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Improving educational outcomes & reducing absenteeism at remote villages with mobile technology and WhatsAPP: Findings from rural India

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Abstract Reduction of teacher and student absenteeism, together with consistent teacher support and training, are critical factors in improving the quality of education in rural India. As part of an ongoing project involving schools and educational centers in rural areas spread across 21 Indian states, this study investigated how implementation of two simple, accessible technologies could not only reduce absenteeism but also increase teachers' effectiveness and improve student performance. In addition to students and teachers, key stakeholders included educational coordinators who provided support and monitoring regarding use of WhatsApp and two additional apps designed specifically to support simple educational improvements. In our study we coded and analyzed nine months of messages ($n = 8968$), both photographs and texts, posted by 26 participants. The number of text messages related to attendance was strongly positively correlated with frequency of interactions between coordinators and teachers. Our approach resulted in increased teacher and student attendance, as well as improvements in lessons and other planned educational activities. This model functions well in rural settings where there is poor internet connectivity and lack of supporting infrastructure. Remote schools can easily adopt this tablet-based model to reduce

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teacher absenteeism, improve teaching techniques, improve educational resources, and increase student performance.

1 Introduction

A major challenge for schools in rural Indian villages is the lack of quality teachers. Most qualified teachers are not willing to move to the rural environment. Teacher absenteeism and accountability (administrative, ethical, teaching, and reporting), are serious issues in government schools that provide most of the education in rural areas.

Motivated and committed teachers are key stakeholders in improving the quality of education for sustainable development. The teachers' subject knowledge and pedagogical skills directly influence learning outcomes for children. Rural and remote schools in lower socio-economic areas are characterized by a large number of teacher vacancies, teachers with lower skills compared to those in cities and higher teacher absenteeism. Specifically, inefficient and sometimes complete lack of teacher monitoring and accountability significantly contributes to lower quality education in poor areas of developing countries.

Many schools, particularly primary schools, lack the required number of teachers. The problem is exacerbated in rural primary schools with only one to four teachers; this often results in reduced educational access and lower levels of learning that in turn, discourage children from attending school.

Academic qualifications, in-service and pre-service training, satisfactory remuneration and favorable working conditions influence the quality of teachers, and these factors tend to be less available to teachers in rural areas. In situations where these factors are at low levels, technology, applied wisely, has the potential to mitigate some of the negative impact of these factors regarding education in rural areas. Furthermore, technology provides flexibility and access and has significant transformational capabilities to enhance learning and success of students from low socioeconomic status (Devlin and McKay 2016). Some studies reveal that learning technology benefits are even greater for students of elementary schools in rural areas than for students in non-rural schools (Howley et al. 2011).

MIMs (mobile instant messaging) applications such as WhatsApp offer free or inexpensive features to share information or download images, videos and audio clips. Whatsapp like messengers also help to build togetherness through sharing of day to day happenings (O'Hara et al. 2014). Whereas the traditional phone SMS system is more formal, reliable and privacy-preserving, WhatsApp is more conversational, informal and social (Church and de Oliveira 2013). Additionally, the functionalities of the messaging apps can be accessed with any network, anywhere. Social media, if used appropriately, can inspire pre-service teachers to collaborate and network to develop new pedagogical skills by sharing experiences and ideas (Kabilan 2016). Social networking sites used appropriately and purposefully can inspire the teachers to think beyond the traditional ways of teaching and learning to develop constructively with new pedagogical skills. In the case of teachers in remote villages, these technologies

have the potential to facilitate professional development opportunities that would otherwise be unavailable.

The increase in smartphone and Internet users in remote and rural areas of India substantiated the growing number of people showing interest in possessing a smartphone and using social media, primarily WhatsApp, for various types of communication such as entertainment and sometimes for educational purposes.

This paper presents the AmritaRITE (Rural India Tablet Education) (Nedungadi et al. 2017) monitoring methodology using WhatsApp along with other apps for monitoring remote teachers and classrooms. The main objective of our research study was to assess the ability of this methodology, using mobile tablet technology for monitoring and supporting teachers, to reduce both teacher and student absenteeism and improve student performance. In addition, we found that use of these technologies encouraged teachers and coordinators to share resources and pedagogical suggestions with each other, thus leading to decreased sense of isolation and increased sense of empowerment among teachers.

