Tag a Teacher: A Qualitative Analysis of WhatsApp-Based Teacher Networks in Low-Income Indian Schools

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ABSTRACT

Although WhatsApp-based communication is playing an increasingly large role in the professional lives of teachers in low-income schools, the nature of the interactions that occur and how these interactions enable cooperative work are not well understood. We contribute a qualitative analysis of 26 existing WhatsApp groups (35,567 messages) that examines (1) the strategies used to encourage interaction within teacher-focused WhatsApp groups, and (2) how these interactions are sustained by teachers, management, and organizations over a period of time. We use *teacher networks* and *activity awareness model* to make sense of WhatsApp-based interactions and show how WhatsApp narrows the gap between management and teachers, leading to additional work and stress for teachers. WhatsApp was also used to circulate polarizing and malicious information, leading to a variety of interesting content moderation strategies. Our findings expand the scope of research on teacher networks to low-income contexts and will inform future interventions that enable cooperative work among teachers.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in HCI**.

KEYWORDS

Education; teacher networks; whatsapp; teacher development; cooperative work; ICTD; HCI4D

1 INTRODUCTION

The rapid proliferation of smartphone devices and falling costs of mobile data across the world, and especially in India, has resulted in online communication platforms (e.g., WhatsApp) playing an increasingly large role in people's personal [17, 49, 56, 84] and professional lives [33, 53, 55, 79, 88, 94, 109]. Many new smartphone

users in the Global South, who are often interacting with digital technologies and the Internet for the first time, possess only one (or a shared) device and are expected to quickly learn to balance their use of this device and associated online platforms to coordinate both personal and work communications. In these contexts, it is important to study the nature of the interactions that occur via online platforms to better understand how the technologies may (or may not) enable cooperative work among groups of people and the strategies that have been developed to curate, share, and moderate information.

In this paper, we examine how teachers from low-income Indian schools, school administrators, and staff from education-focused organizations use WhatsApp groups to communicate with each other and provide pedagogical support to teachers. We use the concept of *teacher networks* [65] to examine WhatsApp-based interactions among existing groups of teachers in low-income Indian schools. Teacher networks have long been used to explore how teachers with diverse backgrounds come together for shared activities and experiences to achieve common goals in their work [65]. For example, prior work has shown how teacher networks with strong support structures and cohesive interactions can lead to interventions and policies that improve communal relations [65], collective agency [82], and professional development [95]. However, most prior work on teacher networks has focused on educators in Western contexts. There is a severe scarcity of research that examines teacher networks in low-resource environments in the Global South.

Our research fills this gap by examining how these networks are enacted via WhatsApp group communications among teachers in low-income Indian schools, where both smartphone adoption by teachers and use of WhatsApp for professional purposes are relatively recent phenomena. In particular, we sought to answer the following research questions: **RQ1:** *What strategies are used to encourage interaction within existing WhatsApp-based teacher networks in low-income Indian schools?* and **RQ2:** *How are these interactions sustained by teachers, management, and organizations over period of time?*

To answer these questions, we conducted a qualitative study in which we collected and analyzed conversations from 26 existing WhatsApp groups (a total of 35,567 messages) that took place between teachers, school administrators, and staff from education-focused organizations in India. Our dataset consists of three types of WhatsApp groups: (1) groups that are created and managed by 321 [1], an organization that offers training workshops and support to improve teachers' capacities; (2) groups managed by Meghshala [74], an organization that markets a mobile platform to improve

teachers' pedagogical knowledge; and (3) groups that are administered by schools' higher management.

To examine the nature of cooperative work manifesting on these different types of WhatsApp groups, we use Neale et al.'s [80] *activity awareness* model as an analytical lens. While theoretical foundations of teacher networks are useful to conceptually understand these WhatsApp-based teacher networks as a whole, activity awareness model enables us to study and categorize low-level individual interactions among stakeholders in these networks, thereby allowing us to compare cohesiveness and cooperative work across different groups.

For RQ1, we show how teachers' WhatsApp conversations employed creative structures (e.g., quizzes, puzzles) that often repurposed WhatsApp's built-in features (e.g., emojis, image editor) in innovative ways to engage teachers and encourage them to develop professional skills. The groups were also used to actively recognize and celebrate teachers' work. For RQ2, we show how using WhatsApp to share professional resources helped sustain the interactions but reduced the gap between school administrators and teachers, potentially leading to extra work and stress for teachers. In addition, WhatsApp groups were used to circulate misinformation, malicious spam, and religiously and politically polarizing information, exposing teachers to a range of possible digital harms. In response, participants used a variety of content moderation strategies to keep conversations focused on education and reprimand those who posted unacceptable content.

Lastly, we highlight opportunities for future research to (1) measure the impact of WhatsApp use on teachers' wellbeing, and (2) further analyze the spread of misinformation on teacher-focused WhatsApp groups. In summary, we make the following contributions to the HCI(4D) community:

(1) We expand existing knowledge on teacher networks to the Global South by showing how formal and informal teacher networks are enacted via WhatsApp group conversations between teachers, administrators, and staff from education-focused organizations in low-income Indian schools.
(2) We highlight the strategies used to encourage interaction within WhatsApp-based teacher networks and demonstrate the kinds of cooperative work currently achieved within these groups.
(3) We reveal how interactions are sustained on teacher networks through content curation, sharing, and moderation on WhatsApp-based teacher groups, including how WhatsApp use may create additional work, stress, and risks for teachers, and we discuss the potential effects on teachers' wellbeing.

2 BACKGROUND AND RELATED WORK

Since its launch in 2009, WhatsApp has become a globally popular instant messaging platform. A large body of research has examined people's use of WhatsApp in a wide range of settings, including everyday activities [85], interactions with family and friends [84], how WhatsApp extends and enacts physical relationships [56], and comparisons of WhatsApp to other messaging modalities, such as SMS [24]. Studies have also examined how WhatsApp impacts, for example, stress [102], distraction [2], and privacy [17, 49]. Beyond personal use, research has also examined WhatsApp in professional

settings, including health [53, 57, 58], politics [21, 94], and community engagement [63].

In educational contexts, which are closest to our study, recent work analyzed how WhatsApp might improve student outcomes. Bouhnik et al. [15] explored WhatsApp communications between teachers and students. Cetinkaya [20] suggested that WhatsApp might improve students' structured learning, while Barhoumi [9] found that WhatsApp may help students to discover peer-generated resources, thereby promoting context-free learning.

A recent cluster of studies has also specifically examined the use of WhatsApp in educational settings in non-Western and/or HCI4D contexts [50, 114]. For example, Willemse [113] examined how WhatsApp discussions may improve the education of undergraduate nursing students in South Africa. Poon et al. [89] compared the utility of SMS and WhatsApp in delivering revision quizzes to high-school students in Cameroon. Mudliar and Rangaswamy [76] documented how WhatsApp-based interactions may help to reduce gender gaps that exist in classrooms in India. Nedungadi et al. [81] studied how WhatsApp communication might reduce teacher and student absenteeism and improve student performance in rural Indian schools. Most relevant to our work on teacher WhatsApp groups is a recent study by Varanasi et al. [109] that found how teachers in India reconfigure their work practices around a teacher-oriented technology intervention. Their study briefly highlights that teachers use WhatsApp to share resources, but does not analyze the content and nature of teachers' WhatsApp-based communications. More work is needed to better understand how teacher networks are enacted on technology platforms like WhatsApp.

Our study expands the literature on teachers' WhatsApp use via a qualitative analysis of group conversations that occurred between teachers in low-income Indian schools, school administrators, and staff from education-focused organizations. We now situate our research within prior work on cooperative work and teacher networks.

Technology-Mediated Cooperative Work. The HCI and CSCW communities have a rich history of examining how technology mediates cooperative work, with much of the early work in this space focused on office-based contexts [8, 12, 39]. Although school environments are undoubtedly different from office environments, research in educational contexts has argued for schools to be seen as social organizations where work is done [30, 36]. This line of thinking emphasizes the need to take into account the socio-cultural complexities produced by such organizations, and to understand interventions in the context of broader school environments [99].

