Smartphones: A Catalyst for Tobacco Control Training in India

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Abstract: The tobacco crisis confronting low- and middle-income countries (LMICs) requires scale-up of effective tobacco control programs, such as Tobacco Free Teachers-Tobacco Free Society (TFT-TFS). We previously demonstrated the efficacy of TFT-TFS in increasing tobacco use cessation among teachers and schools' adoption of tobacco control policies in Bihar, India. To scale TFT-TFS, we are now pioneering a smartphone-based mobile learning strategy to train principals (or their designees) in Madhya Pradesh to implement and monitor TFT-TFS in schools. Research underscores the transformative potential of mobile learning: a flexible, scalable, and cost-effective alternative to in-person training methods. Our study is a unique opportunity to test a training approach that could have implications for wider and more efficient delivery of other public health programs. The strategic use of gamification and digital storytelling enhances the TFT-TFS mobile training app. Gamification mechanics—including points, leaderboards, and digital badging—foster a dynamic learning environment to enhance learning outcomes. This approach propels continuous participant engagement toward understanding and implementation of TFT-TFS's six monthly themes and four program components. The TFT-TFS smartphone training program weaves in elements of Indian culture, notably the symbolic use of colors and kites. The Indian kite festival celebrates communal harmony through healthy competition. Similarly, the app employs the idea of school kites, which are divided into six blank segments corresponding to the TFT-TFS monthly themes. Participants navigate each module, engaging with animated videos, digital assessments, and interactive activities. Upon a principal's successful completion of each monthly theme's program components, the school's kite receives a new color, unlocking the subsequent theme. The TFT-TFS smartphone training showcases a unique interactive mobile learning application that integrates gamification and tests how to scale up an effective tobacco control program in schools in India and other LMICs. The TFT-TFS smartphone-based training app may also have relevance to other public health-related training efforts in resource-constrained areas.

Keywords: Smartphones, Training, Tobacco control, Gamification, Schools, Mobile learning

1. Introduction

Tobacco consumption is the world's leading cause of preventable diseases and deaths (World Health Organization, 2011). In India, the world's second-largest consumer of tobacco, 29% of people aged 15 and above smoke or use smokeless tobacco (Tata Institute of Social Sciences, 2018), with notably low cessation rates (Jindal et al., 2006; International Institute for Population Sciences, 2010; Thankappan, 2014). Each year, approximately 1.2 million people in India die from tobacco-related causes (Jha et al., 2008; Sinha et al., 2014). India also has the highest oral cancer rate globally (Reddy and Gupta, 2004; Gupta et al., 2014). Reducing tobacco-related mortality in India and other LMICs requires scale-up of effective tobacco control programs (McMichael, Waters and Volmink, 2005; Siddiqi, Newell and Robinson, 2005)—such as *Tobacco-Free Teachers, Tobacco-Free Society* (TFT-TFS) (Sorensen et al., 2013)—that leverage the power of community leaders and institutions.

Traditional approaches to implement tobacco control programs in LMICs often involve in-person training (Fernandes *et al.*, 2007; Mormina and Pinder, 2018), which brings logistical challenges and variability in delivery that can affect program integrity (Hayes, 2000; Orfaly *et al.*, 2005; Baron, 2006). Smartphone-based mobile training may bridge some of these gaps (Government of India, 2020) when scaling up tobacco control programs, particularly in rural and resource-constrained settings.

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Defined as "learning across multiple contexts, through social and content interactions, using personal electronic devices," (Crompton, 2013) mobile learning on smartphones offers advantages not found in traditional face-to-face educational settings, including: ready access to current content in audio and video formats (Curran *et al.*, 2017); real-time data feedback and tracking; and information sharing among participants and with community members (Anikeeva and Bywood, 2013; Curran *et al.*, 2017). Digital content can be updated and disseminated more quickly and less expensively than printed materials—a benefit particularly relevant to underserved communities (Anikeeva and Bywood, 2013; Baker, Dede and Evans, 2018).

