Ce Zhang  
Spring 2012

A thesis  
submitted in partial fulfillment  
of the requirements  
for a baccalaureate degree  
in Biology  
with honors in Civic and Community Engagement

Reviewed and *approved by the following:

Stephen A. Matthews Ph.D.  
Associate Professor of Sociology, Anthropology, and Demography  
Thesis Supervisor

Jeremy Cohen Ph.D.  
Associate Vice President and Senior Associate Dean for Undergraduate Education  
Honors Advisor

* Signatures are on file in the Schreyer Honors College
ABSTRACT

This thesis describes a student-founded public scholarship project designed to promote child health in resource-limited contexts. In response to the global burden of diarrheal disease, we constructed a low-cost handwashing promotion program, specifically designed to induce positive handwashing behavior change in schoolchildren. The scholarship component of the project is focused on testing the efficacy of our tippy-tap handwashing program in promoting handwashing rates and reducing the number of self-reported stomach pain episodes in elementary schoolchildren in rural Eastern Uganda. The thesis describes the student contribution and motivation behind this project from inception to its conclusion, and provides suggestions that may enable university students to become more motivated and successful in conducting public scholarship projects in the future.

The field research component (September 2010-January 2011) was a collaboration with volunteers from the Uganda Village Project. Pre and post intervention surveys were fielded in eight schools (398 students, ages 7-13). Four intervention schools were given tippy-taps, soap, and educational materials while four control schools initially received only educational materials. After one month, intervention schools reported large increases in handwashing rates, soap usage, and a reduction in the absence of stomach pain episodes compared to control schools. After receiving the intervention, control schools attained similar handwashing and stomach pain rates.

The school-based tippy-tap handwashing program improved handwashing rates and has the potential to reduce the incidence of infectious diarrheal disease for children residing in resource-limited contexts. Future research goals include modification of our educational program, direct handwashing observation, focus group analysis, and the design of objective trials to measure the impact of washing hands on diarrhea.
TABLE OF CONTENTS

List of Tables and Figures........................................................................................................iv
Acknowledgements....................................................................................................................v

Chapter 1: Introduction .............................................................................................................1
  a. The Global Burden of Diarrheal Diseases .................................................................1
  b. Vulnerable Populations...............................................................................................2
  c. Role of Public Health .................................................................................................2
  d. Handwashing with Soap (HWWS).............................................................................3
  e. Challenges of Current Handwashing Interventions...................................................4
  f. Tippy-Taps ..................................................................................................................5
  g. Aim and Motivation for Study...................................................................................6

Chapter 2: Methods ..................................................................................................................8
  a. Study Population .......................................................................................................8
  b. Handwashing Program Design ................................................................................9
  c. Experimental Design ..............................................................................................12

Chapter 3: Results .....................................................................................................................14
  a. Differences between Enrolled Schools at Baseline..................................................14
  b. Handwashing Behavior and Diarrheal Disease .......................................................14
  c. Tippy-Tap Use and Idea Dissemination ....................................................................15

Chapter 4: Discussion .............................................................................................................19
  a. Handwashing Behavior and Diarrheal Disease.......................................................19
  b. Tippy-Tap Use and Idea Dissemination ..................................................................20
  c. Cost Analysis ..........................................................................................................20
  d. Study Limitations .....................................................................................................21
  e. Conclusion .................................................................................................................22
  f. Key Findings ..............................................................................................................22
LIST OF TABLES AND FIGURES

Table 1: Enrolled Control and Interventions Schools.........................................................9
Table 2: Summary of Project..............................................................................................13
Table 3: Handwashing and stomach pain in control and intervention schools......................16
Table 4: Responses to questions on tippy-taps usage and maintenance................................17
Figure 1: Photos of a Tree Branch vs. Wood Tippy-Tap....................................................11
Figure 2: Photos of Construction and Maintenance of Tippy-Taps.................................11
Figure 3: Percent graph of students indicating handwashing “3 or more times” per day........17
Figure 4: Percent graph of students indicating handwashing at school..............................18
Figure 5: Percent graph of students indicating zero episodes of stomach pain.....................18
Acknowledgements

I would like to thank the collegiate student team of Adam Mosa, Ntalo Julius, Wandira Henry, James Muwereza, and Kasajja Anthony, whom provided instrumental support in the design, implementation, and data collection of this project in Uganda. Without the help of these compassionate student scholars, carrying out the project to completion would be impossible. I would like to thank the Uganda Village Project, whose executive director is Dr. Alison Hayward, for providing essential staff and financial support to conduct this research study. I would also like to thank the Schreyer Honors College for supporting me to take on this endeavor. Lastly, I would like to thank my thesis supervisor, Dr. Stephen Matthews, and my honors advisor, Dr. Jeremy Cohen, for their guidance and continued support of my development as a researcher and public health advocate.
CHAPTER 1
INTRODUCTION

The Global Burden of Diarrheal Diseases

Diarrheal diseases are the fourth leading cause of child mortality in Uganda (World Health Organization 2006a) and second leading cause of child mortality globally (Black et al. 2003). In addition to direct health consequences such as delays in physical development and cognitive abilities, there are other indirect negative impacts for children in the developing world. For example, diarrheal disease can lead to higher rates of absenteeism and lower educational attainment, the latter disproportionately affecting young girls (UNICEF 2006).

Diarrhea is characterized by having “three or more loose or liquid bowel movements per day” (World Health Organization 2011). If diarrhea lasts for more than 2-4 weeks, then it is considered chronic (Centers for Disease Control and Prevention 2011). Chronic diarrhea can be caused through infectious or non-infectious agents. Examples of infectious causes include parasites, bacteria, and viruses. Moreover, some non-infectious causes may include side-effects from medications, disorders of the intestine, tumors, and suppressed immune system function (Centers for Disease Control and Prevention 2011).

Diagnosis of chronic diarrhea is difficult and may require conducting a physical exam or diagnostic tests such as blood and stool tests, endoscopy, or x-rays (Centers for Disease Control and Prevention 2011). Lastly, treatment of chronic diarrhea is largely dependent on whether the causative agent is infectious or non-infectious. If infectious, diarrhea can be treated with antibiotics or other drugs. If non-infectious, then treatment may include long-term nutritional and
medical support, which many require surgical intervention (Centers for Disease Control and Prevention 2011).

**Vulnerable Populations**

Individuals that have compromised immune systems, such as AIDS patients and those under chemotherapy, are especially vulnerable to developing chronic diarrhea. On a socioeconomic level, residents of low-income countries, especially children, are also more vulnerable to developing infectious diarrheal diseases (Centers for Disease Control and Prevention 2010). Children, whom do not have fully developed immune systems and are less educated on proper sanitation practices compared to adults, possess increased vulnerability to developing communicable diarrheal disease. Hygienic practices can also be constrained in developing countries where there is a lack of resources such as soap and clean water.

**Role of Public Health**

Public health plays an important role in controlling the spread of diarrhea with emphasis in developing countries. For treating existing infections, a popular medical intervention used is oral rehydration therapy (ORT), which treats dehydration associated with diarrhea (Centers for Disease Control and Prevention 2003). However, barriers to ORT in the developing world may include a lack of parental knowledge on treatment of diarrhea, lack of training of medical professionals to administer treatment, and cultural beliefs. Continuing, initiatives have also focused on prevention of diarrheal infection through health promotion and educational campaigns that ingrain proper hygienic behaviors. A current strategy towards prevention of diarrhea includes providing increased access to hygienic technologies through construction of
improved latrines and handwashing facilities in low-income areas (World Bank 2011). Moreover, establishing a consistent source of clean water and soap has also been a priority for many public health initiatives, particularly in rural areas. Other strategies have focused on creating school health programs that foster promotion of proper sanitation behaviors in schoolchildren, which can send a larger message to the community for increased demand of sanitation technologies. Lastly in the status quo, some initiatives have focused on persuading the private sector, such as the media and soap manufacturers, on promoting health education through advertising soap and its usefulness in preventing diarrhea (World Bank 2011).

**Handwashing with Soap (HWWS)**

Handwashing with soap is the most cost-effective prevention strategy (Curtis et al. 2009) that can reduce the incidence of infectious diarrheal disease and respiratory infections by almost one-half (Curtis et al. 2003; Ejemot et al. 2008; Luby et al. 2005; Shahid et al. 1996) and is the single most important means of preventing the spread of infection (Centers for Disease Control and Prevention 2008). HWWS is not a common practice in many high, middle, and low-income countries and only occurs on about 5–15% of key moments that could lead to bacterial transmission (such as going to the bathroom) (Scott et al. 2003).

A major driving force of HWWS behavior is habitual practice (Curtis et al. 2009). Literature has shown that habit i.e. automatic reactions to specific cues, drives as much as 50% of daily activity (Wood et al. 2002; De Bruijn et al. 2007). HWWS, similar to toothbrushing, is a part of daily routines (Aunger 2007) that are often established during childhood (Whitby et al. 2006). Thus, it could be useful to design handwashing interventions that target children in an early stage of their development, for the purpose of instilling long-term habits.
Further research is necessary to elucidate specific cues for handwashing behavior. For example, a previous research study found that placing posters in handwashing locations in hospitals could cue handwashing behavior (Naikoba et al. 2001). Thus, simply placing handwashing stations next to toilet exits may be helpful or even erecting a sign next to a latrine stating “Wash Your Hands” could cue handwashing behavior as well.

Local social norms such as religion and culture are also potential driving forces for instilling certain handwashing habits. Being part of an Islamic religion can promote handwashing practices due to ritual practice of tasks that involve cleaning hands. Cultural beliefs about being lucky or holy can facilitate adoption of handwashing practices (Curtis et al. 2009). Conformity with one’s local environment is also a powerful driver of behavior (Perkins 2004). Thus, individuals could be more inclined to practice certain behaviors that are also practiced by their peers. Lastly, fear of stigmatization and wanting to be accepted within one’s social group can lead to positive handwashing practices. For example, being known as unclean can make others perceive you as a threat to society and can lead to shunning and ostracizing.

**Challenges of Current Handwashing Interventions**

There are two significant challenges in designing public health interventions that aim to promote correct handwashing practices: successfully transforming knowledge into lasting behavioral change in at-risk populations, especially children, and ensuring the affordability and availability of handwashing supplies and infrastructure.

Several quantitative studies on handwashing interventions, involving education and/or soap provision, have been published, but these efforts may not be an optimal strategy to induce long-term, self-propagating behavioral change in adults and children (Luby et al. 2009). First,
many handwashing programs do not provide readily-available handwashing devices for use after engaging in activities that lead to bacterial transmission. Second, many interventions emphasize a single component rather than a holistic approach, such as the Central American Handwashing Initiative which mainly focused on education (Tain and Bendahmane 2001). Third, the current Uganda National Handwashing Campaign is geared towards adults i.e. caregivers, for whom behavioral change may be more difficult to induce than in young children. Ultimately, the incidence of child mortality could be cut dramatically if a simple, low-cost, and comprehensive program for cleaning hands were widely promoted and practiced.

