

Investigating Technostress Among Teachers in Low-Income Indian Schools

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Smartphones play an increasingly large role in the professional lives of teachers in low-income contexts, creating an urgent need to better understand the role of technology-related stress (technostress) in teachers' smartphone use for work. We contribute a mixed methods study analyzing the impact of smartphone use on teachers' work lives in low-income Indian schools. Findings from 70 interviews and 1,361 survey responses suggest that although smartphones aid teaching and administrative functions, smartphone use also significantly predicts burnout among teachers, with technostress providing a major explanation for this relationship. We reveal how teachers' work is constantly surveilled and monitored via technology and how teachers' personal smartphones were controlled and repurposed through socio-technical structures by the higher management to serve management's goals, substantially increasing the work teachers were required to perform outside of work hours. Our work extends technostress research to HCI4D contexts and highlights the need to develop better support structures for teachers and rethink how smartphones are used in their work.

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

Additional Key Words and Phrases: HCI4D, ICT4D, teachers, education technology, technostress, surveillance

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1 INTRODUCTION

The global proliferation of smartphones has led to them becoming an indispensable work tool for a diverse range of workers in HCI4D [30, 54, 80], including teachers who work in low-income schools in India [18, 106, 111]. A rich body of HCI4D research has examined how smartphones can be used to support teachers in classrooms [2, 3, 18, 37, 106] and advocates for the integration of smartphones into teachers' work [37, 63]. While there are arguments that smartphones can improve teachers' productivity [37] and compensate for a lack of pedagogical training and resources [107], discussions of how the integration of smartphones into teachers' work lives might have negative effects, particularly on technostress (defined as a specific type of stress that individuals experience due to their use of technology), are notably absent.

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A cluster of prior education-focused studies has established a strong connection between technology use and technostress in countries like South Korea [53], Turkey [72], and Finland [94]. However, the sources of technostress for teachers in these technology and resource rich settings typically stem from a variety of educational technologies (e.g., laptops, tablets, and smart classrooms) that are used for work. By contrast, teachers in low-income settings in the Global South often rely on smartphones as the *only* available digital technology. Moreover, the smartphones that teachers in the Global South use for work are often also their personal devices, which may be shared with family members [1, 89]. These sharing practices introduce additional complexities in the use of these devices for work.

This paper presents a mixed-methods study to answer the following research question: **How does teachers' smartphone use impact their technostress at work in low-income schools?** We analyze data from 70 interviews and 1,361 survey responses from teachers who work at a wide range of low-income government and private schools in India.

Our analyses revealed that teachers relied heavily on their personal smartphones for various work activities. However, we also discovered how teachers' devices were controlled and repurposed by higher management to serve management's goals and expectations, without establishing official policies around smartphone use for work. Higher management used smartphones to surveil teachers to ensure they followed the school norms, restrict their smartphone based work via CCTV cameras, monitor their work through location tracking. Moreover, teachers were required to constantly submit evidence to prove that they were doing their job.

Higher management also enlisted teachers' peers to aid their surveillance and monitoring efforts, limiting the support that teachers were able to receive from peers, increasing perceptions of strain and burnout. Teachers also used smartphones extensively for administrative work, primarily via work-related WhatsApp groups. Although this was convenient for both teachers and higher management, it also led to higher management using WhatsApp to frequently assign work to teachers outside of work hours with tight deadlines. This increased anxiety and technostress for teachers, many of whom described having an unhealthy work-life balance.

Finally, teachers felt that the 'always-on' nature of smartphones enabled students and their parents to indiscriminately make requests of them outside of work hours. For example, students who did not pay attention in class asked teachers to reshare digital resources and information, leading to more work for teachers. Students also used WhatsApp groups to openly question teachers' expertise by posting challenging questions found on the Internet, thereby contributing to teacher embarrassment and strain.

These findings depict a concerning landscape in which teachers' smartphone use is associated with technostress and burnout. We further investigate this issue by quantitatively examining the relationship between smartphone use, technostress, and burnout using 1,361 survey responses. We use linear regression to show that teachers' smartphone use for work significantly predicts burnout, meaning more the teachers used their smartphones for work-related activities, higher the stress and burnout they experienced. Then, we use mediation analysis to demonstrate that technostress provides a major explanation for the relationship between smartphone use and burnout. Finally, we use moderation analysis to see the impact of support on the relationship between smartphone use, technostress, and burnout. We see that both peer and school support play a significant role in controlling the relationship between smartphone use and technostress, whereas only school support influences the relationship between smartphone use and burnout.

Taken together, these findings extend the concept of technostress to teaching work in HCI4D settings. Our findings also suggest opportunities to rethink how teachers use smartphones for work. We discuss the need to develop better policies and support structures that reduce technostress experienced by the teachers. We also shed light on the ethical aspects of several problematic practices

surfaced in our findings, including monitoring and surveillance issues, while also acknowledging the systemic, socio-technical challenges (e.g., teacher absenteeism, procrastination) that may have led to such practices. We then explore the role of policy and non-profit organizations in (re)defining the role of smartphones in teaching by recognizing and demarcating appropriate usage of smartphones for work. Finally, we discuss the potential to create safe spaces for teachers via appropriate boundary setting between teachers and parents/students, along with ways to improve teachers' work lives.

In sum, our contributions to CSCW and HCI4D are:

- (1) Qualitative analysis of 70 interviews showing that, although smartphones are useful for teaching and administrative tasks, teachers' personal devices were controlled and repurposed by higher management, used to surveil and monitor teachers' work, and increased the amount of work teachers' were required to perform outside of work hours.
- (2) Quantitative analyses of 1,361 survey responses that triangulate our qualitative findings by showing that smartphone use significantly predicts teacher burnout, with technostress providing a major explanation for this relationship.

2 RELATED WORK

We start our literature review by introducing the concept of technostress. We then explore how the concept of technostress has been developed in different fields, such as HCI, CSCW, and teacher development studies. We then situate our work in prior HCI4D literature focusing on teachers in low-income settings in order to further develop the concept within teacher work in HCI4D settings.

Technostress: Conceptualization and Development of Technology's Role in Stress. Technostress is defined as "a specific type of stress that individuals experience due to their use of Information Systems (IS)" [95]. It is a recently established concept in IS that is increasingly gaining prominence in the HCI literature [102]. However, the conceptual exploration of technostress started in early 1980s, with Brod [14] defining technostress as "*a modern disease*" that occurred when people failed to cope with new computing technologies. Thereafter, conceptualization of technostress has been heavily influenced by decades of development around the concept of workplace stress. But it is only in the last two decades that technostress has been developed and operationalized into a strong theoretical concept in occupational settings [6, 26, 78, 95].

The concept of technostress has evolved through three main strands of work. The first strand of work looked at identifying technology features that contributed to the feeling of stress by the workers when interacting with a technology [6]. Ayyagari categorized these features into three main categories: usability features (e.g., usefulness, reliability); dynamic features that indicated rate of technology change over time; and intrusive features in technology that enables employees to be reachable and identifiable.

Another strand of research identified and categorized the resultant stress experienced by the individuals into different kinds of technostress [77, 95–97]. Ragu-Nathan et al. [77] identified five forms, namely (a) techno-overload, needing users to work with technology more than required, (b) techno-invasion, requiring employees to connect to technology to fulfill demands even outside their work time, (c) techno-insecurity, feeling a sense of insecurity about their own knowledge of technology in comparison to others, (d) techno-complexity, needing to constantly learn changing technology, and (e) techno-uncertainty, feeling stressed due to fast changing ICTs. A constant feeling of one of these technostress perceptions contribute to negative outcomes in the individuals like low productivity, exhaustion, poor performance, and burnout [95].

A final strand of research has looked at organizational factors that impact technostress perceptions in different ways. For instance, Wang et al. in their study demonstrated how organizations with centralized structures induce more technostress when compared to the decentralized ones [110].

More recent studies have hinted that characteristics such as surveillance prone culture [7, 33] or organizations' expectations of employees' availability outside work hours [9] could lead to negative outcomes. Taken together, current research in technostress has been predominantly explored in traditional IS workspaces leaving a great scope for development in work settings that are not confined to an office space [95].

Technostress Research in HCI, CSCW, and Teacher Development Studies. Interdisciplinary research in HCI and CSCW has expanded the notion of technostress in new directions. In particular, one set of research studies has looked at developing novel techniques to cope with technostress from different kinds of technologies. For example, Kiss and Schmidt engaged with interaction challenges that create technostress in mobile work devices (as opposed to work desktops) to propose design recommendations around them [56], while studies like that of Moya and Pallud [29] have explored the use of wearable technology in the context of technostress. A second group of studies have adapted the technostress phenomena to study individuals in everyday activities, including the impact of notifications on productivity [76], managing private information [74], dealing with online harassment [71], and managing personal health [82]. Lastly, studies have examined the nature of technostress, specifically the techno-invasive nature of work technologies and management of work-life balance outside traditional IS work spaces [20, 64, 75]. For instance, Cecchinato et al. studied micro-boundary strategies used by university lecturers to avoid techno-invasion as they moved between their teaching, research, and personal spaces. Similarly, Calif et al. explored the impact of positive and negative technostressors on healthcare workers in Western settings [17].