Researchers in India and the United States previously demonstrated the success of TFT-TFS in a cluster-randomized study in Bihar, India. Tobacco use cessation rates among teachers in intervention schools were double those of teachers in control schools (Sorensen *et al.*, 2013), and all schools adopted school tobacco control policies (Pawar *et al.*, 2015). TFT-TFS engages tobacco users and non-users around six themes designed to resonate with teachers' personal experiences, and centers teachers as school and community role models. We tested an in-person training-of-trainers model, leveraging the Bihar Department of Education (DOE) infrastructure (Nagler *et al.*, 2023). However, program scalability faced resource limitations and logistical challenges. These constraints inspired the development of a smartphone-based TFT-TFS training format that could reach a broader geographic area with increased efficiency and enhanced data collection capabilities.

Grounded in the ubiquitous use of smartphones across India, the India/US research team is now examining the utility of a gamified smartphone-based training app for TFT-TFS program implementers, i.e., school principals (or their designees) in two districts of Madhya Pradesh (MP). While in MP the program implementer is referred to as the Program-In-Charge, for clarity, here we will refer simply to the "principal." We are conducting a comparative effectiveness trial using a cluster-randomized design in which principals in MP are randomly assigned to receive TFT-TFS program training in person or via smartphone. Once trained, principals in both groups implement the TFT-TFS program within their schools. Our research question is: Will implementation of the TFT-TFS program, defined as implementing a minimum standard of core program components within the school, be as good or superior (i.e., non-inferior) in the smartphone training arm compared to the in-person training arm? Our study aims are to: (1) Develop in-person and smartphone-based training models based on systematic assessment of contextual factors in MP using the Consolidated Framework for Implementation Research (CFIR)(Damschroder *et al.*, 2009); (2) Compare program implementation fidelity, effectiveness, and cost for the two training models; and (3) Identify factors affecting program implementation after in-person vs. smartphone-based training.

This case study from India describes the gamified TFT-TFS smartphone training app we are testing in MP schools. We describe the development and design of the app; challenges encountered and overcome; measurement of outcomes; and future directions. Finally, we conclude with reflections on how this technology might be adapted to train people who implement other public health-related programs in low-resource settings. We also offer practical insights into scaling up tobacco control and other social impact programs using smartphone technology in schools across India and in other LMICs—a critical step toward reducing tobacco-related diseases and other non-communicable diseases (NCDs).

2. Infrastructure

Setting: Madhya Pradesh, India's second largest state, has a population of over 72 million (Government of India, 2011). Approximately 34% of all adults (50% males, 17% females) (Tata Institute of Social Sciences, 2018) and 21% of school personnel (28% males, 8% females) (Sinha, Gupta and P, 2007) in MP smoke tobacco and/or use smokeless tobacco (Tata Memorial Centre, 2018, pp. 2016–2017). We selected these districts for their high tobacco use prevalence (60% of adult males and 7% of adult females, on average, use tobacco) (Karuppusamy *et al.*, 2021); having rural, urban, and tribal populations, proximity to our local collaborator; and safe roads.

Population: We randomly selected 200 high schools across the two districts and randomly assigned 110 to the smartphone training arm and 90 to the in-person training arm.

TFT-TFS program: TFT-TFS is a school-based program for teachers implemented during work hours for six months across an academic year. With the goal of creating a tobacco-free school environment, TFT-TFS centers on six themes, which the principal delivers one-per-month (following one initial Orientation session): i. Teachers as Role Models; ii. Health Effects of Tobacco; iii. Motivation to Quit Tobacco; iv. Skills to Quit Tobacco; v. Dealing with Withdrawal; and vi. Maintenance and Celebration. TFT-TFS has four core program components that incorporate the monthly themes:

• Theme-based group discussions with teachers, facilitated by the principal

- Cessation support, including sharing a self-help quit booklet and referrals to government resources
- Hanging six theme-based tobacco control posters
- Displaying and implementing a school tobacco control policy

The essential role of teachers in TFT-TFS—voluntary, but encouraged by the DOE—is to become tobacco-free ambassadors by conducting "bonus activities." Bonus activities include: motivating students, family, and community members to quit using tobacco; and sharing information on the harmful effects of tobacco, cessation resources, and the TFT-TFS self-help quit booklet. Recording bonus activities in the app helps the schools' kites achieve height.