2 Teacher accountability, absenteeism and monitoring

Absenteeism in public services has remained a concern in many parts of rural India, especially in the health and education sectors (Banerjee and Duflo 2006). Major concerns that affects education in rural India is both teacher and student attendance in schools. The level of teachers' accountability, which is linked to teacher attendance, has a major impact on student performance. Research on teacher attendance revealed that the teacher absenteeism was high in many states in India. It is about 42% in Jharkhand (Ramachandran et al 2005). Many criteria influence teacher absenteeism such as gender, marital status, age, tenure at schools, social and political involvement, etc. Compared to male teachers, for example, the rate of absenteeism of female teachers is greater (Chaudhury et al. 2006). Local teachers are more likely to have an understanding and be involved in social matters of their locality as they live in the community.

Similarly students in remote disadvantaged areas generally have lower attendance (Govinda and Bandyopadhyay 2008). Student absenteeism may be influenced by the level of education and socioeconomic status of the parents (Dreze and Kingdon 2001) and by schools closed due to absent teachers ((Diwan 2012). These often lead to poor student performance, and eventually increase in school dropouts (Pratichi India Trust Kolkata 2009).

Attendance and performance of students in rural schools is another yardstick to measure the accountability of teachers in those schools. Teacher absenteeism is hard to monitor as accurate administrative records of both teachers and students may not be maintained, and in some cases, may be falsified as teachers cover for themselves.

A direct observation of teachers during surprise visits to randomly selected nationally representative primary schools in India in 2002–03 showed a 25% absence rate (Chaudhury et al. 2006). This was a conservative number as teachers were marked present if they were in the school even if they were not teaching at the assigned

classroom. Teacher absence varied across states in India. Many studies worldwide have shown that teacher absence affects learning gains and that absence is greater in poorer and disadvantaged neighborhoods (Clotfelter et al. 2007; Duflo and Hanna 2005). A longitudinal study in Andhra Pradesh, for example, indicated that teacher absenteeism showed little change with the introduction of teacher incentive bonus payments (Muralidharan and Sundararaman 2008). The fact that teacher salary does not seem to be a factor in teacher attendance is significant since teachers in rural private primary schools in India make one-quarter to one-fifth as much as government school teachers.

In one study, private school teachers in villages had absence rates one third lower than those of their government school counterparts in the same villages, despite the fact that private school salaries were only one fifth to one quarter of public school salaries (Kremer, et al. (2005). A possible reason is that private schools will dismiss a poor performing teacher, while government schools do not. In India, only one in 3000 public school head teachers had discharged a teacher for excessive absence (Kremer, et al. 2005).

Vegas and Umansky (2005) define nine factors that can attract, retain and motivate teachers and impact their performance. These include internal motivation, social prestige, job stability, pensions and other benefits, professional growth, adequate facilities, sense of mastery in the job, response to supervisors and salary differentials between teachers and non-teachers.

Monitoring teachers, along with instigating consequences for unexplained absenteeism and failure to engage in teaching, are important in teacher motivation and performance. However, monitoring teachers is challenging, particularly in remote, rural areas that lack infrastructure and resources. The age-old practice of maintaining handwritten logbooks is still used in many schools where the teachers have to sign in a register when they enter or leave the school. However, this is not a reliable source as records do not include exact time of teachers' arrival and departure, and sometimes absences are not mentioned in log books at all. Furthermore, even when a teacher is present at the school, it is difficult to ascertain whether the teacher is actually teaching in the class or engaged in other activities.

Local monitoring by head teachers has been shown to improve teacher attendance at a lower cost than automated methods, but this method risks collusion (Chen et al. 2001). Supervision of schools is another way of tracking the activities of teachers in the school. Programs like "Sarva Shiksha Abhiyaan" have introduced methods of decentralizing supervision and monitoring of absenteeism in schools. This practice involves parents and local communities observing the accountability of local teachers. However, this method may be difficult to mobilize in remote, rural and poor villages where parents and community members are illiterate and may neither understand the value of education nor the benefits provided by the government under various programs.

