IMPROVING DENGUE FEVER KNOWLEDGE, ATTITUDE, AND PRACTICES IN PRIMARY SCHOOL CHILDREN IN FLORIDA THROUGH ANIMATION

by

Julie Weisenbacher Huthmaker

HALEY CASH, PhD, Faculty Mentor and Chair

ELLEN HOPE KEARNS, PhD, Committee Member

ROBLENA WALKER, PhD, Committee Member

Christy Davidson, DNP, Interim Dean, School of Nursing and Health Sciences

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ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 - 1346

Abstract

Background: Incident rates of dengue fever are rapidly increasing worldwide. Contributing factors including climate change, urbanization, globalization, and vector mutation, are creating significant public health challenges. Dengue fever has no vaccination, and no cure; therefore prevention through vector control is the primary method of public protection. Research indicates that community involvement is critical in achieving vector control, and that children, disproportionally burdened by this disease, are an effective and appropriate population to target with interventions. Innovative, sustainable, cost effective strategies are needed. Objective: It was theorized that an educational animation regarding dengue fever, created using CDC guidelines, would be effective at improving knowledge, attitude, and practices in primary school children in Florida. An animation entitled "Dengue Fever Comes To Town" was developed to assess this concept. Methods: A pretest/posttest study was conducted. Knowledge changes were statistically evaluated using a Two-tailed Paired Sample t-test. Attitude changes were evaluated using a Wilcoxon Matched Pair Signed Rank. Practice changes were evaluated using a chi-square test. Results: The animation was effective at improving knowledge, attitude, and practices in third through fifth grade levels, for both males and females. Recommendations: Given the vulnerability of the population, and the increasing risk of dengue fever, establishment of preventive education is recommended, including adding the educational animation to school curricula in Florida.

Dedication

This dissertation is dedicated to my brilliant, supportive, loving father. When I was a child, with no real appreciation for quotes written on graph paper, you taped up on my bedroom wall, “Cogito ergo sum” (Descartes, 1644). I guess you were determined that someday it would be meaningful to me. I love you so very much, Dad. Thank you.

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CHAPTER 1. INTRODUCTION

Introduction to the Problem

More than one-half of the world's population resides in areas where they are at risk for dengue fever (DF) infection. An estimated 390 million cases occur annually (Beaumier, Garcia, & Murray, 2014), with approximately 25,000 fatalities (Wilder-Smith et al., 2012). No cure or vaccination is available for this virus, which can be excruciatingly painful (Center for Disease Control and Prevention [CDC], 2012a). Each year in the United States several hundred cases of dengue are reported, most of which are travel-associated.

From 2001-2007, there were 796 cases of dengue reported in the United States, mainly imported (World Health Organization [WHO], 2009, p.7). However, beginning in 2001, infected local mosquito populations have led to dengue outbreaks in Hawaii, Texas, Key West (Adalja, Sell, Bouri, & Franco, 2012), and Martin County, Florida (Singer, 2013). From January of 2014 until the beginning of June, there were 24 cases of dengue fever in Florida (Liston, 2014). Further, 14 cases of chikungunya virus, transmitted by the same vector, the *Aedes aegypti* mosquito, were reported in Florida in the first half of 2014 (Liston, 2014).

In the past, vector control efforts have been effective in limiting the spread of mosquito-borne diseases in the United States; however, experts believe that this strategy will become increasingly ineffective due to vector resistance (Zettel & Kaufman, 2008),

and the complex effects of climate change, urbanization, and globalization (Gubler, 2011). New strategies are needed to control the spread of dengue fever. The purpose of this study is to examine the efficacy of an educational animation regarding dengue fever in improving knowledge, attitude, and practices (KAP) of third to fifth grade children in Florida.

A great deal of research is available on public health campaigns to decrease the spread of dengue fever, yet no current research exists for the U.S. population. Previous studies have been conducted on the use of animations in educational campaigns, and on targeting children in dengue campaigns; however no study has been published on the use of an animation for promoting Knowledge, Attitudes, and Practices (KAP) regarding dengue. This study used a pre and posttest design in order to measure changes in KAP after viewing an animation containing prevention messages promoted by the Dengue Fever Branch of the CDC. This researcher, along with a subject matter expert and technical consultant, created the animation.