Gamification: Utilizing game elements in a non-game environment (Deterding *et al.*, 2011), or gamification, increases motivation to complete tasks (Deterding *et al.*, 2011; Werbach and Hunter, 2012). Researchers have identified more than 200 game "mechanics," or elements that may be employed to engage end users (Peters and Cornetti, 2019). Gamification enhances learning outcomes by increasing motivation, engagement, and retention (Sailer *et al.*, 2017). In the context of health behavior change, gamification has been shown to encourage participation and program adherence (Cugelman, 2013).

Digital storytelling: Digital storytelling is a pedagogical approach that (Smeda, Dakich and Sharda, 2010) presents consistent themes, characters, and story arcs throughout the training. Digital storytelling allows learners to: synthesize the material into their understanding of their daily activities; draw conclusions about how to apply their knowledge; and identify thematic relationships across training materials. As a result, digital storytelling has been shown to increase participant engagement, reduce time to mastery, and dramatically reduce abandonment rates (Hunter and Hunter, 2006).

Formative research: To inform the app design, we visited 23 schools in four districts to conduct a qualitative formative research study. Formative research consisted of 13 focus groups with teachers (4 to 14 participants per group) and 17 key informant interviews with principals in June-July and November 2022. Data collection: Interviews and focus groups were conducted in Hindi by a trained facilitator, accompanied by note takers and digitally recorded, with questions guided by four CFIR domains: innovation (TFT-TFS program and training); inner setting (school); outer setting (state/district tobacco control initiatives and the Clean India Mission); and individual (principals as TFT-TFS program implementers). We also explored principals' mobile usage patterns and preferences, technological familiarity, and awareness and perceptions of gamification. Analysis: Data from interviews and focus groups were transcribed verbatim in Hindi and translated into English. Framework Analysis informed our work, since it is well suited for multidisciplinary teams to enhance credibility and relevance of findings (Smith and Firth, 2011; Iliffe et al., 2015). We followed a five-step process (Bryman and Burgess, 1994) (i) data familiarization, (ii) thematic framework identification, (iii) coding in N'Vivo, (QSR International, 2019) (iv) charting data into themes, and (v) data interpretation. A study team member in Mumbai reviewed all codes and matched them with the CFIR domains to ensure the data were interpreted appropriately. This allowed us to tailor the TFT-TFS content to MP schools and ensure contextual relevance. The Harvard T.H. Chan School of Public Health's Office of Regulatory Affairs and Research Compliance, and the Healis Sekhsaria Institute for Public Health's (Healis) Institutional Ethics Committee approved all study procedures.

Findings revealed that almost all principals and teachers interviewed had Android-based smartphones. They had grown familiar with various smartphone teaching apps during COVID-19, and preferred shorter, animated audiovisuals in Hindi. Further, they recommended the use of a leaderboard to motivate and maintain healthy competition among schools.

We also conducted the Reiss Motivational Profile with six MP principals to reveal what engages them (Reiss, 2013). Principals ranked high on curiosity, honor, idealism, order, and status. Based on these findings, we developed strategies to enhance their learning outcomes by tying game mechanics (e.g., a point system) to these specific motivations. The TFT-TFS training program thus employs a combination of gamification mechanics and digital storytelling to immerse and engage participants in the content.

Kite theme: Based on our formative research findings, we selected a kite-flying motif for our app design and gamification strategy. In Indian society, kite flying symbolizes communal harmony through friendly competition. Colorful kites symbolize a festive spirit, their height depicts achievement, and their flight depicts freedom. The ritual of preparing and flying a kite takes skill that takes time to build; thus, the kite is symbolic of schools' efforts to make their environment tobacco-free—and fosters friendly competition with other schools. In the app, each school is represented by a kite that is segmented into six parts corresponding to the six TFT-TFS monthly themes. A school's performance is gauged by gains in colors and height.

Cultural relevance: We converted in-person TFT-TFS training content into training videos using Vyond or Camtasia, which allowed the study team to design a creative, customizable, and immersive environment. Informed by our formative research, we created characters and stories in Hindi that align with local MP culture and representation.

