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Multimedia Development for Hygiene Education in Developing Countries

Nathan Brough
yes@byu.edu

Jason K. McDonald
Brigham Young University

Cougar Hall
Brigham Young University

S. C. Yanchar

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MULTIMEDIA DEVELOPMENT FOR HYGIENE EDUCATION IN DEVELOPING COUNTRIES

Nathan Brough

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A design and development project in partial fulfillment of the requirements of the degree

Master of Instructional Psychology & Technology

Brigham Young University
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Project Description

The Liahona Children’s Foundation (LCF) is an organization that provides humanitarian aid around the world—specifically addressing malnutrition with children ages 0-6. The LCF was founded by members of the LDS Church and seeks primarily to aid members of the LDS Church (hereafter, “the church”), although it is not directly affiliated with the church. Their objective is stated as follows:

To identify and implement effective ways of reducing malnutrition among the LDS population and their friends. We do this by providing nutritional supplementation to malnourished children, supporting families in sustained breastfeeding, and teaching families about nutritional and hygienic food preparation” (LCF, 2018, emphasis added).

Although the LCF has a well-established infrastructure for distributing and delivering nutritional supplements, only recently has it begun implementing teaching resources and materials for the purpose of nutrition and hygiene education. In the organization, volunteer “coordinators” are called in each stake (a group of local chapters in the church) and are responsible for each malnourished child and his/her mother in that stake. The coordinator’s duties include purchasing nutritional supplements (using LCF funds), delivering the supplements monthly, and educating the child and mother about nutritional and hygienic food preparation during that visit. However, until recently, existing hygiene education materials and resources were very limited. LCF leaders have recently produced a written teaching guide for coordinators to use when providing nutrition and hygiene education to mothers.

There is a significant need for robust nutrition and hygiene educational resources, which stems from the issue that in spite of essential nutritional supplements being consumed by the children of the families served, diarrhea and other illnesses (caused by lack of hygiene and sanitation)
render those supplements ineffective because the body is unable to absorb the nutritional supplements.

This project sought to improve the effectiveness of the written teaching guide by designing and producing multimedia components to be used in educating mothers and children. It is anticipated that our product will help motivate an improvement in hygiene habits, thereby reducing occurrences of diarrhea and other intestinal illnesses.

**Front-End Analysis**

The following section analyzes the task at hand, the limitations we expected to encounter, the learners and their common qualities, and precedents considered during the design process.

**Constraints**

Various constraints limited what and how much was possible and practical to accomplish with this project.

**Scope.** Because the scope of this project was limited, in contrast with the broad spectrum of the many countries, cultures, dilemmas, and circumstances that are served by the LCF (Bolivia, Zimbabwe, Mongolia, Philippines, Cambodia, and others), we focused solely on one country. Bolivia was chosen because I was able to travel there for two weeks with LCF volunteers in August 2015, and while there, I was easily able to survey a group of recently returned missionaries from the church who provided accurate insight, which was useful for conducting a well-informed learner analysis.

The scope also set boundaries on the amount of work and the amount of media produced in this project. The LCF organized six lessons to be administered to mothers, so the initial plan for the project was to create multimedia materials for each lesson. However, as development
began on the multimedia content, the details and work involved in production proved to be more expansive than expected. Therefore, in order to avoid the risk of quantity compromising quality, the scope of the project was narrowed from six lessons down to three.

The client (LCF) discussed with us which lessons could stand to benefit the most from the project, and consideration was given to what each multimedia element might look like and what the learner would stand to benefit from it. In the Literature Review, we discuss the power of multimedia being able to reduce cognitive load, especially with regard to complex concepts. We also address in the Task Analysis that one of our core objectives was to introduce an understanding of the relationship between hygiene, illness, nutrition, and health, which implies a basic understanding of bacteria and germs (an understanding which, according to our Learner Analysis, is not ubiquitous amongst our learners).

With those notes in mind, it stood to reason that those lessons which demanded more, cognitively, would benefit the most from multimedia content, especially those dealing with germs. Referring back to our project focus of improving the effectiveness of the existing written instructional materials, we noted that hygiene concepts would benefit from supplemental multimedia more than diet and nutrition concepts. We set the following criteria for which lessons we would focus on:

(a) Lesson stands in need of help (in order to achieve effectiveness),

(b) Lesson subject matter lends itself to instruction through media, and

(c) Creating media for this lesson would not overstep the scope of this project.

We then selected the three lessons that best applied: handwashing, clean water, and food preparation. Our scope was then adjusted accordingly.
**Distance.** A consequential limitation in working with a developing country is the distance from and access to the learners and volunteers. The practicality of communicative access was limited, so we worked with travelling LCF board members in distributing materials and instructions, as well as for observing results and effectiveness.

**Timeframe.** The client did not have any set deadlines for the production and delivery of instructional materials; however, in the interest of time, we targeted a schedule of design and development to be completed during the months of April through September 2017. Because of unanticipated delays, the project was completed and tested in November.

**Budget.** Based on consultation with the client, the estimated project budget was set to approximately $5000. That estimate largely influenced the limitation of quantity and variety of avenues we were able to pursue with our content development. A follow-up trip to Bolivia was also not practical because of the cost and the full-time limitations of my current employment.

**Delivery.** Because the lessons are administered via the local volunteers, the implementation is completely reliant upon their availability and diligence in taking on this responsibility. The LCF has generally had little trouble finding volunteers who are interested in becoming involved and taking on the responsibilities of being a coordinator. Their reliability in recording and reporting the statistics of their area has been inconsistent at times, however, so the constraint of consistency was a limiting factor in the implementation of our product.

**Testing.** At the time of the completion of the product, there was not an available set of trained volunteers that could administer the instructional materials to learners and gather data. However, two scheduled volunteer trainings occurred shortly after the product was finished. We were able to test the instructional materials with the volunteers in lieu of mothers and make inferences based on the results.
**Literacy & Technology.** Additional constraints on the design of the end product existed because of the limited literacy and economic status of the learners. Because our learners (Bolivian mothers and children) are rarely literate, we could not assume that they would be able to read any words we would otherwise incorporate as part of the media. They are also poor enough that they generally cannot afford any type of media player (smartphone, DVD player, etc.). However, the LCF implemented a plan to purchase and distribute tablets for volunteers to use in delivering hygiene lessons. This limitation proved to be impactful and also to coincide with deliberate design advantages as discussed in the Development Narrative.

**Learner Analysis**

One of the more challenging and crucial decisions made was determining who the learner would be—given the opportunity to focus on either the volunteer coordinators, the mothers, or the children. Considering that the children we help are between the ages of zero and six, we anticipated that the most significant health changes we could affect would come as a result of a more educated and disciplined mother (as opposed to focusing on educating the children or the coordinators). Practices such as using a toilet and washing hands (for children who are no longer in diapers) are usually prompted by mothers (and by setting an example for their children by practicing those same habits themselves). Also, food preparation and clean water are provided by the mother as well. For this reason, although children may learn and benefit from the multimedia, the focus of the project was directed toward the mother as the primary learner in order to achieve the most effective outcome.

To better understand the nature of our learners, the following seven-question survey was sent out to 20 recently returned missionaries that served in Bolivia, of which four responded. The questions included in the survey inquired about the general hygiene habits, technological
resources, and literacy levels observed in the thousands of homes that the missionaries had visited over the course of their service.