Background of the Study

Incidence rates of DF have increased 30-fold in the past 50 years (WHO, 2015). Along with DF, global trends in dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS) are also increasing and correlate to the number of circulating dengue viruses (Caribbean Public Health Agency [CARPHA], n.d.).

Seminal author Duane Gubler has published more than 300 articles on DF over the past 42 years (Break Dengue, 2013). He has described the rising threat of DF in numerous articles, stressing that climate change, urbanization, and globalization are the major factors contributing to the increase of dengue and other infectious diseases

(Gubler, 2011). Climate change impacts vector borne disease by (a) decreasing the extrinsic incubation period, (b) increasing the duration of rainy seasons, and (c) increasing breeding sites (Gubler, 2006). Population growth leading to unplanned urbanization, mainly in the tropics and subtropics, has resulted in urban environments that are densely populated with both humans and mosquitoes. Subsequently, inadequate infrastructure creates issues with sanitation, solid waste removal, and water storage. Globalization has created the conditions for unprecedented rapid movement of disease (Gubler, 2011).

In the United States, dengue outbreaks are rare but there is an increasing trend of reported cases. Currently, there is limited U.S.-specific educational material regarding dengue control and prevention. Florida has experienced two of the five recent outbreaks in the United States. Close proximity to dengue endemic areas including the Caribbean, South America, and Central America, as well as the presence of the disease vectors, *Aedes aegypti* and *Aedes albopictus*, places Florida at great risk for future outbreaks of dengue and other mosquito-borne diseases.

The chikungunya virus is also a concern for public health officials in Florida. The chikungunya virus, transmitted by the same vectors, *Aedes aegypti* and *Aedes albopictus*, is currently being detected in Florida, and causing widespread epidemics in the Caribbean with over 100,000 cases, in 17 countries, during 2014 (Liston, 2014). Although the disease is not specifically addressed in this intervention, the same protective practices apply and may benefit participants.

Previous studies have shown that schoolchildren are an effective audience to target with educational interventions and additional studies have shown that animations

are an effective and user-preferred methodology for information delivery (Avila Montes, Martinez, Sherman, & Fernandez Cerna, 2004; Bieri et al., 2013; Jayawardene, Lohrmann, YoussefAgha, & Nilwala, 2011; Leiner, Handal, & Williams, 2004; Moore et al., 2011; Overgaard et al., 2012; Sinor, 2011; Tae et al., 2012; Tjiam et al., 2012; Tjiam et al., 2013; Vesga-Gomez & Caceres-Manrique, 2010; Wangroongsarb, 1997; Wohl, Christie, Matheson, & Anisman, 2010). Studies also indicate that the use of animated media is superior to other educational methodologies including printed material (Disney, 1955; Leiner et al., 2004; Sinor, 2011). In China, an educational animation regarding Soil Transmitted Helminthes (STH) reduced disease rates by 50%, an unprecedented rate of efficacy for a STH public health campaign (Bieri et al., 2013).

The spread of DF is at a critical juncture and there is clearly a need for innovative educational strategies. This project will complement the current dengue educational materials in Florida by providing a multimedia tool to incorporate in science curricula and include on health department web sites.

Statement of the Problem

There are many gaps in dengue research including: lack of a vaccination, no available treatment, inadequate surveillance, changing global parameters, and entomological evolution (Gubler, 2011; Troyo, Porcelain, Calderon-Arguedas, Chadee, & Beier, 2006; Zettel & Kaufman, 2008). Therefore, there is an urgent need to develop tools for translating what is known about risk factors into risk-mitigating practices within communities.

In the 2014, Florida had 67 cases of imported dengue fever (United States Geological Survey (USGU), 2015). However, in 2010 and 2013 the state faced locally-

acquired outbreaks. An effective animation, with flexible, sustainable, affordable delivery, may serve health department dengue-related educational needs for an extended period of time and help to prevent potential future cases.