Automated monitoring methods, such as time-stamped cameras, can reduce teacher absenteeism and improve student performance (Duflo et al. 2012). However, installation of cameras is expensive and subject to other risks such as theft, lack of consistent electricity affecting functioning of the camera and the ability to capture and save the video feeds. ICT-based techniques can also address the challenge of remotely monitoring teachers in rural areas, but computer labs are not a viable option due to lack of infrastructure, consistent electricity and high bandwidth Internet in these areas.

However, mobile devices such as Android tablets with SIM cards and data plans constitute a viable option and can be easily made available in these areas (Megalingam et al. 2012). Android tablets, outfitted with apps to gather and send data, along with mobile messaging applications such as WhatsApp, form a user-friendly platform to get real-time data about the teachers' activity in schools.

3 Remote monitoring of teachers, students and classroom

The AmritaRITE methodology uses a multifaceted monitoring system that involves cluster coordinators, central coordinators, teachers and technology. Cluster coordinators support and monitor educational activities for a cluster of four or five villages. They periodically visit the centers and sometimes conduct surprise visits to cluster schools. On an average, about five village centers have a cluster coordinator and about 5 clusters have a central coordinator.
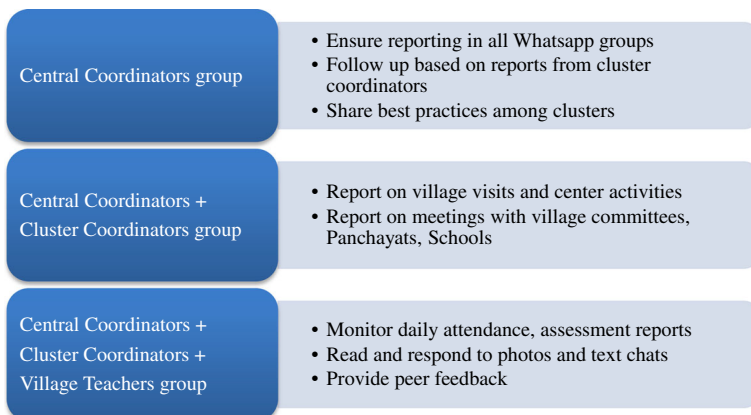
The teacher tablets have a 2G SIM card, while the student tablets have local content and connect to the teacher tablet for reporting activities. Teacher tablets are used to send daily status data to the central monitoring team.

The remote monitoring methodology involves both physical site visits to villages and village teacher travelling to centers for training, and online groups. The data collection and analysis used in this paper is primarily via. apps, and whatsapp. This is an ongoing project that has been active for three years. Only the whatsapp group and the AmritaRITE app data for the villages in the state of Uttarakhand are used in this paper. The netnography approach studies the behaviour and evolution of communities as they communicate online.

A goal of the study was to understand whether using online apps to monitor, support teachers and monitor active engagement of community by the teachers helped attendance and or performance on both teachers and students.

There were 3 distinct types of WhatsApp groups (Fig. 1) in the system.

Systematic collection and analysis of data improves the efficiency and effectiveness of the implementation. Benefits of using the AmritaRITE methodology of having

Central Coordinators group	• Ensure reporting in all Whatsapp groups • Follow up based on reports from cluster coordinators • Share best practices among clusters
Central Coordinators + Cluster Coordinators group	• Report on village visits and center activities • Report on meetings with village committees, Panchayats, Schools
Central Coordinators + Cluster Coordinators + Village Teachers group	• Monitor daily attendance, assessment reports • Read and respond to photos and text chats • Provide peer feedback

Fig. 1 Major groups and roles

teachers use the tablet apps and WhatsApp for monitoring and evaluation of both teaching and attendance include:

- Making teachers active partners in monitoring and evaluation
- Real-time access to data for further analysis (e.g., monitoring quality and progress.
- Tablets have short set-up time and immediate data access.
- Mobile messaging app allows multilingual typing and supports transliteration.
- Method for simultaneously measuring teacher and student attendance.