The following table describes the four main focuses of hygiene:

Table 1: Four Core Hygiene Habits

<table>
<thead>
<tr>
<th>Human waste disposal</th>
<th>Handwashing</th>
<th>Clean water</th>
<th>Food preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Best</strong></td>
<td>Uses Indoor toilet</td>
<td>Always washes hands for at least 20 seconds after using the bathroom and before cooking &amp; eating</td>
<td>Clean water (bottled/filtered/treated/boiled) is used for drinking, cooking, and brushing teeth</td>
</tr>
<tr>
<td><strong>Better</strong></td>
<td>Uses latrine with slab</td>
<td>Usually washes hands for at least 20 seconds after using the bathroom and before cooking &amp; eating</td>
<td>Usually...</td>
</tr>
<tr>
<td><strong>Good</strong></td>
<td>Uses latrine without slab</td>
<td>Sometimes washes hands for at least 20 seconds</td>
<td>Sometimes...</td>
</tr>
<tr>
<td><strong>Bad</strong></td>
<td>Urinates and/or defecates outside near home or water sources</td>
<td>Rarely washes hands for at least 20 seconds</td>
<td>Rarely...</td>
</tr>
</tbody>
</table>

Table 2: Survey Questions and Responses

<table>
<thead>
<tr>
<th>Survey Question</th>
<th>Response</th>
<th>Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Considering that the different areas where you may have served might have exhibited different characteristics, was there any one bad habit that seemed to be most pervasive or common?

| Complete absence of any handwashing (3) | In Bolivia, handwashing does need a significant amount of attention. |

Thinking back on your fond memories of being in both members' homes and investigators' homes, what are some memories of hygiene habits that surprised you?

| Dishes washed in dirty water (3) | Food preparation education will need to extend beyond just food preparation to also include dish washing. |
| Insects in meals (1) |

What are some suggestions you might have about what helped people be receptive to making changes in their habits and lifestyle?

| Varied: “Understanding the real life present importance of the habit.” |
| Receiving a little education—“Most people don't practice good hygiene mostly because they don't know what good hygiene is.” |
| “Letting them think that it is their idea to make the change.” |

Some dilemmas may vary greatly among our individual learners—whether it comes down to awareness, comprehension of concepts, or motivation. However, while this is helpful input, we will likely need to look for direction from more formal studies of culture.

What were some cultural practices/norms that might make it hard to maintain any of the four of the habits above?

| Lack of running water (2) |
| Water preservation cultural concern (1) |

We will need to decide if our learner education will focus on learning how to improve their circumstances (get access to running water), or on motivating them to do the best they can with what they have (boil the water that they have).

What did children love? What kept their attention? Illustrated books? Cartoons?

| Candy/toys |
| TV/cartoons (stories were |

Animated media will likely find an effective place in our situation considering the
Stories? (The target audience is children between 0-6 years old.)

What was the lowest standard of technology in homes? Smart phones? Plain cellphones? No phones? (Would they be able to watch instructional media on their own devices, or did they not usually have them?)

Very few smartphones TV & DVD set present in almost all homes (except the poorest)

Delivery of any electronic multimedia would require portable hardware for volunteers to bring along.

How many mothers are literate? (All / most / few / none?)

Few / Very few / 60%

Most children are more literate than their parents.

In order to find success on a large scale, we will have to assume that our learner is illiterate.

Although there were few responses, the responses were surprisingly consistent in wording and opinion. According to the survey results, Bolivian families only have access to dirty or no running water and have generally poor hygiene habits in both human waste disposal and food preparation. Clean spaces for food preparation are also more of a challenge. This validated not only the value of the service offered by the LCF, but also the need for effective hygiene education.

A study conducted in a neighboring South American country analyzed a similar prevalence of poor hygiene habits and their correlation with digestive illnesses. Califano (2000) reported the following statistics in a study conducted in Argentina of food preparation habits: In all 107 responses analyzed, at least one violation of safety guidelines was reported. Over 50% of respondents consume food that includes raw eggs, approximately 20% wash their hands before food preparation "only sometimes," and 32% neglect to wash cutting boards properly after
using them with raw meat or poultry, and most subjects (72%) employ unacceptable reheating criteria.

Additional guidance in analyzing the learners has come from travelling to Bolivia. I was privileged to be invited to accompany LCF volunteers on a two-week visit to conduct health screenings in five cities in all different parts of Bolivia. This helped offer a thicker description of both of our learners as well as their circumstances.

While at the health screenings, there was opportunity to ask each mother about their habits regarding our focuses of hygiene. Most were oblivious to the dangers of raw meat but were aware of the importance of handwashing, using toilets, and clean drinking water. Because of the manner in which they responded to the questions asked regarding hygiene, the sincerity of their claims to following those guidelines seemed questionable. This was confirmed later in the trip when several actively serving missionaries reported that most mothers were aware of the importance of boiling water and washing hands, but that it was too inconvenient, and so they simply did not do it. The lack of sufficient motivation was kept in consideration during the design process.

**Current Resources and Training**

Existing LCF resources for hygiene education consisted of a teaching guide with lesson plans that are currently provided to the local coordinators for use in individual and group visits to mothers. It should be noted that the completion and distribution of this manual is recent. The manual consists of six lessons: each lesson addresses a specific hygiene habit or nutrition practice. Lessons are written to follow a “7 steps for skill development” approach, which takes an approach similar to that of Gagne’s nine events:

I. Follow up
II. Why (Importance of the Skill)

III. How (Steps for Developing the Skill)

IV. Show (Model the Skill)

V. Do (Allow for Skill Practice and Rehearsal)

VI. Feedback

VII. Encouragement and Cues to Action

The lessons include guidelines, offering recommendations such as assessing the family’s current level of hygiene and nutrition performance, focusing on a clearly defined goal, and teaching with relevant cultural implications in consideration.

The LCF constructed the lesson plans based upon best practices for health education curriculum development recommended by the Centers for Disease Control and Prevention (CDC). The CDC’s Characteristics of an Effective Health Education Curriculum is based upon research identifying 15 characteristics that positively influence health behaviors and practices (2012). One effective characteristic identified by the CDC is building students’ personal and social competence through the development of important skills aligned with general health education standards (Joint Committee on National Health Education Standards, 2007). For each skill, teachers guide learners through five developmental steps. First, teachers discuss the importance of the skill, its relevance, and its relationship to other learned skills. Second, teachers present steps for developing the skill. Third, teachers model the skill for learners. Fourth, teachers allow learners the opportunity to practice and rehearse the skill. Fifth, teachers provide learners with feedback and reinforcement specific to performance. Each LCF lesson has been constructed around these fundamental steps for skill development. Designing lessons focused on skill development is consistent with theoretical constructs supportive of health behavior change.
In particular, skill-development approaches are supported by Bandura’s Social Cognitive Theory, which maintains that self-efficacy, or one’s belief in one’s ability to succeed in specific situations or accomplish a task, is key to adopting or maintaining health behaviors (Bandura, 1977).

Given that the seven steps align a great deal with Gagne’s nine events, we might expect to see correlated advantages, such as information retention (through follow up from previous lessons), more thorough comprehension through rich context (demonstration from the coordinator), as well as attention and improved performance (through solicited participation, feedback, and encouragement).

**Precedents**

Historically, efforts to address malnutrition resulting from poor hygiene have been approached in a variety of forms. While most take the form of in-person verbal training, a few have included media-centric approaches, such as a radio show designed to educate on proper care of ill children, demonstrative training videos, or basic illustrations designed to accompany standard in-person training.

For example, an African project, NGO Zimbabwe AHEAD (Zimbabwe AHEAD, 2013), developed rudimentary sketched flash cards as part of a hygiene education effort, covering the topics of water purity, germ theory, general hygiene, infectious threats, sanitation, and nutrition.
Another organization, PATH Programs, facilitated training videos to be developed by community members in India. Some benefits they cited were that the community members trusted the training videos more because they knew and trusted the ‘actors’ in the films. In addition, a community member described the positive power of education through multimedia, “Before, when I used to visit a village and share health information, they would listen but not put it into practice. Now, when they see the films, they understand. They understand by seeing what to do” (Zimbabwe AHEAD, 2013). This example represents the type of outcome we would hope to achieve, although our constraints limit us to a slightly different approach of developing our rich multimedia materials in-house, rather than by the participant community itself.
The World Food Programme (WFP, 2011) has developed educational brochures specifically addressing awareness of the role and importance of micronutrients in health. However, no materials or multimedia that address hygiene education were available.

