

Levine, David I.; Riggs, William; Steffen, Kelsey

Article

Rapid prototyping a school-based health program in the developing world

Development Engineering

Provided in Cooperation with:

Elsevier

Suggested Citation: Levine, David I.; Riggs, William; Steffen, Kelsey (2017) : Rapid prototyping a school-based health program in the developing world, Development Engineering, ISSN 2352-7285, Elsevier, Amsterdam, Vol. 2, pp. 68-81, <https://doi.org/10.1016/j.deveng.2017.04.001>

This Version is available at:

<https://hdl.handle.net/10419/187790>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by-nc-nd/4.0/>



Rapid prototyping a school-based health program in the developing world



David I. Levine^a, William Riggs^{b,*}, Kelsey Steffen^b

^a University of California, Berkeley, United States

^b Cal Poly, San Luis Obispo, United states

ARTICLE INFO

Keywords:

Hygiene
School-based health intervention
Sanitation
Behavior change
India

ABSTRACT

Basic sanitation and hygiene can prevent roughly a million deaths a year. This study examines the rapid prototyping of a pilot school-based handwashing, safe water, and sanitation program in Chennai, India. Our content analysis identified challenges in the classroom (Localization; Curriculum supplies; Program implementation; Communication and language; and Teacher commitment), factors outside the class but within the school (School administration and support and Hygiene and sanitation facilities and supplies) and factors outside the school such as family and slum conditions. We report on the pilot, the barriers it faced, and the changes we made in pursuit of a sustainable school-based health program.

Low-cost preventions such as washing hands with soap and improved sanitation can save millions of lives a year (World Health Organization, 2009; WaterAid, 2012). While standard health interventions typically provide supplies and/or information, they usually lead to only modest behavior change (Aittasalo et al., 2012).

These limitations on the impacts are to be expected: People in public U.S. restrooms do not usually wash hands after defecating, and (until recently) doctors in U.S. hospitals usually did not wash hands between patients. But in both cases, individuals are more likely to use soap if they knew someone was watching (Pittet et al., 2004; Harris and Munger, 1989; Gaby et al., 2009)—changing norms being an important complement to supplies and information. Consistent with this literature, we have created a curriculum of games, stories and vivid activities to teach about and to change norms about handwashing, safe water and sanitation. Our target audience is elementary school students (though most materials work for lower secondary students) living in poor communities. This study reports on a pilot of that school-based health, hygiene, and sanitation curriculum.

The pilot took place in five schools in Chennai, India, a city of over 4 million people. The piloting involved multiple cycles of rapid prototyping and improvement of the curriculum (Collins and Chambers 2005; Chou et al., 2013). The team tried out a variety of educational materials, revised the materials and presented them several other times in different classes and schools. Some materials went through up to 5 revisions. The pilot intervention accomplished its goals of helping improve the intervention, leading to short-run behavior change such as handwashing with soap (sometimes), and helping us understand

barriers to scaling this program.

To help understand these barriers facing our curriculum, we conducted a content analysis on qualitative observations recorded during the pilot program. These observations can inform other community-and-school-based health programs. We conclude by discussing how we continued to revise the curriculum to address those barriers, continuing to use rapid prototyping, as we continue to develop a more sustainable version of the curriculum (as of 2016 under development in Tamil Nadu and New Delhi).

1. Literature review

Every year, large amounts of resources are spent implementing community-based health programs, yet few of them continue after the initial implementation period (Shediac-Rizkallah and Bone, 1998). The greatest challenge to the implementation of a sustainable health intervention program is behavior change (WaterAid, 2012).¹

Behavior change is more likely to succeed when there is an understanding of what motivates, facilitates, or prohibits hygienic behavior (Curtis and Cairncross, 2003). Previous studies, have identified motivators for behavior change to include the need to protect children, the need to conform to family or group norms, comfort and convenience, pride, disgust, dignity, economics, and existing cultural beliefs. This list goes far beyond the benefits of good health as a result of improved hygienic practice (WaterAid, 2012). John Oldfield, suggests there needs to be a change in the cultural perception of sanitation practices in India, which is consistent with the results of (Bennett et al.,

* Corresponding author.

E-mail address: wriggs@calpoly.edu (W. Riggs).

¹ Slow behavior change in health behaviors is consistent with findings in other fields regarding the relationship between the intervention and behavior shift (Heyman and Ariely, 2004; Riggs, 2015; Riggs and Kuo, 2015) as well as established theory on the ecological model for health behavior (Sallis and Owen, 2015).

<http://dx.doi.org/10.1016/j.deveng.2017.04.001>

Received 29 March 2016; Received in revised form 12 October 2016; Accepted 3 April 2017

Available online 13 April 2017

2352-7285/ © 2017 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

2014) that beliefs in non-pathogenic theories of disease can impede uptake of safe behaviors. People need to be motivated to preserve their dignity and avoid shame from practices such as open defecation (Bliss, 2015), particularly in settings where many people consider open defecation cleaner and at least as sanitary.

In late 2014, the Prime Minister of India, Narendra Modi launched the Clean India Campaign, pledging that every Indian household will have a toilet by 2019. Unfortunately, even when sanitation supplies, such as toilets, have been provided, many people are unwilling to use them. (Sethuraman, 2012). In a recent study of 32,000 rural households, half of the respondents believed that defecating in the open was the same or better for health than using a toilet (Bliss, 2015; Coffey et al., 2016). More generally, while the campaign has led to millions of new toilets, there is limited public attention to the health problems from lack of safe sanitation (Sethuraman, 2012) and little emphasis on maintenance or education (Gahlot, 2015). Addressing the sanitation crisis not only requires proper sanitation infrastructure, but also a societal awakening about the costs of the sanitation crisis, and the burdens the entire country bears (Bliss, 2015).

1.1. School-based health, hygiene, and sanitation programs

Schools are potentially well-suited for health and hygiene interventions as they are often hubs for fecal-oral diseases and are also a site where teachers can integrate health education into daily lessons and practices. Schools may also facilitate knowledge sharing among students. Schools are also ideally situated to establish new norms among students and to implement routines. It is plausible that instilling new behaviors is most effective for younger children (Aarts et al., 1997).

The benefits of school-based programs can extend beyond the students. Often in developing countries, young students are tasked with the responsibility to care for younger siblings, and can influence those siblings and possibly the entire family's hygiene practices (Ozier, 2014; WaterAid, 2012). Unfortunately, little attention is currently paid to sanitation programming in schools, despite the evidence that these programs can improve students' lives (World Health Organization, 2014).

1.1.1. Facilities and supplies

Schools often lack basic facilities for safe behaviors, including water for handwashing, safe water for drinking, and enough working toilets (ideally with separate facilities for girls [Snel, 2003]). Hardware is necessary, but not sufficient, as there also must be maintenance (such as keeping toilets working, changing elements in water filters), cleaning (especially of toilets), and a steady stream of supplies. Most obviously, while some school-based programs assume soap is available (Curtis and Cairncross, 2003), many schools lack soap (Biran et al., 2009).

Educational programs also often call for educational materials to be available on the school premises. This presents additional barriers, where teachers and program implementers need to bring supplies themselves. It is also a challenge to make educational supplies inexpensive and well adapted to the local conditions (WaterAid, 2012). Without proper materials or supplies, many programs fail, especially when the initial program stops, and outside sources no longer provide and/or monitor the supplies (IRC, 2007).

1.1.2. Behavior change for teachers and school administrators

Previous programs have also often encountered barriers within the school such as a lack of training for teachers, lack of educational methods that are child centered, no organization within the school to support the implementation, and a lack of student supervision (Snel, 2003). The importance of teachers has been highlighted in several studies implementing hand-washing lessons in rural India, with high teacher involvement increasing students practicing personal hygiene activities (Dongre et al., 2007).

Low support for implementation by school institutions is one of the

key factors contributing to the failure of school health and hygiene programs (IRC, 2007). The lesson and activities presented in most programs are not familiar in practice to the teachers or school staff. Without sufficient support from the school to supply basic materials that reinforce the lessons, and basic hygienic practices, even the most motivated of teachers have struggled to implement programs on their own (Gachuhi, 1999; Gatawa, 1995).

Thus, most long-running programs in a school or other community environment have only done so with someone outside the community facilitating, funding, and continually evaluating the progress of the program (Minkler, 2005). Determining methods of monitoring, collecting data, and evaluating the level of sustainable change is one of the greatest challenges that face program facilitators (WaterAid, 2012). There is still very little information regarding program longevity and behavior change following the initial program implementation period (Fewtrell et al., 2005).

1.2. Rapid prototyping

While this list of obstacles is familiar from around the globe, addressing these barriers (and identifying new ones) requires local knowledge. Thus, we use community-based and participatory design (Corburn, 2005; Collins et al., 2005; Minkler et al., 1997; Minkler, 2000) coupled with rapid prototyping (Leung et al., 2004; Byrne and Sahay, 2007). This approach involves our team working with local teachers and students to modify our curriculum repeatedly to better suite users' needs and local conditions.

2. Intervention and research methods

2.1. The curriculum

The purpose of our pilot was to teach basic health and sanitation behaviors to children through interactive games, stories, and songs. Lessons focused on prevention of diarrheal disease by demonstrating the importance of washing hands with soap, drinking clean water, and using toilets. The intervention was based on all theories of learning and of behavior change that we thought might apply: rational decision-making, the importance of habits and routines, social relationships, and the role of vividness and reminders (Aunger et al., 2009; Ajzen, 1991; Godin and Kok, 1996; Bandura, 2004; Wakefield et al., 2010; Umberson and Montez, 2010).

The stories and games are engaging because they are based on *conflict* between pathogens and people, they focus on disgusting things like *poop* (which interests young children), and they *relate to students' lives*.

3. Constructing the curriculum

3.1. Heuristics for creating activities

To construct the curriculum, we used several heuristics: Existing materials that taught these health lessons, the core health lessons as creativity prompts, adapting existing activities to our lessons, using existing activities as creativity prompts, and "Be the germ." For each prompt and each candidate activity, we looked for ties to our several theories of behavior change. For example, we tried to increase how vivid each activity was, how closely it related to students' lives, how it promoted norms of safe behaviors, and so forth.