**Tippsy-Taps**

A tippy-tap is a simple, economical (US$1-2) handwashing station that can be made from commonly available materials and can serve as a handwashing faucet in underdeveloped, rural areas. The original concept of the tippy-tap can be credited to Dr. Jim Watt, of the Salvation Army in Chiweshe, Zimbabwe. The tippy-tap consists of a jerrycan or jug which releases a small amount of water each time it is “tipped.” When the “tap” is released, it swings back to its starting upright position. Moreover, a tippy-tap is suitable for implementation in water-scarce regions as it uses only 40-50 mLs of water per handwash on average compared to 500-600 mLs of water when using a faucet (Hurtado 1993). Many different models of the tippy-tap have been invented in many developing countries. The design invented initially by Dr. Watt does not require ground support but is rather suspended in the air by a plastic net (Centers for Diseases Control and Prevention 1995). The most widespread design is using tree branches implanted in the ground to suspend the jerrycan (Westra and Holtslag 2008).
Aim and Motivation for Study

Low-cost promotion of handwashing can be a cost-effective intervention of choice, in areas where handwashing rates are low and where diarrheal disease and child mortality is high. Hygiene promotion programs against diarrheal diseases are one of the most cost-effective in terms of recovering disability measured in disability adjusted life years (DALYs) (Laxminarayan et al. 2006).

It is well-known that handwashing with soap can prevent bacterial disease transmission, but more work is required to find effective and affordable approaches that can induce lasting behavior change, especially in children. In response to the global burden of diarrheal disease, which is a leading cause of child mortality, we have designed and implemented a low-cost hand hygiene promotion program based around tippy-taps, education, and soap, specifically targeted towards schoolchildren in resource-limited settings. Pre- and post-intervention surveys were used to solicit information on the program’s effectiveness as well as behavior and attitudes regarding handwashing. Our results suggest that the introduction of the program changed the frequency of handwashing in intervention schools and also reduced the prevalence of self-reported cases of diarrhea. To the best of our knowledge, our study provides the first quantitatively assessed study of the effect of tippy-tap implementation on handwashing behavior in the school-setting. We believe the tippy-taps coupled with education and soap provision, can provide an efficient, low-cost, and fun strategy for inducing handwashing behavior change in children.

The motivation for this project began at the end of my freshman year, when I noticed a volunteer advertisement on the Schreyer Honors College listserv for the Uganda Village Project (UVP), which is a public health promoting non-governmental organization based in the Iganga District of Uganda. I took this opportunity and volunteered with UVP in the summer of 2009,
where I lived in a village with a team of four other students and conducted public health
fieldwork on a variety of topics such as HIV/AIDS, malaria, sanitation, safe water, obstetric
fistula, etc. One day, our team visited two elementary-level schools in our village that were
interested in forming health clubs. Surprisingly, we noticed that in both schools, there was a lack
of handwashing facilities for children to wash their hands immediately after using the latrine or
after playing outside. For many of us growing up in industrialized nations such as America, we
are accustomed to having bathrooms with piped water supplies, drinking water from faucets after
exercise, or even portable hand sanitizers to use after having a single thought of uncleanliness.
Yet, in many countries where water technologies are scarce, preventable bacterial diseases
surface and cause substantial mortality that can otherwise be prevented. Moreover, it can be
difficult and costly to inhibit epidemics such as malaria and AIDS, but simple and cheap
hygienic interventions such as handwashing can help prevent the spread of bacterial and
diarrheal diseases.

After returning to Penn State, I formed a public health research team with another Penn
State student, Adam Mosa, and a faculty member, Dr. Stephen Matthews. Our goal was to design
and implement a study to test the efficacy of tippy-taps in promoting handwashing behavior in
schoolchildren. This thesis summarizes the design and preliminary findings from a
comprehensive, child-centered tippy-tap handwashing program implemented in rural school-
settings. Our main goal is to improve handwashing and sanitation practices in rural Uganda in
order to reduce the burden of disease and improve overall quality of life for its residents.
CHAPTER 2

METHODS

Study Population

This project is a partnership with the Uganda Village Project, a non-governmental organization that promotes public health and development initiatives in the Iganga District in the Busoga region of Eastern Uganda. The study mainly focused on elementary-level schoolchildren in the Iganga District. As discussed previously, children are among the most vulnerable populations afflicted by diarrheal diseases because of their lack of bodily maturity and lack of health education. Furthermore, the majority of global child deaths are concentrated in low-income countries (Black et al. 2003; Vella et al. 1992; Victoria et al. 1989). We decided to implement the program in the school environment because it provides an ideal location for the initial distribution of handwashing technology; schools are a point of congregation for large numbers of students from the surrounding community.

In Iganga, children under 15 comprise 54% of the total population (Uganda Population Census 2002), and the child mortality rate in 2004 was 147/1000 (diarrheal disease was a leading cause of death [National Environment Management Authority (2003/2004)]). We decided to enroll eight particular Iganga District schools after we found that the schools did not possess handwashing stations or were subjected to any handwashing-promotion programs, and also because the headquarters of the Uganda Village Project was based in the Iganga District.

This study was undertaken from September 2010-January 2011 and targeted students in grades 2-5, from 8 elementary schools with an average student body size of 900 students. Ethical approval was obtained from the Penn State University Institutional Review Board (IRB# 34055),
and all participants in the study provided informed consent. Participating schools were divided into four intervention schools and four control schools. The intervention schools were provided with tippy-taps, soap, and a complementary educational program designed to promote handwashing behavior. The control schools initially only received the education program, but were given tippy-taps and soap at a later time point. Table 1 contains information on the approximate number of students and any religious affiliations of the enrolled control and intervention schools.

**Table 1. Enrolled Control and Interventions Schools.**

<table>
<thead>
<tr>
<th>School Name</th>
<th>Number of Students</th>
<th>Religion</th>
<th>Control or Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lady Gladus</td>
<td>650</td>
<td>Islamic</td>
<td>Control</td>
</tr>
<tr>
<td>Nakigo Primary School</td>
<td>820</td>
<td>No</td>
<td>Control</td>
</tr>
<tr>
<td>Bunama</td>
<td>1000</td>
<td>No</td>
<td>Control</td>
</tr>
<tr>
<td>Wairama</td>
<td>700</td>
<td>No</td>
<td>Control</td>
</tr>
<tr>
<td>Tree Life</td>
<td>1300</td>
<td>No</td>
<td>Intervention</td>
</tr>
<tr>
<td>Bulubandi</td>
<td>920</td>
<td>No</td>
<td>Intervention</td>
</tr>
<tr>
<td>Nakigo Nubuwati</td>
<td>760</td>
<td>No</td>
<td>Intervention</td>
</tr>
<tr>
<td>Fairway</td>
<td>1200</td>
<td>No</td>
<td>Intervention</td>
</tr>
</tbody>
</table>

**Handwashing Program Design**

The handwashing promotion program contains three components: handwashing education, construction of tippy-taps, and provision of soap.

The education component is centered on instructional lessons about the benefits, proper technique, and critical times when handwashing should take place (e.g. after using the latrine,
before and after eating, when hands are dirty). This included poster presentations modeled on CDC materials (Centers for Disease Control and Prevention 2007), a handwashing song (Uganda Village Project 2009), distribution of flyers, and discussions with students about handwashing with soap. All educational materials were translated from English to Lusoga, the local language. As mentioned previously, current national handwashing campaigns in Uganda are focused on mothers of households and Village Health Team (VHT) workers (Biran 2011). Specific handwashing programs targeting children in the school-setting is uncommon. Yet, it is important to note that changing the handwashing behavior of school-aged children may be less challenging than changing the behavior of adults. Our specific focus on the schoolchildren population allows handwashing habits to be instilled at an early stage, which can reinforce hygienic behavior through adolescence and adulthood, and can motivate schoolchildren to become active agents in promoting handwashing behavior at home (Blanton et al. 2010). Furthermore, as the schoolchildren eventually mature into adults and begin starting their own families, the knowledge gained from our handwashing promotion program will allow them to instill positive hand washing habits in their children.

All tippy-tap construction materials (plastic jerry cans, wood, string, nails, a hammer) were available locally. Five tippy-taps were constructed and installed near boys’ and girls’ latrines at each intervention school. Although tippy-taps have been implemented previously, we have modified the widespread tree-branch design that can be easily broken, to a sturdier station made out of wood ($2), which is durable for high usage by children in the school-setting and where a child could have immediate access to clean water and soap (See Figure 1).
Students assisted in tippy-tap construction (under adult supervision) and maintenance duties (Figure 2) such as refilling the jerrycan with water, cleaning the tippy-tap, and replacing soap. Only the study participants constructed the tippy-taps, were given the educational program, and assigned the maintenance duties. Soap was purchased in bulk from local markets (25 bars for US$13) and a one-month supply (100 bars) was provided for every 5 tippy-taps.
Experimental Design

The data for our study was obtained using pre- and post-intervention surveys designed to solicit information on the program’s effectiveness as well as behavior and attitudes regarding handwashing. The surveys were distributed to approximately 25 boys and 25 girls (ages 7-13), randomly selected by research staff in each of the 8 elementary schools (for a total sample of 398 students). The same children received the pre/post intervention surveys.

The data collection waves, three in all, were spaced one month apart. At time 1, baseline surveys were implemented in all schools. The baseline survey was designed to gather attitudinal and behavioral data on personal sanitation at school and home, and self-reported data on stomach pain episodes in the past month. Between time 1 and time 2, the intervention schools received tippy-taps, soap, and a handwashing education program, while control schools only received the education program. At time 2, the intervention schools were given the post-intervention survey and the control schools repeated the pre-intervention survey. The post-intervention survey was used to gather data on handwashing behavior, use of tippy-taps, stomach pain, and student-parent idea dissemination. Between time 2 and time 3, the control schools each received tippy-taps and soap. Finally, at time 3, the post-intervention survey was administered in control schools.

The research team designed the surveys, experimental set-up, developed the educational program, and analyzed the data in conjunction with the staff and students at the Uganda Village Project (UVP). UVP, a Uganda-based non-profit, coordinated all in-country operations: translated surveys, identified and worked with schools, consented the students, provided educational materials and training regarding tippy-tap construction and maintenance, and implemented the surveys. Data were analyzed using SPSS Statistics 19. Table 2 provides a
concise summary of the components of our tippy-tap handwashing promotion program and the research design.

**Table 2. Summary of Project**

<table>
<thead>
<tr>
<th>1.) Construction and Soap Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Gathering of tippy-tap materials: jerry cans, wood, string, nails, hammer, and stones</td>
</tr>
<tr>
<td>• 5 tippy-taps per school near boys and girls school latrines, $2 per tippy-tap</td>
</tr>
<tr>
<td>• Adult-supervised student construction of tippy-taps</td>
</tr>
<tr>
<td>• Soap was purchased from local village markets at a rate of 25 bars for $13</td>
</tr>
<tr>
<td>• A monthly supply of 100 soap bars was given for every 5 tippy-taps installed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2.) Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Age-appropriate poster presentations, handwashing songs, discussions about handwashing with students, distribution of flyers</td>
</tr>
<tr>
<td>• Student-led maintenance of tippy-taps such as cleaning, replacing soap, refilling water</td>
</tr>
<tr>
<td>• Distribution of flyers to students on how to build tippy-taps for their families</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3.) Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pre and post-surveys to compare handwashing behavior at baseline and after intervention</td>
</tr>
<tr>
<td>• Intervention is 5 Tippy-taps + complementary handwashing education</td>
</tr>
<tr>
<td>• Time 1: Implementation of baseline surveys, and installation of tippy-taps + education in intervention schools. Control schools only receive education program</td>
</tr>
<tr>
<td>• Time 2: first post survey of intervention schools with tippy-taps + education and control schools with education only. Control schools then receive tippy-tap installation</td>
</tr>
<tr>
<td>• Time 3: Post-surveys administered to control schools with tippy-taps + education</td>
</tr>
<tr>
<td>• Each time point spaced one-month apart</td>
</tr>
</tbody>
</table>
CHAPTER 3
RESULTS

Differences between Enrolled Schools at Baseline

Baseline survey results reveal some differences in school handwashing behavior, though both the intervention and control schools revealed low compliance rates, with the modal category reported being “sometimes”. Similarly, the reported use of soap, while low, was different between schools. However, the students in the intervention and control schools appear to have similar profiles with respect to handwashing after visiting the latrine, the absence of stomach pain, and the number of times they washed their hands per day. While there was variation in the frequency of stomach pain episodes, the percentage of students experiencing stomach pain in the previous month was approximately 94.9% and 93.0% in the control and intervention schools, respectively.