A variety of theoretical frameworks have been proposed to characterize or evaluate technology-mediated cooperative work (e.g., [72, 80, 86]). In our study, we find Neale et al.'s [80] model for evaluating *activity awareness* especially useful for characterizing the kinds of cooperative work that manifest in teachers' WhatsApp groups. Activity awareness model helps to systematically analyze individual activities within complex cooperative networks. To achieve this, the model outlines five types of activities that explain how tightly coupled the work is: *lightweight interactions* (most loosely coupled), *information sharing, coordination, collaboration*, and *cooperation* (most tightly coupled). The more of these activities a group is able to achieve, the stronger their cooperative work.

The first two layers of the framework refer to loosely-coupled activities. *Light-weight interactions* are only loosely tied to the work itself and encompass both casual social interactions and communication about the work, often providing information and background that helps to understand the work context and contextualize behavior and group interactions [80]. These interactions are reminiscent of Nardi's work on "outeractions": social and informal communications that occur in formal work settings [78]. The next layer is *information sharing*, which may occur in one direction (e.g., someone shares information with no response/acknowledgment) or in share-response pairs. Prior work has examined the complexities associated with information sharing [38, 115], such as research on *common information spaces* that looked at how actors represented and attributed meaning to the information in work spaces [14].

The other three layers refer to more tightly-coupled activities. *Coordination* requires group members to coordinate the content of the work and the process involved in carrying it out [32, 37, 80]. *Collaboration* involves group members working toward a common goal, with individuals often doing separate tasks (that are interdependent) but with shared goals and knowledge [23, 77, 80]. Finally, *cooperation* is the most tightly coupled activity, involving *"shared goals, common plans, shared tasks, and significant consultation with others about how to proceed with the work"* [80].

We use the activity awareness model as an analytical lens to examine our research questions. In our findings, we highlight which types of activities manifest in the WhatsApp groups we study. We then discuss in Section 7 the characteristics of the groups that may (or may not) have facilitated cooperative work. In doing so, we build on prior research that suggests that groups of teachers collaborate and co-exist as part of larger professional networks that ultimately seek to enable cooperative work [46].

Teacher Networks. In addition to exploring how the WhatsApp groups in our study may enable cooperative work, we also examine the extent to which these WhatsApp groups constitute *teacher networks*. Teacher networks are a concept that, initially, were considered to be loose and borderless social constructs (e.g., Lieberman [65]). These initial networks covered both formal and informal aspects of teacher work, similar to group work in other professional settings [78], with the aim of examining teacher connections through the lens of broader social constructs (e.g. social capital) [46, 65].

Acknowledging the importance of teacher networks, prior research has explored a range of different models of these networks or communities. One example is *knowledge communities* [87], which seek to understand how teachers come together physically and virtually to co-create knowledge. Such communities are based on Lave and Wenger's [64] concept of *communities of practice*, which has been extended to include virtual communities [42, 45]. Prior research has also explored how different *learning communities* can push for self- and peer-based reflection within groups, via strategies such as sharing success stories or listening and responding to others' experiences [82, 107, 117]. However, most community-based studies of teacher networks have focused on the formal aspects of learning; very few studies emphasize the informal interaction that happen among networks without facilitation (e.g. staffrooms) [71].

Both teacher networks and the activity awareness model share common roots in activity theory and are extensively used to study teacher development [65]. Teacher networks are useful to examine broader network characteristics and their interrelationships, and are synergistic with the activity awareness model's pragmatic focus on examining low-level interactions in these networks. Drawing on this synergy, we use both teacher networks and the activity awareness model to deeply examine WhatsApp groups at multiple levels. In particular, we use teachers networks as a theoretical lens to examine the role of different stakeholders in WhatsApp networks as a whole whereas we use the activity awareness model as an analytical lens to examine low-level individual interactions between stakeholders in these networks.

Although a cluster of studies in HCI [6, 13, 19, 34], CSCW, and CSCL [60, 116] has examined the role of *technology* in teacher networks, these studies have focused on Western communities in developed countries. Our study contributes a new perspective to this literature by examining how both formal and informal teacher networks are enacted via a novel medium: WhatsApp group conversations, and in a novel context: low-income Indian schools. Specifically, we conducted a qualitative study to answer the following research questions: **RQ1:** What strategies are used to encourage interaction within WhatsApp-based teacher networks in low-income Indian schools? and **RQ2:** How are these interactions sustained by teachers, management, and organizations over a period of time?

3 DESCRIPTION OF WHATSAPP GROUPS

Before describing our study methods, we provide background on the three types of WhatsApp groups in our study to appropriately contextualize our findings. All of the groups already existed at the time of our study (i.e., we did not create them) and all were set up to facilitate communication and coordination between groups of teachers in low-income settings. Two types of groups were created and managed by staff at education-focused organizations (321 and Meghshala) while the third was set up and administered by school management.

321 WhatsApp Groups. 321 [1] is an education-focused organization in Hyderabad, Mumbai, and Bangalore that aims to improve teachers' capacities via a two-year support model that (1) conducts workshops to teach classroom management and pedagogy, (2) provides one-on-one teacher coaching on specific topics (e.g., observation, creating assessments), and (3) organizes events to celebrate participating teachers (e.g., with certificates).

The WhatsApp groups that 321 administers were set up to *complement* their in-person workshops and coaching, and teachers who participated in their workshops were invited to join a group consisting of teachers from their school. The average size of the 321 groups in our data was 17 members, with an average of 86 messages per group per month (see Table 1). Groups consisted mostly of Hindi- and English-speaking teachers (about 90% women) and with one or two 321 staff. The content posted to the group is highly structured and curated by 321 staff. A content design team creates customized media and messages that are posted to the groups by training staff who have previously interacted with the teachers face-to-face (e.g., in workshops). Messages are designed to prompt responses from

teachers by including activities like quizzes, puzzles, and requests to share content.

Meghshala WhatsApp Groups. Meghshala is a Bangalore-based non-profit organization whose objective is to improve teachers' capacity by building their pedagogical knowledge. To achieve this, Meghshala provides a mobile app-based intervention delivered to teachers via an Android device. The app provides content modules, developed by Meghshala's team, that are carefully contextualized to the state government's curriculum and pedagogical philosophy while also incorporating new ideas and practices to build teacher capacity. In addition to the app, teachers receive support from Meghshala's staff via weekly in-person visits and organization-run WhatsApp groups.

Similar to 321, Meghshala's WhatsApp groups explicitly aim to complement their in-person support by improving connectedness and providing technical support to aid adoption of Meghshala's app by teachers. The groups had an average of 48 members (a mix of men and women), mostly government school teachers from a range of different schools who spoke Kannada, Hindi, Marathi, and English. The groups averaged 173 messages per group per month (see Table 1). WhatsApp interactions in these groups are unstructured and open-ended. Teachers use the group to report issues or give feedback to Meghshala staff on app usage. To aid further motivation for teacher interaction, several groups have Meghshala management as members.

School WhatsApp Groups. The third type of WhatsApp group consists of government teachers and higher management (e.g., Cluster Resource Officers and Block Officers[1]). These groups are administered by cluster resource officers (who rank above principals). The groups are typically large, with over 75 members who are mostly teachers (a mix of men and women) from several schools. These were the most active groups in our dataset, with an average of 728 messages per group per month. These groups provide a platform for higher management to streamline and better manage school administration. Cluster and Block Officers use the groups to share information with teachers (e.g., announcements and reminders). They also often send detailed instructions that teachers are required to follow and resources intended to aid teachers' work.

Overall, Meghshala and 321 groups focused more on capacity building of teachers through development of *student-centered* pedagogical techniques and resources that emphasized on learning through lived experiences [29]. School groups, on the other hand, took a more teacher-centered approach, focusing on providing everyday support for teaching and managing classrooms [98].