However, the most relevant research for our work is the exploration of technostress phenomena in teacher work settings. Within this, several studies have explored the relationship between teachers' technology use and technostress. For instance, Joo et al. [53] analyzed the impact of technostress on teachers' intent to use technology. Syvänen et al. explored contextual predictors of technostress among teachers' work lives [94]. Another set of studies have looked at different ways to alleviate technostress around teachers' profession. For instance, Ozgur looked at how school support and technological knowledge in the context of teaching reduced technostress experience by the teachers [72]. But most of this prior work examining technostress in teacher work is situated in western contexts, with the majority of the studies relying solely on quantitative methods.

The Need for Exploration of Technostress in HCI4D Settings. A rich body of HCI4D literature has examined technology-supported education in low-resource settings [34, 57, 99, 105], with a growing focus on building tools to support teachers in classrooms and beyond [4, 35, 42, 49, 51, 55, 73, 84, 86]. To name a few examples, Mathur et al. [63] developed a phone-based content authoring system to help teachers develop teaching aids, Ames examined the One Laptop per Child intervention in Paraguay [2, 3], and Frias-Martinez et al. evaluated a mobile learning tool in classrooms in Peru [37]. Focusing specifically on teachers' smartphone use at work, Varanasi et al. describe how Indian teachers reconfigure their work practices around technological tools [106], while Buabeng-Andoh discussed challenges that hinder technology adoption by teachers in low-income communities [16]. Relatedly, Cannanure et al. [18] explored how teachers' aspirations may impact their smartphone use at work. These studies suggest that smartphones are playing a critical role in teachers' work lives, directly impacting their practices in low-income settings [48, 100, 107].

However, research that examines the direct relationship between teachers' smartphone use and technostress in HCI4D is notably absent, with only limited work calling out a need for deeper engagement on this subject [52, 108]. Our work contributes to this literature by asking: **How does teachers' smartphone use impact their technostress at work in low-income schools?** We answer this question by discussing the role of smartphones in teachers' work lives and how technostress manifests in low-income contexts. It is important to study these work contexts because

teachers in these settings frequently encounter systemic issues, such as teacher absenteeism, high student-teacher ratios, and poor performance that are very different than Western settings [23, 79].

3 RESEARCH METHODS

We conducted an IRB-approved mixed-methods study consisting of 70 interviews and 1,361 survey responses from teachers who work at a wide range of low-income government and private schools. The study lasted six months and was conducted while school was in session. All data was collected just before the COVID-19 pandemic impacted India. In this section, we briefly discuss the context in which our research took place before describing our study methods.

3.1 Background and Research Context

Our work took place in the southern part of India, in collaboration with two partner organizations: (1) a residential school society of 230 government schools (rural and urban), and (2) a consortium of 240 low-income private schools. Both organizations are dedicated to improving education in low-income communities and have existed for over 20 years. The first author, who did all the fieldwork, was born and raised in the community where the organizations are situated.

The government schools in our study provide free education and safe shelter to students from low income families, many of whom are first-generation learners. Although the private schools in our study do charge fees, these are typically low (US \$50 to \$500 per year), with these schools specifically catering to the needs of low-income urban communities. Unlike government schools, which are often located on relatively large areas of government land, private schools are typically located in a residential apartment with limited physical space.

Government schools are overseen by several layers of higher management, including a secretary, senior officials, and regional coordinating officers (RCO). Individual school principals report to RCOs who in turn report to the senior officials and are situated close to the cluster of schools they oversee. Senior officials report to the secretary and are situated in a head office in the capital city of the State. Although government schools follow the state curriculum for education, the secretary in the last few years has introduced a few student-centered pedagogical reforms, including, modular teaching [58], flipped classrooms [103], and after-school clubs.

For private schools, however, higher management is situated immediately above the school principal without additional hierarchies. Consequently, higher management (in most cases) is physically located in the same place as the teachers. Typical higher management consists of founders, funders for an established trust, or a board that established the school. Private schools follow either national or state curriculum. In both private and government schools, higher management frequently collaborates with NGOs that focus on improving education.

Becoming a teacher in a government school requires passing a written exam and earning a degree in education. Teachers earn an average of US\$ 650 per month. By contrast, teachers in private schools do not have written exams or degree requirements (some teachers have just a high school degree), and earn an average of about US\$ 250 per month depending on the grade, subject, and experience of the teacher. Teachers in these schools sometimes work on contract in multiple shifts across different schools in a day. Despite these differences, teachers in both government and low-income private schools experience acute challenges, including (1) teacher and student absenteeism, creating uneven workloads [59], (2) being overburdened with teaching and non-teaching duties (e.g., election management, COVID management work) [46, 61, 79], (3) extremely high student-teacher ratio [50], and (4) lack of equal and regular access to professional development training [68, 107]. Many teachers are also new Internet users and lack know-how to operate smartphones [107]. They also frequently share their smartphones with their family members [106]. In the next section, we describe our mixed-method study that comprise of a)

understanding the role of technostress experiences in teachers' work lives through semi-structured interviews and b) establishing relationship between teachers' observed technology use, technostress, and burnout through quantitative surveys, which were informed by our interview protocol and prior literature in teacher development [18, 106, 107].

3.2 Semi-structured Interviews

We conducted 70 semi-structured interviews with teachers from government and private schools to understand their use of smartphones for work and the benefits and challenges they provided.

Recruitment. To recruit participants from government schools, we obtained a list of 54 schools from our partner organization, and selected 12 schools that provided a range of geographies (rural and urban) and performance levels. We obtained permission from the school's management to visit and interview teachers. To recruit participants from private schools, we sent a WhatsApp message to school principals via the consortium's WhatsApp group. Our message described our study and invited principals to respond. Overall, we obtained permission from seven principals to contact teachers in their schools. All the schools were located in low-income areas of the city. We invited all teachers who taught grades 6–10 to participate to ensure consistency in our findings between public and private schools that otherwise have different curricula in the primary grades. In total, we interviewed 47 participants from government schools and 23 from private schools, stopping when we reached data saturation. Table 1 provides participants' demographic information.

Procedure. Interviews were conducted in-person, lasted between 40 minutes and 2 hours, were mostly in participants' local languages (Telugu=49, Hindi=13, English=8), and were audio-recorded with participants' consent. Our questions covered four high-level topics, including (1) how teachers currently use smartphones at work/home, (2) their positive and negative experiences with smartphones, (3) impact of smartphone use for work on private life and vice-versa, (4) different types of coping strategies to alleviate frustrations around smartphone use and (5) different support strategies offered to teachers to reduce stress from smartphone. After each interview, we refined our questions to include new probes, stopping when we reached saturation. In addition to interviewing teachers, the first author participated in a range of school activities, including classroom activities and meetings between higher management and teachers.

Data Analysis. Our dataset consisted of 78 hours of audio-recorded interviews and extensive field notes. Recordings were translated to English (if necessary), transcribed, and analyzed thematically using MAXQDA. We began by reading through the data several times and creating an initial set of codes. This was followed by multiple rounds of open coding. After each round, we used peer debriefing to refine the codes, resolve discrepancies, and reach consensus [28]. Our final codebook (see Appendix A) had 29 codes (e.g., digital vulnerability, excessive workload, peer assistance), which were clustered into six themes (e.g., worklife balance, emotional labor, and social structures).

3.3 Survey

We complemented our interviews with an online survey. Our goals for the survey were to: (1) enable broad participation by a large number of teachers from all schools connected to our partner organizations, and (2) collect data to quantitatively measure teachers' smartphone use, technostress, and its impact on burnout. Our survey had the following scales:

Smartphone Use for Work. This scale had 14 structured questions to capture teachers' smartphone use for educational activities (e.g., lesson planning, in-class activities) and specific apps used (e.g., WhatsApp, YouTube). The questions were created based on our interview results and prior

Interview demographics (n=70)		
School type	Government schools: 47	Private schools: 23
Participant type	Higher management: 9, school staff: 38	Higher management: 7, School staff: 16
Gender	Female: 32, Male: 15	Female: 19, Male: 4
Age (yrs)	Min: 28, Max: 54, Avg: 37, SD: 6.4	Min: 19, Max: 50, Avg: 33, SD: 8.97
Experience (yrs)	Min: 1, Max: 36, Avg: 10, S.D: 9.45	Min: 2, Max: 22, Avg: 10, S.D: 6.16
Education	Bachelor's: 7, Master's: 40	High-school: 10, Bachelor's: 12, Master's: 1
Survey demographics (n=1361)		
School type	Government schools: 1246	Private schools: 115
Marital status	Single: 171, Married: 1072, Other: 3	Single: 48, Married: 61, Other: 6
Gender	Female: 826, Male: 420	Female: 94, Male: 21
Age (yrs)	Min: 20, Max: 58, Avg: 36.19, SD: 7.12	Min: 18, Max: 52, Avg: 31.15, SD: 9.12
Experience (yrs)	Min: .39, Max: 35, Avg: 8.8, S.D: 7.43	Min: .17, Max: 33, Avg: 8.18, S.D: 7.09
Education	High school: 12, Bachelor's: 223, Master's: 1011	High school: 29, Bachelor's: 53, Master's: 33

Table 1. Demographic details of interview (top) and survey (bottom) participants from government (first column) and private (second column) schools.

literature around teachers in the Global South [18, 106, 107]. Response options were adapted from prior work on social media use scales [104]: from never used (1) to 40 hours or more (9).