Handwashing Behavior and Diarrheal Disease

A comparison of pre- and post-intervention data from intervention schools indicate handwashing frequency increased. Both handwashing at school and after using the latrine increased after the introduction of tippy-taps. The proportion of students “always” washing their hands after using the latrine, increased from 5.5% to 65.0% in the intervention schools (washing hands after using the latrine among students in the control schools increased from 3.6% to 79.3% by time 3). The proportion of students reporting “always” or “often” washing their hands at school increased from 3.5% at baseline to 100.0% in the intervention schools (replicated in the control schools by time 3). Use of soap in the intervention schools increased from 13.5% to
84.5% (with even higher proportions reported at control schools in time 3). In the intervention schools, the proportion of students reporting washing their hands 3 or more times/day increased from 5.5% to 93.0% after tippy-taps installation. After the installation of tippy-taps with the educational program, the control schools attained the handwashing rates of the intervention schools, increasing from around 10.0% to 97.9%.

Proxy data on the incidence of diarrheal disease is indicated by the number of students reporting stomach pain episodes in the previous month. Students reporting no stomach pain episodes increased from 7.0% to 80.0% in the intervention schools and from 4.1% to 73.6% in control schools (between time 2 and 3). Figures 3, 4, and 5 are line graphs which highlight the ability of the intervention to cause increases in handwashing behavior daily, at school, and an overall reduction in stomach pain episodes respectively.

**Tippy-Tap Use and Idea Dissemination**

Table 4 provides data on student reactions to the implementation of tippy-taps in their schools. Overall, the vast majority of students indicated positive responses to the tippy-tap handwashing program. 99.7% and 100% report that using a tippy-tap was fun and that more tippy-taps should be constructed the schools. 98.7%, 99.2%, and 100% of the students reported that the tippy-taps were maintained well, had soap available, and were still working at the schools, which indicates that the maintenance program was effective throughout the study period. Lastly, potential for idea dissemination was also observed as 98.7% of surveyed students indicated that they told their parents about the tippy-tap and that 99.7% have seen friends wash their hands with the installed tippy-taps.
Table 3. Handwashing and stomach pain in control and intervention schools pre- and post-intervention, numbers and percents (Total sample N = 398).

<table>
<thead>
<tr>
<th></th>
<th>Pre-intervention (Baseline)</th>
<th>Pre-intervention</th>
<th>Post-Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Intervention</td>
<td>Control</td>
</tr>
<tr>
<td>Total</td>
<td>198</td>
<td>200</td>
<td>195</td>
</tr>
</tbody>
</table>

Do you wash your hands at school?

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Intervention</th>
<th>Control</th>
<th>Intervention</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Always</td>
<td>11 (5.6)</td>
<td>2 (1.0)</td>
<td>12 (6.2)</td>
<td>80 (40.0)</td>
<td>155 (80.3)</td>
</tr>
<tr>
<td>Often</td>
<td>48 (24.2)</td>
<td>5 (2.5)</td>
<td>10 (5.1)</td>
<td>120 (60.0)</td>
<td>37 (19.2)</td>
</tr>
<tr>
<td>Sometimes</td>
<td>88 (44.4)</td>
<td>175 (87.5)</td>
<td>103 (52.8)</td>
<td>0 (0.0)</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>Never</td>
<td>51 (25.8)</td>
<td>18 (9.0)</td>
<td>70 (35.9)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>

Do you wash your hands before using the latrine/toilet?

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Intervention</th>
<th>Control</th>
<th>Intervention</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Always</td>
<td>9 (4.5)</td>
<td>11 (5.5)</td>
<td>7 (3.6)</td>
<td>130 (65.0)</td>
<td>153 (79.3)</td>
</tr>
<tr>
<td>Often</td>
<td>69 (34.8)</td>
<td>55 (27.5)</td>
<td>39 (20.0)</td>
<td>68 (34.0)</td>
<td>37 (19.2)</td>
</tr>
<tr>
<td>Sometimes</td>
<td>87 (43.9)</td>
<td>123 (61.5)</td>
<td>137 (70.3)</td>
<td>2 (1.0)</td>
<td>3 (1.6)</td>
</tr>
<tr>
<td>Never</td>
<td>33 (16.7)</td>
<td>11 (5.5)</td>
<td>12 (6.2)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>

Do you use soap when washing your hands?

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Intervention</th>
<th>Control</th>
<th>Intervention</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>54 (27.3)</td>
<td>27 (13.5)</td>
<td>25 (12.8)</td>
<td>169 (84.5)</td>
<td>193 (100.0)</td>
</tr>
<tr>
<td>No</td>
<td>144 (72.7)</td>
<td>173 (86.5)</td>
<td>170 (87.2)</td>
<td>31 (15.5)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>

How many times a day do you wash your hands?

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Intervention</th>
<th>Control</th>
<th>Intervention</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero</td>
<td>9 (4.5)</td>
<td>9 (4.5)</td>
<td>18 (9.2)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>One</td>
<td>145 (73.2)</td>
<td>98 (49.0)</td>
<td>133 (68.2)</td>
<td>1 (0.5)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Two</td>
<td>24 (12.1)</td>
<td>82 (41.0)</td>
<td>27 (13.8)</td>
<td>13 (6.5)</td>
<td>4 (2.1)</td>
</tr>
<tr>
<td>Three or More</td>
<td>20 (10.1)</td>
<td>11 (5.5)</td>
<td>17 (8.7)</td>
<td>186 (93.0)</td>
<td>189 (97.9)</td>
</tr>
</tbody>
</table>

In the past month, how many times have you experienced stomach pain?

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Intervention</th>
<th>Control</th>
<th>Intervention</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>10 (5.1)</td>
<td>14 (7.0)</td>
<td>8 (4.1)</td>
<td>160 (80.0)</td>
<td>142 (73.6)</td>
</tr>
<tr>
<td>Once</td>
<td>61 (30.8)</td>
<td>93 (46.5)</td>
<td>80 (41.0)</td>
<td>25 (12.5)</td>
<td>43 (22.3)</td>
</tr>
<tr>
<td>Twice</td>
<td>97 (49.0)</td>
<td>50 (25.0)</td>
<td>62 (31.8)</td>
<td>14 (7.0)</td>
<td>8 (4.1)</td>
</tr>
<tr>
<td>More than Twice</td>
<td>30 (15.2)</td>
<td>43 (21.5)</td>
<td>45 (23.1)</td>
<td>1 (0.5)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>
Table 4. Responses to questions on tippy-taps usage and maintenance

<table>
<thead>
<tr>
<th>Questions on tippy-taps usage</th>
<th>(Percentage of respondents indicating Yes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using tippy-taps fun?</td>
<td>99.7</td>
</tr>
<tr>
<td>Friends wash hands with a tippy-taps?</td>
<td>99.7</td>
</tr>
<tr>
<td>Soap Available?</td>
<td>99.2</td>
</tr>
<tr>
<td>Should more tippy-taps be constructed at your school?</td>
<td>100</td>
</tr>
<tr>
<td>Have the tippy-taps been maintained well?</td>
<td>98.7</td>
</tr>
<tr>
<td>Do tippy-taps still work at your school?</td>
<td>100</td>
</tr>
<tr>
<td>Told parents about tippy-tap</td>
<td>98.7</td>
</tr>
</tbody>
</table>

Figure 3. Percent graph of students indicating handwashing “3 or more times” per day in experimental and control schools at three time points spaced one month apart.

Q: How many times do you wash your hands a day?

1 = Baseline; 2 = Post Survey 1 (Follow-up Intervention); 3 = Post Survey 2 (Follow-Up Control)
**Figure 4.** Percent graph of students indicating handwashing at school following intervention.

**Q: Do you wash your hands at school?**

![Graph showing handwashing percentages](image)

1 = Baseline; 2 = Post Survey 1 (Follow-up Intervention); 3 = Post Survey 2 (Follow-Up Control)

**Figure 5.** Percent graph of students indicating zero episodes of stomach pain in the preceding month at three separate time points.

**Q: In the past month, how many times have you experienced stomach pain?**

![Graph showing stomach pain percentages](image)

1 = Baseline; 2 = Post Survey 1 (Follow-up Intervention); 3 = Post Survey 2 (Follow-Up Control)
CHAPTER 4
DISCUSSION

Handwashing Behavior and Diarrheal Disease

Low rates of handwashing with soap usage contribute to the transmission of bacterial
diseases (Burton et al. 2011), especially at key moments (e.g., after using the latrine). A tippy-tap
based handwashing program may provide a successful and low-cost model for handwashing
initiatives in remote and low-resource school-settings. Our data provides evidence that the
provision of tippy-taps, soap, and a simple education program can increase handwashing rates,
soap usage, and reduce the number of self-reported stomach pain episodes among elementary
school-aged students. The placement of handwashing stations such as tippy-taps near latrines can
be effective at disrupting bacterial transmission as it can serve as a cue for handwashing
behavior. Our data also suggest that education alone, focusing on the benefits and critical periods
of handwashing, is not sufficient to induce short-term behavior change, as found in other studies
(Alvaran et al. 1994; World Health Organization 2006b). Without access to a handwashing unit
and soap, students did not have the opportunity (in the school environment) to translate newly
acquired knowledge on sanitation and hygiene into action.

It is important to note that changing the handwashing behavior of school-aged children
may be less challenging than changing the behavior of adults. To enhance the learning process of
students, our tippy-tap handwashing program allowed students to assume a primary role in
constructing and maintaining tippy-taps. This appeared to foster active and engaged participation
in the health learning process, and help reinforce healthy behaviors and utilization among
students. Student-led maintenance allowed children to play an active role in maintaining their
own devices would grant children a sense of responsibility— which can accelerate learning in adolescents (Serpell et al. 2011). Results indicated the schoolchildren-led maintenance program was effective as the majority of the students reported that soap was available during tippy-tap use and that the tippy-taps were maintained well and still working. As shown in table 4, another possible explanation for the success of the intervention is that young students enjoy using the tippy-tap because it is a fun device to use compared to other methods. This could have lead to 99.7% of students reporting that their friends also washed hands using tippy-taps. Other reasons that could have contributed to the high friend usage include the simplicity of the tippy-tap device and the effect of peer influence in motivating other schoolchildren to wash hands.

**Tippy-Tap Use and Idea Dissemination**

In the post-intervention survey, we observed students telling their parents about the tippy-tap and usage of the tippy-tap by the friends of the respondents. Research staff also directly observed many students mobilizing their families to donate tippy-tap supplies. These observations suggest that schoolchildren can act as agents in the dissemination of health knowledge to their homes and potentially their communities; though we did not directly measure community dissemination in this study. Idea transfer from students to adults is a phenomenon previously seen and shown to improve hand washing techniques in the household while decreasing student absentee rates (Blanton et al. 2010).