The World Health Organization does not have many multimedia resources designed for learners on their website, although they have produced a 5 Keys to Safer Food campaign. Resources for this campaign include an in-depth manual designed for “trainers.” It is, to an extent, similar in intent and content to the manual recently produced by the LCF. However, as has been most common with the majority of hygiene education efforts, the direction offered by this manual is simply to deliver instruction verbally through conversation. The LCF volunteer manual goes a step further by recommending and describing participatory activities that engage the learner. In addition to the LCF manual, our project was designed to add rich multimedia components to improve the effect of the hygiene lessons. The WHO did produce one companion video to be used with their manual; however, it uses a vocabulary far above that of the learner and is illustrated with flashy, high detail 3D animations, which are likely to distract the learner from the message rather than help the learner focus on the message. The WHO also has a short live action video that demonstrates good handwashing technique. It is demonstrated in a first world country setting, which presents a potential distraction in this context (WHO 5 Keys Video, 2015).

The following table compiles the variety of the preceding educational approaches and a comparison of their pros and cons:
Table 3: Pros and Cons of Educational Approaches

<table>
<thead>
<tr>
<th>Organization</th>
<th>Media produced</th>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>NGO Zimbabwe</td>
<td>Simple sketch illustrations</td>
<td>Low cost, easily distributed. Do not rely on learner being literate.</td>
<td>Lower quality, not in line with all multimedia principles recommended by Richard Mayer.</td>
</tr>
<tr>
<td>PATH</td>
<td>Illustrative videos</td>
<td>Very effective in facilitating and accelerating comprehension by learners.</td>
<td>Their approach required the participation of local community members. We will not be able to coordinate such efforts within the scope of our project.</td>
</tr>
<tr>
<td>WFP</td>
<td>Promotional brochures</td>
<td>Communicates and describes core hygiene and nutrition needs to improve quality of life.</td>
<td>Designed to inform volunteers and donors; not useful in directly educating the learners.</td>
</tr>
<tr>
<td>WHO</td>
<td>Educational video</td>
<td>Clearly illustrates the nature of germs, where they reside, and how to kill them.</td>
<td>Created in a first world context (flashy, high quality 3D cartoon animation). Those details are likely to distract from our learner’s attention to the core message.</td>
</tr>
</tbody>
</table>

**Budget and Timeline**

The LCF receives financial support from generous donors and is able to provide funding for the development of the multimedia materials that we developed. The foundation has been actively engaged since 2008 in servicing families in need, communicating with volunteers, and expanding its reach. Development and refinement has been an active process, and while no firm deadlines were set for the deployment of these lesson materials, we set out a timeframe in which
we expected to be able to reach a final result, deliver usable materials, and assess the effectiveness of those materials.

Table 4 shows a breakdown of the expenses we anticipated for this project.

Table 4: Anticipated Project Expenses

<table>
<thead>
<tr>
<th>Item</th>
<th>Conservative</th>
<th>Moderate</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolivia On-site Evaluation*</td>
<td>$1500</td>
<td>$1500</td>
<td>$1500</td>
</tr>
<tr>
<td>Video production</td>
<td>$500</td>
<td>$1200</td>
<td>$2000</td>
</tr>
<tr>
<td>Still / Graphic art production</td>
<td>$200</td>
<td>$600</td>
<td>$1000</td>
</tr>
<tr>
<td>Media viewing hardware*</td>
<td>$1500</td>
<td>$1500</td>
<td>$1500</td>
</tr>
<tr>
<td>Overhead</td>
<td>$200</td>
<td>$400</td>
<td>$500</td>
</tr>
<tr>
<td>Totals</td>
<td>$3900</td>
<td>$5200</td>
<td>$6500</td>
</tr>
</tbody>
</table>

*Expenses that have already occurred and are not included in the $5000 limit defined by the client.

To manage the timeframe and project progress, we laid out each step in the following Gantt Charts:
Figure 2: Gantt Chart Planned
Figure 3: Gantt Chart Recorded
Due to interrupted communication with board members during international travel and postponed budget approval, the project completion date was pushed back. The animator quoted a labor cost of $4500 which was approved by the LCF committee. Because we stayed within the parameters of the quote, there was the only final production expense, which allowed us to stay within budget.

**Literature Review**

The following resources were consulted in an effort to review literature on the subject of hygiene and health education: BYU Library search tool, Google Scholar, insight from advisors, and general internet searches. The resources found included a few books, many articles, and the websites and online resources of several organizations. Not all were insightful, but many did offer valuable information on what efforts and designs have and have not been attempted. Those were ultimately used to answer the following relevant questions.

*What is the background of hygiene education in third world countries?*

Hygiene education in developing countries has been a worldwide effort for many decades and has been approached in a myriad of ways, achieving varied levels of success. Everett Rogers cites an effort as early as 1955 to institute water boiling in a Peruvian village. Since that time, there have been countless attempts to address not only contaminated water but also other hygiene problems that lead to illness and infantile death. Between UNICEF, the WHO, and many other small organizations, approaches have included education on chlorine point-of-use sanitation (QUICK et al., 1999), water source treatment, solar purification, boiling, filtering, and other approaches (Clasen, 2009). Some of these reports and studies, in calculating their effect on diarrheal occurrences, acknowledge a mixture of factors such as handwashing, human waste
disposal, water storage methods, food preparation, and dish/utensil cleaning. Other studies do not account for these factors.

What approaches have been made, specifically in Bolivia?

In Bolivia alone, several different documented approaches and studies have been designed and conducted. In 1991, Michelle Fryer reported on an educational “interactive radio” approach which attempted to educate children on caring for siblings suffering from diarrhea (Fryer, 1991). In 1975, an evaluation was conducted of Bolivia’s national SNDC program—a program established to aid indigenous populations in adopting modern technology and health practices—including hygiene and sanitation education for mothers (Buschman & Thullen, 1975). A study performed in 2010 investigated the amount of contamination that was occurring between clean (free of e. coli) water sources and contaminated drinking vessels (Rufener, Musezahl, Mosler, & Weingartner, 2010). Another study in 2005 analyzed the correlation between maternal health education and child health (Frost, Forste, & Haas, 2005).

What approaches to eliminating illness does the literature suggest do and do not work?

There are countless other studies that fall in the same vein as those mentioned above. An evaluation by Fewtrell et al (Fewtrell & Colford, 2005) reviewed 39 unique studies addressing diarrhea in third world countries and compared their results side by side. They showed that the various approaches had a significant positive effect, ranging between a 22% and 46% reduction in diarrhea, depending on the approach. The most effective approach (46% reduction in diarrheal episodes) was the result of hygiene education.
The approach of the LCF follows in that approach, focusing on education and improved hygiene habits. Our project specifically helps address the effectiveness of the hygiene education materials and are in line with the findings of this study.

**Theory**

Given that the nature of the project aimed to produce supplemental multimedia resources, we sought guidance offered by well-cited research conducted by Richard Mayer and Ruth Clark and accompanying theories. Mayer demonstrated that learners gain a significant advantage in comprehension when words (either written or verbal) are augmented with multimedia components (images, video, physical objects) (Mayer, Ross, Ross & Ross, 2002). However, multimedia components possess the potential to distract from and inhibit learning when designed poorly. For this reason, Mayer set out 12 guiding principles that help ensure effective multimedia design.

**Table 5: Mayer’s 12 Guiding Principles**

<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coherence Principle</td>
<td>People learn better when extraneous words, pictures, and sounds are excluded rather than included.</td>
</tr>
<tr>
<td>Signaling Principle</td>
<td>People learn better when cues that highlight the organization of the essential material are added.</td>
</tr>
<tr>
<td>Redundancy Principle</td>
<td>People learn better from graphics and narration than from graphics, narration, and on-screen text.</td>
</tr>
<tr>
<td>Spatial Contiguity Principle</td>
<td>People learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.</td>
</tr>
<tr>
<td>Temporal Contiguity Principle</td>
<td>People learn better when corresponding words and pictures are presented simultaneously rather than successively.</td>
</tr>
</tbody>
</table>
### Segmenting Principle
People learn better from a multimedia lesson presented in user-paced segments rather than as a continuous unit.

### Pre-Training Principle
People learn better from a multimedia lesson when they know the names and characteristics of the main concepts.