One coordinator is appointed to take charge of schools in a particular area, distribute the device for WhatsApp communication to each school, collect information from each teacher or school and make necessary decisions. Each staff member of the school will be accountable for care and maintenance of their devices.

An additional advantage to the AmritaRITE approach is that, unlike other methods that use external groups or technology such as cameras to monitor teachers, we empower and actively involve teachers in reporting and accountability. Teachers use the apps to send daily attendance reports of students along with periodic performance reports. In this process of remote monitoring, the teachers take a time-stamped photograph of themselves, along with their students, at the beginning and end of class and send these to their cluster coordinators using WhatsApp (Fig. 2). Teachers also keep a record of what was taught in class each day. Photos and records can be logged every day for every class to keep track of teacher attendance and accomplishments. Teachers who are regular in their attendance and sending daily reports are also given certain monetary incentives.

Fig. 2 Learning and activities

3.1 Teacher support with technology

Besides monitoring, our approach has the potential to provide additional substantial benefits to teachers. The tablets also support ongoing training of teachers as well as sharing of content and experiences. The central coordinator helps plan lessons, sends lesson plans and short instructional videos and also provides feedback on teaching and learning in the classroom after watching class videos. The fact that teachers play a critical, active role in monitoring, combined with the accessible, tailored in-service benefits they receive, contribute to a sense of empowerment.

In addition to providing support to teachers, AmritaRITE has the potential to provide direct support to students. As noted by Devlin and McKay (2016), technology provides flexibility and access and has significant transformational capabilities to enhance learning and success of students from low socioeconomic status. In line with this, AmritaRITE educational apps were specifically developed to be multilingual and culturally appropriate for Indian rural contexts and hence address real life needs of students (Nedungadi et al. 2014). Such apps, along with videos, are sent to teachers through WhatsApp to be used in the classroom. WhatsApp has enabled learning by providing a platform for easy communication, exchange of information and entertainment (Mudliar and Rangaswamy 2015).

4 Methodology

This paper presents the combined use of AmritaRITE apps and WhatsApp as a possible solution for effective monitoring and mentoring of teachers in rural areas. While ethnography studies beliefs and behavior in groups with similar culture (Creswell 2007), 'online ethnography' (Markham 1998) and 'netnography' (Kozinets 1998) extend this to online groups and communities. Netnography evolves with online communication within groups and hence is no longer bound by geographical boundaries.

Ethnographic practices differ in face-to-face situations v.s. netnography, when using online media (Kulavuz-Onal and Vásquez 2013). The type of communication technologies used impact data collection, fosters dialogue. In this paper, we study the change in teacher collaboration, classroom monitoring and improved reporting using a communication group of teachers and coordinators.

Data for this study is part of a larger program in rural India to empower over a 101 villages by strengthening literacy and reducing dropouts with focus on girls and the underprivileged. There are currently over 54 educational village centers, that are actively using this methodology, though the data used is for 18 centers in Uttarakhand. The study includes monitoring of centers in the state of Uttarakhand, which is one of the furthermost states, situated at a distance of more than 2000 kms from the central monitoring team.

There were 19 teachers, 5 cluster coordinators with two central coordinators in the Uttarakhand villages and the data used in this study is limited to the communication and reporting from this group (Table 1).

The central coordinating group is in all the whatsapp groups and also receives the data from the apps installed in each individual teacher and coordinator's mobile device.

Table 1 Whole population v.s. Uttarakhand

	#Centers	#Teachers	#Coordinators	#Central Coordinators
Study group Population	18	19	5	2
Whole Population	54	69	12	5

The data analysed is for a period of 9 months where 8968 chats from this group were coded and analysed.