**Cost Analysis**

The implementation of our school-based program is low-cost. The total program cost and intervention study (including fielding the study and provision of tippy-taps, education, and soap)
was US$1000. Note that the school handwashing program not only provided for the 398 study participants but also the entire school population (approximately 7200 students). After the initial construction of tippy-taps (US$2 each), the maintenance cost is equivalent to the market cost of soap (around $52/month/900 students) or less than US$0.06 per student per month. It is possible that tippy-taps may occasionally break after frequent use; however, the simplicity of the device makes it easy and cheap/free to fix.

**Study Limitations**

We acknowledge that this intervention has several limitations. The project was low-cost and small-scale. These factors limited the range of questions asked, the modes of data collection, and importantly our ability for a long-term follow-up. We relied on student self-report data and did not (were not able) to collect clinical data. While schools were carefully selected, they are all in one sub-district and the possibility of information transfer and influence between control and intervention populations did exist (our data from control schools at time 1 and 2 – that is, before they received tippy-taps – suggests this was not a concern). Differences in behavior between control and intervention schools at baseline could be attributed the presence of an Islamic school in the control group, in which religious practices could account for increased handwashing behavior and soap usage (Katme 1999). We note that soap usage in the control schools decreased between their first and second pre-intervention surveys. This could be due to some control schools running out soap supplies.

To the best of our knowledge, studies of tippy-tap use have focused on adult usage in home-settings and most have been qualitative in nature (Biran 2011). While limitations exist, the
study provides quantitative evidence for an effective low-cost handwashing program that can specifically target and induce handwashing behavior change in young children.

**Conclusion**

Handwashing with soap can save millions of children’s lives, and handwashing promotion can be an intervention of choice if handwashing rates are low and if programs are cost-effective. Here we demonstrate a promotion program built around inexpensive and locally produced handwashing devices coupled with education and soap, which can encourage handwashing behavior and promote health outcomes for children in rural resource-limited settings. We hope that our program will serve as a model that can be replicated and built upon by other health organizations working to improve child hygiene practices.

**Key Findings**

• This program has been successful, over the short term, in promoting handwashing and reducing reported stomach pain episodes in elementary-level students.

• The program’s success may be attributed to the placement of the tippy-tap next to the latrine, active participation from students (i.e. participation in construction and maintenance of tippy-taps and learning about handwashing), the sustainability of the tippy-tap device, and the students’ belief that tippy-taps are fun to use.

• The implementation of this school-based program is low cost. Overall, the cost for an elementary-level student per month in this program is approximately US$0.06.
CHAPTER 5
NEXT STEPS

Future Goals

Our short-term goal is to publish our findings in an academic journal so that we can disseminate our program and receive criticism on our project from public health experts. In the future, we also plan to include additional measures of handwashing behavior aside from the use of surveys, such as direct-handwashing observational analysis and focus group analysis, and the design of objective trials to measure the impact of washing hands on diarrhea. In addition, we are exploring the possibility of setting up a market-based soap supply chain to sustain the continued provision of soap in elementary-level schools. We also plan to modify our current handwashing education program to include specific information that can elicit a feeling of disgust or comfort in children. Disgust could be thinking about potential presence of feces on hands and comfort could be having a sense of being clean. Previous research has shown that disgust and comfort can be potent motivators of HWWS (Curtis et al. 2004; Curtis et al. 2009). Lastly, we plan to conduct a more in-depth study of the potential for students in school-implemented programs to influence behavior change in the household and community setting. Our long-term plan is to continue spreading our handwashing promotion program to more schools throughout Uganda. To accomplish this goal, in the summer of 2012, we will be rolling out the pilot phase of our long-term Ugandan handwashing initiative called LifeTap, based on our researched promotion program. We are also designing a sister school program between United States and Ugandan schoolchildren that may help reinforce our current handwashing education program and provide long-term funding for expansion of LifeTap into more Ugandan schools.
**LifeTap Social Entrepreneurship Venture**

LifeTap is a new entrepreneurial venture which will provide comprehensive school-based handwashing promotion programs to Ugandan schools in order to reduce the burden of diarrheal disease. It is designed to leverage the contributions of the venture’s three independent components, tippy-taps, education, and soap supply chain, to bring about a comprehensive sanitation campaign. LifeTap aims to be the first systematic Ugandan hand-sanitation promoting entrepreneurial venture to successfully integrate multiple strategies for one common goal. Our comprehensive and systems-based approach consists of five sub-components: 1.) Widespread adoption of the tippy-tap technology in the school and home setting 2. Technological development and further refinement of tippy-tap to create a highly efficient and sustainable hand sanitation device. 3. Business model centered on economic sustainability through the creation of a supply-chain for the continued provision of soap to schools. 4. Educational program to induce lasting behavior change through comprehensive sanitation education which emphasizes active student participation. 5. Research aimed at quantitatively assessing LifeTap’s effectiveness, both in terms of impact on diarrheal disease incidence and potential commercialization of tippy-taps from the school to home community.

We have created a detailed business proposal of our LifeTap project and have submitted grant proposals to the National Collegiate Inventors and Innovators Alliance (NCIAA) and the Massachusetts Institute of Technology, in order to fund a one year pilot program of LifeTap. Our LifeTap team is interdisciplinary, and composed of students and faculty that can contribute expertise from a variety of fields such as medicine, systems engineering, business planning, sociology, demography, geography, public health, and rural development, for the ultimate goal of decreasing child mortality. For example, we have enlisted students and faculty from the Smeal
College of Business, who will provide business expertise in the design of a sustainable business model for our soap supply chain and public outreach of our program. We are also currently working with Johnson & Johnson to organize the provision of Savlon antibacterial soap for our soap supply chain to enrolled LifeTap schools. Our current in-country partner is the Uganda Village Project, but we are also looking to enlist the support of major organizations such as UNICEF and Unilever in order to spread the LifeTap program beyond the Iganga District.

**Sister School Program (Pennsylvania Schools for Uganda)**

Pennsylvania Schools for Uganda is a sister school program connecting United States elementary schoolchildren with Ugandan schoolchildren for the purpose of health promotion. Instead of focusing on donations i.e. supplying Ugandan children with materialistic items such as clothes, we will be focusing on the sharing of “health capsules” containing student-created health educational materials that can be shared between schools. Health education is an integral part of a comprehensive public health program. By treating knowledge as a valuable and shared public resource, our project can directly lead to positive change in communities beyond the classroom. The most innovative aspect of our project is the creation of a child health-centered international dialogue with the expressed purpose of reinforcing the benefits of handwashing via fun and engaging classroom activities. Our major premise is that students can be motivated more to wash hands if they observe their peers doing so as well. Thus, the sister school program can complement the handwashing educational program we implement in LifeTap schools. Furthermore, long-term funding generated from the sister school program, in the form of U.S. school fundraisers and donations, will be used for the continued provision of tippy-taps, handwashing education, and soap.
CHAPTER 6
STUDENT-LED PUBLIC SCHOLARSHIP

Importance of Free Discourse in Democracy

The philosopher John Stuart Mill once stated in his essay entitled *On Liberty*: “The peculiar evil of silencing the expression of an opinion is, that it is robbing the human race; posterity as well as the existing generation; those who dissent from the opinion, still more than those who hold it. If the opinion is right, they are deprived of the opportunity of exchanging error for truth: if wrong, they lose, what is almost as great a benefit, the clearer perception and livelier impression of truth, produced by its collision with error” (Mill 1859).

Mill argues that free discourse would generate a “marketplace of ideas” that is a prerequisite for arriving at political truths. Free discussion allows humans to challenge preexisting ideas and prejudices that remain on habit-alone compared to what may be the most logical. Essentially, the marketplace of ideas creates opportunities for the best ideas to prevail, similar to the best products that prevail in an economy.

Public discourse is the essence of democratic institutions. Wilentz notes in the *The Rise of American Democracy* that: “Democracy is never a gift bestowed by benevolent, farsighted rulers who seek to reinforce their own legitimacy. It must always be fought for by political coalitions that cut across distinctions of wealth, power, and interest (Wilentz 2005). Thus, inherent in democracy is the ability of all citizens to participate in the democratic process, which preserves the sovereignty of the people.
Limitations of Student Volunteerism

Volunteerism alone is insufficient to promote and can often silence public discourse of original ideas. Students undertake service-related endeavors for a multitude of reasons. For example, they may want to become more sensitized to other cultures, different levels of socioeconomic strata, or even provide free services to disadvantaged populations. However, the main benefit of charitable service extends only to the individual i.e. the fulfillment of a moral and ethical paradigm that is derived from individuals helping other individuals. Ultimately, service alone cannot efficiently address the root causes behind complex problems prevalent in society, because it is primarily an individual-promoting activity that does not directly contribute to the expansion of the marketplace of ideas in the public sphere. In democratic societies, ideas that are subjected to public scrutiny and choice eventually lead to societal progress.

Yet, that is not to say that volunteerism does not have its benefits. Aside from an aspect of ethical and moral fulfillment, volunteerism can allow individuals to generate potential ideas that can be part of public discourse. This can be especially advantageous for individuals that seek to solve problems in international communities, without a preexisting background on the cultural and demographic conditions of the native population.

Public Scholarship as Volunteerism Coupled with Scholarship

Idea generation is only the first step to preserving a strong democratic capacity. The delivery of ideas into public knowledge requires academic scholarship, which mainly employs academic research in the form of applying specific methodologies to elucidate questions of interest. Academic scholarship provides a way for a consistent and efficient communication of ideas into the public sphere. Students who engage only in volunteerism only, may attain personal
fulfillment and a heightened understanding of their communities but do not contribute to sharing of original ideas through public discourse. In contrast, faculty that primarily focus on academic scholarship and not volunteerism may have engaged in idea contribution, but these ideas may not be the “best” ideas as it could target a concern that is far removed from the most pressing problems of the dynamic communities that they wish to target.

Overall, public scholarship is the undertaking of academic or creative work to address society's most pressing social, civic and ethical problems. Volunteerism and academic-scholarship alone is insufficient to encompass the notion of public scholarship. However, when service-related activities are combined with academics, public scholarship is maximized because the combination provides a platform for the best ideas to be generated and efficiently communicated to the public i.e. the marketplace of ideas. Students studying at the university level are at the forefront of public scholarship projects in their communities and abroad because of academic exploration in their classes, the opportunities for peer collaboration, and the potential resources provided by their institutions for faculty mentorship and financial support. Higher education institutions attempting to foster student public scholarship and democratic ideals should create increased opportunities that promote a complementary combination of volunteerism and academics.

**Application of the Handwashing Project to Public Scholarship**

This handwashing research project is an example of student-led public scholarship because we incorporated volunteerism with scholarly research in order to address internationally disadvantaged populations. The initial motivation behind our school-based handwashing program was derived from volunteering abroad in Uganda, and observing the lack of
handwashing facilities in visited Ugandan elementary schools. Our identified problem was that improper handwashing habits or decreased access to handwashing facilities is detrimental to the normal development of children due to contraction of bacterial diseases. As engaged public health advocates, we felt compelled to design a simple intervention that could address this issue.