4 METHODOLOGY

To answer our research questions, we conducted an IRB-approved study in which we collected and analyzed conversations from 26 existing WhatsApp groups (35,567 messages) that took place between teachers in low-income schools (in Telengana and Karnataka), school administrators, and support staff from education-focused organizations.

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[1]In several states of India, schools are grouped into clusters, and clusters into blocks. Each block contains several schools.

Group type	No. groups	Size (people)	Duration (months)	Messages per group	Messages per month
321	13	Min: 16	Min: 3	Min: 114	Min: 28.5
		Max: 18	Max: 7	Max: 713	Max: 112
		Avg: 17	Avg: 5.4	Avg: 438	Avg: 86
Meghshala	5	Min: 16	Min: 2	Min: 208	Min: 21
		Max: 78	Max: 11	Max: 4435	Max: 443
		Avg: 48	Avg: 8.4	Avg: 1691	Avg: 173
Schools	8	Min: 50	Min: 0.5	Min: 40	Min: 80
		Max: 100	Max: 7	Max: 9340	Max: 2335
		Avg: 75	Avg: 2.3	Avg: 2678	Avg: 728

Table 1: Summary of WhatsApp groups in our data set.

Collecting WhatsApp Data. Prior work [109] suggests that WhatsApp plays an important role in teachers' work, including school communications (e.g., from principals or managers) and professional development programs run by external educational organizations. We wanted to examine WhatsApp use by both kinds of groups and so reached out, via email and WhatsApp, to schools and organizations that work with teachers in low-income Indian schools. We engaged interested respondents in discussions where we explained the goals of our work, methods, data privacy, etc.

Ultimately, the CEOs of two organizations—321 [1] and Meghshala [74]—agreed to provide data from teacher-focused WhatsApp groups run by their organizations (13 groups from 321 and five from Meghshala). The logs of group conversations were exported and provided to us by organization managers. In addition to data from organizations' WhatsApp groups, we received permission to collect WhatsApp data from school groups from a Block Officer in Karnataka. These groups consisted of school management (e.g., principals) and teachers from different clusters of government schools. The logs of eight WhatsApp groups were provided by two Cluster Resource Officers.

Table 1 summarizes the WhatsApp groups in our data set, including the number of group members, duration of logs, and number of messages sent. All of the groups consisted of teachers who taught grades 1-8. Before we collected any data, we asked each group's administrators to publicize the study on the WhatsApp groups, share our consent form, and post information about the study's objective. They also explicitly provided instructions on how group members could opt out of the study by requesting that their messages or posts be removed from the dataset, and emphasized that opting out would not affect the teacher's employment status or relationship with the organizations. Nevertheless, no group members opted out of the study.

Analyzing WhatsApp Data. Exporting logs of WhatsApp group conversations for analysis presented several challenges. Since conversations consist of text and media (i.e., images, videos), the export function provides an option to include media files along with text-based messages. However, this process results in the media files becoming decontextualized from the conversations, since WhatsApp exports all the media files separately in a .zip folder and replaces them in the conversations with a *<media omitted>* tag (see Fig. 1.A). To circumvent this issue, we asked participants to use a screen recording app to record their screen as they scrolled through
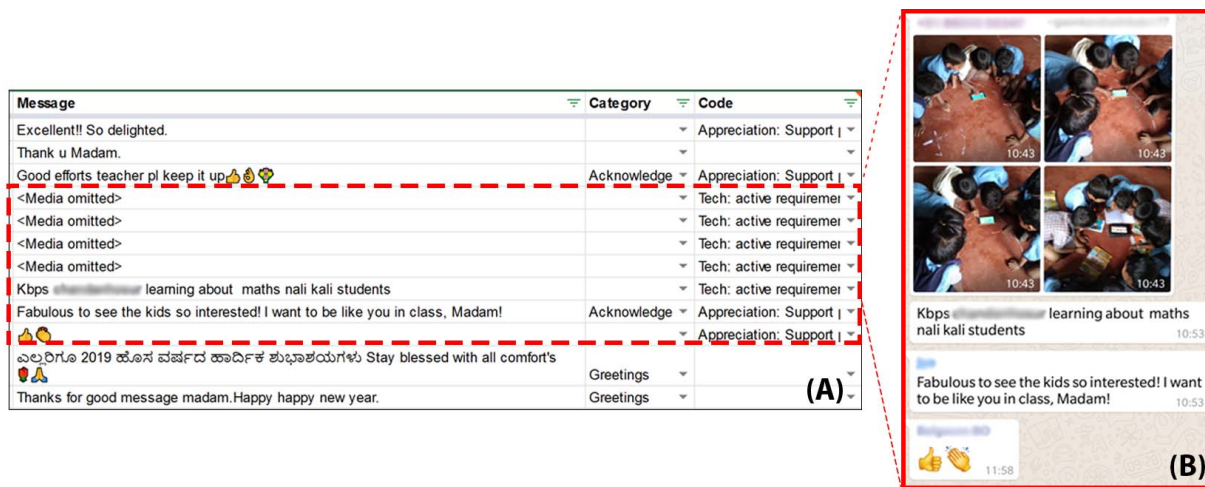
Figure 1: (A, B) Excerpt of WhatsApp log and video content analysis showing how we analyzed WhatsApp data.

the group conversations. We then analyzed the video recording of the media associated with a conversation in parallel to the text-based conversation log, which enabled us to view the media in the context of the conversations (see Figure 1.B).

We began our analysis of text conversation and video recordings of media by cleaning the text files and converting them to standardized UTF-8 encoding to accommodate text written in local languages (Kannada, Hindi, and Marathi) and emojis. We then used inductive thematic analysis to analyze our data [16] with the coding conducted by the first author. We began by reading through the WhatsApp logs (and scrolling through the corresponding video recordings). We then conducted multiple rounds of open coding. We avoided using any preconceived codes and instead allowed the codes and categories to emerge from the data. Our unit of analysis was a single message sent by a participant. If participants broke messages into multiple lines, they were treated as one message. Credibility of our analysis was established by prolonged engagement with the data and multiple coding iterations, with peer-debriefing sessions with the research team after each coding pass [27]. Our analysis resulted in 53 codes (e.g., sharing highlights, policing norms, peer interactions), which were organized into different themes. Finally, following Pierce's pragmatic philosophy, we used an abductive approach [108] to further map, categorize, and structure themes using the activity awareness model. Our analysis yielded final nine themes, namely professional interactions (23%), online-offline bridge (14%), contextualization, (11%), bottom-up support (7%), community care (2%), top-down support (18%), professional wellbeing (13%), capacity improvement (9%), and security (2%). Appendix A provides our complete codebook, along with the prevalence of each theme and code.

Qualitative Interviews To corroborate our analysis of WhatsApp logs, we conducted 12 post-analysis semi-structured interviews with school management and staff who participated in the three groups (4 each from Meghshala, 321, and school groups). Our motivation for conducting these interviews was to triangulate findings from our analysis of WhatsApp logs, obtain additional context for the group conversations, and understand offline activities that may

have motivated actions on the digital platform. To recruit interviewees, we reached out to group administrators via WhatsApp. Administrators sent out a message inviting the group members to participate in the interview. Those who responded were interviewed for roughly 30 minutes in their local language.

Our 12 participants (eight women) included nine teachers and three principals. The average age of the participants was 35 years (min=23, max=47, SD=6.3). Participants had an average of 9.8 years of experience (min=2, max=30, SD=7.3). Interviews were conducted in-person or over WhatsApp audio calls. Our interview protocol sought an understanding of (1) how participants currently use WhatsApp in their work, (2) reasons for interacting (or not) in the WhatsApp groups, (3) challenges and issues they experienced when using WhatsApp, and (4) how WhatsApp enabled (or not) communication and collaboration with peer teachers, staff, or higher management. After each interview, we revised our questions to add new probes, stopping when we reached saturation in our interview data.

