and allow an ASHA (a smartphone user) to act as facilitator and participant at the same time. The other ASHAs (feature phone users) join as peers. Given that the underlying communication paradigm is voice based (conference call), we used group discussion as the central pedagogy. However, just grouping ASHAs and providing access to the tool may not result in positive outcomes of collaborative learning [42]. According to collaborative research, in the absence of instructors, it is necessary to make learners understand what they are expected to do and how to do [42]. Providing good learning material, well defined tasks and roles to play, have been found to be effective strategies in streamlining the learning mechanisms [19, 21, 42]. Therefore, we designed the group learning session such that they have access to some learning material, preferably audio and a task outline to follow. We now describe, the learning material we used, tasks to facilitate collaborative learning, and system components and working.

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<sup>1</sup>code-base publicly available at Github

### 3.1 Learning Material

We prepared the learning material with the help of an NGO, our collaborative partner, working in the field of maternal and child health for the past 30 years, in the northern region of India. The NGO works on close collaboration with National Health Mission of Haryana, the state government concerned with ASHA program. They provided us with audio material on the topic of Home Based Post-Natal Care (HBPNC), which is an important module in the training curriculum of ASHAs and contributes directly to Sustainable Development Goal 3. The dataset basically consisted of two types of audio recording: a.) Topic-lessons: these were ten audio lessons on ten topics of Home Based Newborn Care e.g. newborn temperature control, danger sign in newborn etc. The lessons were studio-recorded in the form of a conversation with a doctor. The content on these topics was same as that given in the training modules of ASHAs. The duration of a single lesson was 15 minutes. b.) Question-answering recordings: there were 175 short recordings of actual conversations between ASHAs and a doctor. A single recording contained a question asked by an ASHA and the answer given by a doctor and had a duration of 2-3 minutes. All of the recordings were in the native language of ASHAs (Hindi).

### 3.2 Task Definition

To facilitate group learning, we provided semi-structuring by using the aforementioned learning material. We defined a task outline for every session that included listening to three content recordings and conducting group discussions after each recording. The first recording was a topic lesson and the other two were Q&A recordings on that topic. The sequence and the duration estimates are shown in Figure 1. The first round of discussion was set to be of longest duration, at least 10 minutes. In this round, the groups could share their understandings of the content, related experiences or clarify doubts. The second and the third rounds of discussion were of shorter duration, 5-7 minutes.

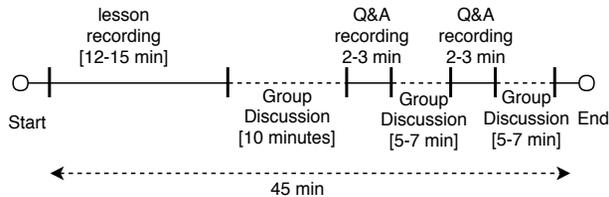


Fig. 1. Task Outline for a Group Learning Session

We imposed the sequence to a certain extent i.e. in the app interface the next audio recording could be accessed only after the previous had been completely played. However, it was allowed to go back to any previously played audio or pause a recording in between to clarify doubts. Except for the recommended sequence, the groups had full freedom and flexibility to try any other alternatives in their discussions e.g. going back to original lesson recording during the Q/A discussion session.

### 3.3 System Components

To incorporate the aforementioned design of tasks and make ASHAs use the tool on their own, we had two main components in the *LEAP* platform.

a.) **Web portal** - This is a central system from which the learning environment of the ASHAs groups can be designed and managed. The portal is like a learning management system used in

online learning programs for administration, tracking, and delivery of educational courses. The basic functions of our portal included the following: uploading and maintaining of learning materials (pre-recorded topic-wise audios), registration of ASHAs, creating and managing of peer-groups of ASHAs, scheduling group sessions, defining group roles and tasks ( facilitator or listener, audio selection and their sequence), and monitoring group interaction and performance. The portal is designed for the organization concerned with ASHAs, e.g. NGO or govt. body. A single system administrator can manage multiple groups of ASHAs using the portal.

After the system administrator has designed a learning course for ASHAs, created their groups and scheduled sessions, all of these details get automatically updated in the smartphone application of the facilitators.

**b.) Smartphone application** - This is to be used by the group facilitators i.e. the ASHAs who can operate a smartphone application. The application receives its group specific data from the server which was set in the portal by the administrator. The role of a facilitator is to conduct group sessions on a given schedule by operating the app and act as a moderator in group discussions.

The app has three main functions (see Figure 3): *Host Program*—shows the upcoming session details (date and time), a button to start the group call. When all the group members are connected, the session screen shows the group members' names, session timer, and count of connected members. By default all the members enter a call in mute mode, whenever the facilitator wants a group member to speak, she can un-mute her or else the group members can also show their intent of speaking by pressing '1' which signals to the facilitator through an icon of hand raise. *Tutorials*—contains the gallery of audio files (topic lessons), this is designed to help facilitators prepare in advance. If any facilitator wishes to prepare herself on the content matter then she can listen beforehand and prepare her notes. *Notifications*—displays text messages, sent by the system or the administrators.

The interface of the app was designed to be simple and intuitive to use for the ASHAs. Further, for the purpose of our study, we kept the experiment design controlled and made functionalities in the app more sequential and controlled. For example, the audio lessons in the gallery are locked by default and are only unlocked only when the corresponding sessions are scheduled. Likewise, the button to start a group call is activated only 15 minutes prior to the session time.

### 3.4 System Working

For a group session, the administrator creates and schedules a session through the web portal. This action makes the details of the upcoming session (topic name, date and time of the call) appear on the mobile application. To explicitly notify the group facilitators and the members, the administrator can also schedule automated calls (IVR-Interactive Voice Response) through the portal. After the group has successfully completed their session, the status, session statistics (connected members, speaking activities, duration etc.) and corresponding session recordings are updated in the portal. The administrator can then schedule the next session (Figure 2).