3.1.1. Existing teaching materials that taught these health lessons

We reviewed all WASH teaching materials we could find. Sources included teaching materials from Community-led total sanitation, other NGOs such as CAWST and SODIS Foundation, books for U.S. children on handwashing (e.g., Cole, 1989) and advice on the web for parents and/or teachers (e.g., KidsHealth.org (Nemours Children's

Health), www.onteorak12.ny.us, and Bagby et al. (1996)). In reviewing content, we used criteria based on our theories of learning and behavior change.

The glitter game, for example, is a standard way to show how germs and fecal contamination spread from one hand to another surface such as someone else's hands or body (National Theater for Children – Health Education).

Some solutions such as soapy bottles and ORS (oral rehydration solution) already existed. It was straightforward to create instructions in the curriculum.

Community-led total sanitation inspired Levine by showing how to combine health lessons with vivid and disgusting content. For example, CLTS presenters gather human feces on a piece of wood during a walk around the village and leave some near some food as they meet with villagers. Villagers soon note (with strong disgust) flies traveling from the feces to the food. Levine adapted this demonstration into a less realistic “poop and flies” simulation in a classroom, using a simulated “fly” attached to a stick to fly between white yogurt (representing food) and a mixture representing open defecation (such as peanut butter and soy sauce).

3.1.2. Health lessons as prompts

The health lessons we wanted to teach were important sources of prompts. At the same time, we wanted lessons that met the criteria of our theories of learning: Vivid, promoting disgust, fun for students, and so forth.

Based on both the health lessons and the desire to promote a vivid understanding that untreated water—even when it comes out clear from a pipe—is often contaminated, Levine and colleagues in Bangladesh created the “Disgusting box” to mimic how feces enter water pipes (Jannat et al., 2017). Levine looked at the famous “5 F” diagram showing how feces are transmitted to someone's mouth by flies, fluids, fingers, feet and foot and thought it resembled a board game. The resulting game, The Germ Race, then became the basis of a story “Gerry the Germ.”

We wanted to promote safe behaviors at home. We faced a constraint that in the target communities it is not appropriate for students to tell their parents how to behave. Thus, we introduced letters from the teacher to parents asking parents to report on the students' safe behaviors at home. We did not anticipate these letters would produce high-quality data. Instead, their goal was to spark a conversation so the parents learn about how fecal contamination

spreads when they do not wash hands with soap, treat drinking water, etc.

3.1.3. Adapting educational activities from other domains to health lessons

Some educational activities such as making posters can fit a variety of educational goals. Thus, we adapted the star charts for a classroom and for a school and the art activities (poster, song, skit or story). Levine found existing version of each activity and then customized them for the health topics. We created simplified instructions. We then wrote prompts related to each topic; for example, suggesting a poster, skit or story could show how flies spread poop, or the shame of not washing hands with soap.

3.1.4. Existing activities as creativity prompts

Sometimes existing stories and activities unrelated to health served as prompts to design new activities.

Levine read hundreds of folk tales from India, Africa, Aesop, the Grimm brothers, and so forth. He also reviewed hundreds of board games, card games, outdoor games (such as tag and hopscotch) and ice-breakers.

Table 1 shows some of the source materials and how we adapted them. For example, Levine found existing “class participation” stories for pre-literate students, and wrote class participation stories for Hygiene Heroes. He found simple stories for early readers (Ness, 2007) and wrote simple stories for early readers (e.g., “Hand is clean. Hand is happy. Mud is on hand. Hand is sad. Hand washes with soap. Hand is clean. Hand is happy.”) (Levine, 2014).

3.1.5. Heuristic of extension

As it evolved, the curriculum became its own prompt. When an activity seemed promising for one chapter, we extended it to other chapters. Thus, most chapters had a very similar class participation story, a variation on Germ Tag, a version of the Tapatan simple strategy game), a board game, and an illustrated story. Most chapters had a “making” project (such as soapy bottles or ORS), so Levine added the fly trap to chapter 3 on sanitation in part so it would also have a “making” activity.

Levine modified the board game “The Germ Race” and the story “Gerry the Germ” that were based on the fecal-oral transmission of germs into the board game “Cold & Flu Germ Race” and the story “Gerry the Germ returns” on the transmission of cold and flu germs.

Table 1
Adapting source material not related to health.

Source material	Appropriated	In our story
Anansi, a west African trickster character	Protagonist / trickster	Monkey Prince
Anansi or bre'r rabbit?	Tricking the snake into letting them tie him to the log	The Monkey Prince
Fairy tale of 3 brothers trying to overcome obstacles	3 brothers facing a challenge, with the youngest succeeding	Gerry the Germ
Class participation stories / rhymes	Rules of class participation: When the reader says a word, she also points to a picture. The class then makes a gesture and/or sound. Rhythm of the story and the minimalist plot	Class participation stories
Games		
Parcheesi board game	Basic rules of the game is a race to move several tokens from base to home	The Germ Race
5F diagram of the fecal-oral transmission (Fig. 3)	Outline of how a germ moves from base to “home” in a Parcheesi-like game	The Germ Race (Fig. 3)
Tapatan, simple strategy game ^a	All of the rules	Soap & Germ
Mille Bornes	Almost all of the rules	Race to Nairobi card game ^b
Outdoor games		
Several forms of tag	All of the rules	Germ Tag (handwashing)
Relay race		Worm tag (sanitation)
Trust activities such as sitting on knees in a circle	All of the rules	Race to safe water
		Activities to show all must work together to be safe

^a “Tapatan,” Wikipedia, <https://en.wikipedia.org/wiki/Tapatan>. Last accessed September 28, 2016.

^b Not tested in summer 2014.

We also repeated some of the prompts for potential stories, songs, art and skits. For example, the units on handwashing, water, sanitation and avoiding colds and flu each had similar prompts about how disgusting it was to do unsafe behaviors that led to consuming poop or snot.

The principle of extension also applied within a chapter. Any powerful image in a simulation or activity became a candidate for a story. As noted above, the “5F” diagram of how germs spread became the outline for the *Germ Race* board game. The poop and flies simulation used by Community-led total sanitation (Kar and Chambers, 2008; UNICEF, 2006) showed up in the “Gerry the Germ” story.

We also converted games to stories. The *Germ Race* board game became the story “Gerry the Germ.” Similarly, the game “Grandma wants you to eat candy” became a story of the same name. (Levine, 2014).

3.1.6. “Be the germ” as a prompt

The primary curriculum designer, Levine, is a teacher and a parent. Thus, his first stories and games had lessons such as “Germs are on hands, so wash with soap.” and “Mosquitos coming, so use your bednet.” His first testers, sons Jeremy and Benji Levine, emphasized that it was more fun to attack than only to defend.

Levine's first response was a card game that let each player both send mosquitoes to attack the opponent (for example) and also put up a bednet to defend. As he worked on this game, he realized it was quite similar to the existing card game *Mille Bornes*. *Mille Bornes* is about a car race, where a player can give a flat tire to another player. Players can have preventions (e.g., a puncture-proof tire) and cures (spare tire). Thus, he ended up adapting the rules of that game to create the card game *Race to Nairobi* (on Hygiene Heroes' website).

Levine's son, Benji, went further and gave the “inverted” heuristic: “Be the germ.” Following this suggestion, Levine designed the *Germ Race* board game where the player is the germ, trying to avoid soap, water filters, and toilets in favor of open defecation, flies and untreated water. As noted above, this game was based on the 5 F diagram (Fig. 3) and was later extended (with Benjamin Levine's help) into the story “Gerry the Germ”.

The team was confident that the “Be the germ” stories and games would be engaging for primary-age students and was fairly confident that these stories and games would convey that germs do not like soap, boiled water, and so forth. It was less clear at what ages students would understand the irony, and not become confused when the germ accused the soap of being mean (for example, see Fig. 1).

The same inversion heuristic led to a story on safely crossing the street, “Monster Maruti” (with Padma Govindarajan). Maruti's are common cars in India, and the Monster Maruti likes to chomp on little kids who do not look both ways before crossing.

3.2. Rapid testing prior to Chennai

The curriculum had several rounds of rapid testing in the United States. Levine tested everything first on a convenience sample of his 2

sons. Their feedback quickly shut down many ideas and improved almost all that remained.

Levine recruited numerous undergraduate research assistants to give feedback and to test the materials on classmates, youth they worked with, etc. Levine and the undergraduate assistants tested some activities in classrooms and summer camps in the United States. Levine taught a 1-unit freshman seminar at UC Berkeley and he and the students play-tested most of the activities. We asked for feedback from any parent, former teacher, librarian, professor or other who was willing to review a story or game. A team at Rochester Institute of Technology developed the *Race to Nairobi* card game. Jenn Kotler did illustrations that we incorporated into many games and stories.

As soon as possible we solicited feedback from those working with youth in poor nations. A head teacher tested handwashing and safe water materials at a primary school in Tanzania. Staff at an NGO working with youth in Cambodia tested handwashing materials. Gautam Srikanth (who was also on the 2104 team in Chennai) tested most of the materials at an urban after-school program in Chennai and at a rural private school/orphanage outside Chennai in the summer of 2013. Two Teach for India fellows, Ganesh Bhagyashree and Divya Sabanagayam taught handwashing and some safe water content in low-income private schools in Chennai.

3.3. The Curriculum in June 2014

The result of this process was a large compilation of activities, totaling over 200 stories, games and activities. Partial chapters covered topics including malaria, household and road safety, immunization and proper use of antibiotics, menstrual hygiene, and dental hygiene.

We decided to focus on the first five chapters, which were the most complete: Handwashing, safe water, sanitation, preventing the cold and flu, and the need to work together to stay healthy. Those five chapters had almost 100 activities to pilot test (Levine curriculum, 2014). Table 2 summarizes the first chapter, on handwashing. The other chapters had a similar mix of stories, games, and vivid demonstrations.

The goals for the summer of 2014 were at two levels. First, pilot test the many activities and create a coherent curriculum. Second, spot problems external to the curriculum itself, to help integrate the curriculum as one component of an effective intervention.