To establish validity of this custom scale, we accessed face-validity [70], a useful method that measures how well a custom-created scale covers the constructs it is supposed to measure. Face-validity was measured by asking (a) three education researchers, (b) four school administrators, and (c) five expert teachers who were not part of our study to rate the scale on a measure of 1 (irrelevant) to 5 (extremely suitable). We received an overall score of 4.72. Cronbach's alpha for the scale items was $\alpha=0.84$, indicating high reliability.

Teacher Burnout. To measure teachers' burnout, we adapted six questions from the Copenhagen Burnout Inventory (CBI) [60] that was originally designed to measure burnout levels in the service industry (in prior work, Cronbach's alpha on subscales were $\alpha=0.85-0.87$). We carefully adapted the questions for the teaching profession and simplified it for participants with a limited understanding of English. For example, in the burnout scale, "Do you feel worn out at the end of the working day?" was adapted to "I feel very tired at the end of the working day." Responses ranged from never (1) to every day (7). To ensure validity, we measured Cronbach's alpha for the scales, which were $\alpha=0.82$ for the burnout scale, indicating high reliability.

Technostress. We measured technology stress (technostress) using Ragu-Nathan et al.'s scale [77] (in prior work, Cronbach's alpha on subscales were $\alpha=0.71-0.90$). Originally designed for organizational studies, we adapted two sub-scales that captured *technology overload* and *technology invasion* aspects of technostress. Example questions included, "Because of my smartphone, I have to do more work than I can manage" and "I have to give up my holiday time to constantly check school work on my smartphone." Teachers responded with options ranging from strongly disagree (1) to strongly agree (5). Cronbach's alpha for this measurement was $\alpha=0.82$, indicating high reliability.

Peer & School Support. We used Lam et al.'s scale [62] to measure teachers' perceptions of support from peers and higher management (in prior work, Cronbach's alpha on subscales were $\alpha=0.88-0.91$). Two sub-scales—*competence support* (peer) and *collegial support* (school)—consisting of 10 items were adapted to teaching contexts. Example questions are, "My school provided sufficient time to use my smartphone in the classroom" and "Many teachers shared useful resources on how to use my smartphone at work." Responses ranged from strongly disagree (1) to strongly agree

(5). Cronbach's alpha for these instruments was $\alpha=0.83$ and $\alpha=0.84$ respectively, indicating high reliability.

Survey Distribution and Data Analysis. We worked with higher management at private and government schools to send the survey via WhatsApp to teachers at all schools associated with our partner organizations. The WhatsApp message included a brief description of and link to the survey, making clear that the survey was optional, confidential, anonymized, and did not provide any compensation. The survey itself was presented in English. Finally, teachers who had questions or concerns regarding the study had the option to message the first author using an embedded link.

Appendix B provides the full survey. We received 1623 responses in total. To ensure validity of the survey responses, we followed standardized cleaning measures, including deleting 171 incomplete responses, deleting 56 outliers in terms of time completion, and deleting 35 careless responses by comparing them with reverse coded items [112]. Data cleaning left us with 1361 responses: 115 private school teachers and 1,246 government school teachers. Table 1 provides the demographic details of survey respondents.

As our resultant sample size was sufficiently large and we were interested in identifying mediation and moderation effects, we conducted parametric analysis even though our measures did not strictly follow a normal sampling distribution [32, 38]. A cumulative index was created for each scale by computing the average of all survey items for each respondent. Analysis was done using SPSS and Hayes Process package [44].

4 FINDINGS

We found that teachers relied heavily on smartphones for work-related activities including, teaching, preparation, administration, and interaction with parents and peers. Figure 1 shows the average time spent by teachers and the prominent apps used for different activities. On average, they spent 19.2 hours per week ($SD=25.51$, median=11) on their smartphones for work. The use of smartphones for work also extended beyond school hours, with teachers working frequently at their homes as well. Private school teachers regularly used smartphones during school hours despite policies discouraging or forbidding phone use on school premises. Such no-use policies, however, contributed to private school teachers spending significantly less time than government school teachers using smartphones for work ($U=50052.5$, $Z=-5.36$, $n1(pvt.)=115$, $n2(govt.)=1246$, $p < 0.001$). Despite the issues corresponding smartphone use, our data indicated that the teachers found smartphone as a critical tool for multiple work activities. We briefly unpack these smartphone uses before describing how smartphones based work impacted their technostress.

4.1 Teaching and Preparation

Smartphones played an important role helping teachers to teach and manage their classrooms. Teachers used smartphones for nearly 3.5 hours per week for teaching-related activities. Smartphones proved to be an effective tool allowing teachers to have “*information on fingertips*” for supporting their arguments while showing visualizations, teaching aids, and online videos on difficult concepts. In addition to teaching, teachers also repurposed smartphones to manage large and disorderly classrooms. For example, some teachers described how they threatened badly behaved students with recording videos of their misconduct and sharing it with the principal, with the hope that this would deter such behavior. Teacher 64 described how she used smartphones in this way.

“I sometimes try to control misbehavior of students by threatening them that I will record their activity. Sometimes I start recording video. Sometimes I just point the camera towards them and not record anything. They get scared and behave well in the classroom. If the recording goes home, parents punish their child.”

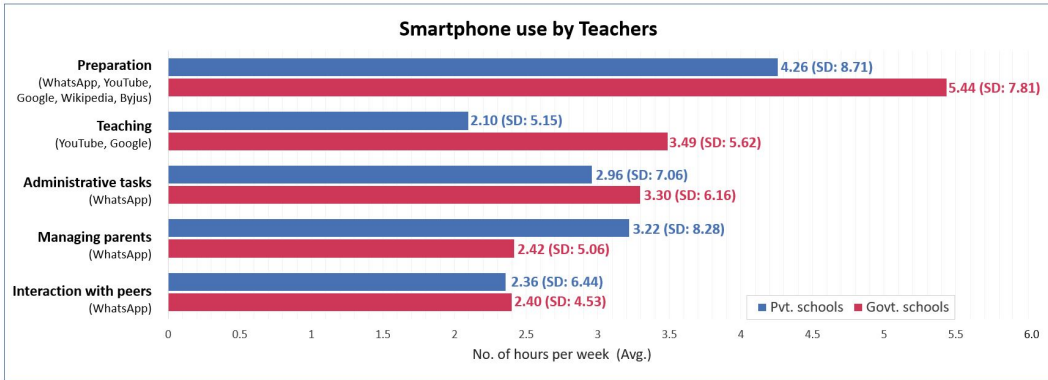


Fig. 1. Average weekly smartphone use by teachers from private & government schools; and popular apps used for each activity.

Teachers preferred such proactive smartphone-assisted measures over more reactive strategies, such as giving students detention or making unruly students stand outside the classroom, allowing them to better manage the classroom without getting strained.

Teaching and managing classes with efficient teaching aids and pedagogical strategies meant preparing a comprehensive lesson with appropriately curated and easy to understand resources. Smartphones helped teachers in this process by providing a much needed support at home, where most of the teachers' lesson preparation process occurred [18, 107]. In our data, teachers used smartphones for an average of 5.4 hours per week to prepare lessons. Common preparation activities included teachers subscribing to different apps and online platforms (e.g., local YouTube channels) that provided localized resources and pedagogical approaches. Prior literature have covered these positive aspects of technology in detail [18, 106, 108]. Below, we add a complementary perspective to this literature by showing how socio-technical structures created by school management and teacher practices when using smartphones at work contributed to multiple forms of technostress.