## 4 METHODS

### 4.1 Study Design

In this study, we aim to understand whether the introduction of the collaborative learning intervention improves ASHAs' knowledge over their regular routine<sup>2</sup> and analyze what kind of interactions ASHAs engage in the absence of trainers.

<sup>2</sup>The routine of ASHAs involves monthly meetings with supervisors. The agenda of these meetings includes incentive formalities, giving new directions, resolution of ASHAs issues and general guidance. The meetings are supposed to have a

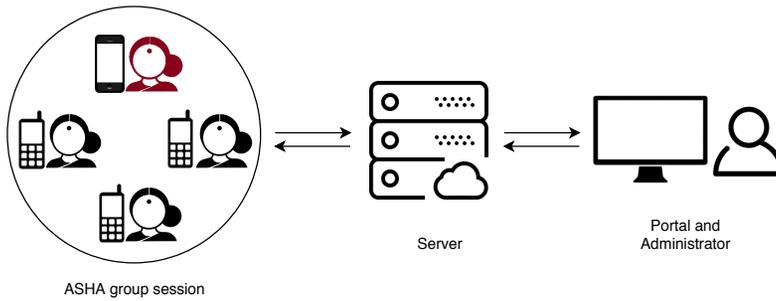


Fig. 2. Overview of LEAP

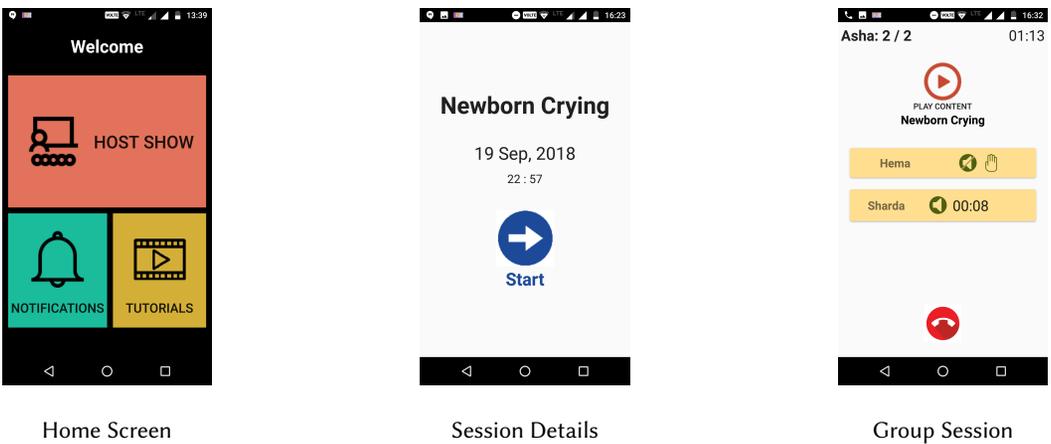


Fig. 3. The user interface of the smartphone application showing the home screen, the screen displaying upcoming session details and a live session with two group members. Here, we show the English translated version of the actual interface which is in Hindi.

We conducted a between-group design experiment study in Delhi with the cooperation and due permission of the Delhi State Health Mission (a government body under Ministry of Family and Health Welfare of India [58]). Delhi has several under-developed areas e.g. slums which are served by ASHAs. As per DSHM, 5000 ASHAs are placed across the eleven districts of the city [58]. We randomly allocated two districts of Delhi: south and east, comprising four health centers. While the two districts were separated by a distance of more than 30 km, the two health centers within a district were separated by only 3-5 km. Therefore, to avoid spill-over effects between the participants, we used district as the selection unit and randomly allocated one into the intervention group. There were a total of 120 ASHAs, with 62 in the intervention group and 58 in the control group (around 30 ASHAs at each center). The intervention group received our collaborative learning intervention in addition to their routine while the control did not. There was no placebo activity organized for the control group.

component of training and knowledge building but that does not happen regularly. So over the time, through meetings and informal knowledge sharing, ASHAs get trained in their job while also going through formal training sessions intermittently.

## 4.2 Participants

Within the intervention group, the ASHA peer-groups were created at the intra-healthcenter level, where they knew each other and therefore, could interact freely. Group creation was based on the availability of ASHAs who could operate smartphones. At every centre, 7-8 ASHAs were smartphone users. Out of these, we preferred those ASHAs who were recommended by their supervisors, as being sincere and active in their work. We finalized six such ASHAs at each center, thereby making six groups which made the group size of 5-6 (total 30 ASHAs at a centre). However, after a few practice sessions, the groups were rearranged due to problems relating to facilitator availability and the quality of cellular networks in their areas. Finally, we settled on a total of six groups, three at each center with group size between 9 and 11 members. The average age of the ASHAs was 38 (ranging from 25 to 55) with the majority of them (86%) educated up to 12<sup>th</sup> standard and a few holding graduate (10%) and post-graduate degrees(3%).

## 4.3 Implementation

Prior to the start of the intervention, we obtained consent from the participants and briefed them about the purpose of the study, the data to be collected and the potential risks. The participants were free to leave at any time. We gave our mobile handsets to the group facilitators for the duration of the deployment to ensure consistency in the system use. Each handset was enabled with a Reliance JIO SIM with a mobile data recharge. None of the group facilitators had WiFi facility in their house. The six group facilitators were trained on the smartphone application features through multiple practice sessions, organized at the respective health centers by the first author and a research assistant. Later, the actual sessions were conducted at the houses of the group facilitators.