The chapters on safe water, sanitation, and avoiding colds and flu had the same mix of stories, games, art activities, vivid demonstrations and making something (e.g., oral rehydration solution for safe water and a fly trap for sanitation).

3.4. The 2014 pilot

The 2014 pilot was conducted in Chennai, in the state of Tamil Nadu, along the southeast coastline of India. Tamil is the primary language. Only 26% of Chennai's 4-million-plus people have access to safe drinking water and more than one third of the population lack access to toilets and sanitation facilities (Transparent Chennai, 2011).

The program team included one of the authors (Steffen), two other interns from United States universities (one of whom grew up in Chennai and had worked with the curriculum the prior summer), and six interns recruited from IIT-Madras and SRM University Chennai. Steffen and the other U.S.-based intern who was not from Chennai acted as key observers: conducting the qualitative evaluation and helping field test and revise the curriculum.

We piloted the program over seven weeks during July and August 2014 at five schools. Two of the schools were private institutions chosen based on their willingness to participate in the program. In these schools the program team acted as the classroom teachers to implement the curriculum.

“Middle School” (name withheld to ensure anonymity) is an all-girls school, where the language of instruction is officially English, but the



Fig. 1. Gerry the Germ views the soap as mean.

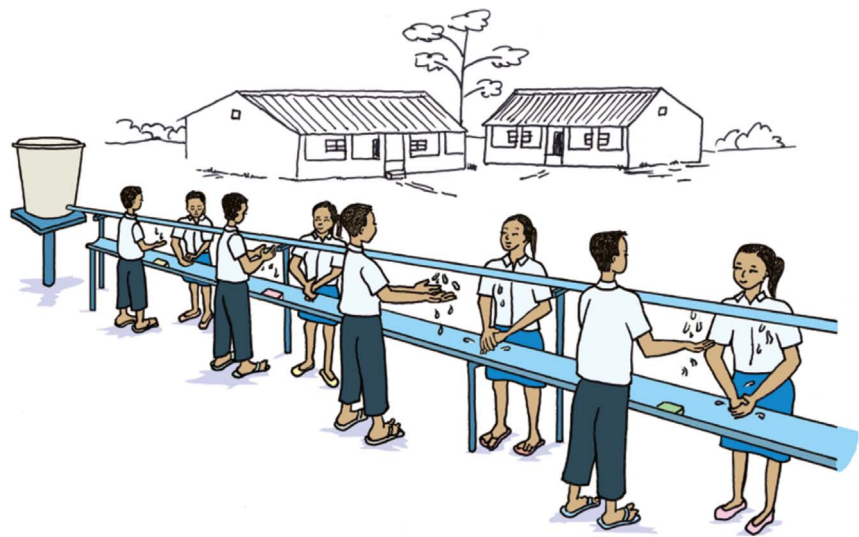


Fig. 2. Ongoing Group Handwashing.

students speak almost no English. Thus, we taught in Tamil. The students who attend this school live in low-income households. Most of the students and their families have either shared community bathroom facilities or no bathroom facilities. The pilot program spent the most time at this school, working with sixth and seventh grades

students two days a week and in five classrooms a day. The program team visited the students in their classrooms during scheduled hours. Often no teacher was present during the visits. “Primary School” is a co-ed English speaking school, with students from upper-middle-income households. These students almost all have

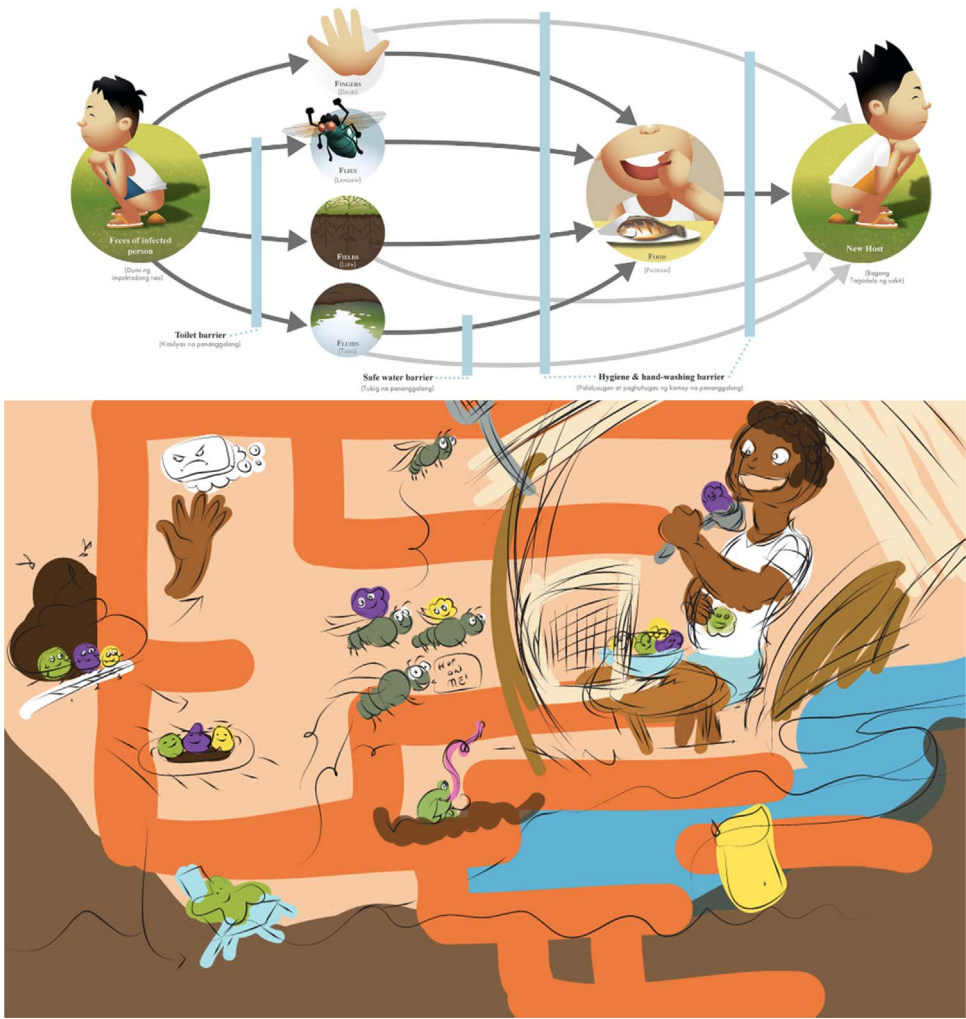


Fig. 3. 5F diagram [Source: https://en.wikipedia.org/wiki/Fecal%E2%80%93oral_route, last accessed September 28, 2016] and germ race game / story graphic.



Fig. 4. The Soapy Bottle.



Fig. 5. Grandma Wants You to Eat Candy (Board Game).

access to toilets at home. The program team visited this school one day per week and taught two sessions per day. The sessions gathered two to three classrooms (so up to eighty students) in a large multi-purpose room. The teachers escorted the students to this room and helped supervise the students.

At both schools a typical session was forty minutes and covered three or four activities. The Tamil-speaking members of the team typically presented the activities (although the U.S. team taught a few sessions at the English-language Primary School.) The Tamil-speaking members also served as translators for the English-only observers. In addition to one or more team member serving as instructor, at least two observers (one or more of whom spoke Tamil) attended each session. Observers recorded information about the activity, the environment, and the students. They also recorded students' health-related behaviors such as handwashing with soap.

The other three schools involved in the pilot included two government-aided public schools, and one low-income private school, all of

whom had a teacher affiliated with Teach for India (TFI). Teach for India is a project of Teach to Lead, placing college graduates and young professionals in under-resourced schools throughout India for two years (Teach for India, 2015). At each of three schools, there was one TFI fellow who volunteered to bring the lessons into her classroom. We received email and phone reports from these teachers. The observations for each of these schools include one or more site visit that included viewing the grounds of each of the school, watching multiple sessions of the program lessons in classrooms, and additional conversations and meetings held between the program team and the TFI fellows.

The TFI fellows who participated in the program received the curriculum early in 2014 (that is, several months prior to the pilot program). They volunteered to teach the material due to an interest in bringing health and hygiene education into their classrooms. Each of the fellows incorporated some of the lessons into her classroom as part of her daily lesson plan.

The first two TFI schools (TFI1 and TFI2) are government-funded elementary schools. At both schools government assistance included uniforms, shoes, supplies, and lunch. TFI1 is a public school attended by children who live in the local slum. These children live in extremely cramped family quarters, and do not have access to clean water or bathroom facilities in their homes or community. At TFI2 the students are primarily from low-income homes and are likely to share bathroom facilities with neighboring families if they do not have their own.

The third TFI school, TFI3, is a privately-run school in the heart of Chennai. The students who attend this school are mostly first-generation students from the nearby slum. These students do not have access to bathroom facilities in their homes or community. This school was in the poorest condition, and provided little support the students. The educational facilities were minimal and the bathrooms filthy.

4. Cycles of rapid prototyping and improvement

For each unit (handwashing, safe water, and sanitation) the team read through the baseline curriculum, selected and grouped activities, revised activities, and then revised them further as they translated. The team then presented around 3 or 4 activities in a 40-min session per classroom to a few classrooms at Middle School, with at least 2 observers taking detailed notes. Often two sub-groups presented in two classrooms in parallel.

The team then met to revise that content. A few days later they presented a revised version of those activities at different classrooms in Middle School. They also presented this revised version at Primary School, often with slight modification due to the younger age of students at Primary School.

As expected some material did not work at all. For example, the fly-trap made at Middle School (based on a design from the preliminary curriculum) caught a mix of insects, but not many flies. This result surprised us, as there was open defecation in a lot adjacent to Middle School.

Almost all other activities worked at least fairly well. At the same time, all activities benefited from revisions. For example, all stories improved when shortened. The stories benefited from editing by both the project team and the TFI teachers.

Sometimes the implementation team combined activities. For example, there was an appealing illustrated story of Gerry the Germ (who wants to get everyone sick! [Levine and Levine 2013]). There was also a not-very-exciting story with class participation intended for pre-literate students, where the teacher reads lines like "Hands are dirty" and all students wave their hands.