Control and Surveillance of Teachers' Smartphone Use. In an effort to enforce a 'no smartphones at school' policy, five out of seven private schools where we conducted interviews required teachers to submit their personal smartphone to an office administrator at the start of the day, and only retrieve them at the end of their shift. To accommodate teachers' needs for emergency communication, some schools designated senior teachers (called *incharge*) who were allowed to carry their smartphones at school and who lent the phone to other teachers in cases of emergency. These incharge teachers were also tasked with enforcing the 'no-smartphone-use' policy inside the school. Teacher 55, a senior Math teacher, explained that if she found a teacher using a smartphone in the corridor or a classroom, her job was to report the violation to higher management immediately. Subsequently, such policy violations were publicly reprimanded by the higher management via announcements on speakers installed in the school, humiliating the teacher.

Despite the negative consequences, many teachers felt the need to use a smartphone at school for work and personal activities, and so hid a device in a handbag and sneaked it into the school. However, they often felt stress and anxiety about being caught or reported to higher management. Teacher 50 explained:

"I constantly show videos to my students around values like appreciation, confidence, etc. If an incharge sees that I am using a smartphone in the classroom, they think – 'This teacher is not teaching. She is always on the phone.' They sometimes threaten me that

they will inform the management. I feel bad that they misunderstand me. They don't even clarify it with me first...I am often tense because of this."

In addition to asking incharge teachers to surveil and report teachers who use smartphones at school, higher management in a few schools also used cameras to monitor teachers' classrooms remotely. Out of five schools that installed the cameras, higher management of three schools described that these cameras had been installed previously in an effort to address known issues in low-income schools such as teacher absenteeism and frequent class cancellations [23, 79]. We saw how higher management re-purposed these cameras to monitor teachers' smartphone use. For example, Teacher 64, an incharge, explained how she followed this process to find disengaged teachers using smartphones:

"A few teachers want to use the phone at any cost. Now we have cameras in place. So being an incharge, I also observe with the principal. I don't confiscate any phones myself. But, I show it to the principal - 'See madam that teacher is busy on her phone. She is not managing her students and they are coming out of the classroom.' We also recommend teachers to inform their family to call them during school hours only in case of emergency."

These findings suggest that higher management does not trust teachers to follow the rules or do their work. This echoes prior work, where eroding trust in teachers was used to justify micromanagement practices, making teachers feel like objects of surveillance [13], contributing to loss of privacy, decreased morale, and fears of job security [113]. Although a lack of trust in *some* teachers is supported by our data, constant use of technology for surveillance and micromanagement that *all* teachers experience creates negative outcomes, such as anxiety and depression, leading to burnout [15]. Another major issue with such surveillance practices is that teachers' daily activities are laid bare for scrutiny not only by the higher management but also by the peer incharges who work alongside teachers on a daily basis, putting them in a position of power who can take undue advantage [33]. Several teachers tried to cope with managements' surveillance practices by learning where the camera's blind spots were and sitting there to use their phone with the students, or turned their back to the camera.

Submitting 'Digital Proofs' of Teachers' Work. Government schools took a completely different approach towards smartphone use during school hours. Unlike private schools, who forbade smartphone use, higher management at government schools required teachers to use their smartphones (WhatsApp) to frequently submit photos and videos of their teaching and other work-related activities to school principals. Principals then shared the messages with RCOs who forwarded these messages upstream to senior officials and secretary. Higher management used these messages to verify whether teachers were carrying out their duties. Higher management officer, such as P47, intended this process to improve teachers' accountability and presence in classrooms.

However, teachers often found this process stressful, "*a form of self-surveillance*" where they are expected to share "*digital proofs*" of their daily work. Teacher 13 described how she had to start capturing digital proofs at 8:30am when she organized her students in the assembly. This was followed by another proof at 10am to show that she was using prescribed student-centered pedagogical methods while teaching in the classroom. At noon, she had to capture a selfie with her students while having lunch to prove that she physically oversaw the provision of mid-day meals to students. This was followed by two more digital proofs to show that she conducted the afternoon session and the after school clubs, respectively. In fact, submitting at least five proofs was a commonly reported practice. Moreover, part-time teachers, who worked in two or more schools in a week, had additional self-surveillance requirements as mentioned by teacher 38:

“We have to update our tasks on an online Google sheet daily to indicate which classes we took, for which grades, in which school. We also have to share our live locations in a WhatsApp group to show that we have arrived at school on time. ... If for some reason, the GPS location is not updated, they [school administration] call us to ensure that we have reached. We have to enable the live location for one hour. Its horrible!!”

Teachers were penalized by the higher management when they did not submit digital proofs of their work. For example, teacher 4 recounted how he received a memo from the higher management citing poor performance when he did not share these proofs regularly. Higher management considered such photos and videos “*evidence of innovation and productivity*”, in other words, a demonstration that teachers successfully incorporated student-centered activities and other lessons from training programs. They issued teachers with memos when they failed to show such evidence. An alternative punishment, described by P42 (a senior official) involved removing offending teachers from official WhatsApp groups (an action that would be visible to the whole group) if they failed to post digital proofs; they were added back to the group only after agreeing (offline) to cooperate.

Management positioned their actions as *care* form of surveillance [88]. Sewell and Barker outlined how adopters of liberal (care) form of surveillance, similar to the management, believe that surveillance is a legitimate tool and the actions to implement surveillance are justified and even required to some extent. Management followed these principals to push teachers to be more accountable by discouraging unacceptable behaviors and achieve “*checks and balances*” in schools. In reality, management’s intent to use smartphones to evaluate and manage teachers’ labor via performance-based measures and targets aimed at excessive accountability only caused more technostress [8].

Teachers were frustrated that such accountability-driven smartphone activities diverted their focus from their main responsibility of teaching. They felt stressed about higher management’s expectations of “*showing innovation*” and experienced burnout from repeating the activities daily. These findings add new insights to prior literature’s limited attention to the connection between technology use for self-surveillance, especially as a requirement for excessive accountability, and negative outcomes such as burnout [7, 33, 95]. We build on these findings and make a stronger case for associating technology use with burnout using quantitative data in section 4.4.

Teachers were also expected to log their work activities via physical (paper) records. When asked about the need to create two separate records, teachers said that physical records were only used to measure long-term work performance, whereas digital proofs were used for short-term evaluations.

Teachers created workarounds to reduce the workload and stress caused by the need to share proofs. For example, a few teachers reused photos from previous days when they had to cancel a class or forgot to take photos. Teacher 35 said:

“We have to share photos by 6pm in our school. Because I have to post something and if I am getting late to catch bus for home, I repost previous day pictures. It is wrong to do this, but other teachers do this too. Some of them skip important duties, go home, and repost old pictures.”

We also note here that although teachers in government schools were required to use their personal smartphones to submit digital proofs, there was no official recognition of smartphones as work tools, or accompanying policies setting expectations regarding their use at work. This extends prior work in other service-based work settings like healthcare, where higher management expected health workers to use personal phones for work-related tasks, without establishing official policies around their use for work [54].

Challenges with Teaching and Managing Classrooms. Several teachers described how using smartphones for teaching actually decreased students’ engagement while increasing teachers’ *techno-overload*. They believed some students were purposely inactive in class because they knew

that the information was available online and they could ask teachers to share digital resources with them later, via their parents' smartphones. Such requests, often made outside of school hours, put more strain on teachers at home, affecting their preparation for the next day. Teacher 62 explained:

"If we use smartphones a lot in class, students also take advantage of it. They say, 'madam, we did not listen to the lesson properly in the class. Can you please WhatsApp us?' It creates more work. A few students ask us to share everything in the group. I then have to do extra work to search again for resources and send them."

Some teachers also described how they were frustrated by students' efforts to outsmart them by looking up difficult and impractical questions online and asking them in the classroom and on WhatsApp. Teacher 53, a Science teacher, explained how she felt angry when students doubted her expertise on purpose, but suppressed her emotions since she was expected to encourage students to ask questions. Such incidents contributed to a sense of increased stress among teachers. In line with work from Hearngreaves [43], we found that negative appropriation of technology to assist stereotyping worsened teacher-student dynamics, resulting in teachers to feel emotionally exhausted and demotivated.

Using smartphones to show teaching aids or visualizations also created tension as teachers struggled to protect their private information in front of the students. Several teachers reported that their personal information got exposed to students when sharing their personal devices with them, resulting in embarrassment. For example, teacher 29 was embarrassed when mature content showed up in recommended videos when he was showing a YouTube video to explain a complex concept. Such incidents not only impacted teachers' relationship with students, but also added serious worry for teachers about how students might share their personal information with others, causing them to be more stressed out.

4.2 Administrative Tasks

Apart from preparation and teaching, teachers also used smartphones for a range of administrative activities, such as responding to higher management's circulars, planning extra-curricular events, and preparing for visitors. Almost all of these tasks occurred over WhatsApp. Most teachers were part of four or more official work-related groups, making WhatsApp an indispensable tool to manage low-income schools. Our survey analysis also found WhatsApp to be the most used smartphone app for work, with teachers using it nearly five hours per week for work assignments alone.