AmritaRITE uses a model of remote teacher monitoring and support using a combination of two specially-designed apps for attendance ad student assessments, along with WhatsApp to send photos and text regarding daily attendance, assessment records, activities like yoga, community services etc. (Fig. 3).
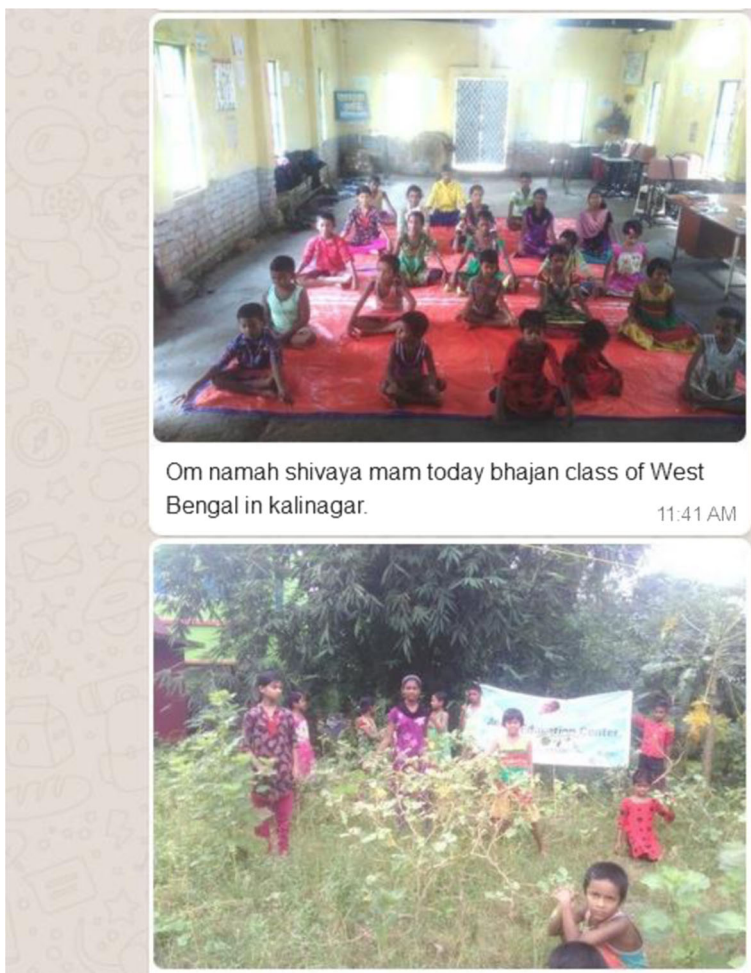
Fig. 3 Communication between various stakeholders

Originally, the project involved various pedagogical apps and tools in nine Indian languages, and WhatsApp was initially used only as a communication tool among educators, coordinators and remote tutors. It was then enhanced as a classroom monitoring tool, as an outcome of the difficulties faced in the early phases of the project in teacher accountability. Additional apps, such as an attendance app, and pedagogical elements such as small modules to train teachers, lessons were also incorporated into the mobile based framework. The messages in the groups are in English, Hindi or transliterated.

Teachers were trained to use WhatsApp installed on their tablets. All teachers in each geographical "cluster" were added on a WhatsApp group, with the Uttarakhand teachers being one such group. The teachers were asked to send daily attendance counts by gender and a photo of the entire class to verify the counts.

Assessments taken by the centers along with student grades from the local schools were also sent by the teachers. In addition, when a certain center needed particular learning materials for the class, we made these available to teachers through WhatsApp. The teachers could download the material on their tablets and show it to their students (Fig. 6). In addition, we could watch videos of how individual teachers teach a concept and could then provide supportive feedback to either improve their approach or confirm that they have the right approach. This intervention helps in continuous assessment and provides closed loop feedback.

5 Discussion and findings

Our analysis used data from both WhatsApp chats and from AmritaRITE monitoring apps, along with GPS data for location. After deleting identifying information, the WhatsApp chats were coded and then categorized mapped to three overarching objectives (Table 2).