The team combined these two activities into a high-energy class participation story, where students in the front of the room held up a poster with a picture for each key word: Hands, Gerry the Germ, Soap, and so forth. The whole class had a gesture and sound for each key word. The interns then re-wrote the Gerry story to be much shorter.

Table 2

Overview of the handwashing curriculum, June 2014.

Activity June 2014	Source	Brief description
Background Objectives for Handwashing Unit Preparation: Needs assessment Introduction for teachers Simulation: Glitter		Explain health and educational burden of diarrheal diseases Explain desired new knowledge, attitudes and behaviors Understand situation to customize the curriculum
Introduction to germs	Adapted from existing simulations (NTC Health Ed.)	Demonstration of how glitter spreads – hinting how germs spread
Story: King Akbar Writes a Law	Adapted from (Nemours; Onteora Sch. Dist. ; Bagby et al.)	Explain what germs are and how they spread on hands
Class participation story: Handwashing	Uses familiar folk tale characters in north India and Bangladesh Inspired by a class participation story Levine observed in his child's school	The prime minister lets the king learn that handwashing with soap is important after using the toilet Teacher reads a simple story and students call out a sound and gesture for key words (SOAP, GERM, HAPPY, etc.)
Demonstration: Proper Handwashing	Adapted from kidshealth.org (Nemours)	Along with the demonstration, we introduced a soapy bottle for each classroom: a used water bottle with two holes poked on top filled with water and 2 cents worth of laundry soap. It can replace a 10 or 15 cent bar of soap, with the added advantage of being harder to steal (Fig. 4)
Demonstration: What is on our hands	Original	Have students wipe their hands after they have “washed” with water and show how dirty the towel becomes
Fig. 5 . Grandma Wants You to Eat Candy (Board Game)	Related to Chutes and Ladders (which was based on the traditional Indian game Snakes and Ladders)	Reinforce the benefits of safe water, sanitation and hygiene behaviors
Soap or Sorry	Closely based on an existing game, Tapatan	A simple strategy game where players move cards “soap” or “germ” and try to make 3 in a row
Outdoor game: Germ tag & Handwashing	Invented independently, but many others had invented similar games	
The Bully (comic)	Original	
Test students' application of their new knowledge	Original	Offer students a treat and see how many recall to wash hands with soap first
Making a Soapy Water Bottle to bring home	As in Saboori et al. (2010)	Students make a soapy bottle to take home
Ongoing Group Handwashing (Fig. 2)	Adapted from UNICEF (2013) , Shordt et al. (2007) and TippyTap.org (Levine curriculum P. 33) Adapted from UNICEF (2013) and Shordt et al. (2007)	Proposes a group handwashing station Proposes routines for handwashing before lunch
Star chart for classrooms	Adapted from a familiar parenting technique	Track success in teaching the lessons, introducing the soapy bottle, and implementing the safe routines
Reinforce the Habit of Handwashing	Adapted from Fogg, 2013 ^a	A self-talk reinforcement for handwashing with soap,
Art activity: Skits	Adapted from Locks et al. (2006)	Students reinforce lessons by explaining (in a fun way)
Art activity: Songs		Students reinforce lessons by explaining (in a fun way)
Art activity: Posters	Adapted from Locks et al. (2006)	Students reinforce lessons by explaining (in a fun way)
Integrate family with letter home on handwashing	Based loosely on STIR Education (2012)	A letter home where parents explain if the child has access to soap, uses soap, etc.
Quiz		
Quiz Game: Place the Steps in Order	Based on familiar educational activity	
Resources on Handwashing		Links to online stories, games, videos, etc.

^a Fogg, B.J., Tiny Habits, <http://tinyhabits.com/>. [last accessed August 26, 2013].

Now the activity was shorter, to the point, and very engaging for the students.

As we hoped, we also learned from the students. The most important case involved the soapy bottles. We had assumed these bottles would remain in the toilet. When we discussed this possibility with the girls at one class in Middle School, they said the soapy bottle would be misused in the toilet, so it should stay in the classroom. At the end of the session the bell rang for lunch. At that moment the lead girl (a role in each classroom) grabbed the soapy bottle and instructed the class to line up. As students left the classroom, they held out their hands and she squired each hand with a bit of soapy water. The students then proceeded downstairs to rinse hands at the tap.

Organizational scholars have long emphasized the power of standard routines (e.g., [Nelson and Winter, 1982](#)). Particularly in classrooms, a routine such as this one that fits in the rhythm of the school day is very promising. This spontaneous innovation is now an important part of the curriculum.

The bottom line was that classrooms implementing the routines had high rates of handwashing before lunch. At the same time, our (admittedly spotty) follow-up found that no school administrators continued to provide soap once the supplies we provided ran out.

The resulting changes to the curriculum made during the summer

of 2014 (or soon after) are outlined in [Table 3](#) on modifications and [Table 4](#) on additions. Not listed is the storyboard activity, where students write and illustrate a short story. We added this activity, but then moved it to a later chapter as part of our drive to simplify the curriculum for teachers by removing alternative art activities.

5. Content analysis

During the summer of 2014 the team focused on teaching and recording observations each day, and revising activities each week. We also wanted to take time to reflect on the larger-scale lessons learned. Thus, we carefully coded all of the notes and performed a content analysis to explore the major obstacles the curriculum encountered.

5.1. Data

During the seven weeks of the pilot program, two “key observers” (Kelsey Steffen and Ricky Williams) kept journals. They recorded observations from the program sessions, time spent at the school, team meetings and planning sessions, traveling to and from the schools, and reflective observations after a full day of implementing the Curriculum. The two key observers recorded observations on teaching sessions with several methods:

Table 3
Modifications to the Handwashing Curriculum, July 2015.

Activity June 2014	Change?	Status July 2015
Background	Kept	
Objectives	Kept	
Preparation: Needs assessment	Moved	Moved to school or district level
Introduction for teachers	Shortened	
Simulation: Glitter	Minor modifications	Converted to use turmeric, which is more easily available
Introduction to germs	Kept	
Story: King Akbar Writes a Law	Modest modifications	Shortened
Class participation story: Handwashing	Major modifications	Changed the king's advisor to Tenali Rama, a more familiar folk tale / historical figure in southern India
Demonstration: Proper Handwashing	Major modifications	Combined with the first part of an illustrated story, <i>Gerry the Germ</i> that was inspired by the 5 F diagram (and taught in unit 3 on sanitation)
Demonstration: What is on our hands	Replaced	Enriched with feedback from an Indian MD
Board Game: Grandma wants you to eat Candy	Cut	The new activity, "What is in our classroom?" is a more vivid demonstration of how poop and germs spread in a classroom
Soap or Sorry	Cut	Very popular, but (1) requires costly colored printing and (2) teachers are not used to teaching with board games
Outdoor game: Germ tag & Handwashing	Cut	Somewhat fun, but low pedagogical value
		Very popular, but teachers do not run PE and are not used to teaching with games. Some schools lack play yards. Also, in this and other games that simulate prevention (in some rounds), when players use effective preventions, the game is less fun.
The Bully (comic)	Cut	Low pedagogical value
Test students' application of their new knowledge	Cut	Requires candy, and we are minimizing supplies
Making a Soapy Water Bottle	Kept	
Ongoing Group Handwashing:		
Hardware	Moved to school level	Teachers cannot create hardware such as the group handwashing station
Routines using group handwashing stations	Major modifications	Based on innovation by students, added routines using the soapy bottle
Reinforce the Habit of Handwashing	Cut	Not piloted as required ongoing cooperation of teachers
Art activity: Skits	Moved	Time for only one art activity / unit, so moved to sanitation unit
Art activity: Songs	Moved	time for only one art activity/ unit, so moved to safe water
Art activity: Posters	Kept	
Integrate family with letter home on handwashing	Major modifications	Divided into 2 letters: (1) Is the child using the soapy bottle he or she brought home? (2) Did the child teach a family member why it is important to wash hands with soap?
Quiz	Kept	
Quiz Game: Place the Steps in Order	Cut	Simpler to give teachers fewer choices
Resources on Handwashing	Moved	Expanded on website.
		Deleted from printed materials to shorten and focus.

The change in **bold**, soapy bottle routines, is the single largest change in the curriculum.

Table 4
Additions to the curriculum June 2014–July 2015.

Activity added after June 2014	Source	Brief description	Status July 2015
Demonstration: What is in my classroom?	Inspired by a public service announcement from Ghana ^a	Students visualize poop and germs from hands not washed with soap spreading all over the classroom	Replacing "What is on my hands?" demonstration
Story: <i>Gerry the Germ goes to School</i>	Based on the handwashing parts of "Gerry the Germ" plus the demonstration "What is in my classroom?"	Gerry the Germ loves it when kids forget to use soap!	Focus only on handwashing, so useful for unit 1

^a <http://www.youtube.com/watch?v=wCvbwW1oEfQ>.

- 1. Individual Raw Observations** were recorded typically on-site and during curriculum sessions. Observers usually recorded these observations quickly by hand to capture all aspects of the sessions.
- 2. Individual Reflective Observations** were recorded either on-site during teaching sessions, or shortly after the sessions had concluded. These observations were recorded both by hand and computer and include interpretive analysis of the initial observations.
- 3. Joint Reflective Observations:** The two key observers recorded these observations shortly after each curriculum session has concluded. During this time, the observers would discuss individual raw and reflective observations recorded during the day.

Observational data was collected while observing the two main intervention schools, while visiting Teach for India classrooms, and during team meetings. One of us (Levine) visited for ten days and

recorded observations at the two main schools and two of the TFI classrooms. Neither Levine nor the two key observers speak Tamil. The entire team also wrote English-language notes on each activity, largely collected by the Tamil-speaking interns.

There were also a complete set of revisions of the curriculum that followed the field tests.² In addition, we reviewed lessons plans and interview notes with the TFI teachers and reports from piloting in a school and an after-school program that Gautam Srikanth carried out in the summer of 2013. (Srikanth also was on the 2014 piloting team that forms the basis of this report).