Transition from Paper to Digital. Teachers found WhatsApp the most suitable platform for administrative communication because of its ubiquity and familiarity. Take the case of circulars from higher management. Teachers preferred to receive circulars online over in-person (where a junior teacher takes the physical copy to each teacher and gets their signature on it). With the in-person system, P40, a senior official at the head office, mentioned that they used to receive many complaints from teachers stating that the principals forgot to share the circulars on time. Instead of sending physical copies of circulars, P40 mentioned how they have recently started emailing digital circulars to principals to reduce turnaround time. Principals, with the help of their data operator, translate these circulars into WhatsApp messages, add their own instructions, and share them with teachers. Teachers felt that the new workflow made it easier for them to respond to the circulars quickly and found WhatsApp more convenient than email for such communications.

However, the shift of administrative work from paper to digital also created challenges that caused more stress and burnout. For instance, several teachers complained about receiving a barrage of administrative messages outside of work hours, often with tight deadlines, and sometimes even

late at night. Teacher 9 described his sense of helplessness and frustration on receiving important circulars during after school hours:

“Everyday some message comes on the WhatsApp: do this work, do that work. Even if I am on leave, they expect me to work. Sometimes, they ask me to work as soon as I get home. We get circulars even on Sundays.”

The low effort in posting digital circulars allowed school management to send multiple revisions, adding to teachers’ confusion, frustration, and burden. For example, teacher 37 shared how he was about to submit the original requirements of a circular, when he received an amendment that invalidated his previous work. Teachers also felt annoyed when higher management sent follow-up messages on WhatsApp groups tagging teachers and using labels like ‘siren message’, ‘most urgent’, ‘very important’, or ‘answer immediately’. The fear of not responding to such urgent messages pushed teachers to constantly check WhatsApp, even in their personal time.

These findings suggest that smartphones enabled higher management to “speed-up” the work creating *techno-overload* and extend teachers’ expected working hours well into their personal lives, creating *techno-invasion* [78]. We connect here to work in other service sectors such as aviation [47], health [17], white-collar desk jobs [64] and ridesharing services [27, 40] that showed how employers constantly found opportunities to speed-up the work due to the increased demands of the industry. This became a source of appraisal for workers’ technostress, who experienced depletion of their resources, and subsequently failed to perform the work expected of them. We see similar issues with management moving paper-based administrative work to WhatsApp. This shift provides management with opportunities to assign work to teachers with tight deadlines, pushing teachers to work faster to meet management’s targets. These demands deplete teachers’ resources and increase their stress levels as they struggle to meet management’s expectations.

Teachers with limited understanding of English also had to rely on others to understand circulars from higher management. At school, most communications happened in local languages and teachers often discussed circulars with each other. But at home, in the absence of such scaffolding, some teachers felt inadequate as they had to request help from family members and wait for their availability. This created feelings of frustration and inadequacy contributing to technostress in the form of *techno-complexity* [78]. For example, teacher 64 recounted how she had to approach her son or her daughter for help, depending on who was willing to help at the time. Similarly, teacher 54 said that a senior teacher asked her to translate text messages and circulars into the local language.

Teachers also felt that they did not receive support from school administration to manage their workload and technostress. Although higher management conducted professional development training programs for teachers (1–3 times a year), topics that dealt with technology stress and work-life balance were notably absent. In addition, a senior official (P46), while describing training programs, justified the absence of topics like stress management by expressing how they prioritized and only offered training to “passionate” teachers who teach and perform well.

Work-life Balance. Most teachers felt that higher management was insensitive towards their work-life balance and misused WhatsApp to indiscriminately assign more work to them. These messages severely interrupted the personal lives of teachers. For example, teacher 9 had to leave a friend’s wedding in haste to meet an officer after seeing a message that the management sent at the last minute. Some teachers reported having arguments with family members who struggled to understand why they had to be “online always on WhatsApp.” For example, teacher 22, a young woman, explained how her parents thought that she was having an affair:

“My family does not understand that I do work on WhatsApp. Being a young woman, my parents raise several questions around my work. I regularly get circulars outside work hours on WhatsApp. Therefore, I am often online on WhatsApp. I tell my family that I am

busy with work but when they see me online... they start questioning 'what is she really working on at 10:30pm'. I have to explain myself a lot."

Many teachers felt that they had an unhealthy work-life balance, primarily due to intrusion of work-related messages in their private time. Women teachers believed that they had more family responsibilities at home compared to their male counterparts, making their family life more stressful. Our survey analysis supported this observation. We found that women reported significantly more burnout than men ($U = 186723.5$, $Z = -2.379$, n_1 (F) = 920, n_2 (M) = 441, $p = 0.017$). These findings corroborate prior work's results on *techno-invasion* created by the management through the use of emails, text messages, or calls. [9, 19, 20, 109]. In contrast to teachers, four higher management officers we spoke with described how they considered it to be a teacher's responsibility to maintain their own work-life balance.

Teachers in our study proactively searched for what Tarafdar et al. called *threat coping responses* [95] to cope with techno-invasion and separate their professional and personal digital life. For example, a tech savvy Hindi teacher described how she helped many teachers, including the principal, to implement a hack that enabled running multiple instances of WhatsApp simultaneously. The hack allowed them to separate work and personal conversations, and apply different notifications and visibility settings to each instance. A few teachers installed custom apps that enabled notifications only from people in their contact list, thereby avoiding stress related to anticipation of messages from higher management.

Many teachers also disabled read receipts (check marks that indicate a message's delivery and read status), 'last seen', and 'online' features on WhatsApp to ensure that the higher management could not claim that they knew teachers were online and therefore knew about the work assigned on WhatsApp. A few teachers reported taking advantage of low technological awareness and skills of the principal to avoid work in their personal time. For example, when teacher 46 ignored the principal's messages outside work hours, she told the principal that her "phone got corrupt."

4.3 Interaction with Peers and Parents

Teachers often used smartphones to interact with their peers and students' parents, spending an average of nearly 3.6 hours per week on such communications. Interestingly, both activities accounted for 13% each of the total usage time. In the case of peers, smartphones created stressful situations when peers became competitive with each other and used smartphones as a tool to show other teachers in a bad light. Some teachers reported how jealous peers recorded their digital conversations on WhatsApp or took photos of them relaxing in classrooms, only to share these with higher management. For example, Teacher 23 shared how a peer recorded a WhatsApp call in which she criticized higher management and sent it to them. Teacher 26 described how her colleague transferred to another school due to similar challenges:

"She was not in good standing with this peer of ours. The peer took pictures to expose her negligence at work and shared them with higher management. There were egos involved."

Teacher 17 explained why he acted against a group of peer teachers:

"Those teachers regularly came late to classrooms. I captured proof [of their absence] and sent them to the principal on WhatsApp. The principal then questioned them citing the WhatsApp message. ... On WhatsApp, the messages are recorded with a proper date and time. Principal can then see in the picture that they were late and that can act as proof."

We also found cases where teachers found sensitive information stored on peers' smartphones. Teacher 18 shared:

"I was working with a new person in school management team. I had to share a few photos of an event and he gave me his phone for transferring the photos. While going through the gallery, I saw his photos with a woman teacher from our school."

In some cases, teachers reported being blackmailed by peers in exchange for keeping private information secret. Teacher 61 shared how her colleague told another teacher to do more work when the colleague came across messages in which the teacher was critiquing higher management. Similar adversarial use of technology has been seen in other workplace settings too [98].

Teachers perceived these peer-based practices as a direct threat to their positive relationship with higher management, impacting their overall standing. These findings extend the limited understanding of how technology-based monitoring is conducted by peers due to competition [95]. The negative perceptions also made teachers hesitant to share their inner feelings with peers at their own school. Teachers were worried that any discussion on stress, burnout, or workload could be taken out of context and restricted themselves to sharing only positive feelings with peers, so that they comply with higher management's expectations of expressing care towards their peers.

Communicating with Students' Parents. Many schools required teachers to create WhatsApp groups to share announcements with students' parents instead of writing remarks in students' diaries. Teachers found digital communication easier and faster, and appreciated how some administrative work was more convenient to do on WhatsApp for both parents and teachers. For example, P31, described how parents in government schools need to physically visit the school to apply for a leave for their child. Before WhatsApp, they traveled all the way to school only to realize they received a rejection. Now parents submit the necessary paperwork via WhatsApp and receive a decision in advance.

While teachers saw benefits of communicating with parents on WhatsApp, they felt irritated when parents disrespected their personal boundaries. Teachers expressed concerns about being *"too accessible to parents"* and shared instances of aggression from parents. For example, teacher 21 shared how a student's drunk parent sent her a voice message saying *"all teachers in the government school should be dosed with kerosene and burnt,"* when she denied a leave to the student. Such stressful incidents caused serious harm to teachers' wellbeing and increased burnout.