In addition to meeting the needs in Florida, this animation may be helpful in numerous other locations. Interventions implementing new developments in technology, such as downloadable educational material, help to transcend structural inequalities in developing (Humanipo, 2013) and developed countries. Technology that is now available allows for leapfrogging of years of technological advancement and access to state-of-the-art tools (Munyua, 2000).

Purpose of the Study

Currently there is a dearth of educational material available regarding DF in the US. The general population knows little about this illness and rising rates of locally-acquired disease, especially in Florida, further illustrate the need for new material. While rising rates of DF are concerning, increasing rates of serious disease, particularly amongst children, are more troublesome (WHO, 2014a). Death from DHF and DSS is often the result of untreated shock; however, with early medical intervention, fatalities can be reduced to less than 1% (Jiddou et al., 2012). In the absence of treatment or an effective vaccination, prevention of dengue fever remains focused on controlling the vector, *Aedes aegypti*. The purpose of this pretest-posttest quantitative study was to determine the efficacy of the animation, "Dengue Fever Comes To Town," in improving the KAP of third to fifth grade students in Florida.

Rationale for the Study

There is a need for innovative, effective, sustainable approaches to promote public health awareness regarding DF. Epidemiological data identifies children as high risk for dengue morbidity and mortality. The successful use of animation in other public health campaigns supports the concept that an animation may be effective in improving KAP regarding DF for this high-risk population.

School-Based Interventions

Worldwide dengue is found mostly in poverty stricken areas where it carries a high disease burden among children (Dengue Matters, 2013). Studies in locations endemic with dengue have shown that schoolchildren are effective in decreasing larval indices through knowledge-based interventions (Avila Montes et al., 2004; Jayawardene et al., 2011; Overgaard et al., 2012; Vesga-Gomez & Caceres-Manrique, 2010; Wangroongsarb, 1997). These studies support collaboration between the ministries of health and education on dengue control programs to target children as an effective means of reducing transmission and identifying early-stage disease for treatment.

Efficacy of Animations

Numerous studies have established the efficacy of animation in public health initiatives and patient education (Bieri et al., 2013; Leiner et al., 2004; Moore et al., 2011; Sinor, 2011; Tae et al., 2012; Tjiam et al., 2012; Tjiam et al., 2013; Wohl et al., 2010). Studies also indicate that the use of animated media is superior to other educational methodologies including printed material (Disney, 1955; Leiner et al., 2004; Sinor, 2011). However, to date, no studies have been published regarding the use of animation in dengue campaigns.

In Tanzania, a participatory action research study was conducted to investigate an approach where children acted as agents of change. Authors found that participants preferred an approach where children were given an active role as "health change agents" (Mwanga, Jensen, Magnussen, & Aagaard-Hansen, 2008, p. 16). Further, children were able to effectively work together with their schools and community health education programs (Mwanga et al., 2008).

Percy-Smith and Burns (2009) researched the use of schools in developing sustainable communities. Within this model, children were viewed as "actors of social change" (p. 21), and four factors emerged as impacting their ability to act. Factors included: (a) learning that extended beyond just acquisition of information; (b) having the opportunity to take on leadership roles and responsibility; (c) having sustained encouragement from adults, and (d) having an "adult-child relationship based on an explicit recognition of the capabilities of children" (Percy-Smith & Burns, 2009, p. 22). Such research supports the idea that children can make a difference, but that their capacity to do so is dependent on recognition and support from adults.

Research Questions and Hypotheses

Three research questions and two corresponding hypotheses for each are presented in this study.

Research Goal

To determine the efficacy of an animated film in improving primary students KAP regarding dengue fever in Florida.

Main Research Aim

RQ1: Is the animation, "Dengue Fever Comes To Town," effective at increasing knowledge, improving attitude, and improving practices regarding dengue fever in third to fifth grade students in Florida?

Ho1: The animation, "Dengue Fever Comes To Town*," will have no effect or decrease* knowledge, attitude, and practices regarding dengue fever in third to fifth grade students in Florida.

Ha1: The animation, "Dengue Fever Comes To Town," *will increase* knowledge, improve attitude, and improve practices regarding dengue fever in third to fifth grade students in Florida.

Minor Research Aims

RQ2: Is there a difference in the efficacy of the animation related to gender?