One of the authors assumed the role of administrator and handled the portal. The role of the administrator was limited to monitoring the server logs during sessions in order to provide technical assistance if required. To schedule these sessions, we consulted the ASHAs and based on the majority views, fixed the time slots for every group as per their convenience. Because of the availability of only one administrator, the sessions' timings were made mutually exclusive. The groups of one of the centers were scheduled on three alternative days in a week and the groups of the other center on rest of the two days. The time slots were in the afternoon: 2 -3 pm, 3:30 -4:30pm, and 5 to 6 pm. If a group could not conduct their session on the assigned day, then they were supposed to complete it on the subsequent day. In around 6 weeks, the groups completed all their sessions. Some of the sessions were assisted by the administrator due to cellular network issues in the areas of the facilitators.

## 4.4 Data Collection and Analysis

We adopted mixed-method approach of data analysis in this study, both quantitative and qualitative.

To test the effect of the intervention in terms of learning gains, we conducted a pre-post intervention test with the help of a questionnaire, which was prepared with our NGO partner, an official collaborator of the govt. for ASHA training. The questionnaire had 20 open-ended questions on the 10 topics of Home Based Newborn Care, prepared by an experienced pediatrician and ASHA trainer. Example questions are as follows "*How can a mother determine that her newborn has taken enough breast milk?*", "*Why is it important to keep newborn baby warm?*". The answers of ASHAs were checked to contain certain required information items. For example, the correct answer of the question "*How can a mother determine that her newborn has taken enough breast milk?*" contained items as "*The newborn may fall asleep to indicate that it has had enough, the newborn stops actively suckling or stops suckling completely, the newborn may unclench its fists, arch its back, or smile or yawn, the mother will feel that her breasts have become soft.*". So, depending on the number of items

present in the respondent's answer, the score is computed (e.g. presence of 2 out of 4 items gets 50% of the maximum score). We used two examiners, blind to this study, to evaluate the answers given by ASHA using the answer key. Each examiner was randomly assigned one-half of the answer sheets of every center. Data of the participants present in both the pre and post tests were included in the analysis (99, 52 in the intervention group and 39 in the control group). Using the *t*-test, the differences between pre- and post-test scores were examined for statistical significance.

At the end of the intervention, semi-structured interviews were conducted with the group facilitators to understand their experiences with *LEAP*. These interviews were conducted over telephone calls in the Hindi language which were recorded for later analysis. The average duration of an interview was 10-15 minutes. ASHAs group sessions were analyzed by two coders, one was author and other was research staff. The themes were generated inductively from the sessions audio recordings (the native language of the participants and the coders was the same) and session transcripts (also generated by the same coders). In multiple iterations, codes were shared and refined to find the emergent themes. There were total 60 call recordings corresponding to 10 group sessions of the six groups.

We remunerated the ASHAs according to their routine monetary incentive method after consulting the medical officers of the health centers. The ASHAs in the control group received 200 INR for the pre-post tests (100 INR per test). The intervention group was provided additional remuneration for the group sessions and the extra time used in the workshops. The incentive amounts of the ASHAs in the intervention group also depended on their attendance rates during the sessions. For example, an ASHA with 100% attendance (10 sessions) was given 1200 INR (100 per session, 200 for pre-post test). The group facilitators were given an additional 300 INR for their extra time.

## 5 RESULTS

We now present the combined results obtained from the quantitative and qualitative analyses. Throughout the paper we refer to the four health centers as  $I_1$ ,  $I_2$  (intervention group);  $C_1$ ,  $C_2$  (control group). The ASHA groups (total of six, three at each center) in the intervention group are referred as  $I_1G_1$ ,  $I_1G_2$ ,  $I_1G_3$  ( $I_1$  center);  $I_2G_1$ ,  $I_2G_2$ ,  $I_2G_3$  ( $I_2$  center). To present ASHAs' quotes, we have changed the names to preserve their privacy.

### 5.1 Effect on Knowledge

To investigate the effect of the intervention on the knowledge levels of the participants, we compared the differences in their pre-test and post-test scores by applying paired *t*-test to the mean values of the test scores. Considering center-wise comparison, we found the improvement rates of the  $I_1$  and  $I_2$  centers to be 38% ( $M = 2.04$ ,  $t(28)=9.95$ ,  $p < 0.05$ ) and 13% ( $M = 0.70$ ,  $t(22) = 3.75$ ,  $p < 0.05$ ) respectively. In the control group, the improvement rates for  $C_1$  was 12% ( $M = 0.73$ ,  $t(22) = 3.58$ ,  $p < 0.05$ ), and  $C_2$  was 4% ( $M = 0.21$ ,  $t(15) = 1.1271$ ,  $p$ -value  $> 0.05$ ), shown in figure 4.

We were surprised by the results of  $C_1$  center group and also by the large difference between the performances of  $I_1$  and  $I_2$ . The  $C_1$  center group did not receive the intervention, yet it showed statistically significant improvements in the test scores.

On further inquiry, we came to know that another training program - known as mobile academy - was started in parallel at  $I_1$  and  $C_1$ . We analyzed the contents of Mobile Academy program and found that around 50% of their training material overlapped with ours.

We believe that this parallel training was the potential confounder that might have caused additional knowledge gains. As the health centers have little control over the directions they receive from higher authorities, it was practically impossible for us to stop or delay any parallel interventions.

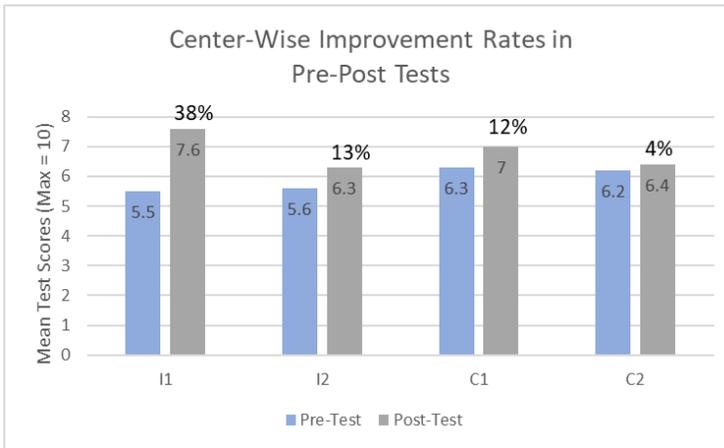


Fig. 4. Center wise comparison

Nevertheless, the comparative analysis of the remaining centers ( $I_2$  and  $C_2$ ) which did not undergo any other training still gives us a reasonable inference that the knowledge of the participants did improve from the collaborative learning intervention.