App usability testing: We selected Nielsen's Usability Framework (Nielsen, 1993) to guide usability testing because it is a well-established, user-centered, practical framework to help us ensure the app was easy to navigate and accommodated principals' preferences that were identified through our formative research. We conducted three rounds of usability testing. The first two rounds were with the India/US study team and other Indian researchers at Healis. After revising the app based on their feedback, we conducted a third round of testing with five principals from the study districts in MP. Using a "think aloud" technique, principals performed specific tasks and provided feedback about challenges faced and potential solutions to improve the app design and functionality.

TFT-TFS training app: The app login screen (Figure 1) features the image of "Aadarsh Vidyalaya" (The Ideal School), emphasizing TFT-TFS's aim to help schools create a tobacco-free environment. The app is divided into three sections: (1) The "Principal's Journey" provides access to gamified training content and the four core components for each theme; (2) the "Teachers' Journey" helps teachers track their bonus activities; and (3) the "Dashboard" displays a school's progress in comparison to other schools.



Figure 1: Login screen with the idyllic school image

Principal's Journey: The home page features a map of MP (see Figure 2) with the themes plotted on it to simplify navigation. The Orientation module at the beginning of the journey map provides an overview of TFT-TFS, app features, scoring, navigation, and animated videos offering insight into tobacco use in India. To track how well principals understand the content, they are asked to take a brief three-to-five-question quiz after each video. This process of verifying participant's knowledge is repeated throughout the app. Upon completion of the Orientation, the school is awarded an outline of a kite divided into six segments, with each segment representing a TFT-TFS theme.

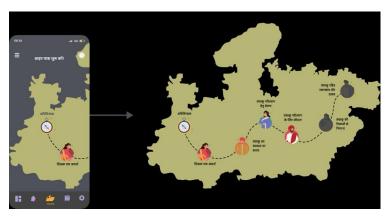


Figure 2: App home page and the full map of Madhya Pradesh when swiped

All themes are similarly structured. The principal first views training videos that explain the theme. For instance, Theme 1, titled *Shikshak ek Aadarsh* (Teacher as a Role Model), features a video narrating the story of a teacher who raises awareness about tobacco's harmful effects after a student drops out due to family circumstances related to tobacco use. After completing a quiz, principals download a guide to facilitate the first theme-based group discussion with teachers, and instructions for implementing the theme's other three program components (i.e., sharing the quit booklet, hanging the theme-based poster, and displaying the school tobacco policy). Additionally, the app guides principals in encouraging teachers to conduct bonus activities in the school, family and community.

To document component implementation, the principal completes a form and uploads a photo (e.g., of a poster on a school wall). Once a school completes Theme 1, the school kite gains the color blue. Similarly, after completion of Theme 2, the school kite gains orange, and so on, until the kite is filled in with the six colors.

Each theme's module has its own landing page. Content is organized in a carousel-style display that allows the learner to swipe and see viewed and unviewed content within the theme. Users can navigate back to previous content or activities at any time. The app also delivers weekly push notifications to motivate principals to complete their monthly activities.

Teachers' Journey: Teachers begin by watching the TFT-TFS program overview video outlining the six themes and four program components. The video illustrates how the themes are connected to the game of kite flying and how schools can score points. Upon completion of these videos, teachers are encouraged to conduct bonus activities with students, fellow teachers, friends, and community members and record their actions on their smartphones. Each bonus activity has a recording form. The bonus activities remain the same throughout the six monthly themes.

How schools score points: Implemention of the four core program components—alongside teachers' bonus activities—earns schools points and determines a school's standing in the kite flying game. Points range from two to six per activity, with a maximum of twenty-four points per theme achievable for the school. If a single teacher completes the activity, the school scores two points, while if 100% of the teachers at the school complete the activity, the school scores a maximum of six points. So, the combination of core and bonus activities within each theme offers schools opportunities to score in the game, with greater activity completion indicating greater implementation within the school and community.

Dashboard: The dashboard (Figure 3) is divided into four tabs that track the progress of every school: Kite Page, Bonus Activities Page, Leaderboard, and Scoreboard. The Kite Page offers a summary of program component completion per theme, displaying the earned colors on their kite. The Bonus Activities Page displays all bonus activities conducted by teachers. The Leaderboard displays the top five schools in the district, represented by their kites flying highest in the sky. Finally, the Scoreboard lists all district schools, ranking them based on score.