Ho2: There *will not* be differences in the efficacy of the animation related to gender; differences between male and female scores will not be significant.

Ha2: There *will* be differences in the efficacy of the animation related to gender.

RQ3: Is there a difference in the efficacy of the animation related to grade level?

Ho3: There *will not* be differences in the efficacy of the animation related to grade level.

Ha3: There *will* be differences in the efficacy of the animation related to grade level.

Research Objectives

- Increase primary school children's knowledge and recall of dengue signs and symptoms, and transmission.

- Impress that dengue fever is a serious disease, and that children can make a difference in decreasing the spread of disease.
- Empower children to assess home and community risk factors and take corrective action.

Feasibility of Research Questions

While this animation aims to increase the general knowledge of dengue and improve modifiable risk practices in the primary school population, in large-scale campaigns, larval indices are used to gauge efficacy. The scope of this project is most likely not large enough to impact larval indices. However, if the animation is integrated into Florida science curricula, larval indices and disease rates may be significantly impacted and could be included as research questions in follow-up studies.

Significance of the Study

Dengue Fever (DF) is currently the "most important mosquito-borne viral disease in the world" (WHO, 2015, p. 1). In the state of Florida, experts believe that dengue, and a similar virus, chikungunya, pose an "imminent threat" (Lee, 2014, p. 1). Research indicates that in the event of severe illness, early detection was identified as a "critical factor for survival" (Guha-Sapir & Schimmer, 2004, p. 1). This effort addresses the need for proactive educational material, proven effective in the US population, where no studies on dengue educational campaigns have been conducted.

Definition of Terms and Abbreviations

CDC: Center for Disease Control and Prevention

Dengue fever: In 2009, the World Health Organization outlined new case definitions for dengue fever, dividing the illness into two classifications. "Dengue without warning signs" is the term used when fever and two of the following are present: nausea/vomiting, rash, aches/pains, leukopenia (low white blood cell count), and positive tourniquet test (greater than 10 petechiae appearing after a blood pressure cuff is applied for five minutes), while "dengue fever with warning signs" is used when patients have the above listed manifestations as well as any of the following: severe abdominal pain, persistent vomiting, fluid accumulation, mucosal bleeding, restlessness, enlarged liver, or increase in hematocrit along with decrease in platelets (CDC, 2013).

Dengue hemorrhagic fever and **dengue shock syndrome:** These are both considered Severe Dengue. Dengue hemorrhagic fever is characterized by hemorrhagic symptoms including bleeding, thrombocytopenia, reduction of intravascular blood volume, and evidence of hemoconcentration. Dengue shock syndrome is a worsening state of dengue hemorrhagic fever with circulatory collapse (CDC, 2013).

Endemic: A location where the disease occurs every year (CDC, 2014).

Epidemic: When a large number of people are infected in a given location during a short period of time (CDC, 2014).

Heterotypic reinfection: A second infection with a different vial serotype (Caribbean Epidemiological Centre, 2000).

Hyperendemic: Typically this term refers to high levels of circulating disease, but when referring to dengue fever, it means high levels of different viral serotypes circulating at the same time, in a given location (Oki & Yamamoto, 2012.)

Laval surveys: May include (a) house index, expressed as the percentage of house infested with larvae or pupae; or (b) container index, expressed as the percentage of water containers infested with larvae or pupae; or (c) Breteau index, expressed as the number of containers with larvae or pupae per 100 houses inspected (WHO, 2014a).

Viral serotype: A type of virus, distinguishable from other strains, based on antigenicity, of the genus *Flavivirus* (Gubler & Clark, 1995).

WHO: World Health Organization.

Assumptions and Limitations

Assumptions

Assumptions are inherent in research and constitute such an integral part of the research question that "without them, the research problem itself could not exist" (Leedy & Ormrod, 2010, p. 62). However, assumptions cannot simply be stated, they must be justified (Simon, 2011). Paradigmatic, logistical, and conceptual assumptions are discussed.