Interviews were audio-recorded (with consent), translated into English, transcribed, and analyzed using MAXQDA. We used thematic analysis to analyze our interview data [16]. We performed multiple passes over the data, allowing codes to emerge freely. After each round of coding, we used peer-debriefing [27] with two co-authors to iterate on the codes and improve consistency. Our final codebook consisted of 38 codes (e.g., local contextualization, sharing resources, celebrating promotions). These codes were then clustered into nine themes (e,g., peer collaboration, bottom-up support, and misinformation) and collated with themes from our analysis of WhatsApp logs. Throughout our findings, we deliberately interweave analyses of WhatsApp logs with analyses from interviews, using the interview data to provide additional context and insights to the log data, rather than presenting the interview data separately.

Ethical Considerations. We received IRB approval for our study as well as approval from 321's and Meghshala's management and appropriate school Block Officers. We also took several steps to safeguard the privacy and interests of the teacher members of the WhatsApp groups. We asked group administrators (Cluster

Resource Officers and organization managers) to publicize our study on their groups and inform all group members about our research. As part of this process, we provided teachers with the ability to opt out of the study (i.e., remove their messages from our data set). However, we did not receive any such requests from teachers, which may be because all of the messages sent were already accessible to many group members and visible to their school's management and organization personnel (i.e., they were comfortable sharing this information with a large group and our study did not change that).

In reporting our findings, we use pseudonyms for participants and anonymize quotes and messages. We have replaced all potentially identifying information, including names, phone numbers, and addresses. However, we chose to keep the day and time at which messages were sent unaltered, since this provides context for understanding the interactions.

5 STRATEGIES TO ENCOURAGE INTERACTION WITHIN WHATSAPP GROUPS

We organize our findings around our two research questions. To answer the first question, we (1) discuss a set of creative structures that groups used to engage teachers and promote the development of professional skills, and (2) show how the groups encouraged teachers by actively recognizing and celebrating teachers for their efforts. As discussed in Section 2, we use Neale et al.'s [80] *activity awareness model* as an analytical lens to link our findings with theory on technology-mediated cooperative work.

5.1 Creative Structures to Encourage Interaction

Our analysis reveals a range of creative strategies that organization staff and school management employed to promote interaction in the WhatsApp groups. Organization-run groups used WhatsApp's built-in features in innovative ways to encourage teachers to post and respond to messages. One strategy that we saw in 321 groups was for staff to instruct teachers to interact with activities using *only emojis*. For example, Rubina, a 321 staff member, posted:

Feb 18, 10:50 PM. 321 staff: *Give us a* 🤩 *if you're excited to receive your certificates. Are you wondering - how is a PARTICIPATION different from a COMPLETION? Or how is a RECOGNITION different from an EXCELLENCE? Stay tuned, we'll share more info about certificates in the coming weeks. DM us any questions. Waiting for your* 🤩

In response to this message, seven teachers posted a 🤩 emoji. As Rubina described in a followup interview, emoji-only interaction enabled shy teachers, who may not otherwise feel comfortable, to take a risk and post in the group. It also enabled participation from those teachers who were hesitant to communicate in English because they feared that they might make mistakes and embarrass themselves in front of others.

Emoji-only interactions extended beyond single questions to multiple-choice quizzes that asked teachers to post answers to several questions (e.g., matching classroom management techniques with appropriate classroom resources) using different combinations of emojis (see Fig. 2.A). Some teachers struggled to locate emojis due to limited WhatsApp know-how. They shared their answers by drawing the relevant emojis on a piece of paper and taking a photo of it that was shared with the group. To ensure that correct answers were not posted before most teachers had a chance to think about the questions, organization staff members asked teachers to refrain from posting answers until they sent a second message requesting responses. WhatsApp features such as the *delete for all* functionality also allowed teachers to retract their answer from everyone's phones when they wanted another chance to answer the questions.

We recognize these emoji-only activities as *lightweight interactions* [80] involving casual and fun communications within the group. These findings also connect to prior work on teachers' cooperative work (e.g., Dunlop et al. [34]) which showed that technology-mediated communication with complementary and contextual interactions (especially risk taking) can encourage fruitful participation and communication at a teacher's own pace.

Along these lines, another common strategy staff used to encourage teacher interaction was to post a message or announcement to the group in English followed by an audio recording of the same message in spoken Hindi, with the goal of reducing teachers' hesitations to participate if they lacked confidence communicating in English. This allowed teachers to freely express themselves by typing or recording replies in their local language.

Another creative use of WhatsApp features that we observed involved using the built-in image editor to interact with content in innovative ways. For example, a 321 staff member shared a picture of a wordfinder puzzle in their group and asked teachers to use the built-in image editor to draw their answers over the picture and reshare it with the group (see Fig. 2.B). WhatsApp's image editing tools were also useful for allowing teachers to provide feedback on Meghshala's app content. For instance, we saw occasions where teachers in the Meghshala group used the image-editing feature to notify Meghshala's staff about incorrect mathematical notation in Kannada (the local language). Teachers drew boxes around inaccurate content and shared it with Meghshala staff in the group.

Peer-based Activities. Another set of structures that organizations created aimed to promote interaction via peer-based activities. One type of activity encouraged teachers to tag peers (using WhatsApp's function) and engage in an activity with them offline that was then shared with the group. As one 321 staff member posted:

Sep 29, 1:10 PM. 321 staff: *Hi teachers, Welcome back! We had a refreshing holiday* 🏖️💃🌴 *. We are all set to share more winning solutions and come visit your classrooms once again.* 😊 *If you are as excited as we are, ∗ tag a teacher* 👩‍🏫👨‍🏫 *who you saw doing something interesting in her/his classroom∗ We look forward to hear from you!*

Among the six responses that teachers posted, one read:

Sep 09, 2:02 PM. Teacher: *These days are very important because its revision time. My friend Yasmeen is making her revision time very interesting for students using the practice class chant.*
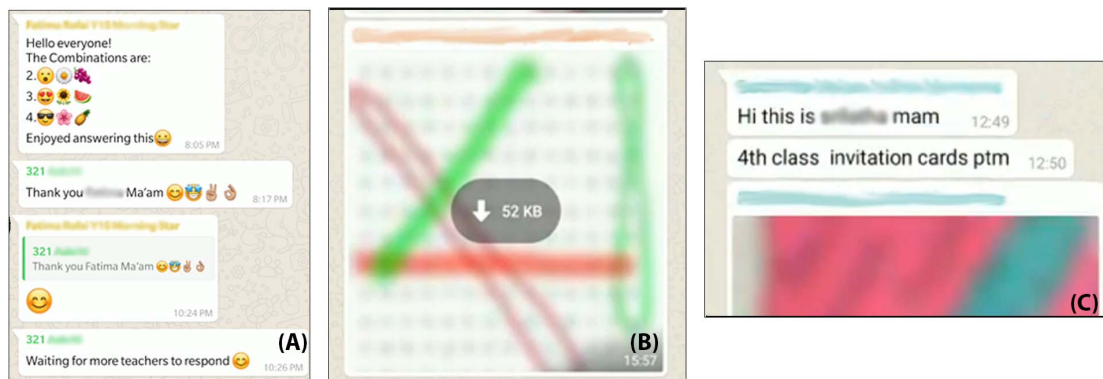
Figure 2: (A) A teacher uses emojis to respond to a quiz; (B)Teachers in Meghshala & 321 groups using WhatsApp's built-in drawing tool; (C) A teacher signs her name when using a peer's phone

However, these planned initiatives to include teachers did not always work. There were a few instances where teachers felt dejected that they had not been tagged by peers. For instance, when no member of the group tagged her, a teacher posted, *"There is no one to take my name 🙁"*. In such situations, 321 staff tried to tag these teachers and provide positive encouragement. In addition, 321 staff often used tagging to increase engagement with questions that received few responses, such as by nudging teachers who did respond to tag five more teachers. Content designers at 321 described that the explicit action of digitally tagging other teachers encouraged action-oriented peer reflection, similar to in-class peer-based activities that they conducted during their training workshops.