The contributing factors towards knowledge gains can be both the content and the discussion. In the next sub-section, we will investigate the factor of group discussions in the learning curve.

## 5.2 Peer Learning Aspects

ASHAs group activity consisted of listening to three audios- topic lesson, two field cases and conducting group discussion after each. Apart from this, we did not control the interactions using any pedagogical techniques that include talking in a particular pattern or following any rules [65]. We aimed to understand the quality of interactions in their natural form. We now summarize the elements of peer learning observed.

*Verbalization* [65] was one of the main theme surfaced in the analysis of the interactions. The group facilitators solicited peers thoughts in round robin fashion giving equal chance of participation to all the group members. While mostly all the present members spoke on their turn, some were more active and had higher participation. We observed, that on average, in every group, there were three speakers who spoke with confidence and presented their ideas in coherent ways. Some of these were articulate, enjoyed speaking at length and demonstrated characteristics of becoming group facilitators in future. Further, their participation laid good examples for others, often helping shy peers to open up. In the sequence of the conversations given below, we observed that an ASHA who was initially reluctant in speaking shared her experience after listening to another ASHA:

**Facilitator:** “have you experienced any case in which the mother shared crying related problem of the newborn with you?”, **Meera:** “I will share if I find...”

**Rajeshwari** - “I got to know about the causes of crying, if the newborn is crying even after feeding then we need to check her properly, whether the clothing is fine or not, whether the baby is feeling fine or not. We should caress her, if she doesn’t feel fine we should take her to doctor”, **Facilitator** - “good points, share any of your past experience”, **Rajeshwari** - “in recent past, a baby was crying excessively and was vomiting. After checkup, some internal problem was found...”

**Facilitator:** *“did you find any patient in your area? If yes, please share”,* **Meera:** *“there was one woman whose newborn used to cry a lot, especially at night. After I explained her to take baby in her lap, caress and love her, the baby started feeling calmer”*

*I<sub>2</sub>G<sub>3</sub>, Newborn Crying*

Apart from these active members, there were others who showed passivity in participation and spoke minimally that too upon prompting in form of posing a question or case by the facilitators.

The second theme was *co-construction of knowledge* that included questioning, summarizing, repeated explanations and elaborations, activities that have been found to be develop high-level of thinking practices [45, 65]. Especially, the facilitators exhibited characteristics of peer tutors. In the sequence of conversation below, the facilitator tried to elicit thoughts of the peer ASHA by first framing direct question, then modifying into in-direct and finally into condition based question:

**Facilitator:** *“have you observed any depression case in your area?”* **Saraswati** - *“no”*

**Facilitator:** *“can you identify a depressed mother?”* **Saraswati:** *yes, if the mother is not communicating with others, not taking care of her child and her personal hygiene then we need to persuade her/*

**Facilitator:** *what will you do if the mother doesn't get persuaded? we will have to take her to doctor.....the mother must be happy if she is not then it is a serious problem”*

In terms of coverage of topics, we observed *chaining* in the ideas often triggered by the first speaker or an active ASHAs who generally brought new topics to the discussions. The ASHAs built on each others' ideas and collectively recalled the facts and experiences.

**Kiran:** *“from today's lesson, I got to know many facts related to crying like why newborn cries, which babies cry more and which less”,* **Facilitator:**...

**Punita:** *“often babies cry very much at night”,* **Facilitator** - *“yeah, babies who sleep sufficiently during day time generally wake up more at night, mothers should play with their babies during day...”*

**Neelam:**...*“babies should also have appropriate clothing according to the weather otherwise it can create discomfort which lead to crying”,* **Facilitator** - *“yeah, even excessive crying can also affect the mind of the babies...”*

ASHAs also showed inter-personal skills by encouraging each other, augmenting viewpoints and resolving conflicts. This factor was reflected in the behavior of the group facilitators since they had the major control over speaking. Further, the words of praise and acknowledgement by the facilitators encouraged ASHAs in sharing their opinion.

We also noticed a good amount of topic adherence in the discussions. Few or no occasions were observed in which the groups deviated from the topic lessons in their discussions.

### 5.3 Reflections on the Need to Learn

While discussing a range of issues and topics, ASHAs actively self-defined their roles in society and reflected on how necessary it is to have good knowledge. After listening to lesson recordings, ASHAs often acknowledged gaps in their home visits practices and ways to improve them and apply new knowledge.