Paradigmatic assumptions consider whether the research question is better answered with a qualitative or quantitative approach (Simon, 2011). Qualitative research assumes the topic is best explored subjectively, focusing on the individual's experience. Quantitative research assumes that reality can be measured objectively and study design focuses on experimental replication and generalizability (Simon & Goes, 2013).

The "Dengue Fever Comes To Town" study was primarily concerned with transferring currently established information, regarding general knowledge of dengue and modifiable behaviors, from research to community practice. Therefore, the primary

paradigmatic assumption was that the animation could quantitatively improve population knowledge, attitude, and practice.

Key logistical assumptions included that (a) the researcher would obtain all required approvals in a timely manner, and (b) that the researcher would have support and cooperation at the study location.

Key conceptual assumptions included:

1. Improvements in KAP in the student population would have a positive community impact on risk factors for dengue such as reducing standing water and mosquito populations (Avila Montes et al., 2004; Bieri et al., 2013; Jayawardene et al., 2011; Leiner et al., 2004; Moore et al., 2011; Overgaard et al., 2012; Sinor, 2011; Tae et al., 2012; Tjiam et al., 2012; Tjiam et al., 2013; Vesga-Gomez & Caceres-Manrique, 2010; Wangroongsarb, 1997; Wohl et al., 2010).

2. Students cared and wanted to make a difference (Edwards, Gandini, & Forman, 2011; Hewett, 2001).

3. Animations were an effective modality to reach this population (Bieri et al., 2013; Leiner et al., 2004; Moore et al., 2011; Sinor, 2011; Tae et al., 2012; Tjiam et al., 2012; Tjiam et al., 2013).

4. In accordance with the health belief model, there was a high enough "perceived threat" in this population to create a response to "cues to action" (Hayden, 2014).

Limitations

The "Dengue Fever Comes To Town" study had a number of limitations that were difficult to overcome in the study design. Time constraints and a lack of funding placed substantial restrictions on the scope of the study. Limitations included an inability to

assess program impact on larval indices and disease rates, limited global/cultural generalizability, limited age-related generalizability, and the absence of a time delayed (3 and 6 month) follow-up.

Larval indices and disease rates. The ability to assess program impact on larval indices, and most importantly, disease rates, is the gold standard of an efficacious intervention (Gubler, 2011). This standard of measurement is complex in the realm of vector-borne disease. Many factors affect these variables, such a weather patterns, local infrastructure, urbanization, and anthropogenic change (Gubler, 2011). Further, the limited sample size and the short timeline of the study were unlikely to produce measureable change in the larval count. The study was primarily concerned with prevention, which is a valid concern; however, it is difficult to measure in terms of study efficacy.

Generalizability. The study takes place with the third to fifth grade population in a developed country. The sample was drawn from a large population of students, present in a summer camp, which uses a sliding scale to calculate fees. Therefore the sample was estimated to be a reasonable cultural and sociodemographic representation of the Florida area. However, it is possible that the intervention may have a large potential audience including middle school, high school, and young adults. Generalizability could be assessed in a follow-up study to determine optimal parameters of age and location.

This study was designed for the state of Florida; however DF incident rates are increasing worldwide (WHO, 2015). In order to increase generalizability, all key elements that increase risk for dengue were incorporated into the film; for example, the

removal of standing water. While specific mosquito breeding sites may vary by location, the central message is transferable.

Three and six month follow-ups. The intervention would best be measured with the use of time-delayed follow-ups. Repeated posttesting at 3 and 6 month intervals would considerably strengthen the study design. Unfortunately, a single pre and posttest design was used due to time constraints.

Theoretical Framework

Richard Mayer's Cognitive Theory of Multimedia Learning

Richard Mayer's (2001, 2005) cognitive theory of multimedia learning is based on the principle that people have two different channels for learning, with independent capacities for audio/verbal and visual/pictorial input. Mayer developed his theory by combining the new field of multimedia learning with known principles of cognitive science. The theory is based on three assumptions:

1. Dual channels–this assumes that humans have separate channels for the processing of visual and auditory data.

2. Limited capacity–this states that each of the two channels has a limited amount of capacity for processing information at a given time.

3. Active processing–this asserts that humans learn by arranging relevant information into mental representations, and integrating those representations with other knowledge (Mayer, 2005).