Finally, not all teachers owned or had full-time access to smartphones. This is in line with prior HCI4D literature that extensively documents shared smartphone use in the Global South [3, 18]. To overcome this barrier, 321 staff encouraged teachers who did not possess a smartphone (and therefore WhatsApp) to participate by borrowing a peer's smartphone and using it to participate in the group. To tell the difference between multiple teachers using the same device, teachers adopted the practice of signing their name at the end of the message to indicate the sender (see Fig. 2.C). We found four teachers that utilized this practice. Using the activity awareness model, we see how these peer-based activities constitute *coordination*, particularly activities such as sharing a smartphone with others to complete activities [80]. This suggests that the 321 WhatsApp groups engaged in relatively tightly-coupled work [59].

5.2 Celebrating and Recognizing Teachers

Recognizing Teachers' Professionalism. We found that these WhatsApp groups actively celebrated teachers' achievements and recognized them for incorporating better pedagogical techniques to encourage interaction. The WhatsApp groups provided a space for promoting and acknowledging teaching as an important profession and emphasizing teachers as professionals. In 321 groups, staff incorporated specific keywords in their messages to achieve this, such as *modern professionals* and *nation builders*. When asked to reflect on their own role, teachers often used the same terminology in their responses:

Nov 10, 4:24 PM. Teacher: *Hello! I think being a Modern Professional and A Nation builder I use all the skills in one or other way. I think all students are unique because when we used all these skills in our teaching they collaborate with each other they openly accept the challenges, practice their knowledge with kindness and build a new creativity. ♻️*

Other messages sought to align teaching with other important professions, such as doctors. For example, a 321 staff member posted, *"Can you share with us what tools you use as modern professionals? For example, a doctor uses thermometer, teachers use textbooks."* Another strategy we saw related teachers to famous leaders, such as Abdul Kalam (a scientist and former Indian president), to highlight positive leadership qualities that teachers should strive for.

Teachers were also recognized for the important role they play in teaching values to students. Organization staff and higher management encouraged teachers to adopt activities that made students happy and share their experiences of teaching values with the group. Teachers responses to these requests suggest that they too saw the importance of their role in shaping the happiness and success of their students. For example, one teacher likened herself to a superhero, posting, *"I wear an invisible superhero crown 👑 everyday that spreads joy and happiness 😊 ✨ while teaching."* Another teacher reflected on her responsibility to teach students to be good citizens:

Nov 11, 10:47 PM. Teacher: *I teach them how to share their feelings with others which will help children not only discover personal success, but also contribute to the betterment of society by improving them. My lessons also let students practice kindness which is really essential because i had learned a nation is known by the character of its citizens.*

Celebrating and Praising Teachers' Efforts. Beyond recognizing their professionalism, the WhatsApp groups also provided important spaces where teachers could be explicitly celebrated and praised for their hard work. 321 staff, in particular, took care to emphasize and praise teachers' efforts to integrate new techniques in their teaching, rather than focusing on success. For example, a staff member posted, *"Thank you all the teachers who have already*

made an attempt to answer how they are integrating these new techniques in their classroom👏👏*."* Staff frequently posted encouraging messages that made heavy use of emojis and WhatsApp's built-in GIF feature to explicitly acknowledge teachers for participating in group activities, trying to answer questions, or sharing evidence of progress integrating new pedagogical practices in their classrooms (e.g., sharing pictures that demonstrate student-centered classroom management strategies using mnemonics learned from in-person training workshops). In addition, 321 staff created custom celebratory structures, such as *special claps* (👏 👏👏), that they 'awarded' to teachers who engaged with their puzzles, quizzes, or shared evidence of their progress, for example, by posting a photo of an in-class activity.

Our interview findings suggest that these WhatsApp-based structures complemented celebrations in the physical world, such as teachers receiving printed certificates, or events that celebrated teachers in their community:

> **Nov 29, 4:33 PM. 321 staff**: *Dear Teachers! . . . all of you have *worked extremely hard and showed exemplar growth* in your classrooms. It is *time to celebrate! Double the efforts, double the celebrations!** 😉 *Let us all *meet tomorrow from 12:45 - 1:45 pm* to celebrate yourself and each other for all the amazing work you have put into your classrooms, schools and students! *Looking forward to seeing you all**😀

In Meghshala groups, organization staff frequently praised teachers who shared photos of themselves using Meghshala's app in class. This applause typically highlighted how teachers' actions positively impacted students. For example, in response to a teacher who shared a photo of her students in class, a school administrator posted, *"Also please all observe the smile and confidence on the face of the children* 👌👏*"*. The staff also added their founder and CEO to a few WhatsApp groups to further motivate teachers and improve morale. The addition of the CEO led to many enthusiastic responses from teachers, such as *"Welcome respected Jaya maam"*. The CEO also posted replies to teachers who shared their experiences adopting the app. For example, when Gita, a fifth grade teacher, shared a photo of herself teaching Math with the app, the CEO replied, *"Fabulous to see the kids so interested! I want to be like you in class, Madam!"*

We also discovered instances where, without prompting, teachers shared achievements with the group that were unrelated to the group's official purpose. Teachers posted messages highlighting their own and their students achievements, inside and outside the school. For example, one teacher in a school group posted a message celebrating a student who was selected for a prestigious interstate music competition. Another teacher shared a picture of herself receiving a teaching award. Such milestone events usually received recognition in the group from teachers and higher management.

Prior work has shown that these kinds of intrinsic rewards, such as positive feedback, may contribute to teacher motivation and the development of self-efficacy [96, 97]. Since these personal and celebratory messages do not necessarily constitute work, but rather motivate teachers to do the work better, we see them as *lightweight interactions* [80]. Moreover, we see the smileys awarded by 321 and Meghshala as mechanisms that reward the interactions

and types of cooperative work they valued in the group, which is synonymous with prior work on the types of rewards given in online communities like Wikipedia [61]. For example, Kriplean et al. studied *barnstars*, tokens given to contributors for valued cooperative work [61]. Their study shows how people who received these rewards cherished them. Similarly, teachers we interviewed described how they cherished the smileys awarded to them and saved screenshots of them.

6 CONTENT CURATION, SHARING, AND MODERATION VIA THE GROUPS

We turn now to RQ2: How are interactions sustained by teachers, management, and organizations over time? We (1) discuss how WhatsApp groups were used to share professional resources. We also (2) describe how the groups were used to circulate misinformation, malicious spam, and polarizing information, before (3) covering content moderation strategies used by group admins to keep conversations focused on education.

6.1 Sharing Professional Resources

Our data shows that all the WhatsApp groups were heavily utilized to share professional resources, often in interesting or innovative ways. In school WhatsApp groups, higher management (e.g., principals, cluster resource officers, block officers) used WhatsApp to make bureaucratic procedures more efficient, such as distributing school circulars or requesting information from teachers via WhatsApp instead of paper. In most cases, the higher management would take a picture of a paper-based circular and share the photograph. Interestingly, when teachers responded to these requests, they too would write the information on paper and share a photograph of it with the WhatsApp group. This is because many of these circulars required teachers to capture lengthy and complex details, such as students' progress in different subjects, from multiple sources, making it easier for them to write the required information on a paper than typing it in WhatsApp. For example, we saw how teachers who were asked to share their lesson plans for a periodic review wrote the requested information in the required format on A4 paper, photographed it, and sent the photo to the higher management via the group. This finding builds on prior HCI literature examining the flow of information across digital and physical spaces [22, 28, 40, 47].