4.4 The Relationship Between Smartphone Use, Technostress, and Burnout

Overall, our qualitative findings demonstrated several instances of technology use by teachers that contributed to technostress. We also found instances of technostress that contributed to burnout among teachers. To support our exploratory evidence of the connection between technology use, technostress, and burnout, we conducted a quantitative study to systematically explore the relationship between the three concepts. In particular we explore the following questions:

RQ-1: Does technology use predict high levels of burnout?

RQ-2: Is the relationship between technology use and burnout explained by technostress?

RQ-3: Does school and peer support moderate the relationship between technology use, technostress, and burnout?

To answer these questions, we draw from data collected via our 1361 survey responses. On a high-level, our quantitative analysis supports our qualitative findings. On average, private and government school teachers used smartphones for nearly 16 hours and 19 hours per week, respectively. As mentioned previously, since most private schools prohibited teachers from using smartphones in classrooms, we found a significant difference between the overall number of hours government and private school teachers used smartphones for work ($U=50052.5$, $Z=-5.36$, n_1 (pvt.)=115, n_2 (govt.)=1246, $p<0.001$).

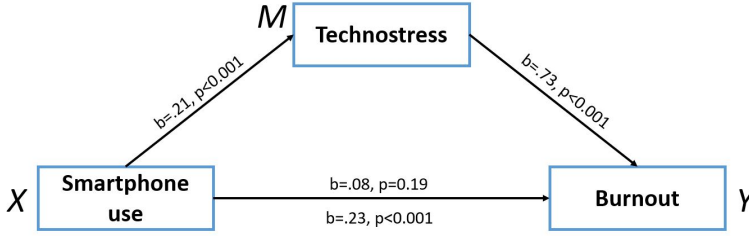


Fig. 2. Path analysis model showing how technostress (M) completely mediates the relationship between smartphone use (X) and burnout (Y). Technostress is a major explanatory factor in the relationship.

Smartphone Use Predicts Burnout. As discussed above, teachers shared how using smartphones during and after school hours added to their workload. Sending digital proofs, receiving after-hours memos from higher management, and managing parents in their personal time led many teachers to feel burned out. Survey data indicated that nearly 60% of teachers felt burned out more than once a month. Among these teachers, 29% of teachers experienced burnout once a week and 14% more than once a week. We also found that government school teachers experienced burnout significantly more frequently than private school teachers ($U=55404$, $Z=-4.03$, $p<0.001$).

To examine if there is a direct link between smartphone use and burnout, we conducted a linear regression analysis using the log-transformed number of total hours spent by teachers using smartphones for work as the independent variable and the frequency of feeling burned out as the dependent variable. Our analysis found that smartphone use by teachers significantly predicted how often they felt burned out ($b=.23$, $t(1359)=3.54$, $p<0.001$).

Technostress Mediates the Relationship Between Smartphone Use and Burnout. Next, we investigated the role of technostress in the relationship between smartphone use and burnout. We began by conducting a linear regression analysis to examine the relationship between technostress and burnout, and found that technostress levels among teachers significantly predicted how often they felt burned out ($b=.73$, $t(1359)=18.33$, $p<0.001$).

Although both groups of teachers experienced high levels of technostress, we found that government school teachers experienced significantly more technostress than private school teachers ($U=59850$, $Z=-2.98$, $p=0.003$). To see if government school teachers were more stressed because they used smartphones for work more than private school teachers, we conducted a linear regression analysis to predict the effect of smartphone use on technostress. We used the logarithmic value of the hours teachers spent using smartphones for work as the independent variable and the technostress index as the dependent variable, and found that smartphone use significantly predicted technostress ($b=.21$, $t(1359)=5.37$, $p<0.001$).

Next, we conducted mediation analysis using path analysis [83] to investigate whether technostress levels (M) mediate the relationship between smartphone use (X) and burnout frequency (Y). We found that technostress fully mediated the relationship between smartphone use and burnout ($X \rightarrow M \rightarrow Y$, $b=.21$, $t(1359)=5.37$, $p<0.001$). Technostress accounted for 65.2% of the relationship between smartphone use and burnout ($X \rightarrow Y$) and 68.4% when we controlled for age, gender, and school type. These results suggest that technostress provides a major explanation of how teachers' smartphone use predicted burnout frequency. Figure 2 shows the results of our linear regression and mediation analyses.

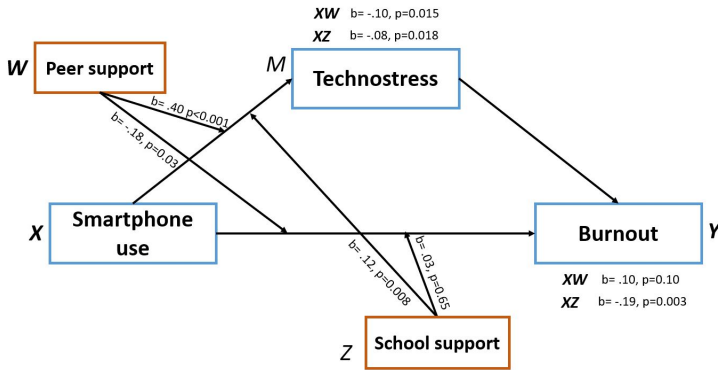


Fig. 3. Moderated-mediation model showing how peer support (W) and school support (Z) significantly controlled the relationship between smartphone use and technostress ($X \rightarrow Y$). However, only school support (Z) significantly controlled the relationship between smartphone use and burnout ($X \rightarrow Y$).

Support Moderates the Relationship Between Smartphone Use, Technostress, and Burnout.

Finally, we conducted a moderated mediation analysis [44, Chapter 11] to measure whether peer and school support has moderating effects on the predictive relationship between smartphone use, technostress, and burnout (i.e., the overall model shown in Figure 2). In particular, we examined how peer support and school support influence the relationship between: (1) smartphone use and technostress, and (2) smartphone use and burnout. We controlled for age, gender and school type to generalize the results across different teacher demographics.

Our results (see Figure 3) show that both peer support (W) and school support (Z) act as moderators for the relationship between smartphone use and technostress ($X \rightarrow M$) with significant interaction effects of peer support and smartphone use ($b = -0.10, t(1359) = -2.42, p = 0.015$) as well as school support and smartphone use ($b = -0.75, t(1359) = -2.36, p = 0.018$). These results indicate that, as peer support and school support increase, they reduce the effect of smartphone use on technostress. On the other hand, we found that only school support (Z) acts a moderator for the relationship between smartphone use and burnout ($X \rightarrow Y$) with significant interaction effects of school support and smartphone use ($b = -0.19, t(1359) = -3.66, p = 0.003$), meaning that an increase in school support reduces the effect of smartphone use on burnout. These quantitative results support our qualitative findings and suggest that creating both formal and informal support structures for teachers could help to reduce their stress and burnout.

5 DISCUSSION

Our findings depict a concerning landscape that contrasts the general techno-optimism associated with the adoption and use of smartphones in HCI4D settings [37, 63, 81]. Although HCI and Organizational Studies research in the Global North have recognized the potential for technology to induce strain and burnout in work settings and hamper work-life balance (e.g. Right to Disconnect policy) [10–12, 45, 85], very limited conversations (e.g., Karusala et al.’s work around health care workers [54]) exist around similar themes in HCI4D settings. Instead, most prior work in HCI4D has focused on improving productivity, efficiency, and access, without engaging deeply with the possible negative implications of technostress around such technology integration. This is especially concerning in educational settings in the Global South because, unlike resource-rich settings where

teachers' use of technologies may have established norms and policies, smartphone use by teachers in the Global South does not have clearly defined norms, policies, or checks to protect teachers from technostress. In this Section, we (1) expand the technostress phenomenon to accommodate work settings in HCI4D contexts, (2) discuss the ethical issues surfaced as a result of different technostress situations in these work contexts, and finally (3) propose avenues for beginning to address the technostress that teachers experience.

Expanding Technostress Beyond IT Offices: Technostress in HCI4D Work Settings. As mentioned in Section 2, most prior research around technostress has investigated the phenomenon in traditional office-based settings [6, 22, 95]. Work-based technology in these settings is provided, and therefore recognized, by the management. This provision also allows management the ability to control these devices through established internal checks and required demarcations (in the form of software) to regulate the expected employee behavior in work settings. This is a common scenario in call centers where employers routinely install applications to monitor and manage employee behavior [41, Chapter 7]. This is in contrast to most work settings in HCI4D contexts, where employers often do not provide work devices to employees. Instead, employees, like teachers in our study, repurpose their own personal devices (e.g., smartphones) for work to meet the increasing demands of productivity. Additionally, these workers share ownership of these devices with their family (unlike Western settings), limiting device availability outside work hours [1, 107]. As a result, these smartphones do not attain official status of work devices. Moreover, as these devices are personally owned by the teachers, management cannot control and monitor these devices directly through internal checks. Consequently, we show how these differences in “work” technologies between Western and HCI4D settings extend the concept of technostress in multiple ways.