*“So far, we used to ask about the babies, from now on we will ask about the mothers also, so that she can openly share the problems with us.”—Rajni, I<sub>2</sub>G<sub>3</sub>*

**Facilitator** - *“if mother is depressed and in tension, what advice should be given?” Santosh* - *“we should make frequent visits, and explain her again and again that she should focus on her baby, this will engage her, we should counsel the family members also and suggest to see the doctor.”—I<sub>2</sub>G<sub>3</sub>*

They discussed their proximity to the families and opportunities to bring positive changes. For example, in the following dialog, the facilitator emphasizes the opportunity of developing a relationship with a mother during pregnancy to prepare for better care:

**Host:** *“...to counsel a mother we have so much of time, we get associated with her right from her pregnancy period, from her first trimester she starts meeting us. So, we can discuss upon these topics early on, how to feed baby, we can tell all the important things as well as explain to her family too and solve the problems.”—I<sub>1</sub>G<sub>1</sub>*

They frequently discussed the challenges in persuading families towards healthy practices. They brought topics of prevailing myths around post-natal care, handling societal issues e.g. women empowerment, gender discrimination among newborns and the dynamics of power in families. As investigated in prior research, there are many mal-practices associated with post-natal care in India and are main deterrent towards healthy care of the mother. Still many Indian families practice outdated rituals and traditions. For instance, post-delivery, mothers are confined to home for a period of 40 days and are put under various types of restriction related to diet, physical movements and behavior etc. [10, 11]. ASHA discussions on field cases included many such examples, one of these is as follows:

**Facilitator:** *“In a delivery case when I went to the house of a lady, I found that the mother-in-law had given harira soup to the mother in the summer weather, which increased bleeding. So, I explained her mother-in-law to give food according to the weather and referred her to the hospital.”—I<sub>1</sub>G<sub>1</sub>*

Further, the other common topic discussed amongst these challenge was related to the gender of children. In India, many families have strong bias towards male child [37] due to which the health of mothers get affected. When the content topic was postpartum depression, the most common example discussed across groups was birth of second or third girl child. In these examples, ASHA discussed family attitudes towards babies and the mother, and the mother behavior towards the baby. As also found by prior studies, girl child tend to less breastfeed as compared to male child.

Some active ASHAs even picked subtle information relating to attitudes: *“a mother’s thinking should be good; mother should think that she is doing a great job, giving milk to baby, keeping her baby.”—Manju, I<sub>1</sub>G<sub>3</sub>*

#### 5.4 Impact of Learning Material

In group learning sessions, ASHAs listened to two types of learning materials: topic lessons and Q&A recordings. We noted that ASHAs appreciated the quality of content and discussed the relevance of topics. At times they compared the content presentation with that of their training. In particular, they appreciated the fact that smaller details were highlighted.

**Vidya:** “Never before did we realize how to recognize the depression of the mother, now we will be able to easily identify what is the problem, **Facilitator:** Yes, we never knew before that so much, **Vidya:** These things have never been taught to us openly before”...— $I_2G_3$

On noticing new information, the ASHAs felt good and immediately highlighted it in their discussions.

**Facilitator** - “And a new thing has come to knowledge, the blurriness in the eyes of mother happens due to low blood pressure”, **Rameshwari** - “even the dizziness is also because of low BP”, **Facilitator** - “We did not know that before” **Rameshwari:** “were never told, how could we know when it was not explained.”

**Facilitator-** “did you notice the new thing? It is said that when a baby is born, there is a yellow layer on his body, None of us knew this new thing, the yellow layer should not be removed from the skin”.

$I_2G_3$ , Danger Sign in Newborn

Some ASHAs expressed their interest in the continuation of the training on a regular basis.

“the recordings were very good, we want this program to continue, so that we can get knowledge from time to time.. Although, we do receive training but somehow we are not able to get so much of knowledge.”—Rajni,  $I_2G_3$

Further, the Q&A recordings were liked greatly because they were short and contained real problems. The ASHAs were able to relate them to their field cases. During our interaction with the group facilitators post-intervention, some of them mentioned that while the lesson recordings were good but the duration of 15 minutes was too long. It required higher engagement which found to be difficult in their household settings due to external disturbances. They suggested having multiple shorter recordings instead of one long recording.

#### 5.5 Role of Group Facilitator

We found that communication skills, and initiatives taken by group facilitators affected interaction within the group. Facilitators who had leadership skills and were active enough to elicit conversations from their peers led good discussions. For example, the facilitator of the group  $I_1G_1$  was the most active one. Prior to a scheduled session, she would always listen to the lesson recording to take notes and prepare herself so that would have a good understanding of the content. To ensure she would sound like a facilitator, for the initial sessions she prepared her speech scripts too. Before starting a session, she used to give an introduction to the topic and likewise summarize every audio upon completion. She was able to speak fluent Hindi with good vocabulary and also attempted to augment the content presentation in her own style. For example, after the second Q&A recording in a session in which an ASHA talked about the baby crying, she summarized the Q&A essence by appreciating the doctor’s viewpoint on crying and elaborated on it in her own language in which she recited a poem to engage users.

Table 1. Characteristics of Group Facilitators

| $I_1G_1$   | $I_1G_2$  | $I_1G_3$  |
|--|---|---|
| <ul style="list-style-type: none"> <li>• <b>Articulate</b></li> <li>• <b>Acknowledging and Encouraging</b></li> <li>• Group Discussion Strategies: <b>sharing of field experiences</b>, problem solving, <b>questioning and answering</b>, case based discussions</li> <li>• Tutor characteristics: <b>knowledge of topics</b>, <b>explanation skills</b></li> <li>• <b>Positive Attitude</b></li> </ul> | <ul style="list-style-type: none"> <li>• Group discussion strategies: <b>questioning and answering</b></li> </ul>   | <ul style="list-style-type: none"> <li>• <b>Articulate</b></li> <li>• <b>Acknowledging and Encouraging</b></li> <li>• Group Discussion Strategies: <b>sharing of field experiences</b>, <b>questioning and answering</b>, <b>general feedback based discussion</b></li> <li>• Tutor characteristics: <b>explanation skills</b>, <b>knowledge of topics</b></li> <li>• <b>Positive Attitude</b></li> </ul> |
| $I_2G_1$   | $I_2G_2$  | $I_2G_3$  |
| <ul style="list-style-type: none"> <li>• <b>Acknowledging and Encouraging</b></li> <li>• Group Discussion Strategies: <b>general feedback based discussion</b></li> <li>• Humorous and <b>Friendly</b></li> </ul>  | <ul style="list-style-type: none"> <li>• Group Discussion Strategies: <b>questioning and answering</b>, <b>general feedback based discussion</b></li> </ul> | <ul style="list-style-type: none"> <li>• <b>Acknowledging and Encouraging</b></li> <li>• Group Discussion Strategies: <b>sharing of field experiences</b>, <b>questioning and answering</b>, <b>general feedback based discussion</b></li> <li>• <b>Friendly</b></li> </ul>   |

*“You are my sun, you are my moon, Oh, you are the twinkle of my eyes, looking at you, the world says-what mother’s darling are you?”*

Her preparation also included constructing examples and cases for the explanation. To start a conversation, she would ask a question, cite a related field experience, or present a problem to be solved. She cited her personal experiences and emphasized success stories. After an ASHA had spoken, she would acknowledge her, augment the information, and encourage her.