The theory is supported by a set of principles, which may inform development of effective multimedia presentations. The principles include:

1. The multimedia principle states that both words and pictures should be included. When words and pictures are used together mental images are created, which are more effectively intergraded into existing knowledge.

2. The continuity principle states that there is a cognitive importance of placing words and corresponding graphics near each other. When words and images are separated, cognitive effort is drained to connect them. When content-related words and images are placed closed together, learning takes place more efficiently.

3. The nodality principle refers to the mode in which the auditory data is presented to learners. Audio data should be presented verbally, rather than as text, so that each channel (audio and visual) is stimulated by just one element. If audio data is presented as text with visual/pictorial data, that channel can be overloaded with images, while the audio channel is not activated.

4. The redundancy principle states that presentations should include audio or text, but not both. When learners are presented with both, they will use cognitive processing resources to subconsciously combine the audio and visual text, unnecessarily using cognitive capacity.

5. The coherence principle states that extraneous information, not related to the learning goals, should not be added to multimedia education. Interesting but not relevant information will unnecessarily use up cognitive capacity. Educators should remember that working memory capacity is extremely limited.

6. The personalization principle states that conversational language should be used when presenting educational material, which introduces a social element and increases learning.

7. The segmentation principle states that messages should broken into parts to decrease the complexity of large lessons.

8. The pretraining principle states that previously learned lessons and related ideas should be presented along with key terms and definitions prior to introducing a new concept. This helps to set learner expectations, increases comfort, and decreases cognitive load during the training exercise (Negus, 2009).

Multimedia Learning and "Dengue Fever Comes To Town"

Many of the multimedia learning theory's tenets are well addressed in the "Dengue Fever Comes To Town" animation. Multimedia and continuity principles are demonstrated, with simplistic pictures and short audio present in each scene. The coherence principle was honored throughout the animation, and little extraneous content was included, with the exception of the details needed to create a storyline. Personalization occurred throughout the story, as youngsters could identify with the characters, and conversational language was spoken. The animation was segmented into short scenes, with each scene covering a limited amount of material visually and verbally. Finally, the pretraining Principle took place inadvertently during pretesting. This "priming" is recognized to be an important component in learning, and recommendations are made in the discussion regarding this point.

Two of the principles were violated in the dengue animation, the modality principle, and the redundancy principle. These principles assert that only audio or text should be used, preferably audio, along with the corresponding imagery. "Dengue Fever Comes To Town," which is a still-frame animation of a book, contains both audio and written text in each scene. The content and pace of the animation are relatively simplistic,

and may not be placing students' working memories at capacity. However, the animation may be more effective with a broader audience if the text was removed from the animation. This point is further considered in the discussion.

Empowerment Theory: the Reggio Emilia Approach

The Reggio Emilia Approach to education developed in and around the villages surrounding Reggio Emilia, in northern Italy, following World War II (Edwards et al., 2011). In this resource-poor environment, Loris Malaguzzi, together with parents and other educators, drew on the ideas of past educational theorists and philosophers including Maria Montessori, Friedrich Froebel, John Dewey, and Lev Vygotsky. They created a cooperative movement in learning that integrated numerous modes of expression including, "words, movement, drawing, painting, building, sculpture, shadow play, collage, dramatic play, and music" (Edwards et al., 2011, p. 3). The Reggio Emilia approach became part of the municipal system in Italy, open to the public, and leading children to the development of extraordinary symbolic skills and creativity (Edwards et al., 2011). The major foci of the approach are (a) the framing of education as a group activity, (b) the concentration on projects (long and short-term) and, (c) problem solving. These pursuits take place communally, with open discussion, speculation, and sharing of culture between children and adults (Edwards et al., 2011).

The Reggio Emilia approach describes children, through their constant investigation, as researchers (Gandini, 1993). Drawing on theorist John Dewey, the approach honors the explicit statement that "all thinking is research" (quoted in Hewett, 2001, p. 96). Hewett cited Stanley, who stated that children question, hypothesize, predict, experiment, and reflect on discoveries, embracing the entire research process

(Hewett, 2001, p. 96). This "researcher within" is nurtured as children are giving the opportunity to work on in-depth projects in groups, expanding their thinking and defining themselves as researchers.