Volunteering abroad was critical to understanding the context of our specific international population and helped us shape our designed intervention. After conducting an electronic literature search, our volunteer team found about the tippy-tap and decided to test it initially in the field. After implementing the tippy-tap at Ugandan elementary schools within our village, we first observed that students were able to construct the device themselves and that they were very receptive to the device. At that point, we conducted another literature search on published data relating to tippy-tap based handwashing programs, which there was a lack of. Thus, we aimed to create a model of handwashing promotion that was built around tippy-taps in order to elucidate the effects of the device on changing handwashing behavior in students.

Volunteering in Uganda was also important in the sense of building a strong relationship with a local non-profit partner, whom is willing to support you in any future endeavors. For students interested in conducting projects internationally, pursuing a project becomes much easier when you have an ongoing relationship with a supporting international partner, in this case the Uganda Village Project. For example, one major challenge of conducting an international public scholarship project was to obtain Penn State Institutional Review Board approval. We began the IRB process in the Fall of 2009 and gained approval during the Spring of 2010, before we implemented the project during the Summer of 2010. Some of the major hurdles of the IRB process was obtaining signed approval from the Iganga District Education Office for our project, informed consent from the study participants in each of our eight schools, and providing
translated documents of our research materials from English to Lusoga. We were able to accomplish these tasks even though we were still at Penn State during the summer, due to the help of staff from the Uganda Village Project. This is a prime example of the importance of establishing a working relationship with an in-country organization. Obtaining consent and translated documents, while still at Penn State, would have been near impossible without having previous relationship with the Uganda Village Project.

In terms of the scholarship component, we enlisted the help of a faculty member at Penn State, Dr. Stephen Matthews, in order to design a research study to measure the efficacy of our intervention, with the eventual goal of disseminating our results to the public (Appendix N) in the form of public presentations and publication in an academic journal. I first met Dr. Matthews through my student partner, Adam Mosa, who previously took a medical sociology class taught by him. The benefit of having a supporting faculty mentor cannot be stressed enough. As undergraduates, although we are motivated learners, we are limited in our experiences pertaining to the process of research. One specific example I remember was during the initial stages of the project, when Dr. Matthews suggested seeking IRB approval if we wanted to publish our work. At that point in time, I didn’t know what an IRB was. Overall, Dr. Matthews provided critical advice for us at important junctures, such as design and implementation of our research study, IRB approval, data analysis, and project dissemination to the Penn State community. The camaraderie between Dr. Matthews and us led to the efficient generation of many ideas that have led to the successful implementation of this project. Furthermore, our knowledge and ability to carry out an independent research project increased as well.

Lastly, funding of our project was an important issue for us. Since our project was student-founded, it was not sponsored by faculty-level grants. We had to limit the scope of our
study so that it was low-cost and could be supported by undergraduate grants from start to finish. Fortunately, the focus of our project was on a low-cost device for handwashing, so financial support wasn’t a major concern. However, we could have designed a more detailed study if we had additional funds. The funding for this project was supported mainly by the Schreyer Honors College in the form of a $1000 research grant and also a $250 contribution from the Uganda Village Project. Overall, for student-founded public scholarship projects, it is important to do a comprehensive search of all available grant programs at one’s university and then to design the scope of the project around potentially available finances. Public scholarship projects that are run by faculty and universities, although not student-founded, are beneficial from a financial standpoint in that more money is potentially available to support larger projects.

**Current Challenges and Potential Solutions**

Public scholarship projects are the result of an initial generation of an idea attacking societal problems, finding support for the project, using research to evaluate the impact of the project, and sharing of the results on a public level. Often for students, independent generation of an initial idea without faculty support is very difficult, unless there is direct personal exposure to the targeted area or group of interest. University-wide creation of classes with a special emphasis on societal problems, promotion of students to engage in internationally-focused classes, student organizations, and/or public service-related summer internships, can help students to be exposed to an environment that promotes idea generation. For example, Penn State has a Civic and Community Engagement minor (CIVCM), which incorporates a balanced program of coursework and fieldwork to motivate students to apply issues of knowledge from their majors towards issues of importance beyond the classroom. As a student who conducted a public health
related project, it could be useful in the future for the CIVCM to forge an affiliation with the Department of Biobehavioral Health (BBH) and Health Policy and Administration (HPA) in order to attract students interested in conducting public scholarship projects that address global health issues. The University Office of Global Programs at Penn State is also a crucial facilitator of international experiences for students because the office provides numerous study abroad opportunities. However, to facilitate public scholarship projects that address global low-income populations for example, there should be increasing emphasis on study abroad opportunities in less developed countries. Often, financial support is a limiting reason behind lack of student participation in projects so there should also be creation of student grants that will specifically fund public scholarship projects outside of the College of Engineering, College of Agriculture, and the Schreyer Honors College. For example, the Eberly College of Science lacks undergraduate research grants for internationally-focused projects. Lastly, the university should create more opportunities to increase visibility of student research projects to the public. Examples of opportunities could include a student public scholarship speaker series, creation of an undergraduate research journal, or simply compiling a list of opportunities for students to share their projects on a local, state, or national level.

As a large research university with abundant resources, Penn State is in a prime position to facilitate the growth of a new generation of public scholars whom address key societal issues that are of domestic and global importance. Ideas of service and outreach are long established at Penn State and possess good intentions. However, in the long-term, it would be best to couple academic depth with service and outreach so that students can disseminate original and creative ideas that can serve the public good while being subjected to public scrutiny.
Appendix A: Recruitment and Verbal Assent Script

Recruitment Script

Hello, my name is ( ), and I am a member of the Uganda Village Project, an organization that is dedicated to improving health in the Iganga District. We deal with issues such as HIV/AIDS, malaria, safe water, sanitation, family planning, etc. Today, I would like to tell you about a great research project that we want to conduct in your school that can improve hand sanitation. How many of you heard of a Tippy-Tap? Well, a Tippy-Tap is a low-cost, simple, and fun handwashing station made from common materials found in Uganda such as wood, tree branches, jerrycans and string. We would like to put Tippy-Taps in your schools as a fun and low-cost way to wash your hands in schools. The goal of this project is to see if the students at this school will wash their hands more with the Tippy-Tap, at points where disease causing bacteria can be spread easily such as going to the latrine, playing outside, eating. So this is project is a research project in that we will see if Tippy-Taps will allow you to wash your hands more than usual at critical points. This research project is done in cooperation with the Uganda Village Project and Penn State University in the United States. This project will be done only with primary-level Iganga schoolchildren, because we believe that the children at a young age have the greatest power to influence and spread health improving ideas to their families and villages as they grow older.

Verbal Child Assent Script:

This Tippy-Taps project will be carried out in three steps. Today, in the first step, we will give out a short survey that will allow us to see your current health behaviors toward sanitation. In the second step, we give a short education program on handwashing and we will allow you to build the Tippy-Taps and use the Tippy-Taps for one month. We want to see how you respond to the Tippy-Tap and if it makes you want to wash your hands more. In the third step, we will give a post-survey that will ask you questions about your health behaviors and your opinions on the project. Your participation in this project is voluntary in that you don’t have to fill out the survey or use the Tippy-Taps if you don’t want to. The surveys are anonymous in that we will not ask you for your name so no one can identify who you are. However, we encourage you to fill out the surveys, which are really short and easy, because it will help us see if Tippy-Taps useful. If you have any questions about the research project, I will leave the phone number of our project coordinator ___________ with your teacher. Thank you and does anyone have any questions?
Appendix B: Recruitment and Verbal Assent Script (Translated)

Recruitment Script/ Okukobya okusokha


Verbal Child Assent Script / Okwo’ghenzha abanha

Ekinabiro kye-obwala kiterebwa wo mumitendera essatu_Olusokha, no’okusomesa ku kubighemeghana ku bwo –oyondha n’o kunaba mu’bwalal, ngeri eyo okuzimba mu ebinabiro kyo omubwala okumala omwezi. Twendha okuboona engeeri abanha kyebakoozesu mu ebinabiro kyo’omubwala_Ekyo’okusatu, tubuza ku ebibuzo ebigemeghanha n’okunaba mu buala no’obulamu obulunghi, nengeri eyo okwengera ekitongole kinho amanhi. Oliwa idhembe, okwira ihala mu ebibuzo ngha bwoyendha, bwo oba oyendha totaku mainha go_Bwo-oba ilinha kyobuza ekivulaku, kubira ku kayungirizi waifhee Ntalo Julius __________ no’ omusomesa wanho. Mwekaze inho. Ériyo alinha ekibuzo?
Appendix C: Implied Informed Consent Form for Social Science Research
The Pennsylvania State University

Title of Project: A Low-Cost Strategy for Improving Child Health in Rural Uganda:
A Tippy-Tap based School Intervention

Principal Investigator: Ce Zhang
9 Simmons Hall
State College, PA 16802
E-mail: cxz5013@psu.edu
Tel: 570 441-1940

Advisor: Stephen A. Matthews, Ph.D.
The Pennsylvania State University
601 Oswald Tower
University Park,
PA 16802-6211
E-mail: matthews@pop.psu.edu
Tel: 814 863-9721

Other Investigator(s): Adam Mosa
Kaluani Mambwe
Bryan Butto

1. Purpose of the Study:
We wish to install Tippy-Taps, low-cost handwashing stations consisting of a freestanding frame, a jerry can, and soap. We will test the impact of our handwashing educational program along with Tippy-Tap installation on handwashing behavior in elementary schools in Uganda. We also would like to see if students will build Tippy-Taps outside of school.

2. Procedures to be followed:
The students at your school will be asked to answer a ten question multiple choice survey about their handwashing behaviors before our team arrives to install the Tippy-Taps. The team will arrive one week after the first survey with the materials necessary for the construction of the Tippy-Taps. On the installation day, the team will present a brief educational component on the benefit of hand sanitation on health, and on proper construction of the handwashing stations. After the installation, we will leave the handwashing stations in place so that over the course of the next month the students will have a chance to use them. When our team returns, we ask the students to fill out an eighteen question follow-up survey. We ask that the teachers get involved by assigning tasks such as maintenance of the Tippy-Tap to different students as they see fit. Lastly, we would appreciate if the teachers could give us feedback, comments or observations, on what was found to be most effective. By participating in the research procedures listed above, the students and the teachers give implied consent to implement this research project at your school.
3. **Discomforts and Risks:**
There is a minimal risk associated with the construction of the handwashing station because it involves the use of hammers and nails. However, the students will be supervised by you and the volunteer team throughout this process to ensure the safety of your students. Also, the questionnaires ask minimally personal questions.

4. **Benefits:**
The benefits of introducing low-cost handwashing stations are that they can reduce the burden of disease by increasing sanitation practices. We believe the Tippy-Taps can provide an efficient, low-cost, and fun strategy for educating children about sanitation. Furthermore, there is a potential for the students to bring the information learned in our program back to their communities where they could build Tippy-Taps for their families.

5. **Duration/Time:**
There will be an initial baseline survey implemented, which would take a couple of minutes. A week later, students will be required to listen to a brief presentation on the benefit of handwashing and the construction of Tippy-Taps. We estimate that on the day we arrive to install Tippy-Taps, it will take 2 hours for everything to be done. The teacher’s role on this day is to supervise the students in constructing the Tippy-Taps. Afterwards, we will monitor the students’ use of the Tippy-Tap for one month by physical observation. After one month, we will then return for a follow-up survey, estimated to take 1 hour. In total, we ask that the students are available for 3 hours to provide us with the information we need for this study.