**Facilitator** - *“Has there been a case in which a mother has complained her baby getting hot or cold?”* **Sunaina** - *“no”*, **Facilitator** - *“well, let me tell you, just yesterday I took a baby for injections, the baby was weak. I asked the mother what kind of milk is given to the baby, she said because my milk production is insufficient that’s why I give external milk. I explained her to strictly forbid external milk and check the temperature around the area of neck and abdomen, if the temperature is greater than 38°C then it means fever and you need to contact me...”*

Given that, no prior training had been given, her efforts exceeded our expectations. Overall, all of her conversations held a good portion of experience sharing. The facilitators of groups  $I_1G_3$ ,  $I_2G_3$  and  $I_2G_1$  also did a fair job. Their strategies to encourage discussions varied. For example, the  $I_1G_3$  facilitator showed the characteristics of a tutor as she used to initiate conversations by asking questions from her peers. She would construct different types of questions around the lesson content, to check the learning of her peers. The facilitator of the  $I_2G_1$  group used to solicit feedback over the content and queries of peers. The  $I_2G_3$  facilitator was more flexible trying a variety of approaches ranging from seeking feedback, to experience sharing. An excerpt of their statements for starting the conversations are given below:

*“What do you understand by the crying of newborn baby, why is it necessary to cry?”*

“How to care for the child while crying?”

“Why is this so that babies sleep during day time and cry at night?”

$I_1G_3$  facilitator, Newborn Crying

“Did you hear the recording, what did you learn? tell me more, do you want ask anything from me?”

“What did you like in the recording? what would you like to tell us?”

“What did you learn?”

$I_2G_1$  facilitator, Newborn Crying

“how did you find the recording?”

“did you learn anything new?if yes what was that?”

“please share your field experience, did you find any patient in your area of this condition”

$I_2G_3$  host, Newborn Crying

There were other groups ( $I_2G_2$  and  $I_1G_2$ ) in which the facilitators were not effective and showed a clear need for training. The  $I_1G_2$  facilitator, in her initial few shows, got help from the  $I_1G_3$  facilitator, who lived close by; thereafter, followed the same strategy of asking questions. However, she could not sustain effective group discussions. The total time spent on discussion was the lowest among all the groups, whereby, she mainly focused on completing the conversations superficially. The  $I_2G_2$  facilitator, like others, was more open, and used to ask general questions and take feedback about the content. However, she would herself pay less attention to the quality of discussions. A common behavioral aspect of both of these facilitators was that while conversing they would neither give proper acknowledgment to the speakers nor extend the dialog by augmenting new facts or giving feedback. This led to monotony and a decrease in the tempo of the discussions. In particular, the ASHAs who lacked the confidence to speak or had little interest in participation were affected the most.

The facilitator of  $I_2G_2$  performed better than  $I_1G_2$  and she was able to have long discussions. Her group had a good number of active members who, at times, attempted to carry the discussions and cover up the inefficiencies of the facilitator. For example, the dialog below shows an ASHA emphasizing her statement assertively when the facilitator ( $I_2G_2$ ) did not pay much attention:

**Saroj** - “it was a good question, due to problems post-delivery sometimes it becomes difficult to decide about what to do after mother has come home, as the doctor said in the recording, should immediately go to the hospital”, **Facilitator** - “If everything is fine then there is nothing to worry, but if there is excessive bleeding then we will have to go to the doctor”, **Saroj** - “why did it happen?, what did actually happen? to know all these it is necessary to immediately see the doctor”, **Facilitator** - “we can only counsel the family”, **Saroj** - “yeah we need to counsel, many families follow misconceptions like they get concerned about the temperature of the food, cold or hot, to be given to the mother and become careless about the nutrition level of the food. We need to focus on eradicating these myths by explaining to families and should advice them to see the doctor in case of any danger sign.” We have summarized the characteristics of all the facilitators in the table 1.

## 5.6 Missed Opportunities

In our design, the group activity was structured such that the groups were supposed to use the content material and interact in a pre-defined sequence. There was no other form of scaffolding to validate the understanding from the content or help them escalate queries. We observed that in the absence of instructors, in some cases the groups developed inconsistent knowledge of the facts or could not clear their doubts. The two statements from two different groups, given below, differed in the recommended duration of hand washing before touching a newborn.

**Facilitator** - “how should we clean a baby, how should we wash hands? how should we explain about these things to the mothers?” **Sarita** - “Hands should be cleaned for 20 minutes, every step should be done for 20 minutes.”— $I_1G_2$

**Facilitator** - “for how long should we wash hands?” **Saroj** - “Wash for a good 5 minutes, then dry hands well”— $I_1G_3$

We also observed occasions of passive participation from a few members. Dealing with such members dependent on the facilitator skills. In most cases, we observed facilitators not adopting any specific strategy.