First, some forms of technostress that have come up in the previous literature did not occur in our findings. For instance, the fact that teachers repurposed and brought their personal smartphones as work devices meant that teachers were familiar with the simple technology operations that were required for school work, such as using apps for teaching, or completing administrative requests on WhatsApp. As a result, unlike prior work [87, 96], we saw very few instances where teachers felt stressed by frequent updates to their smartphone apps (*techno-uncertainty*) [77]. We hypothesize that the Play Store updates of these apps were so incremental and small that teachers did not perceive the new features as stressors [6]. Similarly, managements' lack of recognition of smartphones as work devices along with their emphasis on syllabus completion and student development meant that we did not find instances where teachers felt that technology (non)-use might impact their job security, especially to other peers (*techno-insecurity*).

Second, some of our findings do not fit with the current conceptual vocabulary of technostress. For instance, management's lack of internal technological checks on teachers' smartphones was compensated by external socio-technical regulations like using peer-surveillance to curb smartphone use. Management positioned these actions as *care* forms of surveillance [88]. Sewell and Barker [88] outlined how adopters of liberal (care) forms of surveillance, similar to the management, believe that surveillance is a legitimate tool and the actions to implement surveillance are justified and even required to some extent.

In reality, these external regulations were seen by teachers as enforced social structures designed to curb their agency and produce more technostress [8] at work. This contrasts internal technological checks established in IT offices (e.g., activity monitoring apps) that employees consider as part of their job contract. Consequently, these structures created new types of techno-stressors. One such technostress developed when teachers felt that they were in constant conflict with the management to receive permission and use *their* smartphones for work productivity. This form of technostress, in which employees are in constant stress to figure out if a certain technology can be used for work

purposes (or not), is not represented in prior literature of technostress. We propose this type of technostress as *techno-permissibility*. In our study, we saw how certain teachers in private schools experienced this stress when the management denied permission to use smartphones for work even though teachers felt that smartphones were an indispensable work tool. The constant fear of whether or not to use smartphones for teaching contributed to teachers' technostress.

Lastly, implementation of socio-technological structures by the management also meant that certain forms of technostress were observed unusually more in our findings than they were covered previously in the literature. For example, one form of technostress that appeared frequently in our data was the perception of *techno-overload*, which was caused by implementation of self-surveillance structures on WhatsApp. Another form of technostress that we observed frequently is *techno-invasion*, which occurred when parents had access to teachers through WhatsApp. We also observed techno-invasion in instances where teachers had to be online for administrative work.

Ethical Issues Raised in Our Findings. Our findings also depict a number of ethically questionable work practices utilized by both higher management and teachers to navigate the ambiguity of smartphones as work devices. Even though, as researchers, our primary obligation is to report these findings, it is also our responsibility to engage with the underlying socio-technical challenges around such ethically questionable practices. For instance, one set of unethical uses of smartphones occurred when higher management used surveillance techniques in an effort to make teachers more accountable. While private schools chose surveillance using CCTV cameras in classrooms, higher management in government schools repurposed teachers' smartphones as a self-surveillance tool to track and monitor their work. It is important to understand these decisions taken by the higher management in a broader cultural context. These schools face serious teacher-related problems, such as absenteeism, teaching procrastination, and distraction from teaching, that perhaps led to adoption of such extreme measures [59]. In parallel, these schools often prioritize *students* in ways that sometimes overlook teachers' needs. However, our work shows how higher managements' practices are detrimental to teachers' work lives, potentially impacting students' educational growth in ways that contradict the organizations intended aims.

To a lesser extent, we saw how teachers unintentionally exposed personal information (even mature content) to students while using their smartphones as teaching aids. They also appropriated smartphones as potential surveillance tools by threatening to record students' behaviors. These activities have the potential to cause psychological harm to students, which could be worsened if the device used to record the video is compromised. On the other hand, lack of teaching resources pushes teachers to depend on smartphones as a major teaching resource, which is bound to result in situations where teachers' work and private information mix, leading to the challenges we saw.

Overall, these are alarming findings. There is an urgent need, not only from our community of HCI4D researchers, but also the broader ecosystem of education, government, and policy makers to come together and tackle the underlying challenges around technology use. One such challenge, as Toyama points out, is that the technology can only amplify the underlying intent to use the technology [101]. As seen in our study, the intentions of different stakeholders may be in conflict with each other. In the following sections, we advocate for solutions that embrace the notion of *caring* [39, 69] for and about teachers to empower them within the local cultures and contexts they work in, instead of adopting solutions that oppose those structures [93].

The Role of Policy & NGOs in (Re)defining the Role of Smartphones in Teaching. The adoption of smartphones for a wide range of teachers' work activities has happened rapidly, with platforms like WhatsApp, that teachers already use for their personal communications, suddenly playing a large role in their day-to-day work. Indeed, the number of hours that teachers reported

using smartphones for work suggests that these tools are now just as important as other, more traditional work tools (e.g., classroom teaching aids, textbooks, registers, etc.) [36].

However, smartphones as ambiguous work tools, occupy a gray area in which they are sometimes treated as work tools (e.g., higher management requiring their use to submit digital proofs), sometimes seen as personal devices (e.g., banned from work in private schools), and sometimes a mix of the two (e.g., expectations from teachers to respond outside of work hours). As a result, most of the work that teachers do outside of school on these devices becomes invisible work that is not acknowledged by higher management, causing emotional strain in their work and personal lives. Additionally, these forms of invisible work no longer *represent* teacher work and therefore have the potential to be ignored by the designers who are designing for teachers [92]. At the same time, smartphones enabled management to easily scrutinize work that was already visible leading to extreme accountability for teachers [90]. We recognize that this problem cannot be solved overnight and requires systematic planning and deliberation at a policy level as well as concrete actions at local school levels.

First, at the policy level, there is a need to recognize and demarcate appropriate (and inappropriate) usage of smartphones in teachers' work lives in national-level policies and frameworks like the 2020 National Educational Policy (NEP) [66]. The current policy not only fails to include such directions, but also provides vague recommendations for promoting teacher training programs via smartphones that may impact teacher professional wellbeing: *"These [training] programmes may be run through digital/distance mode...as well as smartphones, allowing teachers to acquire Early Childhood Care and Education qualifications with minimal disruption to their current work"* (Clause 1.7, page 8). Since state governments derive their policies from national frameworks, addressing the role of smartphones at a national level will likely trickle down to state-level policies as well.

In the short-term, grassroots NGOs that work with low income schools (also called support organizations [107]) can engage school higher management to initiate dialogue to renegotiate, and then reinforce, acceptable roles for smartphones in teachers work, with these roles agreed on and acceptable to both teachers and management [25]. NGOs are often in a good position to do this because they bring in additional skills and resources that may be beneficial for higher management. For example, NGOs may provide technological and domain expertise, along with a commitment to effective smartphone-based interventions for teachers [107]. Thus, NGOs can create awareness around the role of smartphones in teachers' work lives. Such negotiations can render visible some of the currently invisible work teachers do using their smartphones [90, 91].

Creating Safe Spaces for Teachers through Boundary Setting. The need to establish and maintain healthy boundaries is a key requirement for jobs involving emotional labor [21, 31, 65], including teaching [19, 24]. Before teachers possessed smartphones, if students' parents wanted to interact with a teacher, they needed to visit the school in-person, during school hours, and obtain permission from an administrator before gaining access to the teacher. This physical separation was important to ensure that teachers can perform their duties without constant interruption from students' parents. However, the always-on nature of smartphones, combined with parent-teacher WhatsApp groups that expose teachers' personal contact information, have reduced the distance between teachers and parents/students, enabling parents to directly contact teachers at any time, whether to request clarification about homework, ask additional resources, or threaten the teacher when parents are unhappy with them. The adoption of digital communication has resulted in teachers losing the safe space afforded to them by physical, in-person interaction.

This suggests a need for mechanisms that (re)establish safe spaces for teachers by creating appropriate digital boundaries between teachers and students/parents. Demonstrating a commitment to creating and enforcing such boundaries could provide a key opportunity for higher management

to show care for teachers. For example, mirroring the physical world, higher management might assign a school administrator to act as a digital liaison to mediate communication with parents and shield teachers. This can be facilitated via the use of a newly-available WhatsApp business app with a separate work-only SIM that administrators use for correspondence with parents. Many built-in features of WhatsApp business, such as an “away message” (automatic message when the device is offline) or setting explicitly visible “work-hours”, can encourage parents to follow the announced times, reducing techno-overload and techno-invasion. WhatsApp business also provides an API that opens up the possibility for future research to examine the extent to which such mediation could be achieved by conversational chatbots. Using chatbots as mediators may prevent parents from knowing teachers’ personal phone numbers and could also, for example, store messages sent outside of work hours until the next morning.