6. **Statement of Confidentiality:**
Your participation in this research is confidential. The survey forms will ask for gender, but this information will only be used to see whether differences in practices exist for students of opposite sex. All of the data collected will be sent directly to the investigators at The Pennsylvania State University. The Pennsylvania State University’s Office for Research Protections, the Institutional Review Board and the Office for Human Research Protections in the Department of Health and Human Services may review records related to this research study. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared because your name is in no way linked to your responses.

7. **Use of Photographs:**
Photographs may be taken of students constructing and using Tippy-Taps. The use of photographs is to promote Tippy-Taps by visual evidence of the project. The photos will only link the student to the study through their facial images and will not contain any personal identifiable labels. The photographs will be stored on a computer and only research personnel approved by Penn State will have access to it. The photographs will not be destroyed so that they are available for future use as a means to promote Tippy-Taps.

8. **Right to Ask Questions:**
Please contact Adam Mosa at 16464410446 with questions, complaints or concerns about this research. You can also call this number if you feel this study has harmed you. If you have any questions, concerns, problems about your rights as a research participant or would like to offer input, please contact The Pennsylvania State University’s Office for Research Protections (ORP)
at (814) 865-1775. The ORP cannot answer questions about research procedures. Question about research procedures can be answered by the research team.

9. **Voluntary Participation:**
Your decision to be in this research is voluntary. You can stop at any time. You do not have to answer any questions you do not want to answer. Refusal to take part in or withdrawing from this study will involve no penalty or loss of benefits you would receive otherwise.

Completion and return of the survey implies that you have read the information in this form and consent to take part in the research.

Please keep this form for your records or future reference.
Appendix D: Implied Informed Consent Form for Social Science Research (Translated)

Nampala mu kunonenkererezha: Ce Zhang
Akasanduku: 9 Simmons Hall
State College, PA 16802
Kukabwidhibwidhi: cxz5013@psu.edu
Esiimu: 5704411940

Omuwii- Wamagezhi: Stephen A Matthews PhD
Ku unvasite eya’ pensylavaia
601 Oswald Tower University Park
PA 16802 -6211
Kabwidhibwidhi: matthews@pop.psu.edu
Esiimu: 814 863 921

Abebuuzibwaku abandhi: Adam Mosa
Kaluani Mambwe
Bryan Butto

Ekinunsi kyo’okunonenhenkerezha:
Tuudhuba okuta ekinabiro kyo omubwala eko- empiya entonongoli ngha kya mitii,
akadoomolerera, ssabuni. Tweyidha ku khenta emigaso kyakyo ku kunaba mu bwalla ne’emphisa
mu bwo’ buyondho ne’endwairhe eri abanha abato abasomera mu iwangha lwa Uganda
Twendha no’kubonha abazimba ngha bazimba ebinabiro bye’mubwala kuluya we’eisomero
iwaibwe kubanga eikha waibwe.

Emitendhera e’kyo kugoberera:
Abasomi ku isomero wanho baidha kubwizibwa ebibuzho ngha ikumi mu’kikunsulo
ekibereberwe. Ngha bighemaghanha na’ ku kunamba mubwala – ngha ekibina kyaiife ekiyami
ekinabiro kyo- omubwala kikali kutuka ngha ebibuzho biweirhe, ekibinha kidha kwidha
ne’ebintu ebiyamba okutawo ekinabiro kyo’omubwala. Kulunaku olwo okuzimba, ekibina kidha
kusoka kusomesa – kubi ghemaghana ku kinabiro n’okwidhabirizha ekinabiro kyo’omubwala.
Ngha ekibina kimazhe okuzimba, twidha kuleka ekinabiro kye’ngalo ku isomero, tubonhwe oba
empisha dhina’kyukuku mu bighemaghanha no’okunaba mubwala ngha bava mu kyoloni /
omugwanha, twidha kutegera kino nga tulingirila ku kinabiro kyo’obwala, ngha abasomesa batu-
yambha ku kukubulilisa. Ekisembayo, tuyidha okusima abasomesa no’okuta munkola
bwebanakoba, abazhi mwena ku isomero kunho.

Ekidhaza n’okweghendherezha:
Ebizibu mu kuzimba ekinabiro kyo’omubwala bitonio ngholi, olwo okubha okuzimba
kwendha kukozaesa nundho na’misumali. Aye abenzhi balina okuyamba lwakuba ba nakyewa
ngha bazimba okubonha ngha omulimw kujja mirala. Ne’ebibuzho ebibuzhi bwa nga biri
kumulamwa
Ebibala:
Ebibala ebinava mu ku kozhesa ekinabilo kyomubwala, no’okukendheza endwairhele edhiva kubukyafu nga tupa bayondho. Twikirizha tuti ekinabiro kyo’omubwala kya empiya entonio ngoli era kisomesa no’kusobosezha ebyobuyondho ne’kindhi nti kisobooka basomi okutwala bye’benzhe ku kina kyo’omubwala eikha weibwe, taku no’okukizimba yo n’okukikoza.

Entanghama:

Obwasigwa:
Okunonelezha kunho kwakyama, mukunonenkerezha twidha okubuzha obutonde bwo-omuntu – aye bwidha kutuyamba ku okutegera engeri abawala oba abalenzu nani asingha kwendha bwabyondho. Ebinava mukunonenkerezha bidha kujja butelevu ku itendenkero lwa Pennsylvania state univasite mu yafesi oyo okunonenkerezha no’okukuma omusango ne’nolukwamuko olufuzhi olu’ghemagahana ku bwo’obulamu n’ekulankulanha. Ezira irala binafulumizibwa nga toyenzha

Enkoza eyo’ebifanhanyi:
Ebitunyizha ebinakubibwa abasomi nga bazimba ekinabiro kyo’omubwala, bidha kukozekeza mu kutumbula bya buyondho ne’mumisomo. Tividha kubakw mainha, bidha ku kumibwa mu kyuma kyo kabwindhibwidhi mu intendeke kyo Pennsylvania state univasite yafesi umusango mu (814) 865 1775 oba eri ekibina ekikukola omulimo.

Oluwesigwa olwo okubuzha ebibuzho:
Ghemagahana ne Adam Mosa ku isimu +164 64410446 ku bibuzho no’okwemulugunyia wotamatimba mu koonenkererezha Oyinzha era okumukubira eissimu bwobona nga kwabilabwe Era bwoyaghana ekizibi kyona kyona, bwobwa oyendha okuwabula, tukirira penslyaviana state univasite yafesi ekuma omusango ku (814) 865 1775 oba eri ekibina ekikukola omulimo.

Obwona kyewa:
Okusalawo okweta mu koonenkererezha ku kyo-bwana kyewa (busa) oyinzha okukukomya sawa yonha yonha. Tulinha kwiya ku lintu nga toyenzhe bwodhema oba kwawanu mu koonenkerera kuno ezhira kibonerezo oba kasimoo kowumbwa oba ofuyiwa Okwidhuzha mu ebibibuzho kibonerezo nti osimye omulimo era kwendha kujje mumaiso Kuma bulungi olupapula lunho okubonelangha ku jjebwidha.
Appendix E: Handwashing Education Poster

START

1. Wet hands

HAND WASHING STEPS

2. Soap (20 seconds)

3. Scrub backs of hands, wrists, between fingers, under fingernails.

4. Rinse

http://kerjasampinganaja.blogsome.com/wp-admin/images/handwashing%20steps.jpg

Translated:

Ekifananyi ekyo’okunabha mubwala
(emitendhera egwo okunaba mu bwala)

1 Booza obwala bwo
2 Iwebakhe sabuni okumala obutiitiki makumi abiri
3 Nnunkuzha mubabatu n’o munkumu
4 Sansadha / ndiwayikhe
Appendix F: Handwashing Song (Uganda Village Project 2009).

Sung to Mary had a Little Lamb

Lyrics:

Wash your hands with water and soap
Wash your hands always

Wash your hands with water and soap
wash your hands after using the bathroom

Wash your hands with water and soap
Wash your hands before you eat

Wash your hands with water and soap
Wash your hands after you play

Translated:

O'kunhaaba munghaalo
N'aa amandhi n'e ssaabuni
O'kunhaaba munghaaloo
Essawa yoo'hha yoonha.

O'kunhaaba munghaaloo
ngonva mu'tooi
o'kunhaaba munghaaloo
n'aa amandhi n'e ssaabuni

O'kunhaaba munghaaloo
ngo'okhali o'kulya
o'kunhaaba munghaaloo
n'aa amandhi n'e ssaabuni

O'kunhaaba munghaaloo
nga'omazze okuzhaana
o'kunhaaba munghaaloo
n'aa amandhi n'e ssaabuni
Appendix G: Wood Tippy-Tap Construction Guide

In impoverished areas, lack of access to advanced water technologies such as a piped water supply is an imposing barrier to handwashing. According to the Centers for Disease Control and Prevention, diarrheal diseases cause 17% of deaths for children under the age of 5 on a global scale. The simple act of handwashing with soap and water could cut this figure by half. So without any piped water systems, how does one wash his/her hands? Enter the Tippy-Tap.

The Tippy-Tap is a highly economical water dispenser that promotes handwashing in resource-disadvantaged areas. It is easily made indoors or outdoors with commonly available materials, very hygienic in that it is foot-operated so you only touch the soap, and conserves 10 times the average amount of water compared to handwashing using regular faucets. The Tippy-Tap consists of a water containing jug that is attached to a wooden foundation. The jug is attached to a wooden pedal and releases a small amount of water each time it is tipped with a wooden pedal. Furthermore, a gravel pit is built to drain handwashing water for prevention of standing water that may attract malaria-spreading mosquitoes. Constructing a Tippy-Tap consists of three main steps which require 15 minutes to complete altogether:

1.) Construction of the wooden foundation
2.) Attachment of the water jug and soap to the wooden foundation
3.) Preparing a gravel pit for water drainage

The materials needed for this project are universally recognizable and can be commonly purchased in local shopping markets and woodshops. Thus, there are no advanced terms or concepts that require further explanation. In order to simplify the three construction steps, the purpose of each individual material in the overall Tippy-Tap design is explained in the following materials section. Lastly, maintenance tips for the Tippy-Tap are included in the last section of this document. **Warning:** As a precaution, remember to be very careful in avoiding physical injury when performing steps requiring use of hammer and nails.
Materials Required and Purposes

- Two rectangular long pieces of wood each measuring 2 meters in length
  **Purpose:** Construction of wooden foundation

- Two rectangular medium pieces of wood each measuring 1 meter in length
  **Purpose:** Construction of wooden foundation

- One rectangular short piece of wood measuring 0.5 meters in length
  **Purpose:** Pedal to tip the water jug down which releases water

- Shovel
  **Purpose:** Construction of wooden foundation and digging of gravel pit

- Durable string
  **Purpose:** Attachment of water jug to wooden foundation

- 5 liter water jug
  **Purpose:** Contains water for handwashing

- Knife
  **Purpose:** Cutting string

- Bar of soap
  **Purpose:** Use during handwashing and attached to wooden foundation

- Hammer and Nails
  **Purpose:** Construction of wooden foundation and poking holes through jug and soap

Step 1: Construction of the wooden foundation

**Warning:** Be careful when using the hammer and nails to assemble the wooden foundation in order to avoid physical injury.