### Modality Principle
People learn better from graphics and narrations than from animation and on-screen text.

### Multimedia Principle
People learn better from words and pictures than from words alone.

### Personalization Principle
People learn better from multimedia lessons when words are in conversational style rather than formal style.

### Voice Principle
People learn better when the narration in multimedia lessons is spoken in a friendly human voice rather than a machine voice.

### Image Principle
People do not necessarily learn better from a multimedia lesson when the speaker’s image is added to the screen.

At the root of Mayer's multimedia theory is the separation and labeling of two data input channels that our brain processes: words and graphics. In Mayer’s context, anything in English (or whichever language is the learner's native tongue—in this case, Spanish) is considered to be “words,” whether it be spoken, written, or otherwise. Graphics refer to nonverbal visual communication—pictures, charts, graphs, moving picture (video)—essentially any information that does not rely upon a knowledge of the verbal language. In this sense, Mayer points out that these fundamentals did not emerge with the advent of digital technology—the same underlying principles that have applied for many decades of text with images still apply to the most advanced contemporary technology.
The benefits that our learners reap from multimedia design include a clearer (less ambiguous) message and a lighter cognitive load, facilitating their efforts to integrate new information with their existing knowledge. Additionally, it is noteworthy that our design approach assumed that our learners are illiterate. Therefore, all verbally communicated information will be processed through hearing (the learner will not be expected to read any words). Furthermore, according to the Modality Principle listed above, text on screen should be limited to only that which is necessary, if any is necessary. It states that it is more effective to have the verbal channel delivered by narrative (through hearing it) rather than by reading it because reading distracts the eyes from observing relevant graphics. Multimedia plays a crucial role in accelerating and deepening the learning process by taking advantage of the otherwise untapped visual communication channel.

Mayer’s 12 principles can be followed seamlessly in conjunction with Ruth Clark’s guidance regarding how and why multimedia are used and integrated with lesson content. Her taxonomy distinguishes the relationship between media and its accompanying content and how they support or interact with each other. This proved valuable in our analysis of which parts of the lessons could benefit from multimedia, what function they would serve, and how to integrate them.
**Figure 4: Communication Taxonomy for Graphics for Learning**

Our design efforts aimed primarily to produce multimedia components that serve as “representational” and “interpretive” graphics. In those roles, they stand as core elements of content delivery while the volunteer guides them through the lesson material verbally. This provided a clear purpose and goal that defined the structure and design of our multimedia.

These two principles, which guided product development, grew out of cognitivist theories of learning. As detailed in the Current Resources and Training section, the client’s overarching approach to educating mothers is very similar in nature to Gagne’s nine events, which was also influenced by cognitivist theories in addition to behaviorism. In order to provide a solution that works harmoniously with the rest of their learning resources, we followed their lead in this regard.
Design

Task Analysis

Learners, in short, needed to gain an understanding of hygiene threats, as well as practices that safeguard them from those threats. We initially considered covering all six lessons, including understanding of the importance of balanced nutrition and the importance of breastfeeding, but those two principles were dropped when we narrowed our scope down to lessons addressing hygiene.

We sought to instill in the learner a conscious association (Jansson, 1964) between poor hygiene and illness, as well as a conscious association between proper nutrition and healthy growth and development. In order to foster an understanding of these cause-effect relationships, we created a multimedia product that focused on helping the learner understand five specific chunks. Our learning objectives were the following:

1. Where bacteria exist/reside/lay
2. Where & how they enter
3. How they cause diarrhea
4. How diarrhea affects health
5. Effective habits and practices to keep bacteria from entering the body

These principles are integrated into lessons 2, 3, and 4:

Lesson 2: learn about effective handwashing
Lesson 3: learn how to procure clean drinking water
Lesson 4: learn the essentials of sanitary food preparation
Figure 5: Concept Map
Design Specifications

It was decided that the final product could take on multiple forms, including instructional videos, photographs, and illustrations. The advantages of varied media types justified the combination of mixed media to meet the needs of various aspects of hygiene education.

Ultimately, however, our development process led us to a single multi-use animated instructional video that addressed the common topics as well as the specific focus of each of the three lessons. The details of that transition are further detailed in the Development Narrative section.

During the design phase, the multimedia was planned such that it would facilitate conceptualization of challenging concepts, provide a rich context to information that would otherwise be delivered verbally, and stimulate participation and the exercise of new understanding.

Table 6: Potential Solutions

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Media item</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lesson 1: Human Waste Disposal</strong></td>
<td>Video</td>
<td>Illustration of the nature of germs and how they enter our bodies</td>
</tr>
<tr>
<td></td>
<td>Illustrated Video</td>
<td>Instruction on proper disposal of human waste</td>
</tr>
<tr>
<td></td>
<td>Illustrated graphic</td>
<td>An illustrated scene challenging the learner to identify hygienic threats</td>
</tr>
<tr>
<td><strong>Lesson 2: Handwashing</strong></td>
<td>Video</td>
<td>Instruction &amp; demonstration on effective handwashing, also common mistakes to avoid</td>
</tr>
<tr>
<td></td>
<td>Short Video Clips</td>
<td>Challenges for the learner to identify common mistakes in handwashing practice</td>
</tr>
<tr>
<td>Lesson 3: Water Sanitation</td>
<td>Video</td>
<td>Illustration of the varieties of ways in which water becomes contaminated</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------</td>
<td>-----------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Video</td>
<td>Demonstration of the varieties of ways in which it can be purified</td>
</tr>
<tr>
<td>Short Video Clips</td>
<td></td>
<td>Challenges for the learner to identify potential water sanitation threats and common mistakes</td>
</tr>
<tr>
<td>Lesson 4: Food Preparation</td>
<td>Video</td>
<td>Illustration of common hazards in food preparation and how to properly avoid them</td>
</tr>
<tr>
<td></td>
<td>Short Video Clips</td>
<td>Challenges for the learner to identify common hazards and mistakes in food preparation</td>
</tr>
<tr>
<td>Lesson 5: Nutrition</td>
<td>Video</td>
<td>Explanation of the importance of nutrients in brain development and the consequent importance of a comprehensive diet</td>
</tr>
<tr>
<td></td>
<td>Illustrated graphic</td>
<td>A challenge for the learner to identify which one of various illustrated diets meets developmental needs</td>
</tr>
<tr>
<td>Lesson 6: Breastfeeding</td>
<td>The lessons manual suggests in-person instruction for this lesson.</td>
<td></td>
</tr>
</tbody>
</table>

Some of the proposed solutions included:

- A video demystifying the real nature of otherwise invisible germs. This would have used videos that employ microscopy that will take their understanding further than
they are able to with only their naked eye. Although it would be preferable to have
the learner use an actual microscope to observe live bacteria, in our circumstances the
practicality of a video outweighs the complexity of a live demonstration.

Figure 6: Video Zooming in from What the Naked Eye Can See Down to Actual Bacteria

Relevant guiding principles: Multimedia, Voice

Function: Representational

- Interactive illustrations or videos where the learner could demonstrate new
knowledge, taking the form of scenarios where learners can be challenged to identify
hygiene threats or errors in hygiene practice:

Figure 7: Interactive Illustration Challenging the Learner to Identify Hidden Hygiene Threats
Figure 8: Interactive Video Illustrations Challenging the Learner to Identify Best Practices

Relevant guiding principles: Pre-training, Signaling, Personalization

Function: Representational

- Narrative videos that follow the process of infection from origin to illness, applicable to several poor hygiene scenarios including contaminated water, human waste disposal, and food preparation.

Figure 9: Video Illustrating the Process of How Germs Get into the Body and Affect It

Relevant guiding principles: Pre-training, Signaling, Personalization

Function: Representational, Transformational

- A narrative video that gives real life context to the effects of hygiene by telling the story of Dr. Ignaz Semmelweis and how his innovative idea of handwashing reduced maternal deaths dramatically.
Figure 10: Graph Illustrating the Powerful Effect of Handwashing on Maternal Mortality

Although we considered and provided specific concepts for appropriate multimedia components for five of the six lessons, we worked with the client, as mentioned, and found the most effective approach to scope the project to focus on hygiene where it would be most effective in augmenting the written lesson material.