While WhatsApp made it easy for administrators and teachers to share information, it added more work to teachers. Unlike paper-based circulars, which needed to be physically sent to each teacher for a signature during school hours, using WhatsApp for administrative work enabled higher management to reach out to teachers outside of school hours and request that they do work. Moreover, when sending their requests on these groups, management frequently included the words *URGENT* or *VERY URGENT* to indicate the urgency of the messages, often with accompanying text that explicitly called out their intended audience. For example, a cluster resource officer sent:

> **Jan 09, 5:04 PM. Cluster resource officer:** *All, send urgently before 12 pm by WhatsApp your [students'] information . . . Raman sir, Prashant sir please do it.*

In addition to responding to bureaucratic requests from higher management, several teachers created and shared online resources like YouTube videos with step-by-step instructions to help their less tech-savvy peers complete bureaucratic requirements. For example, one teacher made a video showing how to upload students' scores to a government website and promote them to next grade.

Sharing Event Highlights to Broaden Inclusivity. Another prevalent practice in our data was for participants who attended in-person teacher-development events and workshops to share highlights and summaries of these events, usually with photos or videos, so that teachers who were unable to attend could benefit from the information. For example, a teacher in 321 group, Sahana, shared pictures of workshop activities that involved creating classroom materials, preceded by a textual summary of the activities in question. We saw similar practices in Meghshala groups, where organization staff often shared important snippets of Meghshala training workshops via videos or photos. Staff members told us how this allowed them to reach a broad audience of teachers who were not necessarily part of the in-person training workshop.

According to a cluster resource officer, Suresh, sharing meeting summaries via WhatsApp promoted transparency regarding the activities and provided a written record of decisions made. For example, another cluster resource officer in a school group shared:

> **March 05, 5:21 PM. Cluster resource officer:** *Highlights from today's meeting: ∗ Examination date has been fixed and can not be changed …∗ Now linking of state scholarship with Adhaar is required ∗ We will purchase books from the Department with the cumulative funds. ∗ Meeting of selected school teachers with Meghshala on 8th at [location].*

Sharing Teaching Resources. The WhatsApp groups were also used to share classroom management and pedagogical techniques with teachers. Activities and content shared by organization staff on Meghshala and 321 groups was often tailored to the teachers' specific contexts. In a Meghshala group we saw staff post ideas for summer projects that teachers could assign to students during the holidays. In a 321 group, a staff member posted YouTube links of popular children's songs sorted into a *"Bookmark of Calmers and Energizers"* to help teachers better manage their classroom.

Teachers also shared their own content and resources with peers. For instance, teachers in Meghshala groups shared strategies for troubleshooting technological challenges encountered when using Meghshala's app. As an example, one teacher reached out to a Meghshala WhatsApp group sharing the struggles she encountered trying to show Meghshala content via a tablet with a small screen to her large number of students, and asking for alternative suggestions. In response, another teacher shared detailed instructions and resources for how to repurpose an old LCD TV monitor as a display device by using Meracast (similar to Chromecast) to cast Meghshala's app content onto the LCD TV screen. As another example, a few teachers in Meghshala shared screenshots of their experiments using a new augmented reality app related to their syllabus on planets (see Fig. 3.A). They also shared a web-based resource on how to install and use the app in the classroom. Other

teachers followed their guidelines and in turn shared their results with the group.

All of the activities described here (sharing event highlights, sharing teaching resources, etc.) constitute *information sharing* within the activity awareness model [80], and we see cases in which this sharing is both unidirectional (e.g., sending a circular without a response) and in the form of share/response pairs (e.g., requesting a response from teachers).

6.2 Sharing of Malicious Forwards, Misinformation, and Spam

In addition to professional content and resources, teachers also posted non-work-related information. A large proportion of these posts (34%) were spam or malicious messages forwarded from other conversations. Such messages were relatively easy to identify from their long length, formal language, repetition across groups, and availability via online searches.

Malicious Forwards. One type of forward common in our data consisted of malicious messages that contained suspicious links. These messages drew readers' attention by providing unrealistic offers that enticed people to click on the link, which was often designed to closely resemble a legitimate link (e.g., amazon.com-deal.in). Several such messages in our data were explicitly worded to appear as government education schemes, thereby specifically targeting teachers. For example, one such forward that advertised a non-existent educational scheme read:

> **July 06, 05:30 PM. Teacher:** *PM Modi is providing free mini laptop to every student …Regiser now to get free laptop. Visit Here ∗http://pmyojna.com∗ Share with your friends and groups so they can also apply for ∗Free Laptop∗*

Clicking on the link directs users to malicious websites that utilize a variety of harmful practices, such as prompting installation of malware (see Fig. 3.B) or tricking users into installing spam applications that earn the spammer referral income. Other links lead to forms that prompt users to enter personal information, such as date of birth, phone number, Aadhaar (ID) number, email address, and physical address. These websites often then sell such data to third parties.

Misinformation. Another common type of forward we saw was fake information on a variety of popular topics, including science, technology, and current affairs. These messages often promoted a specific message or agenda. For example, one forward circulated on Meghshala's groups was a link to a YouTube video that claimed "mobile phone radiation lead to brain cancer". The authenticity of such messages was often disputed by other teachers in the group. For example, a teacher in a Meghshala group shared a forward with fake photos that claimed to show pictures of the moon taken by *Chandrayaan2*, India's recent lunar mission. Other teachers quickly responded that the images were fake and *Chandrayaan2* had not yet released any pictures. Some teachers also proactively shared warnings about other forwards that had not yet been posted in the group. For example, one teacher warned the group about a forward that they had seen elsewhere that they believed to be promoting terrorism (although was in fact also misinformation):
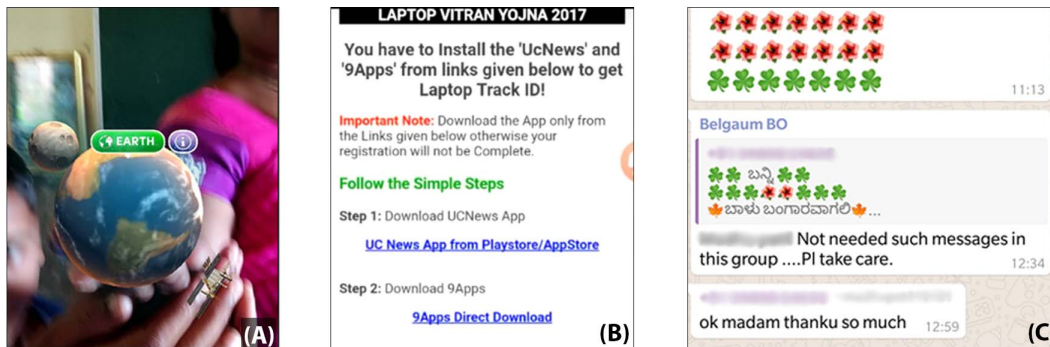
Figure 3: (A) A teacher shares use of an augmented-reality app; (B) Content from a malicious link in a Meghshala group; (C) A block officer moderates content on a WhatsApp group.

April 11, 03:26 PM. Teacher: *There is a WhatsApp group called *Interschools*. If invited, don't join. It belongs to Daesh (ISIS). If you join you will not be able to exit from it. Be vigilant. My dear colleague send it to your relatives and children on WhatsApp so they will also be careful.*

Similar misinformation sharing practices are also generalizable across other forms of cooperative work, such as finance [112], law, governance, and similar social institutions [35]. Moreover, Resende et al.'s [93] work shows that misinformation has the tendency to be shared more frequently on informal tools like WhatsApp than other platforms.

Religious and Politically Motivated Forwards. Another category of controversial forwards we saw were religiously or politically motivated. For example, some teachers in school WhatsApp groups forwarded political posts that promoted propaganda regarding specific political activities. On a few occasions, such forwards combined themes of politics and religion to make their point. For instance, a teacher in a Meghshala group shared a forward that gave an unverified account of Narendra Modi, India's prime minister, in a religious context, thereby indirectly promoting both the religion and Modi. Administrators were usually quick to respond and reprimand people who forwarded such messages. We discuss strategies for group management and content moderation in more detail next.