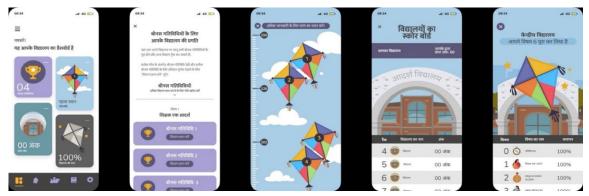


Figure 3: Dashboard with bonus activities, leaderboard, and school kite

3. Challenges

In designing the TFT-TFS smartphone training, we encountered challenges that became opportunities to improve the app's feasibility and acceptability.

For example, principals expressed concerns about the amount of space the app might take on their phones. In response, the team developed training content using highly compressed video and images to limit the amount of space the app requires. Principals also faced internet outages or lack of internet services, particularly in very

rural areas of MP. In response to this contextual challenge, the training content (videos, etc.) was built natively into the app so users can access the videos even without internet connectivity.

Users experienced the app's hiccups in the pilot phase. For example, users initially struggled with the one-time code login or could potentially get kicked out of the app and be forced to log in again. We resolved these bugs before uploading the final version to the Google Playstore.

After years of partnership, our India/US multidisciplinary team has extensive experience working across India to carry out public health research. However, our team was unfamiliar with app usage and internet constraints in rural or tribal MP. To gain contextual understanding, we conducted formative research as described earlier, which included visits to rural and tribal schools to meet with principals and conduct group discussions with teachers. We also received feedback from end users (e.g., principals) and study team members as we developed the app to ensure user-friendliness and relevance for a primarily rural/tribal audience (see *App usability testing*). The team tailored the app in response to user feedback. This involved revising visuals and grammar to the local context; adjusting the aesthetics of the animated characters; and making app functionality more efficient. The formative research and subsequent tailoring of the training app are critical study phases required to enhance participant learning outcomes, personal and cultural relevance, and sustainability.

4. How the Initiative was Received by the Users or Participants

We will conduct a qualitative assessment of the implementation experience in Summer/Fall 2024. However, we learned anecdotally through discussions with principals and their comments to a TFT-TFS WhatsApp group that they appreciate the healthy competition the training app has generated. As one male principal said after completing Theme 3, "My school's kite is at the first position since the beginning of this program. Our teachers are very motivated with this. Thank you for bringing this program to us." Another male principal commented after completing Theme 4, "My school came at 2nd position this time, but I assure you that next theme onwards we will come in the 1st position." Participants also commented that having audio-visuals in Hindi is essential. Finally, a female principal expressed her overall satisfaction: "The app and the program are good, and the leader board is quite a motivating factor. We will keep progressing in the program."

5. Learning Outcomes

The primary learning objective of this initiative is to determine if principals can implement TFT-TFS in their schools following smartphone-based training. To document implementation, principals record on their smartphones: 1) completion of the four core program components for each theme; 2) photos displaying theme-based posters and the school tobacco-control policy; 3) quit booklet distribution; and 4) date, time and number of teachers attending each TFT-TFS group discussion. Teachers track bonus activities on their phones.

Measures: We will assess implementation of each program component and then examine the percentage of schools implementing all four components. Implementation will be a dichotomous measure (successfully vs. inadequately implemented). A school will be coded as having successfully implemented the program if: 1) discussions with teachers addressed at least three of the six themes; 2) cessation materials were shared with all teachers; 3) at least three of the six theme-based posters were hung; and 4) the tobacco policy was posted. We will create a summary measure; if a school did not meet these implementation criteria, it will be coded as inadequate implementation. **Analysis:** The school will be the unit of analysis, and all implementation measures will be assessed at the school level. Implementation will be compared by estimating the difference in successful implementation proportion for the smartphone-based vs. in-person training groups with a 90% confidence interval.

dentifying factors affecting program implementation: In August and September 2024, we will qualitatively identify factors underlying observed variations in TFT-TFS program implementation. Based on our prior research (Aghi et al., 2016; Nagler et al., 2020;), we selected factors expected to influence implementation of TFT-TFS that are relevant to the DOE and that can inform future scale-up efforts. These include factors related to: 1) the TFT-TFS program and smartphone training app features and functioning; 2) DOE leadership support for TFT-TFS and the smartphone training app; 3) compatibility of the TFT-TFS program and its training app with school processes; and 4) principals' ease of using and perceived effectiveness of the TFT-TFS smartphone app. This will deepen our understanding of contextual factors associated with using the TFT-TFS smartphone training app.