Development Narrative

The following sections detail the decisions made in each step of the development process.

Selecting/Determining the Media Format

With design parameters specified, we began production of the instructional materials. As reflected in the Gantt chart, the first step was to determine media type. Originally, both animated content and live video content were considered for use in the final product. After discussing and
analyzing strengths and weaknesses, we concluded that focusing solely on animation would offer the most worthwhile advantages.

Live action video, combined with illustrations, would afford the option of presenting the material in rich context (filming the content in an actual kitchen). In contrast, creating the content in the form of an animation would afford the opportunity to hand tailor each visual aspect more deliberately. Animation also offered the convenience of the option to make adjustments or necessary changes without obligations to reschedule acting talent or obtain access to filming locations.

As discussed in the literature review, one of the key strengths of multimedia is the ability to facilitate understanding that would be difficult or impossible to achieve otherwise. The message being delivered centered around helping mothers understand bacteria—which, in spite of being invisible, creates real pain, added work, and inconvenience. In this regard, considering our budget, animation proved to be a prudent choice. Presenting the world of bacteria in live action film likely would have involved either using costly special equipment and resources in order to film microbes or supplementing the film with illustrations or animation (which would have added complexity to the project).

Additionally, animation simplified our effort in two ways, due to the nature of the production process. First, live video production requires the coordination and management of multiple people, whereas one single animator was able to independently complete the final product on a flexible schedule. Secondly, animation avoids the burden of dealing with unintentional extraneous material. For example, Mayer discusses the application of the Coherence Principle when using images in medical education, stating that “people can learn better from black-and-white line drawings than from colour photographs” (Mayer, 2010).
Photographs present necessary information, but also often unintentionally include extraneous information that may distract the learner. For example, for a novice, a photograph of internal organs is not as easy to discern and interpret as a line drawing of internal organs. This advantage of line drawings compared to photographs transfers to our situation in terms of animation compared to live video.

Ultimately, the selection of animation helped us improve the effectiveness of the LCF teaching guide by more clearly illustrating the central concept of germs and their correlation to, and effect on, healthy growth, which is difficult to clarify in the absence of multimedia. It also helped us to stay within budget.

Authoring Effective Materials

Being already acquainted with a professional animator, I inquired regarding the availability of the animator in advance and was able to arrange for him to perform the animation work, which helped accelerate our schedule. Because of his extensive work history in his industry, the animator had much to offer in terms of consultation, which quickly became apparent. We consulted often throughout the storyboarding process, discussing the animation workflow, and seeking recommendations on how to derive the visual component of our message. The animator recommended beginning by working from a script and then storyboarding that script, rather than making a general storyboard and then scripting the storyboard. The animator also requested that I provide him with contextual source material (photographs of kitchens, clothing, etc., from Bolivia), which was effective in producing a final product that was not only instructional, but which also felt comfortable and familiar to the learner.
Scripting began by considering what exactly the message needed to convey. In the task analysis, we discussed the central aim to help the learner gain an understanding of the concepts listed in our learning objectives:

- Where bacteria exist/reside/lay
- Where & how they enter
- How they cause diarrhea
- How diarrhea affects health
- Effective habits and practices to keep bacteria from entering the body

However, this still left a significant amount of room for consideration of various approaches in authoring a script that would facilitate that understanding. All of the following pieces of information were excellent candidates for helping facilitate our learner’s understanding of the previously mentioned concepts:

- What germs are (small living organisms that the eye can’t see)
- Where germs can live (moist warm places, like hands, chickens, dirty diapers, and most things you touch)
- Why germs are bad (they make you sick)
- Why, then, germs aren’t hurting you all the time (germs can’t get through your skin)
- Where germs can get into your body (places without skin—mouth, nose, eyes, and ears)
- How germs get on things we put in our mouths (spreading from humans, animals, and flies)
- How long germs can survive on dry surfaces (sometimes 15 minutes, sometimes 24 hours)
- How to prevent germs from getting in your body (cooking, washing, or purifying everything you put in your mouth)
- How to kill germs (very high heat, microwaves and chlorine)
- How to wash away germs (with soap and water)
- Why water alone can’t wash away germs (it’s like grease, it doesn’t wash away without soap)
- Common hygiene mistakes (meat/veggie knife, water from tap/well, washing with just water, not washing at all, washing dishes in used laundry water)
- How germs cause diarrhea (they irritate the stomach and cause expulsion)
- Why nutrients are important (your body cannot grow without them)
- How our bodies get nutrients (your stomach absorbs them from your food)
- How diarrhea affects nutrient absorption (diarrhea expulses food before nutrients are absorbed)
- The cause/effect chain between germs, hygiene, diarrhea, nutrition, and healthy growth

Although all of the above information possessed the potential to help achieve our end goal, our message delivery timeframe was limited to just one or two minutes for two reasons. First, for the purpose of maintaining our viewer’s attention, the message needed to be simple and short. Second, our budget was limited, and the general cost of the animator’s service was quoted in terms of the time duration of the animated video.

In an effort to create a concise, yet effective message, we found ourselves confronted with the timeless dilemma, phrased by Blaise Pascal, “I would have written a shorter letter, but I did not have the time.” We began the time-consuming process of drafting and vetting potential scripts that exhibited not only effectiveness, but also brevity. Several ideas for improving the
impact of the message, including those mentioned in the Design Specifications section, were considered in this brainstorming process, such as

- **Connecting with the learner emotionally and eliciting personal investment.** For example, asking learners if they, or anyone they know, have lost a child to malnutrition.

- **Helping the learner recall the principles being taught by presenting the message in a context with which they are already familiar and which they encounter on a regular basis.** For example, constructing a narrative where a mother encounters hygiene threats in daily activities and illustrating the appropriate hygiene habits to prevent infection.

- **Offering relatable anecdotal evidence of the power of hygiene in an effort to add credibility to the notion of germ, and to dispel skepticism.** For example, the historical account of Ignaz Semmelweis—a pioneer in hygiene and health who oversaw a maternity hospital. Semmelweis eliminated frequent maternal death from puerperal fever in his hospital simply by instituting handwashing.

- **Helping the learner see the end from the beginning by working backwards.** For example, describe a scenario in which a child does well in school because of healthy brain development, caused by sufficient nutrient absorption, caused by the absence of diarrhea, caused by good hygiene. Add contrast by describing a child who does poorly in school because of poor brain development, caused by inadequate nutrient absorption, caused by frequent diarrhea, caused by poor hygiene.

- **Following the path of a successful germ.** For example, following a germ from a dirty source all the way to the stomach, as well as following the path of an unsuccessful germ from a dirty source all the way to being washed away, or cooked, or bleached. The intent
being to help learners become more conscious of how their hygiene habits either allow or prevent germs from entering their body.

A variety of scripts were written and revised for each scenario in an effort to evaluate the potential for various candidates. Many ideas continued to take shape, several of which were sketched into storyboards.

Figure 11: Narrative Approach, Walking through the Daily Tasks of a Mother Encountering Hygiene Dangers

Figure 12: Explanatory Approach, Illustrating Cause-Effect Relationships, Followed by Narrative
As each path was explored, it became clear over time that the limitations of scope and budget would not afford us any of the previously mentioned ideas, because insufficient video time would remain to address core concepts. In order to produce materials that would be effective in addressing the core concepts we were targeting, the supplemental content and approaches had to be omitted. The following concepts were deemed of highest importance and made up the entirety of the two-minute message:

- What germs are (small living organisms that the eye can’t see)
- Where germs can be found (everywhere)
- Why germs are bad (they make you sick)
- How germs cause diarrhea (they irritate the stomach and cause expulsion)
- How our bodies get nutrients (your stomach absorbs them from your food)
- Why nutrients are important (your body cannot grow without them)
- How diarrhea affects nutrient absorption (diarrhea expels food before nutrients are absorbed)
- The cause/effect chain between germs, hygiene, diarrhea, nutrition, and healthy growth
- How germs get into your body (drinking impure water, eating unclean food, dirty hands)
- How to prevent germs from getting in your body (cooking, washing, or purifying everything you put in your mouth)
- How to wash away or kill germs (with soap and water or by cooking food well)

The order in which these concepts are presented to the learner was guided by consultation with the animator. Being familiar with principles of narrative, he recommended ordering the concepts such that the learner was presented with the material in a sequence of what, why, and how. The message presented was what germs are, why germs are bad, and how germs affect our
bodies, as well as how to prevent them from affecting our bodies. We anticipated that adhering to this structure would further strengthen the effectiveness of our product.