² The early June 2014 version of the curriculum is at <https://www.dropbox.com/s/bo29xhjajx1ym4/Curriculum%202029.docx?dl=0>, and the revised version from late August 2014 is at <http://hygieneheroes.berkeley.edu/chapters.htmlxx>

5.1.1. Data limitations

There are several limitations to the data collection:

- More than half of the observed sessions were taught in Tamil. The English-only observers collected data based on non-verbal cues and translation during and after the sessions, as well as notes from the Tamil-speaking team members.
- The observers spent much more time at Middle School than at the other schools.
- The observers were also implementing the curriculum, permitting unconscious biases.
- Primary School had significantly higher socio-economic standing than the other schools.
- The key observers collected data only over the seven weeks in which the team taught the curriculum (although the TFI fellows contributed some observations from the prior four months).
- The schools did not allow visitation outside the scheduled sessions.

5.2. Methods

We applied a range of content analysis methods including impressionistic, intuitive, interpretive, systematic, and strict text analyses. This process was flexible, as has been used in other health-related studies (Hsieh and Shannon, 2005; Roseman et al., 2011; Leung et al., 2004). The method was chosen based on its' deployment in similar public-health-related community-based and participatory method (CBPM) studies which drew inferences from qualitative observations for the purpose of informing program development through rapid prototyping and tactical program improvement (see Leung, Yen & Minkler). These contexts, during health-related-behavioral program development, may not be efficient or cost-effective to gather large amounts of quantitative data, provide the ideal format for using such methods.

We identified key themes based on established hypothesis, as well as generated new themes based on the texts. We then generated multiple candidate themes that we later combined into several overarching themes. Our content analysis also included frequency analysis (count) of themes, and key words (Hsieh and Shannon, 2005). While it would have been useful to code themes by intervention type, data gatherers did not consistently code intervention type. In the future, we will code by intervention type to permit a more granular analysis of obstacles. Table 5 provides additional detail about the content analysis.

6. Results of the content analysis

The data analysis generated eight primary themes regarding barriers to program implementation and longevity. Themes included challenges in the classroom (*Localization; Curriculum supplies; Program implementation; Communication and language; and Teacher commitment and capabilities*) factors outside the class but within the school (*School administration and support and Hygiene and sanitation facilities and supplies*) and factors outside the school (*External factors* such as family and slum conditions).

Table 6 describes these 8 key themes, and the keywords and concepts associated with each theme. In total we coded 564 text excerpts and assigned them 865 thematic codes. Thus, a high share of incidents had more than one code. The following sections discuss each theme individually. At the same time, the examples of each theme make clear that many incidents relate to multiple themes.

6.1. Localization

Localization issues arose in almost each activity. For example, one of us (Levine) wrote a story based on a popular north Indian folk tale pair, King Akbar and his wise prime minister Birbal. In southern India these characters were not as well known. Thus, a local intern shifted to

Table 5

The Procedure for the Content Analysis.

1. Each of the journals was transcribed into digital formats.
2. Each of the journal observations was read several times. After each reading, initial (tentative) candidate themes were written down in addition to key words associated with each of the themes and the narrative.
3. The journal observations were read thoroughly several more times, using two methods: taking active thematic notes; reading them all the way through and then, once completed, writing down themes that resonated throughout the process.
4. Candidate themes were then scrubbed for clarity and grouped according to subject, establishing consistent concepts.
5. After doing this, the journals were read through again with the candidate themes in mind. When themes were identified in the text, keywords as well as interpretations of these themes were recorded. This process was repeated several times, counting the number of instances and the associated keywords. During this process the entries were read in different orders, backwards, etc., in order to take an objective approach to establishing, narrowing and refining the themes and their interpretations.
6. Following this, the themes and keywords were entered into the qualitative analysis program Dedoose, in order to conduct frequency analysis and to validate them. This computerized coding is illustrated in the Appendix.
7. Dedoose was then used to generate quantitative analyses and conduct co-occurrence of the observational data.

Note: Riggs and Steffen performed the qualitative coding and analysis.

a southern Indian folk tale character, the wise prime minister Tenali Rama.³

That story also referred to the king's ambassador. That term confused some students, as they knew the term "Ambassador" as a model of an Indian-made car. As part of the rapid improvement process, that section of the story was removed when a TFI fellow edited the story.⁴

The initial version of the curriculum implicitly assumed certain capabilities of teachers that were often not correct. For example, the curriculum proposed a number of outdoor games. In most Chennai schools a dedicated teacher runs physical education classes. Thus, classroom teachers could not easily introduce these games. In addition, while all schools were supposed to have a play yard, one school (TFI3) did not—making the games even less appropriate.

TFI fellows were particularly adept at localization, as they had spent more time in the poor schools than even our interns who grew up in Chennai. They also knew the standard curriculum and format of a lesson plan, making it easier to fit the new content into the familiar rhythm of a lesson (e.g., listing new vocabulary words for each lesson).

6.2. Curriculum supplies

The initial version of the curriculum required color printing, art supplies for students, and many other supplies. Most educational supplies were difficult to procure. The streets of Chennai were crowded and even short trips took a lot of time and energy. In addition, the key observers were from the United States, so the Chennai-based team members had to procure almost all supplies.

Some supplies could not be purchased, but were complex to construct. For example, the "disgusting box" was a vivid illustration of how feces contaminate piped water (Jannat, et al., forthcoming). One of the interns (a master's student in engineering) made the box in his lab at his university. Regular teachers lack such resources.

The high stress associated with almost every supply required by the curriculum emphasized the importance of minimizing supplies not already present in schools.

³ Gautam Srikanth improvised this localization in his 2013 piloting.

⁴ We thank Bhagyashree. Ganesh, a TFI fellow, for editing. The August 2014 version of the story is at <http://faculty.haas.berkeley.edu/levine/papers/king%20akbar%20writings%20a%20law%2015%20b.pdf>.

Table 6
Themes.

Code	Themes	Key Words
1	Localization	Language, culture, religion, unknown variables, supplies, time, technology, adjustment, improvise, cost, age, engage, applicable, relevant, heat, environment, participation, frustration, commitment, dependence
2	Curriculum Supplies	Cost, availability, dependence, transportation, technology, commitment, preparation, resources, kit, support, tools, instructions, frustration, adaptable, reliable, unknown, access, supplemental
3	School Administration & Support	Gender, supplies, reliability, support, culture, religion, connection, assumptions, home, allowed, permission, funding, constraints, ability, honesty, test scores, commitment, facilities, participation, treatment, disruption, dependence, authority, influence, interest, schedule, ritual, buy-in, partnerships
4	Teacher Commitment and Capabilities	Commitment, honesty, availability, priority, quality, support, interaction, ability, creativity, engagement, translate, dependence, value, authority, participation, influence, interest, respect, demonstrate, frustration, ritual, buy-in
5	External Factors	Family, home, climate, sanitation, toilet, defecation, neighbors, condition, religion, belief, culture, language, ability, money, cost, healthcare, practices, tradition, heat, rain, plumbing, water, commitment, dependence, slum, poverty, knowledge, control, influence, honesty, unknown
6	Hygiene, Sanitation Facilities & Supplies	Bathroom, soap, available, water, space, safety, clean, dirty, classrooms, size, allowed, heat, monitoring, number of students, attention, distraction, supplies, frustration, location.
7	Program Implementation	Assumptions, continuation, ability, language, translation, commitment, connection, contract, establish norms, time, number of people, distractions, organization, supplies, transportation, allowance, funding, limitations, unknown and unseen variables, teachers, momentum, dedication, management, interns, dependence, influence, frustration, confusion
8	Communication and Language	Frustration, implementation, understand, ability, reliance, translation, connection, limitations, interns, influence, realistic, engagement, interpretation, expressions, improvisation, participation, adaptability, communication, culture, authority, dependence

6.3. Hygiene and sanitation facilities and supplies

All of the schools we worked in had running water and toilets. At the same time, soap was never present in toilets in any of the schools we worked with (other than soap we procured), few schools had treated drinking water, and the state of the toilets ranged from dirty to unacceptably disgusting. While our intervention is largely focused on behavior change, it will never succeed if there is no soap, there is not safe water, and the toilets are too filthy for students to feel comfortable using.

As noted above, our curriculum included a low-cost (roughly 3 cents / student / year) soapy bottle to overcome the barrier of costly supplies. Even at this cost, most school administrators made clear that most would not use their limited discretionary funds to purchase soap.

6.4. Teacher commitment and capabilities

The levels of teacher commitment and capabilities varied widely. The TFI teachers, for example, all volunteered to teach the curriculum. All had education at elite US or Indian universities, daily internet access, and high intrinsic motivation.

At Primary School we started teaching due to an agreement with the school administration. One of the teachers was very interested in the material. She often chose to be present when we taught and expressed interest in continuing to present the material once our pilot was done.

At Middle School, in contrast, one classroom had no teacher at all. The students there were more challenging than at other classrooms. In the other classrooms, teachers typically took our team's visit as an opportunity to take a break. No teachers at Middle School were interested in learning about the content or how to teach it.

6.5. School and institutional support

School and institutional support varied as widely as did teacher support. At one TFI school, the school principal asked the TFI teacher to expand the content to all classrooms the following year. A second TFI school, in contrast, discouraged any topics that were not part of the official curriculum. The TFI fellow in that school was unable to present all of the material she desired.

The availability of educational supplies to teachers ties again into the school administration and institution. Without support from the school, teachers would have to provide supplies for these activities themselves, or be provided the supplies by an external intervention.

School support can also be a facilitator. At Primary School, teachers felt that the administration was supportive and were proud of their school for bringing the material into the classroom.

6.6. Program Implementation

There were numerous unanticipated challenges in implementing the program. A good lesson plan starts on time and has rapid transitions to new activities.

As we were piloting the activities, often for the first time, time management was often an issue. Some sessions started late, hence we completed preparations during the class. Sometimes we had a pause between activities; students usually found such pauses very distracting. Occasionally we ran out of time to present some planned materials. Some activities had unexpected consequences. For example, making a calendar left a mess on the floor, and a class participation story led to great enthusiasm, but too much noise for the physical space. Being unfamiliar to the class sometimes also occasionally led to poor discipline (if the regular teacher was not helping control the class).