Table 2 Project objectives and categories of chat messages

Objective	Categories of chat messages
Teacher empowerment	Audio/video training modules Peer Discussion among teachers Support from Coordinators Setting Goals/Planning/Calendar of Events Teacher Recognition Focused feedback
Monitoring teacher and student attendance, adherence to acitivites and performance	Daily Attendance Assessment Numeracy, Literacy, Sustainable Development Arts (Drawing, Music) Yoga & Meditation, Awareness & Value Programs
Promoting Community Engagement	Activities that involve partners, parents, villagers, school. Mentoring Adolescents and youth to promoting Gender Equality and reducing substance abuse Medical Camps

Some chats contained transliterated text while others included icons and images. Next we combined related topics to a higher order category. Finally, categories were placed under the broad three objectives. Chats that did not fit into any of the broad objectives were put in a separate heading called others ($n = 91$, 1%). Though various chats may vary in importance and relevance, each chat was given equal weight.

The WhatsApp photos and text related to monitoring student performance were cross checked with data received in various other apps related to attendance and GPS location to confirm the authenticity of the data submitted. In case, the attendance app data contradicted the whatsapp data, a query was raised as to the reason followed by updating with the correct information. WhatsApp groups are closed and moderated, and only images of project activities of the education center activities were encouraged to be posted. Permission from parents and teachers was taken when joining the programs to share images of activities. All personal information was removed from the chat logs before analysis.

During the study, 26 participants sent a total of 8968 posts with Photo accounting for 57% ($n = 5092$) and Text accounting for 43% ($n = 3876$). Teachers accounted for the most of the chat messages ($n = 8073$, 90%) sent using WhatsApp (Fig. 4).

Chats related to Monitoring Student Performance objective was the most common ($n = 5823$, 65%), followed by Teacher Empowerment ($n = 1932$, 21%) and finally Community Engagement ($n = 1138$, 13%) (Fig. 5). More often, an image would have information about learning and attainment activities and could also help in monitoring attendance. Generally, the text message would be more specific and relate to specific categories of activities.

As WhatsApp data sent by one teacher is visible to all others in the group, there is a peer pressure to perform well, and a healthy sense of competition is developed. Teachers get new ideas based on reports by peers. Problems faced by the teachers are posted to the group for feedback and guidance. While in the early stages the guidance came from the coordinator, eventually other teachers offered their input based on experience.

A few enhancements were made to the technology based on the evidence of tampering with the tablets. Some of the apps have enhanced security modes, and cannot be modified by the coordinators or teachers.
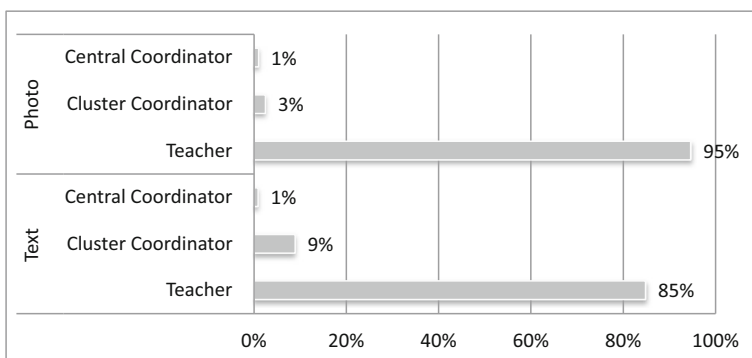
Fig. 4 Chat types (Photo or Text) mapped to participants
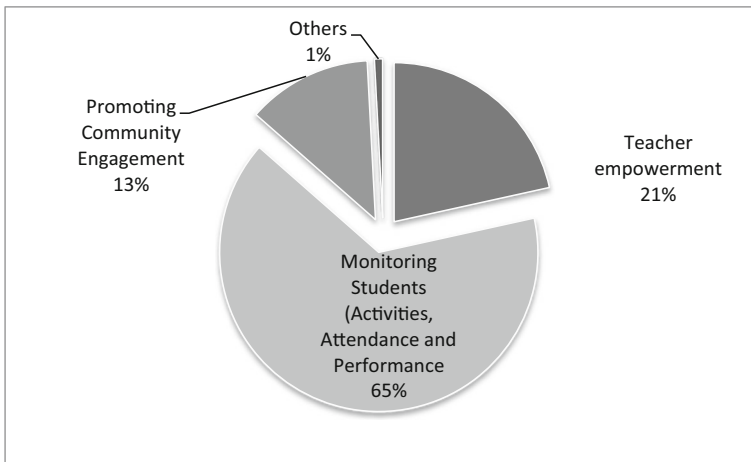
Fig. 5 Percentage of chats mapped to project objectives