While working through the next step of storyboarding and animation, we continued to review and refine the word choice of the message components. Determining the limitations of the learner’s vocabulary was a significant challenge, considering the education level of the learner. Using vocabulary that was unfamiliar to the learner would detract from, or obstruct the communication of the message, clearly rendering the product less effective. In particular, describing and referring to “bacteria” was difficult because, as a new and unfamiliar term for our demographic, it could potentially confuse or distract the learner. One of the LCF board members extolled the idea of educating our learners on hygiene without the imposition of new vocabulary. On the other hand, the concept of bacteria was likely to be new to our learner, and it would be helpful to the learner to have a new term to refer to the new concept learned. After consultation with a variety of Spanish speakers, one of the board members suggested the term “microbe,” which was more likely to be already familiar to our learner, and which did not conflate meaning with non-bacteria organisms, as did other suggested terms such as “bugs” or “insects.”

In summary, the authoring process consumed more time than anticipated; however, the value of a concise, clear message reduced animation costs, refined the message, and facilitated understanding for the learner by trimming out verbal noise.

**Storyboarding and Animation**

Having drafted the main message, we worked with the animator to produce a storyboard from which he could create a final product. This involved meeting with the animator regularly and discussing various visual perspectives and objects to include and weighing the advantages
and disadvantages of each. Meetings took place once every one to two weeks, depending on outside scheduling and availability.

Each meeting began by reviewing a portion of the script and options for how it could be portrayed visually. Previous to each meeting, we prepared various pencil sketches and suggestions for consideration by the animator. Educational merits for each approach were discussed, including Mayer’s principles for effective multimedia development. The animator also offered insight based on personal work experience. The animator then took notes from our discussions and sketched wireframes for later reference when illustrating higher quality samples.

During these discussions, we frequently encountered obstacles that were less obvious during the scripting phase. For example, visual animation offers the advantage of portraying things as good or bad through various techniques. We could portray germs as bad and soap as good. However, tap water presented a dilemma, being good in some scenarios and bad in others. Initially, we planned on portraying it as bad because it is unsafe to drink. However, we realized that the learner might be confused if we portrayed the use of “bad” tap water for washing vegetables, even though it is the prescribed hygiene practice.

Meetings were concluded by noting these various dilemmas, which required consultation and approval from hygienists. The animator would continue to work on the sections that we felt confident about while we would resolve questions and dilemmas through consultation with LCF advisors.

This cycle facilitated a positive forward momentum as we conscientiously tailored the visual component of the video to work effectively in tandem with the narrative component. The process was slow, but cautious in order to minimize the effort required by the learner to receive and interpret the message.
As mentioned, a key component of these meetings and the product development was the application of Mayer’s 12 principles. The following table overviews the features of the product that were shaped by Mayer’s 12 guiding principles, and how we implemented each principle insofar as it was possible and applicable:

### Table 7: Adherence to Mayer’s 12 Guiding Principles

<table>
<thead>
<tr>
<th>Principle</th>
<th>Coherence Principle</th>
<th>Signaling Principle</th>
<th>Redundancy Principle</th>
</tr>
</thead>
<tbody>
<tr>
<td>People learn better when</td>
<td>People learn better when extraneous words, pictures, and sounds are excluded rather</td>
<td>People learn better when cues that highlight the organization of the essential material</td>
<td>People learn better from graphics and narration than from graphics, narration, and on-</td>
</tr>
<tr>
<td>Coherence Principle</td>
<td>than included.</td>
<td>are added.</td>
<td>screen text.</td>
</tr>
<tr>
<td></td>
<td>The animations only presented necessary content, deliberately excluding extraneous</td>
<td>Audio cues, motion, and bright colors were used to draw attention to the elements of</td>
<td>The final product was specifically designed to include only animation, illustrations,</td>
</tr>
<tr>
<td></td>
<td>distractions. This was facilitated by the decision to pursue animation in place of</td>
<td>primary importance.</td>
<td>and narration.</td>
</tr>
<tr>
<td></td>
<td>live video, as live video can often unintentionally include distracting visual</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>artifacts.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spatial Contiguity Principle</td>
<td>No text was used in the final product; however, the principle of proximity was</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>employed in any cases where multiple correlated items were presented simultaneously.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temporal Contiguity</td>
<td>People learn better when corresponding words and pictures are presented simultaneously</td>
<td>Narrative and animation were carefully synchronized so that both visual and audio</td>
<td></td>
</tr>
<tr>
<td>Principle</td>
<td>rather than successively.</td>
<td>communication channels</td>
<td></td>
</tr>
</tbody>
</table>
worked in tandem to deliver a rich, but harmonious message.

### Segmenting Principle
- **People** learn better from a multimedia lesson presented in user-paced segments rather than as a continuous unit.
- **In order to facilitate a simpler delivery**, we presented the video in one continuous segment. However, breaking up the video into smaller portions might still merit consideration depending on future delivery methods.

### Pre-training Principle
- **People** learn better from a multimedia lesson when they know the names and characteristics of the main concepts.
- **The presentation, description, and definition of “microbes” was designated as the initial event of the video.**

### Modality Principle
- **People** learn better from graphics and narrations than from animation and on-screen text.
- **No text was incorporated in the final product. All content delivered through the “verbal” channel was audio narration, allowing the viewers’ eyes to focus solely on processing non-verbal information.**

### Multimedia Principle
- **People** learn better from words and pictures than from words alone.
- **All visual attention was allocated to non-verbal content (illustrations and animations).**

### Personalization Principle
- **People** learn better from multimedia lessons when words are in conversational style rather than formal style.
- **All language in the narration addressed the learner directly, using “you” and “your.”**

### Voice Principle
- **People** learn better when the narration in multimedia lessons is spoken in a friendly human voice rather than a machine voice.
- **A native Spanish speaking female with a friendly voice was selected to narrate the audio. This decision was further intended to increase empathy from the learner by matching the learner demographic.**

### Image Principle
- **People do not necessarily learn better from a multimedia**
- **No image of the narrator was added to the video; all**
lesson when the speaker’s image is added to the screen. imagery was specific to the concepts being presented.

After working through the main component of the message, a storyboard was submitted to the LCF board for approval. Because several members of the board were unable to attend the meeting, the CEO requested that the sample be sent out via email to request feedback before proceeding.

Figure 13: Initial Storyboarding by Animator

The board accepted the storyboard with few criticisms, and regular meetings with the animator continued as we finished the remainder of the script. Once the storyboard for the entire script was complete, meetings consisted of updates from the animator and clarification to address
any questions regarding details that the animator encountered while creating the final product. Shortly thereafter, the animation was completed. I arranged for a native Spanish speaking woman to record the translated narrative in a studio. One final meeting was arranged with the animator to make adjustments in animation timing to accommodate minor differences in the duration of the Spanish version.

**Actual Product**

![Animation Screenshots](image)

Figure 14: Final Animation Screen Captures

The actual final product took the form of a one minute and 51 second color animation video with narration throughout. It visually presents the learner with a child in a kitchen, informing them of the omnipresence of microbes, what microbes are, and how microbes affect the body. The video continues by illustrating the effect of microbes on the stomach and by
contrasting the positive effects of normal digestive behavior (healthy growth), compared with the negative digestive effects of diarrhea-caused bacterial infection (impeded growth).