More broadly, such interventions can enable teachers to reduce technostress and focus on improving different aspects of their wellbeing at work (e.g., mental health, worklife balance) [5]. Explicitly acknowledging the importance of teacher wellbeing, and providing structures that reduce technostress, could help teachers to feel less alienated [67] and improve their overall work lives.

Future Pathways: Teachers’ Technostress in the Post-COVID Era. Lastly, the onset of the COVID pandemic has drastically altered the work of teachers. This is particularly true for low-resource schools, where months-long lockdowns have pushed almost all of the teachers’ work online. We now reflect on some of the long-term changes, discuss how these changes may impact teacher technostress, and what we, as a research community, might do about it. The pandemic is already contributed to a shift from school to home-based teacher work practices, while drastically reducing the visibility management has into teachers’ work. It may also lead to teachers needing to intersperse their work with other household chores and childcare duties, extending their work hours and further blurring their work and personal lives.

The lack of appropriate norms around online work, combined with added invisibility, may push management to incorporate demand surveillance “proofs”, such as “always be on a video call”, or possibly adding online monitors who audit teachers’ activity on teaching apps. Future research is needed to carefully study these changes, and the resultant technostress, to understand their impact on teachers’ wellbeing. We will also need interventions to counteract the technostress that will arise due to this pandemic shift. Teachers are also likely to face increased work burdens from other stakeholders as well. For instance, teachers may be expected to provide greater emotional support to students, who are also dealing with uncertainty and anxiety during the pandemic. Online classes may enable parents to take advantage of being present in the same place as their children who are taking the online classes, facilitating monitoring and scrutinizing of teachers around their classroom engagement. Such situations could easily lead to humiliation of teachers in front of their class, impacting their self-esteem. To avoid these situations, management will need to work even harder to ensure appropriate boundaries between parents and teachers.

6 CONCLUSION

This paper describes a mixed methods study that analyzes the impact of teachers’ smartphone use on their perceived technostress. Although smartphones are convenient for administrative tasks and helpful for lesson preparation and teaching, we find that their use significantly predicts burnout among teachers, with technostress providing a major explanation for this relationship. Higher management controlled and repurposed teachers’ own smartphones to surveil and monitor their work, and demand that they complete administrative work quickly, often outside of work hours, contributing to technostress. Taken together, our findings contrast the general techno-optimism that surrounds the use of smartphones in education settings in HCI4D. We also extend the concept of

technostress in low-resources work settings and suggest opportunities to rethink how smartphone use for work might be restructured to improve teachers' professional wellbeing.

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A CODEBOOK FROM QUALITATIVE ANALYSIS OF INTERVIEW DATA

Theme / Code	Count
Stressors	(27.57%) 295
Digital proofs & surveillance	73
Digital vulnerability	58
Excessive workload	45
Issues of trust	35
Non-digital stressors	30
Additional tech dependencies	23
Relationship between the peers	22
Pressure to adopt smartphone	10
Social structures	(22.14%) 237
Digital regulations	62
Digital hacks	55
Change in habits	45
Image manipulation	30
Interaction w/ parents	25
Gender dynamics	20
Engagement	(17.75%) 190
Teacher strategies	59
Peer connectedness	55
Peer assistance	36
Quicker workflow	35
Encouragement	5
Worklife balance	(14.86%) 159
Worklife balance issues	68
Always online/blurring spaces	48
Hybridity of smartphone	43
Coping mechanisms	(9.53%) 102
Digital mechanisms	42
Social mechanisms	25
Physical mechanisms	15
Mental constructs	15
Higher management assistance	5
Emotional labor	(8.13%) 87
Change in emotion management	55
Emotional aspects of smartphone	32

Table 2. The complete codebook that resulted from our analysis of qualitative interviews, showing six themes (bold) and 29 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.)

B SURVEY

B.1 Demographics

Instructions. Please answer the following demographic questions:

- Q1.1 What is your age?
- Q1.2 What is your overall teaching experience? (years)
- Q1.3 What subject(s) do you teach?
- Q1.4 What is your highest qualification?
- Q1.5 Which gender do you identify with?
- Q1.6 What is your marriage status?

B.2 Smartphone use: Activity

Instructions. For the following questions, please recollect your average smartphone use in the last 12 months for different school duties and select your answer:

- Q2.1 School preparation work using smartphone, in a week (E.g. preparing lesson plans, finding activities for students, etc.).
- Q2.2 Teaching a concept using smartphone, in a week (e.g. Explaining a chapter through a new activity to students in classroom).
- Q2.3 Sharing smartphone with students to help them do activities in class, in a week.
- Q2.4 Administrative tasks using smartphone, in a week (e.g. duties given by a circular).
- Q2.5 Managing parents using smartphone, in a week (e.g. solving parents' doubts).
- Q2.6 Interaction with other teachers using smartphone, in a week (E.g. helping other teachers in subject doubts).

Response options: Never used (1), Less than 1 hour (2), 1-2 hours (3), 3-5 hours (4), 6-9 hours (5), 10-19 hours (6), 20-29 hours (7), 30-39 hours (8), 40 hours or more (9).

B.3 Smartphone use: Apps

Instructions. For the following questions, please recollect your average use of smartphone apps and technologies for instruction in the last 12 months and select your answer. (E.g. lesson preparation, lesson delivery, evaluation, work communication and administrative record keeping):

- Q3.1 Average WhatsApp use for work, every week.
- Q3.2 Average YouTube use for work, every week.
- Q3.3 Average Byjus use for work, every week.
- Q3.4 Average use of Google search for work, every week.
- Q3.5 Average Wikipedia use for work, every week.
- Q3.6 Average Projector use for work, every week.
- Q3.7 Average Digital tablet use for work, every week.

Response options: Never used (1), Less than 1 hour (2), 1-2 hours (3), 3-5 hours (4), 6-9 hours (5), 10-19 hours (6), 20-29 hours (7), 30-39 hours (8), 40 hours or more (9).

B.4 Burnout

Instructions. For the following questions, please recollect your teaching life in school to answer how frequently you experience them in your life:

- Q5.1 I feel super tired at the end of the working day at school.
- Q5.2 I feel that working daily as a teacher is very tiring for me.
- Q5.3 I have enough energy for family and friends during leisure time. (reverse coded)
- Q5.4 My work as a teacher is emotionally very tiring.
- Q5.5 My work as a teacher frustrates me.
- Q5.6 I feel burdened because of the work I do as a teacher.

Response options: Every day (7), A few times a week (6), Once a week (5), A few times a month (4), Once a month (3), A few times a year (2), Never (1).

B.5 Technostress

Instructions. For the following questions, please recollect use of smartphone for your work purposes (i.e. preparation, teaching, and admin work) to answer whether you agree or disagree with the statements:

- Q6.1 Because of my smartphone, I have to do more work than I can manage.

- Q6.2 Because of my smartphone, I have to work with very hectic time-table.
- Q6.3 I am forced to change my old work habits to work with my smartphone.
- Q6.4 I have a higher school burden because it is difficult to use my smartphone.
- Q6.5 I must be in touch with my work even at late night due to my smartphone.
- Q6.6 I have to give up my holiday time to constantly check school work on my smartphone.
- Q6.7 I feel my personal life is being occupied by my smartphone.

Response options: Strongly agree (5), Somewhat agree (4), Neither agree nor disagree (3), Somewhat disagree (2), Strongly disagree (1).

B.6 Peer support

Instructions. For the following questions, please recollect how other teachers have supported your smartphone use in school work (preparation, teaching and admin duties) to answer whether you agree or disagree with the statements:

- Q7.1 Many teachers encouraged me when I faced difficulties in using my smartphone for work.
- Q7.2 Many teachers shared useful resources on how to use my smartphone at work.
- Q7.3 Many teachers shared their smartphone experiences to help me use my smartphone for work.
- Q7.4 Many teachers cared about the challenges I faced while using my smartphone in work.
- Q7.5 Other teachers and I made an effort together to use our smartphones in our work.

Response options: Strongly agree (5), Somewhat agree (4), Neither agree nor disagree (3), Somewhat disagree (2), Strongly disagree (1).

B.7 School support

Instructions. For the following questions, please recollect how other teachers have supported your smartphone use in school work (preparation, teaching and admin duties) to answer whether you agree or disagree with the statements:

- Q8.1 My school gave instructions on how to use my smartphone for lesson planning.
- Q8.2 My school gave enough training to us on how to teach using smartphone in the classroom.
- Q8.3 My school provided sufficient time to use my smartphone in the classroom .
- Q8.4 My school understood my work pressure and gave me freedom to use my smartphone in school work.
- Q8.5 There was good coordination in my school using smartphones so that I could complete my task smoothly.

Response options: Strongly agree (5), Somewhat agree (4), Neither agree nor disagree (3), Somewhat disagree (2), Strongly disagree (1) .

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