**Facilitator** - “did you listen to the recording, Anju - yeah, I listened, but I was feeling sleepy”, **Rajni** - “you must have listened something”, **Anju** - “they told about danger signs such as smelly discharge and bleeding post-partum” **Rajni** - “yeah”, **Rajni** - “listen carefully from the next time”

$I_2G_2$ , Danger Signs in Mother

In the cases of new and complex topics, the need for experts was apparent. For example, on the topic of mother’s depression, the discussions mostly centered around ASHAs’ general perceptions of depression. A major portion of their discussion focused on the gender of the baby. Despite listening to the complete lesson, they did not discuss other causes of depression. ASHAs highlighted symptoms as mother not taking care of herself and child, sadness and related to causes including family issues, health problems, child gender, and child adoption, general sadness. Among these girl child cause was the major one pertaining to cases of more than one daughter and only daughter. As also found by other studies, ASHA knowledge on depression lack in terms of understanding its psycho-social nature, its impact and signs and symptoms. [3, 5, 44]. Also, we did not see any reference to prior knowledge on Depression. Some ASHAs even acknowledged that they had limited or no knowledge on depression. In the group session of  $I_2G_2$ , out of nine interaction exchanges, four were about the depression due to the gender of the baby.

“Nowadays, the son and the daughter are equal, there should be no discrimination between the two”...—Meira

“Some families still consider the difference, but they should not pay attention to all these things and should focus on the child”—Rajni

“Nowadays the parents want the first child as son, seeing the girl newborn they go into depression”—Geeta

“Family members also have to understand that daughters take good care of parents”.—Anju

At other times, the group members sought validation of facts which their facilitators were not able to do. For example, in the dialog below, the group members had a doubt about temperature units in Fahrenheit and Celcius:

**Ravindar** - “we know that the temprature of adults is 98 degree, what is that of babies?”, **Neelam**- “in between 96 and 97, **Ravindar** - okay and what was the logic of 35/36 ”, **Neelam** - “35!, when was it mentioned?”, **Vidya**- “I also asked you before”, **Neelam** - “okay, I will clarify from ma’am”

*I<sub>2</sub>G<sub>3</sub>*, Newborn Crying

## 6 CHALLENGES

We faced a challenge from the quality of the cellular network in the intervention region that hampered the user experience. Since ASHAs did not have access to WiFi facilities at their homes, we used mobile Internet. There were inconsistencies in the speed of the mobile data which affected the real-time behavior of the system. Group calls would hang in between making the group members frustrated. As a workaround, many of the group facilitators conducted sessions on their terraces. The same problem occurred with the group members when their phone numbers became unreachable which in turn reduced their attendance. To monitor the system behavior, the administrator had to remain available live during the sessions and provide assistance over phone calls to the group facilitators e.g. restarting the application or phone.

The other challenge came in conducting the controlled study. Because ASHAs are involved in various government schemes, they are usually engaged in multiple activities at the same time. This makes it difficult to control the study settings. During our intervention period, out of the four health centers, one pair of control and intervention group started another mobile training on topics similar to ours. This raises a question for conducting large-scale trials of such a platform. Given the social dynamics, it is very difficult to insulate the participating groups from similar activities happening around them which may contaminate the results.

## 7 DISCUSSION

Providing regular training and one-on-one interaction with health experts on regular basis is a big challenge in the ASHA program. In this work we study the potential of providing a technology-based support to peer learning of ASHAs in India as a supplementary approach to existing training procedure. The design solution focused on providing opportunities to ASHAs to enhance their knowledge through small group learning activity that included co-listening to audio learning material and conducting group discussions. The sessions were semi-structured in terms of group member roles, session schedules, sequence order of content listening and doing group discussion.

We now summarize the socio-technical implications for designing technology based peer learning solutions for ASHAs both at policy making level and HCI/CSCW research.

### 7.1 Technical Feasibility of the Learning Tool

Designing a learning tool for ASHAs implies considering their accessibility to technologies. Among ICTs, mobile phone is the main form used by ASHAs, whereby mostly it is the feature phone. We observed in our user base, at a health centre, only 25% had smartphones. The low access reflects the gender gap in mobile phone access and usage in India. Women ownership of phone is 36% less than men [30]. The gap further is significantly higher in rural areas (39%) and amongst those with no formal education (41%) [30].

Under such constraints, it is important to design solutions which are low-cost, feasible and contextual. The technical design of *LEAP* lays a good example of effectively utilizing smartphone and feature phone users in providing a synchronous learning model. However, there are still challenges related to network quality. In our areas of study, bad signal strength led to high call disconnections and delayed responsiveness in the app. A significant number of ASHAs managed their

participation by going on the terraces or outside. In longer run, this is a concern for maintaining ASHAs motivation.

*7.1.1 Design Implication.* A potential way is to design solutions that can facilitate group learning in physically co-located settings. ASHAs in a neighbourhood can share a smartphone to work out group learning tasks. As also found by the report [30], women in India who cannot afford a handset frequently borrow from neighbors. Innovations to improve shared experiences of the tool should be investigated, a research direction of potential interest to CSCW community that has extensively explored such tools in usual classroom or online settings, but limited in the context of network and device constrained settings.

## 7.2 Peer Learning and Scaffolding Scope

In our analysis of the group sessions, we found elements of peer learning such as peer tutoring [14], verbalization [65], and co-construction of knowledge [42]. ASHAs questioned on content topics, exchanged explanations, and shared experiences. While doing so, they built upon each others ideas, particularly, the presence of active members, positively influenced other shy peers. Further, the role of group facilitators was found to play a key role in the effectiveness of discussion. Some of them emerged as leaders and made significant efforts in their facilitation strategies e.g. constructing seed examples and cases, augmenting peers' viewpoints, resolving conflicts, and using conversational scripts to act like a professional show host. Despite any training or prior experience of using discussion forum, as a start, these thinking practices were highly positive, suggesting a good scope of designing peer learning solution. To further structure the knowledge exchange, scaffolding techniques as studied in the education research should be explored. In particular, we observed the need of scaffolding for developing good understanding of the material. For example, sometimes ASHAs discussion showed confusion on the facts and inadequate understanding on complex topics e.g. depression.