The narrator then restates the importance of preventing diarrhea, which can be achieved by preventing infection. This is then followed by illustrations and descriptions of the various ways in which infections generally occur. The learner is presented with simple narrated and animated directions that illustrate how to exercise good hygiene to prevent those typical infections. Finally, the learner is reminded that although it is impossible/impractical to completely prevent diarrhea, practicing these good hygiene habits can reduce the frequency of diarrhea, which in turn promotes better health and growth.

Assessment

In an effort to obtain an isolated measurement of the effectiveness of the final product, we designed a pre- and post-assessment to be administered surrounding the presentation of the multimedia. Originally, we intended to create the end product in such a way that it would actually serve as the assessment, however, due to timeframe and budget constraints, we were limited to creating a separate standalone survey, administered before and after the video. Several factors determined the length, content, and format of the assessment. In order to accommodate the limited time that volunteers are able to afford with the mothers, a concise four-question quiz was administered, which sampled the core concepts that make up the message of the instructional video. The quiz questions were authored in two formats. Two opportunities for testing allowed for each format to be administered once. At the strong recommendation of the foundation’s CEO, the questions were written in a multiple answer format to facilitate coding and analysis. Distractors were added to decrease the likelihood of correctly guessed answers.
Later, with a second opportunity for testing, the first three questions were re-written in an open response format to more accurately assess existing knowledge.

The following is the multiple-answer format assessment used:

This quiz will be administered before and after the presentation of the video. We hope that the video will help you learn more about child growth and health.

For each question, mark all applicable answers.

1. What are microbes?
   - Beetles
   - Nutrients
   - Bugs that are too small to see
   - Dust
   - Chemicals

2. Where can microbes be found?
   - In meat
   - On fruits and vegetables
   - In water
   - In vitamins
   - On your hands

3. What happens when microbes get in your stomach?
   - You grow stronger
   - You don’t grow well
   - They help your stomach feel better
   - They irritate your stomach
   - They help with digestion
   - Diarrhea

4. What keeps microbes from getting in your stomach?
   - Not eating enough
   - Washing your hands with soap
   - Laying down after eating
   - Drinking too much water
   - Boiling water
   - Eating only vegetables
The following is the open response format assessment used:

This quiz will be administered before and after the presentation of the video. We hope that the video will help you learn more about child growth and health.

1. What are microbes?

2. Where can microbes be found?

3. How do microbes affect your stomach?

Mark all applicable answers.

4. What keeps microbes from getting in your stomach?
   - Not eating enough
   - Washing your hands with soap
   - Lying down after eating
   - Drinking too much water
   - Boiling water
Eating only vegetables
Cooking meat well

Implementation

Training

As intended, the product was intentionally designed to require minimal training on part of the volunteers. One of the measures of success was the ability of the product to facilitate teaching and learning without imposing additional work or processes on the volunteers.

Three individual evaluators affirmed and described the imbalance of duties that the volunteers experience, which has resulted in neglect of sufficient attention to hygiene education. In order to minimize required time and effort on part of the volunteers, the product delivery was designed such that the volunteers can bring a provided tablet with them, describe the purpose of the video in one sentence, and present the video to the learner. Per the suggestion of one of the evaluators, a brief 30-second video was created to aid the volunteers.

This approach simplifies the process in that the 30-second video can be accessed in the same manner and location as that of the instructional video itself. Volunteers can access both the instructional video and the training video either through links to online versions, or by viewing the pre-loaded videos on their tablet.

After viewing the video, learners may have questions regarding the message or content. The duty of answering those questions falls within the normal responsibilities of hygiene education, and should be treated as part of general education responsibilities. This task should, therefore, not require any additional or special training on our part and should be addressed by standard LCF training.
**Resources**

Physical resources required for implementation are minimal, consisting of a tablet pre-loaded with the animation video file. As mentioned previously, tablets are provided to volunteers by the LCF. It will be necessary for the tablet battery to be sufficiently charged to play the video and is therefore a responsibility imposed upon the volunteers. However, this should already be a common and regular responsibility, since the tablets are used for various other tasks, such as logging and reporting health and measurement data. A copy of the video file itself is in possession of LCF leaders. An online copy is also available without any financial burden, via YouTube.

Volunteer time and availability are also significant resources that are depended upon for delivery of the final product. Because the video is available online, it can be viewed by mothers independently; however, the product is most likely to be effective when accompanied by the contextual education offered by volunteers in full lessons. As the LCF manages trainings and fosters more regular hygiene education opportunities, it is anticipated that scheduled lessons will become readily available, so that the video may be delivered in the context of a complete lesson.

**Spaces**

According to guidelines offered by the LCF, as well as reports from evaluators, lessons can be and are currently taught both in group settings in community spaces, such as chapels, as well as in individual settings in the homes of the mothers. The portable nature of the product provides for versatile delivery, meaning that the only real spatial requirement for its implementation is minimal ambient noise, so that the learner is able to hear the narration. This
lack of need for specialized spaces adds value to the product, helping it achieve its goal of improving the effectiveness of the LCF educational resources.

**Evaluation**

**Criteria and Stakeholders**

The criteria used to evaluate the effectiveness of the project consist of measured learning via pre- and post-quizzes and feedback from volunteers. The project was considered successful if it had a significantly positive impact on the learners’ understanding of bacteria and the correlations between bacteria, hygiene, and health. The project was successful if it also mitigated the hygiene education responsibilities of the volunteers.

Stakeholders in this evaluation include LCF leaders, volunteers, mothers, and children. LCF leaders benefit directly from a product that effectively improves learning because effort and attention required for management and development of learning resources is reduced. Efforts of leaders can then be further dedicated to other needs such as nutritional supplement manufacturing and distribution. An effective product also benefits volunteers by lightening the mental burden of management and delivery of hygiene instruction to mothers. Mothers also benefit, as a result of facilitated learning and reduced cognitive load. Increased understanding is likely to encourage improved hygiene habits, which reduces frequency of illness among both mothers and children.
Procedures

The evaluation for this project was formative in nature because of the continual development of learning materials by the LCF, which can benefit from constructive criticism. Not only is the LCF receptive to informative feedback in developing these materials, but the final product, by design, lends itself to further development. This is a positive outcome of the design process in that the product will not require a complete revision in order to be immediately improved.

Our process of evaluating the product first sought insight directly from the measurable results of the pre- and post-quizzes that were administered to the volunteers. By analyzing the specific results of each participant’s improvement, we were able to derive indications as to how we might improve specific aspects of the product. The pre- and post-video quizzes are the same as those discussed in the Assessment section.

Secondly, our procedure sought feedback from the volunteers. The stated end goal of this project was to improve the effectiveness of the teaching materials, in part as an effort to reduce the load imposed on volunteers. Their feedback regarding the perceived effectiveness will serve as a valuable indicator in our evaluation.

Evidence

In the first opportunity for piloting the product, a sample size of 20 volunteers was used. Volunteers were gathered for a conference in Guatemala during November to receive training on all volunteer responsibilities, including methods and procedures for collecting and reporting health information, distributing nutritional supplements, and conducting health education. During the conference, the multiple answer format pre-video quiz was administered, and a few minutes
were given for volunteers to write their name, read the instructions, and answer all four questions. Then, following the presentation of the video, a new copy of the same quiz was administered and the volunteers were given time to answer the same questions again.

The data sheet in Figure 15 conveys the results of the learning that occurred between pre- and post-quizzes. There are two data columns for each participant. One column containing the pre-quiz results and one containing the post-quiz results. Any instances where the participant’s answer between the pre- and post-quizzes were different are marked with a colored cell.

- Blue cells—Learning occurred. (The participant marked an answer incorrectly in the pre, and but correctly in the post.)
- Red cells—Learning should have occurred, but did not. (The participant marked an answer incorrectly in the pre, as well as in the post.)
- Yellow Cells—the participant marked the answer correctly in the pre, but incorrectly in the post, suggesting that they “unlearned” that item.

Figure 15: Results of Pre- and Post-Quizzes

Of immediate note is the last participant who scored worse on the post-test than on the pre-test, but also did not follow quiz instructions. For that reason, we were inclined to not include his results in the analysis.
The quantity of blue and red cells suggests that there was a significant amount of opportunity for the participants to learn information about germs, hygiene, and health. Or, in other words, many of the participants were not well informed about germs, hygiene, and health before watching the video. The quantity of blue cells suggest that the video was effective in helping the participants learn about germs, hygiene, and health.