6.7. Environmental factors

Urban India is a complex setting for a school-based health intervention. Forces ranging from religion and culture to weather and traffic affected our pilot.

For example, we knew our lessons about avoiding open defecation would be hard for students to internalize if they had no access to a toilet near home. It turns out these lessons were also confusing for students who had a toilet inside their home, as was true of almost all Primary School students (our only school not targeting the poor). Some of these students did not understand why we were teaching about why to avoid open defecation. Once the teaching team reminded them of open defecation near the train station (for example), they understood the reason for the material.

A quite different external factor is how weather affected activities that took place outdoors, such as the several versions of Germ Tag. When it was either raining or very hot by the standards of southern India (that is, approaching hazardous to be outdoors), the outdoor games were not appropriate.

6.8. Communication and language

The curriculum was written in English and 3 of the interns did not

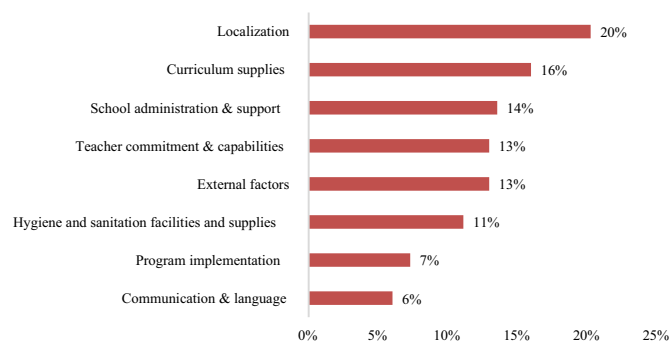


Fig. 6. Frequency of Themes. Note: Percentages are of the 865 thematic codes applied to 564 text excerpts.

speak Tamil. All of the Tamil-speaking interns and TFI teachers spoke perfect English. Nevertheless, miscommunications were common: Recall the students' misunderstanding of "Ambassador" as a model of a car, noted above.

The language of instruction was English in all of the TFI schools. Thus, even TFI fellows who were not from Tamil Nadu had no problem communicating with students.

This communication barrier was observed throughout our study. For example, English-only interns would often need translations from instructors during an activity to modify it.

6.9. Frequency of each theme

Fig. 6 summarizes the frequency of each theme. *Localization* (20%) and *Curriculum supplies* (16%) were the two most common themes, followed by *School administration & support* (14%), *teacher commitment and capabilities* (13%), *external factors* (13%), and *Hygiene and sanitation facilities and supplies* (also 13%). *Program implementation* (7%) and *Communication & language* (6%) appeared less frequently.

Frequency counts are imperfect proxies for the importance of each barrier. For example, sometimes a barrier might have little effect, while other times a less common barrier might have stopped the team from presenting an activity or have caused that activity to fail completely. In addition, the frequencies would be different if we had coded the boundaries of our themes differently, or combined or divided themes.

With these cautions in mind, the high incidence of *Localization* and of *Curriculum supplies* emphasizes the importance of creating a localized curriculum, with easily adaptable materials and content. There is also an importance in keeping supplies and costs at a minimum. In addition, the relatively high frequency of *School administration* and of *Teacher commitment and capabilities* suggest that behavior change for students is only part of what is needed for the program to succeed.

Also, recall that many incidents had multiple codes. For example, about 30% (33/109) of the incidents coded as *Hygiene and sanitation facilities and supplies* and a similar share of incidents coded as *Teacher commitment and capabilities* (35/115) also had codes for *School administration & support*. That is, school administrator support often affected both teacher commitment and the presence of supplies.

7. Changes to the curriculum

In addition to the change to the curriculum during the rapid prototyping, the reflection since the 2014 pilot (the basis of this report) led to broader changes in the intervention. During the summer the team also clearly noted that low teacher engagement was an obstacle, and the team could not help but notice the challenges of providing supplies for both the curriculum and for handwashing and safe water.

At the same time, weaving the obstacles into themes emphasized

that supply side issues and teacher / HM support were pervasively important. The content analysis emphasized that schools and classrooms face very severe constraints in both time and resources. Furthermore, behavior change would require not just students (the focus of the 2014 piloting) but also teachers, HMs, and the entire educational system.

The main result was a decision to be less ambitious and focus Hygiene Heroes solely on handwashing. This is the single behavior with the largest potential effects on health (as it reduces both diarrheal diseases and respiratory infections); soapy bottles are very inexpensive; and students have the most control over this behavior both at school and at home. Our second main goal was to streamline the curriculum along several dimensions: fewer activities, fewer need for supplies, and fewer demands on teachers.

7.1. Localization and Curriculum supplies

Localization and *Curriculum Supplies* were the two most common barriers. Fortunately, these barriers are internal to the project, so we were able to modify the curriculum to address most of these concerns.

To improve *Localization*, for example:

- We eliminated all activities that required classroom teachers to engage in outdoor activities (Germ Tag, etc.).
- We focused on activities that use the teaching methods teachers currently have, so less reliance on games in general.

To address barriers related to *Curriculum Supplies* we eliminated almost all activities that required educational supplies beyond a single printed or digital document for each teacher. For example, the board game "Grandma wants you to eat candy" was very popular with students. At the same time, it required printing two color pages for every 4–8 students. In addition, board games were not a familiar teaching tool in Chennai classrooms. Thus, we cut that game.⁵ We shifted illustrated stories into classroom participation stories that did not require color printing. (We keep the illustrated books as optional supplements).

7.2. Hygiene and sanitation facilities and supplies

Except for Primary School (which mostly served non-poor students), the schools we studied had very limited resources and most had little focus on improving hygiene, safe water or toilet facilities.

Handwashing required the fewest added supplies and is the behavior most in control of the students. Handwashing is also important for preventing respiratory infections as well as diarrheal diseases (Luby and Halder, 2008). Thus, given the many constraints on safe drinking water and clean toilets, we decided to focus on handwashing first.

With the soapy bottle (described above), soap for handwashing costs only about two cents per student per year. Nevertheless, it was apparent that most headmasters had other priorities. Thus, for any future pilots, we assume we will need to resupply schools with soap. To be sustainable, though, will require that schools purchase their own soap. As noted in the next section, we are working with both the state Dept. of School Education in Tamil Nadu and with the NGO SHARP to build in monitoring and incentives for school administrators.⁶

The NGO SHARP has donor funding to improve water and sanitation (that is, build new toilets), as well as handwashing. We have emphasized with them the need to integrate the janitors into the program. Specifically,

⁵ The game is available as a free download. <http://hygieneheroes.berkeley.edu/boardgames.html>

⁶ SHARP (School Health Annual Report Program) is the NGO with the largest school health network in India. It engages in health monitoring and health promotion. <http://www.schoolindia.org/>

we need to understand the many barriers to clean toilets, and then overcome them. We conjecture that providing supplies such as cleanser, brushes and gloves; educating janitors on why their job is essential to student and community health; and increasing incentives are all part of an effective school-based sanitation program.

We suggested their donors should supply soap and other supplies to the schools for an initial period, and also have a signed and public agreement that the school will continue to purchase soap and other supplies (along with follow-up monitoring and incentives).

7.3. School administration and support and Teacher commitment

The 2014 pilot focused on behavior change for students. Our results suggest an equally large effort will be needed to convince teachers of the need for behavior change on their part: engaging in safe behaviors, teaching safe behaviors, and reinforcing the same behaviors.

We now have added an extensive behavior change intervention for school administrators and one for teachers. Each intervention is phrased in terms of helping them understand what to teach students (implying the administrators and teachers already know all the material). We explained that they will demonstrate to students how their classrooms become covered with feces and germs. These germs, we explained to teachers and administrators, endanger their students, themselves, and their own families. A follow-up report will discuss rapid prototyping of this intervention.

We made the curriculum much easier for teachers to implement. We moved from dozens of activities to a streamlined set of 3 lesson plans. We no longer expected teachers to read several alternatives and pick one; instead we recommended posters for handwashing (and allocated the other art activities to later chapters—for schools also covering safe water, etc).

The Tamil Nadu school system already has a system of regular monitoring visits by first-level supervisors. We will work with them to add items such as “Has soapy bottles filled with soap and water in each classroom” to their monitoring checklist.

As of this writing (early 2016) we are preparing to pilot the training and monitoring of school administrators and teachers by the regular training and monitoring staff of the Dept. of School Education. As with the rapid prototyping reported here, we suspect several iterations will be useful to create effect training and monitoring methods.

7.4. Program implementation

Our program used teaching methods that relied on high levels of student participation and engagement. At the same time, most non-TFI teachers and some students found some of the unfamiliar teaching methods a challenge. Thus, we revised the curriculum to focus on the elements that required the least variation in current teaching methods and creating materials that teachers are comfortable presenting. We also used the experience in the pilot to create a short and clear list of preparation and materials and to adjust the timing to fit existing class periods.

7.5. Communication and language

Finally, as we noted previous, we regularly encountered communication barriers due to variations in the number of participants and teachers who spoke English. We now have a full Tamil translation of the curriculum and are designing a fully Tamil version of the training materials for teachers.

8. Next steps

We are continuing to pilot the program using three approaches. First, we returned to Chennai in June 2015 to redesign the curriculum and pilot the new version, making the changes noted above. For example, the 2015 curriculum was much shorter, did not rely on

outdoor activities or board games, and focused strongly on the classroom routines related to the soapy bottle.

We are now (early 2016) working with the Tamil Nadu state primary school department (SSA) to pilot having their trainers present the material and their monitors monitor adherence. The much-modified curriculum holds significant promise. Tamil Nadu is improving the water supply and toilets in schools. The SSA director has said she needs a good hygiene curriculum. If we can succeed in having SSA trainers train principals and teachers to teach students and to introduce the new materials, she hopes to scale the curriculum to the entire state.