In one case, a teacher was found to have sent the previous day's photographs of student attendance on a day when there was no class taught. As a result, an enhanced app for photographs with timestamp as a watermark was deployed to ensure compliance to accurate reporting. Once a month, each teacher posts videos of one class or activity that they conducted. Coordinators and other teacher view this, with interesting discussions leading to improved pedagogical strategies.

Teachers, who were once isolated in a small school in remote and rural India are now able to communicate with teachers in other villages. Occasional face-to-face training is now supplemented by on-going mentoring using tablet technology.

Cluster coordinators keep the central coordinators informed. This data is cross verified with the teacher chat data and information from apps to determine the authenticity of teacher reports. Attendance and assessment reports of students are analysed by the central coordinators and feedback provided to the centers on the list of children who are at risk of dropping out and failing. Coordinators use this information to provide intervention during their scheduled visits to the rural center.

A chi-square test of independence was performed to examine the association between objectives of the study and type of chats sent by participants. The results of the Pearson chi-square test indicate that the association between these variables was significant, $X_2(2) = 955.35$, $p < .05$. This suggests a significant association between objectives of the study and type of chat sent (Photo or Text) (Fig. 6).

The majority of text and photos shared are related to monitor student activities during the classroom (Fig. 7). Note that photos of various activities were used to veryify both adherence to the activity and the attendance. Other text communication includes queries from the teacher or coordinators. Photo shares also include participatory learning activities such as sustainability education, value education, yoga and community engagement that raise the social and health awareness among parents and community members.

The number of chat messages related to attendance and the amount of interaction between coordinators and teachers were strongly positively correlated. (r = .79, p = .02).
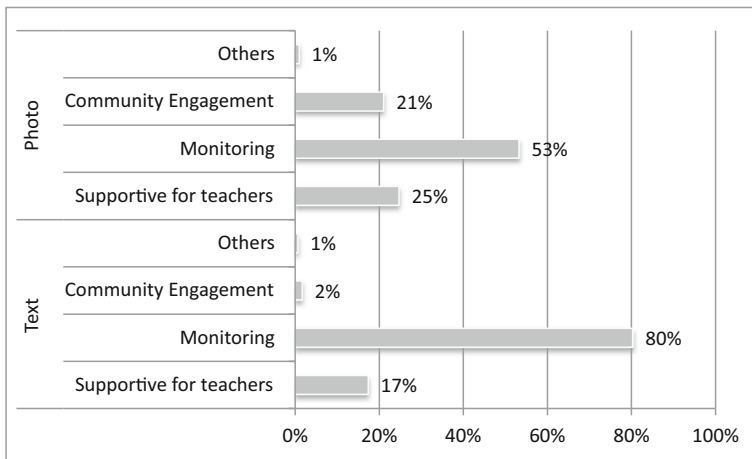
Fig. 6 Categorization of chat type (Photo or Text) mapped to Objectives

This indicates that higher the interaction between coordinators and teachers, more will be the number of chats for attendance.

Messages from the central coordinators include directions and reminders to cluster coordinators regarding visits to villages. To encourage teachers to post without inhibition, coordinators are encouraged to praise in public. Where warnings are concerned, the first two are given to the teacher privately, after which it is in the public group.

Of the 8968 total chats, about 22% ($n = 1932$) corresponded to providing guidance, motivation, assistance, pedagogical content, and problem resolution, which suggests that the AmritaRITE environment is conducive to promote a positive and supportive environment.