Red cells could possibly indicate that either the participant was not paying attention, or that the video could be improved to teach concepts more effectively. Noting that two questions in particular had more red cells than any others suggests that two particular components of the video message could be better communicated or clarified. Those are

1. Communication of the inherent risks of meat
2. Communication of the effects of germs on the body.

Subsequently reviewing the animation, it is clear that the inherent dangers of meat were only lightly touched upon. Also, it is notable that the animated components of germs entering the stomach could lend themselves to confusion and should be revised.

In order to provide a statistical analysis of the scores, a paired-samples t-test was conducted to compare pre- and post-scores on the 22-point quiz, testing awareness of germs and the correlations between germs, hygiene, and health. There was a significant difference in the scores for pre- (M=19.1, SD=1.55) and post-quizzes (M=20.6, SD=1.82); t(19)=-3.81, p = 0.001. These results help suggest that the video did significantly improve understanding and awareness of the principles taught.

In addition to the pilot test discussed above, a second opportunity for testing arose in conjunction with a similar training in Paraguay. Having obtained codified results from the multiple answer format quiz, we took the opportunity to rewrite three of the four questions in an
open answer format with the anticipation that open answer questions would offer more accurate measurements of the existing knowledge of the learner. The format of quiz administration was the same in the Paraguay conference as that of the Guatemala conference. The Paraguay conference consisted of eight volunteers.

In the pre-quiz results, all participants answered the open response questions in such a way that demonstrated awareness of germs as well as the association between germs and illness. Half answered the multiple answer question correctly, and the other half answered it partially correctly. Post quiz results showed two positive indications: response on the multiple answer question was improved and half of the participants in the open response answers made additional note of the association between illness and growth/nutrient loss.

Evidence of feedback from volunteers was expressed verbally by volunteers afterward in both conferences and reported by the leaders conducting the conferences. Feedback offered was non-specific, but very supportive and enthusiastic. Volunteers were grateful to have this teaching resource available to them and felt that it would be effective in helping them fulfill their educational responsibilities.

Outcomes

We anticipate that the video will produce results with the intended learner similar or better than those observed with volunteers, considering that the test subjects share the neighborhoods, culture, and vocabulary of the mothers they will be serving.

Other factors to be taken into consideration regarding the testing conditions include volunteer education level, effect of concurrent conference training, and lack of repeated viewing of the video.
In terms of level of education, volunteers are generally recommended by local authorities
to serve because of their suitability to fulfill tasks, which include hygiene education. This would
suggest that volunteers often already have some familiarity with hygiene and health. Although
the quiz results in the first pilot test suggest that the volunteers had much to learn, they did still
score better on the pre-quiz than we would expect from an uneducated mother. Because we
anticipate that mothers will not have this advantage, being of the same or lesser level of
education, we might expect mothers to score lower on the pre-quiz, which allows for more
opportunity for learning. This would allow for a larger positive gap of learning between pre- and
post-quizzing and, therefore, more significant improvement.

A possible effect of the quizzes being administered during a conference includes a
possible effect on the pre-scores. Because there was general relevant discussion regarding
hygiene and proper practices prior to the pre-quiz, the volunteers could possibly have had an
advantage in scoring better on the pre-quiz. This is encouraging because in spite of a possible
advantage, the volunteers still showed significant learning from the video.

The last factor considered is the intended design of the product to be viewed multiple
times on separate occasions. The volunteers showed significant learning in spite of having only
watched the video on one occasion. Because the video is intended to be presented in each of the
three lessons it addresses, learners will benefit from repeated exposure (Cepeda, Pashler, Vul,
Wixted, & Rohrer, 2006), which should reinforce and improve learning, and improve post-
scores.

In summary, because we were limited to the testing opportunities of volunteer trainings,
an actual evaluation of testing the product with actual learners was not available to us. While
these were not ideal evaluation protocols, they were appropriate measures, given the constraints
of the project. Even so, the inferences that we were able to make based on our volunteer testing seemed promising, and we do still intend to evaluate results with actual learners as soon as an organized opportunity is available.

**Design Critique**

The primary critiques of this design and development project are recommendations regarding specification of client approval processes and scope management.

One particular hindrance to the timely completion of this project was lack of due diligence in establishing the authoritative source of approval at the outset. Although design and initial development moved along according to schedule, it was not until the final approval stage that I was informed that the approval process was different than I had anticipated. All members of the foundation board were required to review and approve plans before authorization for paid work could move to final production stages. Although I had contact and communication with the founder and CEO, I failed to establish in clear terms the necessary procedures for approval. Both the founder and CEO were supportive and helpful in orchestrating the approval, however, scheduling a meeting and communicating approval was delayed due to the international and semi-formal nature of the meeting schedule.

Another critique was the duration of time spent defining the scope of the product. Originally, I set out to produce multiple multimedia products for each of the six lessons. Although instructional media for each of the six lessons would have been valuable, an attempt to produce that much content within the bounds of this project would have stretched the budget and resulted in a greater quantity of lower quality products. My own ambition drew out the design process and delayed the development process. Thankfully, with the foresight of my advisor and
the consultation of the client, the scope was narrowed down to three lessons and allowed for
greater focus on the design and development process.

Several valuable insights learned in the process of designing and developing this product
include guidelines in animated media development, navigation of vocabulary limitations, and
advantages of designing international materials for an illiterate audience.

The decision to follow Mayer’s 12 guidelines for multimedia design proved to be of great
benefit. Mayer had already set the groundwork for tested and proven effective multimedia
design. Heeding those principles allowed us to dedicate more attention to the nuances of
multimedia design, having confidence that the 12 principles would help address some of the
more foundational decisions. The fortuitous opportunity to work with an experienced Hollywood
animator also provided us with valuable insight and consultation throughout the process and is
recommended for future multimedia design projects.

Another valuable facet of the final product was attention to detail in phrasing the
instructional message. Although it did not stand out as a significant need during the analysis
phase, it would have been beneficial to dedicate greater research to the vocabulary limitations of
the target audience. Investing significant effort in exploring various approaches in phrasing
ultimately paid off in the end, as the product was well received, and we were able to
communicate a naturally complex concept in a simple way with simple language. This will
surely prove to be valuable in ensuring that the product is efficacious in creating understanding
with the learner. Considering that the video will likely be re-translated into other languages for
international use, it is advised that a similar level of attention to detail be given in researching the
vernacular of each population to which the video will be delivered.
Finally, it should be noted that although our rationale for excluding any visual text or words from the video was driven by the illiteracy observed in our learner analysis, it would have been equally justified for the sake of multilingual reusability for our international client. In addition, Mayer’s 12 principles discourage the use of text except when necessary. Because the video was produced in this manner, the client will see much greater value in the product, being able to use it in multiple languages simply by recording new audio translations, which is much less costly than editing video components.

Conclusion

Working through the entire ADDIE process of this project was powerfully insightful and valuable. I encountered a variety of challenging decisions to make and learned by experience the nuances of project management, scope management, communication, and of course design and development. Clearly defining the objective of “improving the effectiveness of the written teaching guide” was notably invaluable in guiding crucial decisions. It clearly validates the upfront investment of a thorough analysis of the needs of the client and the learner.

The multimedia resource produced is immediately valuable to the foundation and will continue to maintain value due to its flexible design. It should also provide guidance to development of future resources for the foundation as they further test, evaluate, and modify it. Hundreds of volunteers and mothers will be benefited in a small way, which will hopefully result in greater health, mental development, and opportunities for education. I feel confident that this project has undoubtedly been a worthwhile investment. Ultimately, the objective of the project was to improve the effectiveness of the written teaching guide by designing and producing multimedia components to be used in educating mothers and children. The extent of its effectiveness will become clearer with further testing; however, it has indeed improved the
effectiveness of the teaching guide by delivering a clear educational message without burdening the volunteers.

References