We also continue to pilot with a new set of TFI fellows. Our experience with TFI shows the power of natural leaders to spread a health curriculum – at least in a supportive environment. As noted above, at one school the administrator instructed the TFI fellow not to use the health curriculum as it was outside the mandatory material. At the other extreme, one TFI fellow gained support from her administration, and they asked her to train other teachers on how to teach these lessons in their classrooms. TFI fellows already have a wealth of knowledge regarding the conditions of the school, the administration, and the student's needs. With a well-designed curriculum that is not reliant on technology or supplies, TFI fellows were able to localize the material.

Working with exceptional teachers who have already integrated themselves into the schools systems at various levels provides a unique opportunity for a program such as this. Finally, as noted above, as of 2016 we are working with the NGO SHARP to implement the curriculum at schools in Tamil Nadu and New Delhi.

9. Conclusion

The study examined the major barriers facing one pilot program at one time. Nevertheless, we suspect almost all of these barriers will face most health programs in poor schools around the world.

The curriculum on handwashing requires very few resources. Nevertheless, it is unlikely to be adopted by many Indian schools unless there is either outside funding and support (as with the NGOs TFI or SHARP) or top-level leadership (as from the director of primary education in Tamil Nadu).

Improving safe water and sanitation is even more of a challenge, as each requires improvements in facilities as well as daily behavior change. While India has a massive program to expand toilet access in schools ([Government of India, 2014](#)), there has not been a corresponding program to improve maintenance and cleaning. Without better incentives and supplies for school administrators, teachers and janitors, safe sanitation will remain a challenge for many schools.

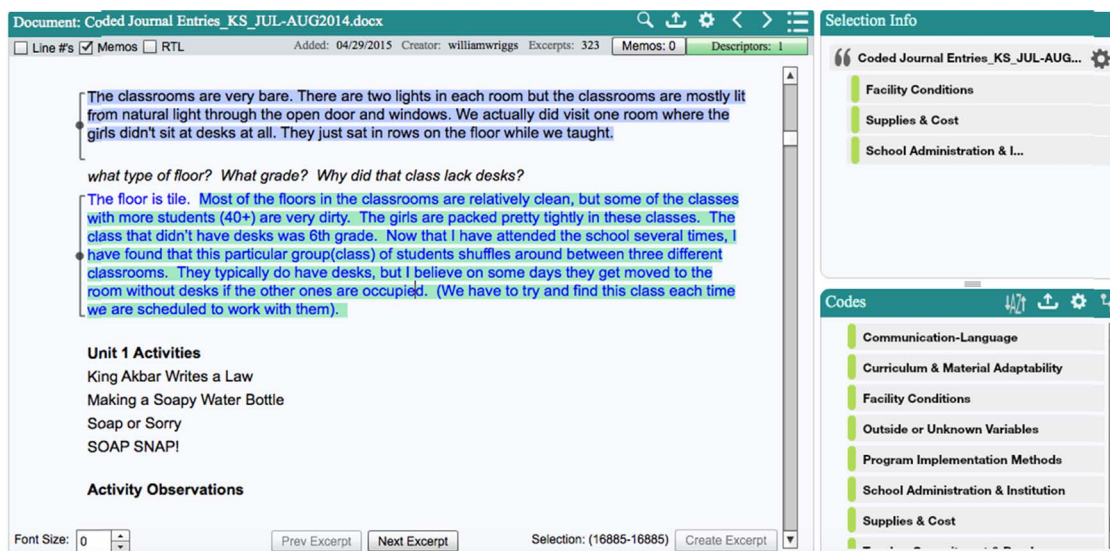
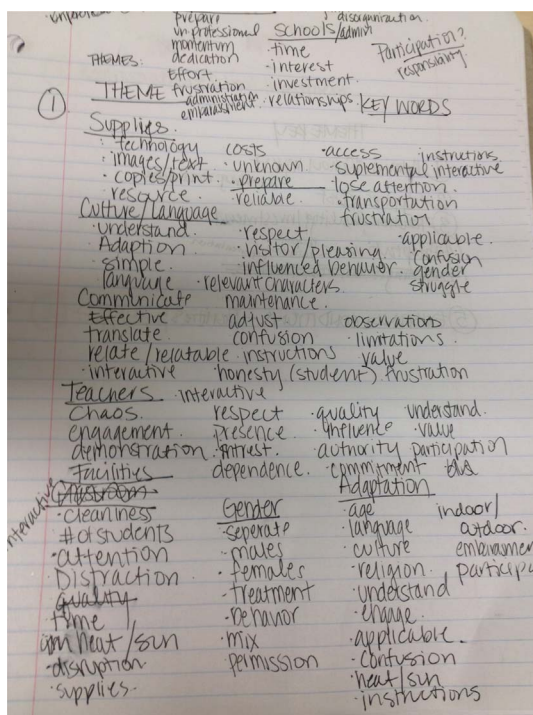
Even focusing only on handwashing, this intervention is much improved compared to the version at the start of this pilot (i.e., that is, June 2014). Nevertheless, it is still not yet ready to go to scale. Each expansion of the program (from classroom to school to multiple schools and then more broadly) will require cycles of testing and improvement.

Our goal is to have a curriculum worthy of a randomized trial and then dissemination to tens of millions of students. We need to “fail fast” many times before some version of this curriculum is good enough to deserve either such a costly evaluation or roll-out.

Acknowledgements

The study draws on the hard work of the TFI teachers Ganesh Bhagvashree, Sharon Koshy, Sriranjini K., Ashok Raeshmi and Divya Sabanagayam; Chennai interns Anjana Krishnan and Aiswarya Rangarajan (SRM University, Chennai), Ashwini Rajagopalan (Syracuse University), Padmapriya Govindarajan, Sriram Kalathoor, and Arya Padmam (ITT Madras); and key observer #2 Ricky Williams. Gautam Srikanth (UC Berkeley) tested materials in 2013, recruited the 2014 Chennai interns, and recruited the two focal schools. We greatly appreciate all the school administrators, teachers and especially students who were our teachers for this project.

Appendix. Example of Hand Coding and Computerized Coding Using Dedoose



References

- ## References
- Aarts, H., Paulussen, T., Schaalma, H., 1997. Physical exercise habit: on the conceptualization and formation of habitual health behaviours. *Health Educ. Res.* 12 (3), 363–374.
- Aittasalo, Minna, Rinne, Marjo, Pasanen, Matti, Kukkonen-Harjula, Katriina, Vasankari, Tommi, 2012. Promoting walking among office employees – evaluation of a randomized controlled intervention with pedometers and e-mail messages. *BMC Public Health* 12 (1), 403.
- Ajzen, Ick, 1991. The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.* 50 (2), 179–211.
- Aunger, R., Schmidt, W.-P., Ranpura, A., Coombes, Y., Maina, P.M., Matiko, C.N., Curtis, V., 2009. Three kinds of psychological determinants for hand-washing behavior in Kenya. *Social. Sci. Med.*, 1–9. <http://dx.doi.org/10.1016/j.socscimed.2009.10.038>.
- Bagby, Robin, Star Campbell, V., Achterberg, Cheryl, Probart, Claudia, Ebel, Kimberlyn, 1996. Every Day Lots of Ways. An Interdisciplinary Nutrition Curriculum for Kindergarten-Sixth Grade. Institute of Education Sciences of U.S. Department of Education. Pennsylvania State Univ., Harrisburg PA, ERIC No. ED426979.
- Bandura, Albert, 2004. Health promotion by social cognitive means. *Health Educ. Behav.* 31 (2), 143–164.
- Bennett, Daniel, Naqvi, Syed Ali Asjad, Schmidt, Wolf-Peter, 2014. Learning, hygiene, and traditional medicine. *Health Econometrics & Data Group*, Department of Economics, University of York, UK, No. 14/25.
- Biran, A., Schmidt, W.P., Wright, R., Jones, T., Seshadri, M., Isaac, P., Curtis, V., 2009. The effect of a soap promotion and hygiene education campaign on handwashing behaviour in rural India: a cluster randomized trial. *Trop. Med. Int. Health* 14 (10), 1302–1314.