1.) Gather two long and two medium rectangular pieces of wood as described in the materials section.

2.) Use a hammer to nail one long wood piece at the right and left edge of one medium piece.

3.) Nail another medium sized piece between the two long pieces in order to provide stability to the foundation. The medium sized piece should be placed approximately 1/4 the length of a long-sized piece (~ 0.5 meters) measuring from the ground.

4.) Dig two holes in the ground where the two long-sized pieces will be implanted. A good estimate of the width between the dug holes is one meter or the length of a medium piece.
5.) Plant the two long wood pieces in the holes and cover the hole up with dirt so that the wooden foundation is stabilized and does not budge in the ground. Try moving the foundation in order to test if the foundation is firmly implanted in the ground.

6.) The completed wooden foundation is shown in the encircled red area below in Figure 1.

![Figure 1: Completed wooden foundation at the end of step 1](image)

**Step 2: Water jug and soap attachment to the wooden foundation**

**Warning:** Be careful when using the hammer and nails to poke holes through the jug and soap in order to avoid physical injury.

1.) Poke a hole using a hammer and a large nail on the right and left side of a water jug. The white arrow pointing to the circled red area in Figure 2 shows the target poking area on one side of the jug. Make sure that the holes are poked near the end farthest from the handle of the jug on the two sides and are large enough so that string can be threaded through.

2.) Thread string through the two holes poked in the jug as shown in Figure 2.

3.) Attach the ends of the string in the jug to the two long pieces.

4.) Poke a hole through the jug at the X-mark shown by the white arrow in Figure 3. This is the hole location where handwashing water will come out of the jug.

![Figure 2: Water jug attached to the wooden foundation](image)

![Figure 3: X-mark showing location where water will be released from the jug](image)
5.) Poke a hole through the soap and thread string through the hole as shown in Figure 4.

6.) Attach the string holding the soap to the top medium piece of the wooden foundation. The soap will dangle from the top of the Tippy-Tap.

7.) Tie the pedal i.e. the short wood piece to the handle of the water jug Using string. Make sure that the string is long enough so that the jug tips downward when your feet presses down on the pedal.

8.) Completed Tippy-Tap at the end of step 2 is shown below in Figure 5. The red paint in Figure 5 shows the placement of the soap with string on the Tippy-Tap.

---

**Step 3: Preparing a gravel pit for water drain**

**Warning:** This step cannot be skipped. Building of a gravel pit is essential to prevent standing water that may attract malaria-spreading mosquitoes.

1.) Dig a rectangular pit that is directly beneath the water jug and pedal of the Tippy-Tap.

2.) Fill the rectangular hole with many stones so that the entire hole is covered as shown in Figure 6.

3.) Test the pit by running water from the Tippy-Tap through the pit. The water should drain through the pit and into the earth, thus eliminating standing water.
**Tippy-Tap Maintenance Tips:**

- On a weekly basis, clean the outside of the Tippy-Tap with cloth and soap and use clean water to wash the inside of the Tippy-Tap.

- If using the Tippy-Tap in a school-setting, teachers should assign students to perform a variety of tasks related to Tippy-Tap maintenance on a weekly basis. These tasks could include:
  1.) Ensure that the Tippy-Tap stays clean at all times
  2.) Refill the water jug if empty
  3.) Organize extra Tippy-Tap materials which could be used for repair
  4.) Ensure that there is soap available at all times

Pictures courtesy of:

Ce Zhang, Akvopedia, Westra and Holtslag (2008)
Appendix H: Generic Educational Lesson on Importance of Handwashing Script

Importance of Handwashing

In order to reduce the risk of becoming infected by diarrheal diseases it is important to wash your hands. This is because many illnesses are related to poor hygiene. When you wash your hands, it is less likely you will become infected by a food or waterborne illness. It has been shown that handwashing is the most important way of preventing the spread of infections and if you use the tippy-tap properly to wash your hands then you could prevent getting sick.

You might now be asking what are germs and bacteria? Well, simply put bacteria are small things which cannot be seen with our eyes. They are so small that they can move into your body without you ever hearing or seeing them. When you use the bathroom, touch animals, or even play in the dirt, there are many different types of bacteria which can get onto your clothes and hands. So wash your hands and you can reduce the number of bacteria on your hands.

We have placed the tippy-taps in your school so that you have the ability to wash your hands. You should use the Tippy-Taps after using the latrine, before you eat food, or even after you play outside. It is important for you to use the handwashing stations in the right way because only when soap is used can you get the full benefits of washing your hands.

Every single day, you are always coming into contact with surfaces that have germs which can make you sick. However, if you wash your hands then you can reduce the likelihood that these germs will cause problems for you.

Translated:

Emigaso mukunhaba nghalo. Olwo okukendhendhezha obulwairhe obwo ekidhakanho, kiba kirunghi inho okunabha mubwala. Olwo’ okubha endwairhe ninghi inho dwa ku bukyafu. Bwo’ onabha mubwala kyongeeera okukendhenzha obuwukha obuleetha endwairhe mubwala bubwo. Era bwo’ okoizesa ekinabiro kyo’ omubwala obukalamu, kiziyiza endwairhe no’okulwala

Oyinzha buti okutandikha okubuza, obowuka obuletha ekirikanho bufanda nha butya- kilunghi. Obuwukha buno bubba butonyongholi inho. Tibu bonekha namaiso butambulira ku mibiri gwaifhe nga tituubboonha oba okubuwuliira tubufunha nga tughemaghana mu bwala nga tituunabye. Kale bwetunnhaba mu mubwala tuba tukhendhenzha kundwairhe oti ne’ endho.

Tutayirhe ekinabiro kye’ omubwala ku izomera lyo tukusobosezha okunaaba obwala, ngaqa ovaa mu kyoloni oba omugwanha nga ova okuzhanha, kirunghi inho okuta ekinabiro kye’ obwala okuba na’ sabunni ne’amadhi buli kaserela olwo’ kisoboza.

Okunaba mu’ bwala okulunghi. Buli lunaku omubiiri gwo, okusingira irarha obwala bwo bugemaghana no’ obukyafu, era oyinzha okulwalwa aye bwonaza mubwala bwo, kino kikendeza endwairle hedi letebwa obuwukha
Appendix I: Baseline Survey

Name:
Gender (please circle one): Male Female

1. How many people are there in your household? (circle best answer)
   a. One  b. Two  c. Three  d. more than three

1a. How many children are under 18, are in your household? (circle best answer)
   a. One  b. Two  c. Three  d. more than three

2. How many times a day do you wash your hands?
   a. 0  b. 1  c. 2  d. 3 or more times per day

2a. Do you wash your hands at school?
   a. always  b. often  c. sometimes  d. never

2b. Do you wash your hands before eating?
   a. always  b. often  c. sometimes  d. never

2c. Do you wash your hands after using the latrine/toilet?
   a. always  b. often  c. sometimes  d. never

3. How many times per day do you wash your hands after using the latrine?
   a. 0  b. 1  c. 2  d. 3 or more times per day

4. Do you use soap when washing your hands?
   a. Yes  b. No

5. Do older students wash their hands more frequently than students your age? (circle best answer)
   a. Yes  b. No  c. same  d. not sure

6. How often do your parents wash their hands at home?

7. How often do you wash your hands at home?

8. In the past month, how many times have you experienced stomach pain?
   a. Never  b. Once  c. Twice  d. More than two times

9. In the past month, how many times has someone in your family experienced stomach pain?
   a. Never  b. Once  c. Twice  d. More than two times

10. What is the purpose of handwashing/ why is handwashing important?
    a. Prevent bacteria spreading
    b. It is fun
    c. make your hands clean
    d. it’s not important to wash your hands
Appendix J: Baseline Survey/Ebibuzho (Translated)

Amainha-----------------------------------------
Ekikula (toneza ku kirara): Musadha --------mukazi ----------

1. bantu bameka ababa eikha?
   a. Mulala   b. babiri   c. basatu   d. basuyika mu basatu

1a. bantu bameka abataweza myaka ikumi na,munana?
   a. Mulala   b. babiri   c. basatu   d. basuyika mu basatu

2. mirundi emeka kyonaba mu byala eikha?
   a. 0   b. 1   c. 2   d. isatu n,okuswikamu

2a. onoba mubwala ku isomer?
   a. emirundi kamala   b. bulidho   c. olusi   d. busa

2b. onaba mubwala nga okali okulya?
   a. emirundi kamala   b. bulidho   c. olusi   d. busa

2c. onaba mubwala nga oviire mu mugwaana?
   a. emirundi kamala   b. bulidho   c. olusi   d. busa

3. emirundi emeka olunaku gwonaba ku mu-bwala nga omazze okukozesa omugwaana?
   a. 0   b.1   c. 2   d. isatu n,okuswikamu

4. okozesa ku sabuni nga onaba mubwala?
   a. Yii   b. busa

5. abasomi abakulu banaba mu bwa la okusingha ku abasomi abatoo? (toneza ku kalala)
   a. Yii   b. busa   c. nekirara   d. tiyidhi

6. abazaire bo eikha bona banaba mu bwala?
   a. Bulidho   b. olusi   c. tibulidho   d. busa

7. onaba mubwala nga oli eikha?
   a. Bulidho   b. olusi   c. tibulidho   d. busa

8. mu mwezi egibise mikuzi emmeeka endha lwekulunye?
   a. Busa   b. mulala   c. eibiri   d. gisuuikha mu,ebiri

9. mu mwezi egibiise mikuzi emmeeka endha lwekulumye ku?
   a. Busa   b. mulala   c. eibiri   d. gisuuikha mu,ebiri

10. mugaso ki ogwo okunaba mu bwala / lwaki okunaba mu bwala ku lungi?
    a. okuziyizha obuwuuka okusasanha
    b. kinyumo
    c. otukuza obwala
    d. kizira mugaso okunaba mu bwala
Appendix K: Post-Intervention Survey

Name: ________________________________
Gender (please circle one):   Male   Female

1. How many times a day do you wash your hands?
   a. 0 b. 1 c. 2 d. 3 or more times per day

   1a. Do you wash your hands at school?
      a. every time   b. often       c. sometimes d. never

   1b. Do you wash your hands before eating?
      a. every time   b. often       c. sometimes d. never

   1c. Do you wash your hands after using the latrine/toilet?
      a. every time   b. often       c. sometimes d. never

2. Does the Tippy-Tap still work at your school?
   a. Yes   b. No

3. Do you wash your hands more frequently now that Tippy-Taps are available?
   a. Yes   b. No

4. Is it fun to wash your hands with a Tippy-Tap?
   a. Yes   b. No

5. Do your friends wash their hands with the Tippy-Tap?
   a. Yes   b. No

6. When you want to wash your hands with the Tippy-Tap, is there soap available?
   a. Yes   b. No

7. Should more Tippy-Taps be constructed for use at your school?
   a. Yes   b. No

8. Have the Tippy-Taps been maintained well?
   a. Yes   b. No

9. Do your teachers ask you to wash your hands using the Tippy-Tap?
   a. Yes   b. No

10. Do you have the knowledge needed to build a Tippy-Tap?
    a. Yes   b. No

11. Do you use soap when washing your hands?
12. Have you constructed a Tippy-Tap for your family to use at home?
   a. Yes  b. No

13. Are the materials needed to construct a Tippy-Tap available to you at home?
   a. Yes  b. No

14. Did you tell your family members what you learned about handwashing and Tippy-Taps?
   a. Yes  b. No  c. Yes, but there are not enough supplies at home to make one