6.3 Strategies for Group Moderation

We observed a range of group moderation and policing strategies in our data. Higher management (e.g., block officers) were usually quick to respond and point out when a message violated the group's norms or purpose (e.g., was not related to education), often calling out the offending teacher by name and warning them not to post such messages. For example, when a teacher, Prerna, forwarded an irrelevant message in the group, a block officer immediately posted, *"Prerna, not needed such messages in this group...Pl[ease] take care."* (see Fig. 3.C). For offensive religious or political content, higher management and organization staff adopted a more aggressive tone, making it clear that teachers who posted such messages will be removed from the group. In some cases, offensive messages caused teachers to leave the group before administrators were able to moderate the conversation. For example, the following conversation

took place after a teacher posted a polarizing religious message that hurt other teachers, some of whom left the group:

6/24/18, 4:41 PM. Teacher-1: *Manika madam, you may call your religion a treasure, we do not have any issue. But, please do not refer other religion as trash. In this group there are teachers from all religions. Please think before sending the messages. A lot of people get hurt.*
6/24/18, 5:30 PM. Teacher-2: *I no longer feel good about being part of such group. Sorry teachers, I am leaving from this group.* [Left the group; two other teachers also left.]
6/24/18, 6:29 PM. Cluster resource officer: *Yes such msgs will not be sheared [sic] to any group. It is wrong ❌❌ We have given many warnings for sending such messages in the group. Manika maam unknowingly sent this msg and maximum teachers in our cluster know that Manika maam always respect others feelings..so plz excuse her this time.*

Unlike other instant messaging and social media services (e.g., Facebook), WhatsApp's underlying encryption makes it difficult to automate content moderation and filtering [5], making social moderation strategies more effective. Beyond moderating interactions around offensive content, administrators also discouraged teachers from using the group for personal chatting. A 321 staff member posted the following after several teachers used the group for personal messages:

2/14/19, 6:00 PM. 321 staff: *Teachers, Hope you had a good day. We will not use this WhatsApp group for personal chat. If you want to use it for personal chat you can make a separate group. Why? Because here we are going to post messages related to classroom, learning, and education and conduct discussions around it. Otherwise, we will miss them.*

We also noted an interesting difference in the moderation messages posted by school block officers, which typically called out the offending teacher by name, and those posted by organization staff, which usually targeted all teachers in the group. Interviews with staff revealed that they adopted this strategy to avoid causing teachers personal embarrassment.

Apart from content moderation in the groups, teachers in school groups also received instructions from higher management on appropriate teacher behavior in the physical world. Cluster resource officers typically sent several messages per month reinforcing rules that teachers had to follow in their classroom. For example, the following message was sent to a school group in anticipation of an upcoming surprise inspection by government officers:

> **March 13, 1:39 PM. Block officer:** *Greetings teachers* There will be a study of classes across the state again from March 18, 2019 . . . observers visited a few schools and made the classroom observation mandatory...So it is very necessary for your classes to be in this way. 1) The wall slate should be written by the child's name and assigned . . . 2) The activities of the children should be recorded and signed and dated. 3) Appliances, Puppet Screen, and Puppet must be compulsory. 4) The children should take the card and sit in the prescribed learning boards. . .

We see the various moderation strategies used in the groups as *information sharing* activities [80]. In general, moderation messages made clear the possibility of negative consequences and/or teachers' expected behavior in the groups. When teachers responded, they usually simply stated that they would be more careful in the future. We did not see any instances where teachers tried to refute or justify their messages. These findings are similar to Hun's [51] work on moderating online health forums, which also showed how such 'template responses' sent by higher management may negatively impact morale, with participants who are being moderated feeling discouraged from participating.

7 DISCUSSION

Having presented findings around our research questions, we now synthesize key takeaways for the HCI community by discussing how teacher networks are enacted via WhatsApp and how different WhatsApp groups enable cooperative work on these online teacher networks in low-resource settings. We also highlight fruitful areas for future research, including analyzing the impact of WhatsApp on teachers' wellbeing, and exploring the role of professional WhatsApp groups in spreading misinformation.

As discussed in Section 2, research in Western contexts has examined the role of technology in teacher networks [6, 13, 19, 34, 60, 116], suggesting that these networks provide fruitful spaces for understanding teachers' work practices and professional interactions. Our study expands this research to the Global South by examining how teacher networks are enacted via different types of teacher-centered WhatsApp groups in India, contributing a high level perspective that is particularly important in light of the rapid adoption of WhatsApp-based communication in schools [76, 109, 110], higher education [83, 92, 113], and other professional domains (e.g., health workers [44, 52, 57]) across HCI4D contexts. At the same time, the activity awareness model [80] provides complementary low-level insights on different types of cooperative work that these teacher networks exhibit, helping us to understand their value addition in teacher professionalization. Drawing on these frameworks, we now

discuss the different types of cooperative work we found on these teacher-focused WhatsApp networks.

321 groups: formal teacher networks with tightly coupled cooperative work. 321 groups exhibited characteristics of formal teacher networks, since they were highly structured and curated by organization staff. Several of the structures used, such as tagging, encouraged peer-based activities and action-oriented peer reflection. In doing so, these groups became coaching networks in digital spaces [95]. Coaching networks aim to support teachers by enhancing their teaching and managerial skills via systematic reflection [111]. Such coaching networks are structured and nourished by a facilitator or a coach (321 staff). We saw how 321's content designers maintained a uniform coaching structure across all their groups, and how facilitators encouraged peer-based interactions via activities. Prior literature has suggested that such collaborative reflections between peers in groups can augment professional growth [10]. Facilitators led engagement in these coaching networks, resulting in groups engaging in tightly coupled activities, namely lightweight interactions, information sharing, and coordination within activity awareness framework's five layers. For instance, peer-based activities that teachers participated in contained interactions that reflected a specific plan to answer questions on teacher professionalization.

School Groups as knowledge communities with loosely coupled cooperative work. By contrast, the conversations in the school groups originated from *teachers*. These conversations represent a more informal network in which teachers were comfortable sharing their own and their students' achievements via messages, photos, and videos. These acts of sharing everyday experiences suggest these networks are operating as *knowledge communities* [87]. Knowledge communities are spaces where educators can share 'amateurishness' experiences (or 'legitimate tellings') [75] and react to each other's experiences openly and honestly. This was also reflective in the cooperative work in the group that was primarily limited to loosely coupled activities, such as information sharing activities around teachers' work. In addition to the informal nature of these knowledge communities, school groups also exhibited formal structures. The hierarchical and bureaucratic ways in which higher management used these groups to facilitate certain types of exchanges (e.g. sharing teaching instructions, sending circulars) constitute a formal network in which management prescribed authorized versions of teacher development that made explicit what behaviors are "right" and "wrong" [25].

Meghshala groups as informal networks with loosely coupled cooperative work. Lastly, Meghshala groups' absence of an imposed structure enabled these groups to operate as informal learning networks [70]. We adopt Livingstone's [66] perspective of informal learning as exchanges that result in understanding, knowledge, or skill without externally-imposed structures. The absence of such structures promotes open discussion and easy sharing of knowledge. In our data, teachers were comfortable providing feedback on incorrect Meghshala content. They also freely shared troubleshooting tips to help their peers develop technical skills (e.g. how to cast content on a TV screen). We saw how peers in these informal networks customize their interactions to the context

of their community, thereby increasing active participation [48]. Of course, the unstructured nature of the networks also means that not all exchanges are relevant to teaching [70], with teachers forwarding messages that were often unrelated to their work. In these cases, group moderation helps keep the network focused on teachers' instructional practices [71]. In contrast to 321 groups, Meghshala and school groups only exhibited two layers of interactions: lightweight interactions and information sharing, suggesting these groups are more loosely coupled. For instance, school networks engaged in information sharing activities around teachers' work, while Meghshala networks were prominent for their lightweight interactions around encouragement.