We will select principals from rural, urban, and tribal schools and DOE leadership to participate in interviews and focus groups. Along with the topics above, we will ask open-ended questions about their implementation experience and TFT-TFS program tracking on smartphones. Additionally, we will invite principals to propose

solutions to implementation challenges and to make recommendations for future use of this e-learning technology.

Findings: We are gathering implementation data and expect to have final results in 2025. Based on data collected in the app, preliminary findings indicate that 96/110 (87%) of the principals assigned to the smartphone training arm completed the Orientation session on the TFT-TFS training app. This indicates their ability to download the app, log in, interact with content, and complete quizzes.

6. Plans to Further Develop the Initiative

Gaps in the literature addressed by the TFT-TFS smartphone training: The TFT-TFS smartphone training study addresses several gaps in mobile learning literature. First, previous studies have not examined mobile apps that are culturally adapted and that use gamification to improve user engagement and effectiveness. Research by Gonzalez and colleagues (Gonzalez et al., 2021) demonstrates the potential of mobile health or "mHealth" interventions, but also stresses the need for culturally-tailored and personalized content that resonates with intended users. The TFT-TFS smartphone training includes cultural elements like the Indian kite festival in its design. Second, the app focuses on training school principals to implement and monitor a tobacco control program, recognizing a need to involve school leadership in health programs (Leksy et al., 2024). The TFT-TFS app meets this need by offering a scalable eLearning technology tailored specifically for principals, making it adaptable for school leaders across various regions. Finally, most mobile health research in India has concentrated on urban areas, leaving rural and tribal populations underrepresented. This is a significant oversight, as these communities often have higher tobacco use rates and distinct cultural practices (Gaidhane et al., 2011; Mohan, Lando and Panneer, 2018). We addressed this gap by selecting a primarily tribal district in MP to implement the TFT-TFS smartphone training.

Future plans: Future directions to develop the initiative include expanding TFT-TFS smartphone training across MP and to other Indian states and LMICs. We expect our results may help guide schools and departments of education to tailor TFT-TFS trainings to the local context and pinpoint specific factors associated with implementation success. As India expands digital technology, this initiative will also contribute new evidence supporting smartphone-based training and learning models. Ultimately, we expect to positively impact tobacco control by evaluating how smartphone-based training can be used to scale up implementation of tobacco control programs and reduce tobacco use and related deaths in resource-constrained areas, including other LMICs.

Additionally, we will explore how smartphones can be used to train program implementers to address other pertinent health issues in LMICs, such as the rise of NCDs, including cancer, heart disease, and diabetes. More than 75% of annual deaths attributable to NCDs occur in LMICs, disproportionately affecting the people in these countries (World Health Organization, 2023).

The overall concept, design, and architecture of the smartphone app can be modified to address a broad variety of issues and audiences. Designers would need to analyze the technology needs and preferences of the intended audience to build and deliver a culturally and linguistically relevant app. They would also need to modify the app content for the language/s and health literacy of the user population (Coughlin *et al.*, 2016). For example, if the app were adapted to train implementers of an adolescent diabetes program in Mexico, designers could use a *luchador* (brightly costumed Mexican wrestler) theme. Designers could create a digital story in which the user takes on the luchador persona and engages in a series of "matches" as they progress through the training app.

7. Conclusion

The TFT-TFS smartphone training showcases a unique interactive mobile learning application that integrates gamification and shows how to scale up a tobacco control evidence-based intervention in schools across India. The smartphone-based training app can also be applied to address other pertinent health issues, as well as implement ongoing programs, such as the School Health and Wellness Program in India and in other LMICs.

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