15. In the past month, how many times have you experienced stomach pain?
   a. Never  b. Once  c. Twice  d. More than two times

16. How often do you wash your hands at home?

17. Constructing a Tippy-Tap requires which of the following? (Circle all that apply)
   a. Wood  b. jerry can  c. Nails and hammer  d. I’m not sure  
   d. String  e. Soap and water

18. Which of the following do you do in handwashing? (Circle all that apply)
   a. run water over hands  
   b. use soap  
   c. dry with clean cloth  
   d. splash water on other children

19. Have you told your parents about the Tippy-Tap?
   a. Yes  b. No
Appendix L: Post-Intervention Survey/ Okugoberera (Translated)

Amainha-----------------------------
Ezikula kyo (tonezaku kalala)
Musadha--------------------------- mukazi---------------------------

1. Emikuzi emeekha olunhaku kyo onaba mu nghalo?
   a. 0      b. 1      c. 2       d. isatu n,okuswikamu

   1a. Onaba engalo nii kwiisomero?
       a. Bulikaseera   b. emikuzi kamala   c. olusi   d. busa

   1b. ekina biro kyo obwala ku isomero kikakola?
       a. Yii   b. busa

   1c. Onaba mu bwala nga okali okulya/ ngha omaze okukozesa omugwaanha?
       a. Bulikaseera   b. emikuzi kamala   c. olusi   d. busa

2. Ekina biro kye obwala ku isomero kikakola?
   a. Yii   b. busa

3. Onaba mubwala inho inho, olwo okuba ekina biro kye bwala kiriwo?
   a. Yii   b. busa

4. kisanhusa okunaba mubwala, wabawoo sabuni kukanabiro bulidho?
   a. Yii   b. busa

5. bakagwabo banaba mubwala?
   a. Yii   b. busa

6. nga oyendha okunhaba mubwala wabawo sabuni ku kinabiro kyobwala bulidho?
   a. Yii   b. busa

7. ekina biroo bwo obwala babizibwe mubungi ku isomero wano?
   a. Yii   b. busa

8. ekinabiro bye obwala babigenywe bukalamu?
   a. Yii   b. busa

9. Abasomesa bakukoba ku okunaba mubwala nga okozesa ekinabiro bwengalo?
   a. Yii   b. busa

10. olinha amaghezi agayendhebwa okuzimba ekina biro kye bwala?
    a. Yii   b. busa
11. okozesa ssabuni mukunaba mubwala?
a. Yii  b. busa

12. ozimbye ekinabiiro ekye omubwala?
a. Yii  b. busa

13. ebintu ebikosebwa okuzhimba ekinabiiro kye omubwala biriyo eikha?
a. Yii  b. busa  c. Yii aye tibimala

14. wakobeeraku abeekha kubyewayeegha ku kinabiiro kye omubwala n’okunaba mu bwala?
a. Yii  b. busa

15. mu’mwezi ogubuse mukuzi emekha gwe okufunhe ekidhukanho?
a. Ezhira  b. mulala  c. ebiri d. giswikha mu ebiiri

16. mukuzi emekha gwo’onaba mubwala eikha?
a. Kamala  b. olusi  c. ngha ndikiryire d. busa

17. okuzimbha ekinabiiro kye omubwala kyetagisa ki? (toonezaku ku kitufamu)
a. Emiti  b. akadhomolere  c. emisumali nenundho  d. tiyidhi  e. akaguwa
f. sabuni na’amadhi

18. bici bwookola ngha onanbha mu bwala?
a. Amandhi gabunha mungaloo danghe
b. Nkozesa sabuni
c. Nkaza obwala na’akatambala
d. Nkukumusa amadhi cubana abandhi

19. wali okubeera ku abazhaire bo kubighemaghana no’okunaba mu bwala?
a. Yii  b. busa
### Appendix M: Photos of Program

<table>
<thead>
<tr>
<th>Image</th>
<th>Caption</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.jpg" alt="Schoolchildren washing their hands with the tippy-tap after using latrine, one month after installation" /></td>
<td>Schoolchildren washing their hands with the tippy-tap after using latrine, one month after installation</td>
</tr>
<tr>
<td><img src="image2.jpg" alt="Students gather around tippy-tap" /></td>
<td>Students gather around tippy-tap</td>
</tr>
<tr>
<td><img src="image3.jpg" alt="Students participate in tippy-tap construction" /></td>
<td>Students participate in tippy-tap construction</td>
</tr>
<tr>
<td><img src="image4.jpg" alt="Construction of tippy-taps near a latrine" /></td>
<td>Construction of tippy-taps near a latrine</td>
</tr>
<tr>
<td><img src="image5.jpg" alt="Schoolgirl washes hands with tippy-tap" /></td>
<td>Schoolgirl washes hands with tippy-tap</td>
</tr>
<tr>
<td><img src="image6.jpg" alt="Students gather to observe handwashing with a tippy-tap" /></td>
<td>Students gather to observe handwashing with a tippy-tap</td>
</tr>
</tbody>
</table>
Children waiting in line to wash hands with tippy-tap

Students watching fifth grader use tippy-tap

Schoolchildren mobilized parents to donate jerry cans for tippy-tap construction

Gathered materials for tippy-tap construction

Older student washing hands with a tippy-tap

Schoolchildren stand by their constructed tippy-tap
Children erecting sign next to a latrine: “Wash your hands after visiting latrine”

Students pose with their finished tippy-tap

Schoolgirls handwashing

Schoolboys handwashing

Students pose with finished tippy-tap

Students pose with finished tippy-tap
Appendix N: Publicity

Website Features

1.) Research Penn State Online: http://www.rps.psu.edu/

2.) Penn State Science Website: http://science.psu.edu/news-and-events/student-stories/student2019s-research-aims-to-wash-away-childhood-disease

3.) Schreyer Honors College Website: http://www.shc.psu.edu/news/news_item.cfm?id=175


5.) Penn State Research Opportunities for Undergraduates website: https://undergradresearch.psu.edu/exhibition_gallery.cfm


7.) Milking the Rhino Innovation Solutions Showcase: http://mtrsolutions.weebly.com/

8.) Penn State Research Interview with Ce Zhang: http://www.youtube.com/user/ResearchPennState

9.) MIT Global Challenge Website: http://globalchallenge.mit.edu/teams/view/266

Research Presentations

1.) Penn State Undergraduate Research Exhibition

2.) Penn State Research Unplugged Lecture Series

3.) Pennsylvania’s Undergraduate Research at the Capitol Event

4.) Oral Presentation at 2012 Unite For Sight Global Health and Innovation Conference
REFERENCES


ACADEMIC VITA

Ce Zhang

CAMPUS:  
348 Blue Course Drive, Apt 263  
State College, PA 16803  
570-441-1940

PERMANENT (HOME):  
10 Sunset Drive  
Danville, PA 17821  
570-763-4310

Email Address: cxz5013@psu.edu

EDUCATION

PENNNSYLVANIA STATE UNIVERSITY, SCHREYER HONORS COLLEGE  
University Park, PA  
B.S. in Biology with Honors in Biology and Civic and Community Engagement  
Expected May 2012

DANVILLE AREA SENIOR HIGH SCHOOL  
Danville, PA  
Fall 2004- Spring 2008

RESEARCH / INTERNSHIPS

PENN STATE INSTITUTE OF THE NEUROSCIENCES  
University Park, PA  
Undergraduate Researcher. Supervised by Dr. Gong Chen  
Fall 2011- Present  
Investigating neural mechanisms that contribute to the balance between tonic and synaptic inhibition in the brain. Currently studying the effects of expressing different GABAA receptor subunit combinations in vitro.

MCGOVERN INSTITUTE FOR BRAIN RESEARCH AT MIT  
Cambridge, MA  
Amgen Scholar. Supervised by Dr. Yingxi Lin  
Summer 2011  
Examined the role of activity-dependent transcription factor Npas4 in regulating inhibitory synapse development in the brain. Demonstrated that Npas4 is a potential regulator of inhibitory synapse development in cortical neurons.

PENN STATE POPULATION RESEARCH INSTITUTE  
University Park, PA  
Undergraduate Researcher. Supervised by Dr. Stephen Matthews  
Summer 2010- Present  
Implemented a four-month hand washing study in eight Ugandan elementary schools, with the goals of testing if low-cost tippy-tap hand washing stations can promote hand washing rates and reduce the frequency of stomach pain episodes in Ugandan schoolchildren.

PENN STATE INSTITUTE OF THE NEUROSCIENCES  
University Park, PA  
Undergraduate Researcher. Supervised by Dr. Bernhard Luscher  
Fall 2009- Spring 2011  
Investigated the post-translational role of palmitoylation in regulating trafficking and clustering of GABAA receptors.

UGANDA VILLAGE PROJECT  
Iganga, Uganda  
Summer Intern. Supervised by Dr. Alison Hayward  
Summer 2009  
Designed and implemented health care and development oriented programs in collaboration with local NGOs and community groups.

LEADERSHIP / ACTIVITIES

Student Organizations Conduct Committee- Fall 2008-Present. Co-Chairperson Fall 2011-Present. Responsible for education of ~900 Penn State student organizations on university policy and accountability for policy violations.
University Park Undergraduate Association Board of Arbitration, Fall 2009-Present. Assistant Chief Justice Fall 2011-Present. Judiciary which oversees matters of dispute between entities within UPUA and interpretation of its constitution.

Tippy-Taps for Africa, Fall 2009-Present. Founder and President Fall 2009-Present – Penn State recognized student organization dedicated to education and promotion of hand washing practices.

Uganda Village Project Board of Trustees, Fall 2009-Present. Part of UVP’s monitoring and evaluation task force, which is responsible for quantitative monitoring and evaluation of UVP’s health-oriented programs in Uganda.

Penn State Student Health Insurance Advisory Board, Fall 2010-Present. Assist in evaluating and recommending changes to Penn State student health insurance programs and services based upon suggestions from the undergraduate population.

Schreyer Honors College Career Peer Mentor, Fall 2011-Present. Mentor SHC students about internships and/or research experiences and lead career development sessions.

Penn State University Ambulance Services, Volunteer Emergency Medical Technician, Fall 2010-Spring 2011 – Provided emergency patient care and ambulance transport to University Park and surrounding areas.

Primary Care Scholars Program, May 2010 – Spent a week at the Penn State Hershey Medical Center participating in lectures and seminars about health care delivery and primary care. Also completed a one week clinical shadowing experience.

**AWARDS AND HONORS**

Amgen Scholarship, Amgen Foundation, 2011 – Provide funds to conduct neuroscience research at MIT.
Eric A. Walker Award, Penn State University, 2012- Presented annually to one student in the senior class who has contributed most to enhancing the reputation of Penn State University through extracurricular activities.
Edward C. Hammond Scholarship, Eberly College of Science, 2012- Academic merit scholarship.
Poole Travel Fund for Undergraduate Research, 2012- Supports travel to research conference.
Johnson & Johnson Rural Healthcare Award, Milking the Rhino: Innovative Solutions Showcase, 2011 – $1000 award given to the top rural healthcare solution out of 61 video entries judged by an expert panel from Johnson & Johnson.
First Prize in Public Scholarship, Penn State Undergraduate Research Exhibition, 2011 – $150 award given to the top undergraduate research project in public scholarship.

**PRESENTATIONS**