We hypothesize that differences in the groups' network structures may have contributed to the different types of activities we saw. 321 groups were typically small (avg 17 users) with teachers from a single school. This ensured that teachers in the groups possessed shared background and contextual understanding, which may have enabled them to carry out activities that involved coordination [26]. 321 groups were also formal networks, with highly structured and curated interactions (e.g., quizzes) that provided professionalization opportunities to teachers. However, this also meant that teachers' participation was largely dependent on active guidance from the organization staff.

By contrast, both Meghshala and school groups were larger (avg 48 and 75 users, respectively) with teachers from several schools. The groups were also more informal networks, without the structured interactions prevalent in 321 groups. Although these characteristics may have made it more difficult to achieve tightly-coupled work, they do enable professional interactions that are currently not possible in the physical world. For example, these groups provide opportunities for teachers to communicate with peers from different schools, something feasible only via WhatsApp. Moreover, we saw how the informal structure of these groups (in contrast to 321's highly structured groups) allowed teachers to freely share information and teaching resources with each other, contributing to loosely-coupled interactions that provided short-term, in-context solutions to professional issues experienced by teachers.

These insights are relevant for HCI researchers interested in creating future WhatsApp-based interventions that promote cooperative work, for both teachers and workers in other domains (e.g., health [52]), by suggesting specific group characteristics (size, composition) and types of activities (structured) that may lead to more tightly-coupled vs. loosely-coupled work. At the same time, none of the groups in our study showed evidence of tightly-knit collaboration or cooperation [80]. One possible reason could be that WhatsApp group messages are displayed as a single long list, rather than, say, threaded forums with searchable topics, categories, etc. This makes it challenging for users to go back to past messages or separate different threads of a conversation (without needing a separate WhatsApp group). This communication style may hinder more complex activities like collaboration and coordination. An interesting area of future work is to study how tightly-coupled layers of cooperative work may (or may not) be achieved via WhatsApp.

Analyzing how WhatsApp use impacts teachers' professional wellbeing. Our analysis provides preliminary evidence for how WhatsApp groups could have both positive and negative effects on

teachers' wellbeing. Dodge et al. [31] define wellbeing as an equilibrium between challenges that affect a person and resources that help the person to cope with those challenges. For teachers, lack of resources and constant challenges have been shown to result in absenteeism, burnout, and stress [11, 41, 62, 100, 103, 105]. However, how *technology* contributes to these issues has received limited attention. A few studies have described technology as a challenge that creates *technostress* [4, 54]. Relevant to our findings, Shernoff et al. [101] and Skalvik & Skalvik [104] showed that excessive workload created by higher management results in increased emotional stress [43]. In our data, higher management's use of WhatsApp for numerous bureaucratic activities and administrative policing, as well as their control over setting priorities and deadlines for teachers, increased teachers' workload and stress and negatively impacted their wellbeing.

However, we also see ways in which WhatsApp groups might improve teacher wellbeing. For example, Meghshala praised teachers who shared their attempts to integrate technology into their classrooms. Similarly, 321 created structures (e.g., *special claps*) to motivate and celebrate teachers, as well as praise teachers for sharing attempts to implement new pedagogical strategies in their classrooms. Such positive feedback structures could promote psychological wellbeing among teachers [91]. 321 also encouraged teachers to share even unsuccessful attempts to implement what they have learnt in their classrooms and praised them for doing so. Prior work has shown that learning by failure is important and can provide positive learning benefits and advancement for individuals [73], which suggests that this too has the potential to improve teacher wellbeing. Lastly, teachers getting encouraging responses when they share messages describing their achievements may also promote wellbeing, especially since these messages are teacher-driven.

These insights suggest a need for future work that measures the impact of WhatsApp use on teacher wellbeing, including by adapting validated scales for assessing wellbeing (e.g., [67, 90]) to low-income Indian contexts. We also see potential for WhatsApp-based interventions that explicitly promote teacher wellbeing in low-income Indian schools.

Exploring how teachers discover, propagate, and mitigate the spread of misinformation on WhatsApp. Our findings showed how teacher WhatsApp groups were used to circulate misinformation, malicious spam, and religiously and politically polarizing information, exposing teachers to a range of possible digital harms. These findings support and extend recent studies in HCI and HCI4D that show the prevalence of disinformation, misinformation, and polarizing content across social media platforms, including Twitter [106], Facebook [68], and WhatsApp [93].

Particularly relevant to our study, Machado [69] and Banaji [7] demonstrated a growing concern around the spread of misinformation on WhatsApp and discussed the need for group members to increase accountability and reduce the spread of misinformation via gate-keeping and moderation. Our study shows different moderation behaviors, with group administrators (not group members) primarily responsible for moderating content and reprimanding offenders. It is possible that, since the groups were created and administered by organization staff or school higher management,

individual teachers did not feel that it was their responsibility (or right) to engage in content moderation. Regardless, our data uncovers a need for future research to examine teachers' mental models of misinformation. Specifically, future studies should aim to examine ways in which teachers discover, engage, propagate, or mitigate the spread of misinformation. Developing this understanding is especially important on encrypted platforms, like WhatsApp, where automated tracing of misinformation is challenging.

8 CONCLUSION

Our study examined WhatsApp group conversations that occurred between teachers in low-income Indian schools, school administrators, and staff from education-focused organizations. We analyzed the strategies employed to encourage interaction within these WhatsApp-based teacher networks and revealed how content is curated, shared, and moderated. Based on these findings, we discussed how teacher networks manifest via WhatsApp groups and explored how these groups achieve cooperative work. We also uncovered interesting directions for future work to measure the impact of WhatsApp use on teachers' wellbeing and explore the role of WhatsApp groups in spreading misinformation. Taken together, our findings will help HCI researchers and practitioners to design future interventions that better support cooperative work and wellbeing for teachers, and workers more broadly, in other domains across HCI and HCI4D.

9 ACKNOWLEDGMENTS

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A   CODEBOOK FROM ANALYSIS OF WHATSAPP LOGS

Theme / Code	Count	Theme / Code	Count
Professional interactions (23.40%)	**3348**	**Top-down support (18.34%)**	**2624**
Irrelevant forward	601	Assistance	670
Sharing highlights	494	School-related forward	446
Sharing memories	438	Top-down structures	436
Sharing learning resource	352	Micromanagement	381
Query	341	Encouragement / nudge	280
Sharing information	326	Policing norms	221
Motivational forward	256	Challenges / issues	178
Forwarding event/occasions	151	Technology support	12
Sharing Progress	146	**Professional well-being (13.08%)**	**1872**
Religious forward	126	Support staff appreciation	702
Forwarding general information	70	Sharing achievements	447
Sharing a promotion	47	Values	175
Online-offline bridge (13.78%)	**1971**	Celebration	149
Tech challenges	797	Engaging	148
Digitization	567	Enquiring wellbeing	101
Offline activity	453	Enjoying	83
Tech requirement	145	Happiness	40
Struggle to write	9	Stress	27
Contextualization (11.28%)	**1614**	**Capacity improvement (9.28%)**	**1328**
Language	682	Classroom management	326
Local	535	Pedagogy observation	225
India	221	Coaching	217
Western	176	Pedagogy strategies	202
Bottom-up support (7.42%)	**1061**	Pedagogy activities	122
Peer interactions	552	Pedagogy challenges	122
Peer appreciation	278	Pedagogy rationale	114
Teaching relevant forward	231	**Security (1.87%)**	**268**
Community care (1.55%)	**222**	Political forward	185
Parent management	114	Fake forward	51
Community challenges/issues	108	Malicious forward	32

Table 2: The complete codebook that resulted from our analysis of WhatsApp logs, showing our nine themes (bold) and 53 codes, including the prevalence (%) for each theme, and the total count for each theme/code. (The count for each theme is the sum of the counts of all codes within that theme.)