- Bliss, L., 2015. January 2), India's Government Will Now 'Check and Verify the Use of Toilets. [<http://www.citylab.com/design/2015/01/indias-government-will-now-check-and-verify-the-use-of-toilets/384174/>], last (accessed 12 February 2016).
- Byrne, Elaine, Sahay, Sundeeep, 2007. Participatory design for social development: a South African case study on community-based health information systems. *Inf. Technol. Dev.* 13 (1), 71–94.
- Chou, W.S., Prestin, A., Lyons, C., Wen, K., 2013. Web 2.0 for health promotion: reviewing the current evidence. *Am. J. Pub. Health* 103 (1), e9–e18.
- Coffey, Diane, Gupta, Aashish, Hathi, Payal, Khurana, Nidhi, Spears, Dean, Srivastav, Nikhil, Vyas, Sangita, 2016. Revealed preference for open defecation: Evidence from a new survey in rural north India. SQUAT Working Paper No. 1-26 June 2014. [<http://squatreport.in/wp-content/uploads/2014/06/SQUAT-research-paper.pdf>], last (accessed 29 September).
- Cole, Joanna, 1989. *The Magic School Bus: inside the Human Body*. Scholastic, New York, NY.
- Corburn, Jason, 2005. *Street Science: Community Knowledge and Environmental Health Justice*. MIT Press, Cambridge, MA.
- Collins, L.M., Murphy, S.A., Nair, V.N., Strecher, V.J., 2005. A strategy for optimizing and evaluating behavioral interventions. *Ann. Behav. Med.* 30 (1), 65–73.
- Collins, C.M., Chambers, S.M., 2005. Psychological and Situational Influences on Commuter-Transport-Mode Choice. *Environ. Behav.* 37 (5), 640–661 <https://doi.org/10.1177/0013916504265440>.
- Curtis, V., Cairncross, S., 2003. Effect of washing hands with soap on diarrhoea risk in the community: a systematic review. *Lancet Infect. Dis.* 3 (5), 275–281.
- Dongre, A.R., Deshmukh, P.R., Boratne, A.V., Thaware, P., Garg, B.S., 2007. An approach to hygiene education among rural Indian school going children. *Online J. Health Allied Sci.* 6 (4).
- Fewtrell, L., Kaufmann, R.B., Kay, D., Enanoria, W., Haller, L., Colford, J.M., 2005. Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis. *Lancet Infect. Dis.* 5 (1), 42–52.
- Fogg, B.J. *Tiny Habits*, (<http://tinychabits.com>) last (Accessed August 26, 2013).
- Gaby, Judah, Augner, Robert, Schmidt, Wolf-Peter, Michie, Susan, Granger, Stewart, Curtis, Val, 2009. Experimental pretesting of hand-washing interventions in a natural setting. *Am. J. Public Health* 99 (S2), S405–S411.
- Gachuhi D., 1999. "The impact of HIV/AIDS on education systems in the Eastern and Southern Africa Region, and the response of education systems to HIV/AIDS: Life Skills programmes." Report prepared for UNICEF East and South Africa Regional Office.
- Gahlot, M., 2015. April 3). India steps up efforts to encourage use of toilets. *USA Today*, Global Post. Retrieved May 6, 2015. (<http://www.usatoday.com/story/news/world/2015/04/03/globalpost-india-toilet/25236383/>).
- Gatawa, B.G., 1995. Zimbabwe: aids Education for schools. Case Study. UNICEF Harare, Zimbabwe.
- Godin, Gaston, Kok, Gerjo, 1996. The theory of planned behavior: a review of its applications to health-related behaviors. *Am. J. Health Promot.* 11 (2), 87–98.
- Government of India, 2014. *Clean India: Clean Schools A Handbook*. UNICEF, India (http://unicef.in/CkEditor/ck_Uploaded_Images/img_1397.pdf), (last) (accessed 27 March 2016).
- Harris, S.J., Munger, K., 1989. Effects of an observer on hand washing in public restrooms. *Percept. Mot. Skills* (69), 733–735.
- Heyman, James, Ariely, Dan, 2004. Effort for payment. *Psychol. Sci.* 15 (11), 787–793.
- Hsieh, H.F., Shannon, S.E., 2005. Three approaches to qualitative content analysis. *Qual. Health Res.* 15 (9), 1277–1288.
- IRC, 2007. *Towards Effective Programming for WASH in Schools: A Manual on Scaling up Programmes for Water, Sanitation and Hygiene in Schools* (TP series; no. 48. 93 pp). IRC International Water and Sanitation Centre, Delft, The Netherlands.
- Jannat, Kanniz, Rahman, Mahfuzur, Unicomb, Leanne, Levine, David I., 2017. "The Disgust box: a novel approach to illustrate water contamination with Feces." *Glob. Health Promot.*.
- Kar, Kamal, Chambers, Robert, 2008. *Handbook on Community-Led Total Sanitation*. Institute of Development Studies & Plan UK, London, UK, (ISBN 978-0-9550479-5-4) (<http://www.communityledtotalsanitation.org/sites/communityledtotalsanitation.org/files/media/cltshandbook.pdf>).
- Levine, Benjamin, Levine, David I., 2014. "Gerry the Germ." Hygiene Heroes. Haas, University of California, Berkeley (<http://hygieneheroes.berkeley.edu/curriculum/stories/gerry.pdf>).
- Levine, David, I., 2014. *Germs and Games: Teaching Health and Infectious Diseases with a Combination of Stories, Games and Fun Activities*. Haas, University of California, Berkeley (http://faculty.haas.berkeley.edu/levine/Old_HH/Curric2014.pdf).
- Leung, M.W., Yen, I.H., Minkler, M., 2004. Community based participatory research: a promising approach for increasing epidemiology's relevance in the 21st century. *Int. J. Epidemiol.* 33 (3), 499–506.
- Locks, Lindsey, Canaday, Miles, Tesfaye, Beza, 2006. *Games and Activities for AIDS Awareness Clubs. Sekolo Projects*. Connecticut, USA, & Namibia. [http://www.sekoloprojects.org/images/uploads/Activity_Book_Final_Acrobat5.pdf], last (accessed 28 September 2016).
- Luby, Stephen P., Halder, Amal K., 2008. Associations among handwashing indicators, wealth, and symptoms of childhood respiratory illness in urban Bangladesh. *Trop. Med. Int. Health* 13 (6), 835–844.
- Minkler, M., 2000. Using participatory action research to build healthy communities. *Public Health Rep.* 115 (2–3), 191–197.
- Minkler, M., 2005. Community-based research partnerships: challenges and opportunities. *J. Urban Health* 82, ii3–ii12.
- Minkler, M., Wallerstein, N., Wilson, N., 1997. Improving health through community organization and community building. *Health Behav. Health Educ.: Theory Res. Pract.* 3, 279–311.
- National Theater for Children. *The Invisible Invaders From Inner Space – Germ Awareness*. NTC, Minneapolis, MN.
- Nelson, Richard R., Winter, Sidney G., 1982. *An Evolutionary Theory of Economic Change*. Belknap Press of Harvard University Press, Cambridge, MA.
- Nemours Center for Children's Health Media. *What Are Germs?* Wilmington, Delaware. [<http://kidshealth.org/kid/talk/qa/germs.html>].
- Ness, Clark, 2007. *Dee and Dad: A collection of stories for Level Kindergarten 7*. [<http://www.clarkness.com/Reading%20files/Single%20Page%20Stories/Kindergarten%20Level%2007%20Stories.pdf>], last (accessed 28 September 2016).
- Onteora Central School District. *Healthy Eating 1, HE-1: Goodbye Dirt and Germs*. [<http://www.onteora.k12.ny.us/cms/lib01/NY24000036/Centricity/Domain/333/healthy%20eating%20uited%20way.pdf>], Boiceville, NY.
- Ozier, Owen W., 2014. Exploiting externalities to estimate the long-term effects of early childhood deworming. *World Bank Policy Research Working Paper*, 7052.
- Pittet, Didier, Simon, Anne, Hugonnet, Stephane, Pessoa-Silva, Carmen Lucia, Sauvan, Valerie, Perneger, Thomas V., 2004. Hand hygiene among physicians: performance, beliefs, and perceptions. *Ann. Intern. Med.* 141 (1), 1–8.
- Riggs, W., 2015. Testing personalized outreach as an effective TDM measure. *Transp. Res. Part A: Policy Pract.* 78, 178–186. <http://dx.doi.org/10.1016/j.tra.2015.05.012>.
- Riggs, W., Kuo, J., 2015. The impact of targeted outreach for parking mitigation on the UC Berkeley campus. *Case Stud. Transp. Policy* 3, 2. <http://dx.doi.org/10.1016/j.jcstp.2015.01.004>.
- Roseman, M.G., Riddle, M.C., Haynes, J.N., 2011. A content analysis of kindergarten-12th grade school-based nutrition intervention: taking advantage of past learning. *J. Nutr. Educ. Behav.* 43 (1), 2–18.
- Saboori, Shadi, Mwaki, Alex, Rheingans, Richard, 2010. Is soapy water a viable solution for handwashing in schools? *Waterlines* 29 (4), 329–336.
- Sallis, J.F., Owen, N., 2015. Ecological models of health behavior. In: Glanz, K., Rimer, B., Viswanath, V. (Eds.), *Health Behavior: Theory, Research & Practice* 5th ed.. Jossey-Bass/Pfeiffer, San Francisco, 43–64.
- Sethuraman, S., 2012. *Urban Sanitation in Tamil Nadu: A Report on Public Conveniences*. Retrieved March 15, 2015. (<http://www.transparentchennai.com/urban-sanitation-in-tamil-nadu-a-report-on-public-conveniences-2/>), last (accessed 12 February 2016).
- Shediac-Rizkallah, M.C., Bone, L.R., 1998. Planning for the sustainability of community-based health programs: conceptual frameworks and future directions for research, practice and policy. *Health Educ. Res.* 13 (1), 87–108.
- Shordt, K., Snel, M., Krukkert, I., 2007. Towards effective programming for WASH in Schools. UNICEF and IRC [online] (<http://www.irc.nl/content/download/128071/348559/file/TP>), 2048.
- Snel, M., 2003. "School sanitation and hygiene education: thematic overview paper." IRC International Water and Sanitation Centre. IRC International Water and Sanitation Centre, Delft (http://www.sswm.info/sites/default/files/reference_attachments/IRC%202003%20School%20Sanitation%20and%20Hygiene%20Education.pdf), (last) (accessed 12 February 2016).
- STIR Education, 2012. *Parental Involvement in Student Tracking*. London, UK. [http://www.stireducation.org/sites/default/files/STIR_India_2012-14_Micro-Innovations.pdf], last (accessed 28 September 2016).
- Teach for India, 2015. *Beginnings*. Retrieved June 15, 2015, from (<http://www.teachforindia.org/about-us>).
- Transparent Chennai, 2011. *Research*. Retrieved June 15, 2015, from (<http://www.transparentchennai.com/public-toilets-and-sanitation/>).
- Umberson, Debra, Montez, Jennifer Karas, 2010. Social relationships and health: a flashpoint for health policy. *J. Health Soc. Behav.* 51 (Suppl), S54–S66.
- UNICEF, 2006. "Guidelines on School Led Total Sanitation." Steering Committee for National Sanitation Action. Dept. of Water Supply and Sewerage, Nepal (http://www.communityledtotalsanitation.org/sites/communityledtotalsanitation.org/files/media/SLTS_Guidelines.pdf).
- UNICEF, 2013. *The Three Star Approach for WASH in Schools*. [http://www.unicef.org/wash/schools/files/UNICEF_Field_Guide-3_Star-Guide.pdf], last (accessed 28 September 2016).
- Wakefield, Melanie A., Loken, Barbara, Hornik, Robert C., 2010. Use of mass media campaigns to change health behaviours. *Lancet* 376 (9748), 1261–1271.
- WaterAid, 2012. *Hygiene Framework*. WaterAid, London, UK.
- World Health Organization, 2009. *Diarrhoea: why children are still dying and what can be done*. UNICEF/WHO, Geneva, Switzerland.
- World Health Organization, 2014. *Investing in water and sanitation: Increasing access, reducing inequalities*. Special Report for the Sanitation and Water for All (SWA), High-Level Meeting (HLM). GLASS (UN Water Global Analysis and Assessment of Sanitation and Drinking-Water).