Training and building a process for teacher monitoring and accountability has resulted in better attendance of both teachers and students and more streamlined and predictable execution of planned activities.
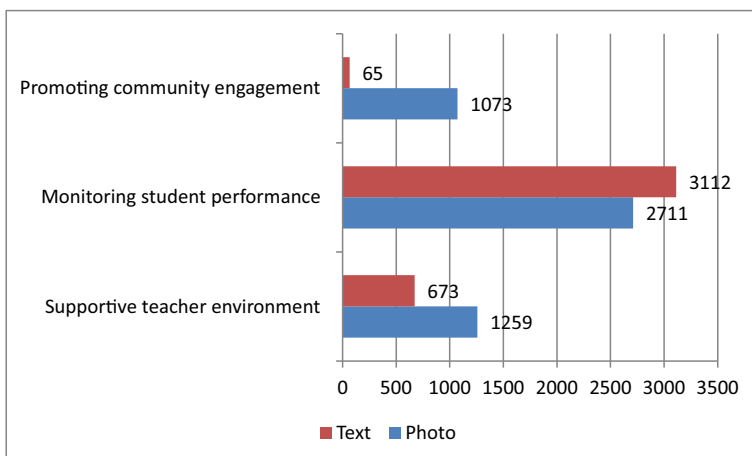
Fig. 7 Chat type mapped to objectives

6 Conclusions

While mobile technology is now accepted as a transformational tool in improving the quality of education for rural children, it has not been used in monitoring and mentoring teachers. Compared to current methods of monitoring teachers in rural India that use external committees or technology such as cameras, AmritaRITE's incorporation of mobile technology puts reporting in the hands of the teacher, empowers them with more information and best practices and enables immediate feedback and intervention.

Though many programs use whatsapp for sharing and communication, this methodolgy is unique in that it uses an integrated monitoring system with a set of android apps and whatsapp to implement a process that tracks both teacher and student attendance, adherence to planned activities and encourages peer learning. Hence, the online communication is designed with the specific goals of improving teacher and student attendance, improving the quality of teaching through remote support of materials, adherence of planned activities and monitoring student performance through the assessment apps.

Our objectives of classroom monitoring, supportive environment to teachers and community engagement improved with the integration of monitoring apps along with social media tool WhatsApp. The majority of app-related communications focused on monitoring class activities followed by providing support to the teacher. Community engagement was generally limited to once a week and hence this had the minimum communication. Participants were very comfortable using WhatsApp with minimal training and more often they used photo than text to communicate.

The AmritaRITE method has increased teacher attendance, peer learning and adherence to planned activities. Feedback suggests that it boosts their interest and engagement in teaching as they can share new learning resources for the students with the aid of technology. This helps teachers improve performance by receiving learning modules from experts, getting immediate answers to their queries and sharing ideas with peers, thus providing both pedagogical knowledge and classroom strategies.

An unexpected benefit of the monitoring systems was a reduction in the frequency, and thus cost, of field visits. The monitoring methodology that included structured teacher and coordinator systems, along with proprietary monitoring apps and WhatsApp together allowed multiple layers of cross-verification so as to more effectively monitor the classroom.

Though there was some initial resistance to the daily monitoring as it involved more work, teachers started valuing the online support as it improved the teaching and learning outcomes. Though the monitoring is for the entire classroom activities, the teacher attendance is automatically tracked as the teacher sends multiple reports each day, along with weekly reports by visiting coordinators. As achievement at each center was acknoledged to the entire group, teachers reported an increase in motivation.

Our policy recommendations for small government schools in rural India include actionable consequences to teachers based on teacher accountability and absenteeism. As parents are worried that raising issues will negatively impact their child, there should be easy methods for anonymous input of teacher performance from community and parents. A multi-pronged school monitoring policy that includes mobile technology, along with monitoring, support and feedback from heads of schools, teachers, parents and local community committees would be highly effective. Multiple low-cost

channels for rural classroom monitoring that include customized apps, social media such as WhatsApp, along with periodic planned and surprise field visits, can help enforce accuracy in reporting and accountability, empower teachers, and improve the quality of education overall.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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