*7.2.1 Design Implication.* To further enhance the skills of facilitators, the app can be enhanced to allow addition of meta-content which facilitators can use on-the-fly during group sessions. Feature to support in-session exercises should be explored in order to further structure the group learning activity. For example, application like clicker can facilitate problem based learning, giving more quantitative data to analyze the learning gains.

To mitigate learners developing partial understanding of the facts, techniques like problem based learning [31, 32] can be applied. For factual information, strategies should be used to emphasize the information. More of an emphasis can be given placed on the information by repeating or employing exercises to validate understanding. Further, we observed that for a certain type of teaching topics, it is necessary to engage instructors occasionally or develop an application to escalate queries. Likewise, group discussion can be structured through techniques e.g. scripted roles and stances [65], jigsaw [6], external collaboration scripts [47], problem-based learning [32]

Further, utilizing group composition is another factor that can contribute towards making peer learning approach effective. Research has confirmed the benefits of heterogeneous group composition having students with mixed performance - low, mid and high [13, 40]. For ASHAs, the group composition can be experimented both at the intra-centre and inter-center levels. While the intra-centre group composition can help shy ASHAs to open up, the inter-centre group composition, can help in gaining new experiences from the ASHAs of other centres and have more opportunities of healthy competition. System wise, statistics about the individual and group performance can be maintained by collecting groups performance and then used in generate group compositions automatically.

Finally, we observed that taking feedback from ASHAs and involving them in designing the system is important to make the system use effective. For example, in the feedback on the learning material ASHAs mentioned their preference for shorter audios. This actually highlights the importance of designing content with the real users. The work *Projecting health* [49] is a good example of creating impactful content when the community members themselves participate in creating it. Particularly in local contexts, benefits are manifold as the top-down approach misses the local nuances embedded in the societies in which ASHAs work.

### 7.3 Forum to Practice Discourses and Exchange Perspectives

Informally ASHAs are a community who invariably leverage each others' knowledge in performing their duties [81]. They share common understandings of the context and personally face the same challenges as that of their communities. These include women position in society, familial contexts, financial constraints, societal norms, and awareness on healthcare. When ASHAs discussed on such aspects, they not only discussed challenges but also how did they address them. Thus, bringing forward their situated knowledges and developing common understandings. However, the health experts at higher positions might not have that level of visibility. Irregular exchanges and top-down nature of meetings further increases the disconnects between ASHAs and the health experts [35, 75, 77]. Providing a regular forum of discussion to ASHAs would help in surfacing the ground realities and prevailing perspectives in the communities that eventually helps in making health care delivery effective. From management point of view, such forums can be utilized to address the coordination challenges amongst the health workers at inter-personal and inter-departmental level [35, 77]. Further, having an online community would help ASHAs develop their confidence. Studies evaluating ASHA performance have highlighted lack of confidence as one of the important factor in skill building. A discussion forum creates a healthy and structured environment to practice discourses, that would potentially help in improving the confidence of ASHAs to deal with the cases e.g. client counselling. Past studies providing voice forums in the field of agriculture, citizen journalism have marked the same benefits [63, 69].

*7.3.1 Design Implication.* Considering penetration of mobile phones, voice based forums should be explored for ASHAs. Rich literature exists for IVR based voice forums [63, 69, 80], *LEAP* further extends them by incorporating smartphone users in the design and extending it to real time interaction. Further, to incorporate different stakeholders of the healthcare system, a learning management system can be developed that takes inputs from ASHAs forum automatically. For example, considering *LEAP* architecture, in routine group sessions, ASHAs can be given the choice to feed in their queries, submit session recordings or raise a thread of discussion. This data should be collated at the system server that makes it visible to the supervisors who can then respond appropriately. Going ahead, smartphones should be leveraged in developing online communities.

### 7.4 Affording Flexibility

ASHAs are situated in specific context of socio-cultural and gender, they are constantly challenged by existing norms and practices. As women, they are expected to fulfill household duties including daily chores, taking care of children, elders and food [75]. Failure to do so seriously affect their relationships. This gender based social obligations limit their professional role [75]. Studies have found that increasing workload and involvement in various community programs on top of their household duties have produced a feeling of overburden [28, 75]. In our study, we observed some of the ASHAs attending the session calls while doing their household tasks. For longer implementation, this aspect thus hold a great importance. Further, since our deployment was more controlled that

included recording of sessions, ASHAs participation might have affected. There is a need for investigation regarding the sustainability aspect.

*7.4.1 Design Implication.* Since ASHAs are involved in various programs, sometimes overlapping in their agenda and content, planning between different programs. System design wise, ASHAs should be provided more flexibility in terms of managing their learning activities. Like the *LEAP* platform, a group of ASHAs should be able to decide when they want to meet. Designing a combination of asynchronous and synchronous learning model is a potential way. To address participation issues, techniques like creation of on-demand groups might be preferable by ASHAs.

## 8 CONCLUSION

Through our field experiment, we found that the collaborative learning approach to train ASHAs is a promising strategy to overcome the shortage of instructors as well as to support their learning needs. We designed a peer-led educational intervention in which ASHAs organized their group learning sessions independently. By using already developed content and providing minimal guidance for group discussions, we could see that ASHAs were able to show significant knowledge gains and most importantly feel empowered by sharing their thoughts with peers. They were able to acknowledge their knowledge gaps and have discussions on the areas of improvement. By analyzing ASHAs' group learning sessions, we arrived at design guidelines for developing collaborative learning platforms for ASHAs. Overall, we believe that the model of collaborative learning must be investigated further with different pedagogical strategies and tried at a larger scale of deployment.

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