Reggio Emilia and Dengue Education

As previously described studies have shown, children are effective agents of change. "Dengue Fever Comes To Town" is an animation empowering children with knowledge and motivation to make constructive social and environmental changes in their community. The project is grounded in the belief that children can be instrumental in helping their communities. Studies (Avila Montes et al., 2004; Jayawardene et al., 2011; Leiner et al., 2010; Overgaard et al., 2012; Wangroongsarb, 1997) have supported Dewey's (1966) contention that children are, as Hewett (2001) put it, "powerful, competent, creative, curious, and full of potential and desire" (p. 96). As evidenced in the above referenced studies, children acted as researchers and agents of change. Children's ability to research, contribute, expand knowledge, and create change is central to the animation's success.

Health Belief Model

In addition to multimedia learning theory and empowerment theory, the study is supported by the health belief model (HBM), which provides a framework for understanding what components contribute to behavioral change. Five theoretical constructs serve to develop the essence of the theory, which is that "personal beliefs influence health behavior" (Hayden, 2014, p. 31). These constructs include perceived seriousness, perceived susceptibility, perceived benefits, perceived barriers, and self-efficacy. The model suggests that together these perceptions guide behavior.

Two other constructs contribute to the HBM: modifying variables and cues to action. Individual modifying variables, such as level of education, culture, and level of motivation, are thought to impact perceptions. These variables may increase or decrease perceptions of seriousness and susceptibly. Cues to action are "events, people, or things" that trigger behavioral change (Hayden, 2014, p. 33). Cues to action are external inputs such as a media campaign, the illness of a friend, or a reminder card sent from a health provider.

Health Belief Model and Dengue Education

The HBM provides a clear framework for developing dengue awareness and influencing modifiable risk factors. School-aged children in Florida may have limited development of their perceptions of the disease. While some children may believe their risk to be nonexistent, others may be fearful, with an inflated perception of susceptibility and seriousness. Under such circumstances, the presentation of factual information is critical in developing healthful community behavioral patterns.

Epidemics of dengue in Florida, in the years 2010 and 2013, primed students with "cues to action." The outbreak reports were ubiquitous, with media coverage on the television, internet, and newspapers. According to the HBM, people do not do new things unless they think they are capable of doing them; fear of failure creates a barrier (Hayden, 2014). The animation "Dengue Fever Comes To Town" provided students with age-appropriate information to accurately formulate perceptions and address perceived barriers by visually depicting specific actions for children to reduce risk.

Organization of the Remainder of the Study

Chapter 1 has provided an overview of dengue fever, a brief summary of relevant literature, a discussion of the research question, and a discussion of limitations and assumptions. The remainder of this study will include: Chapter 2, the Literature Review; Chapter 3, Methods; Chapter 4, Analysis; and Chapter 5, Discussion. The references and appendix will be included at the end of the text.

CHAPTER 2. LITERATURE REVIEW

Introduction

The literature review consists of four sections. The first section includes the global history of dengue fever and the results of several large-scale public health campaigns and interventions. The second section provides a history of dengue fever in the United States and an account of the current American educational materials. The third section describes the successful targeting of schoolchildren in dengue public health campaigns, and finally, the fourth section provides support for the use of animation in public health campaigns.

World History and Re-emergence of Dengue Fever

Origins

The origin of the word "dengue" is unclear; however researchers believe that some early phrases may have been describing the disease. "Ka-dinga pepo" is Swahili for "cramp-like seizure caused by an evil spirit", or "the disease of the devil" (McGuire, 2010, para. 4). The Swahili word "dinga" is thought to originate from the Spanish word "dengue," which means "careful," and could describe the movement of someone suffering from dengue fever (Dengue Virus Net, 2014).

Dengue fever is a very old disease, with the first reported cases of compatible disease occurring in China in 992 CE (Gubler, 1998). At that time, the Chinese referred

to the disease as “water poisoning” and were able to connect its occurrence with flying insects (Gubler, 1998). Outbreaks of illness thought to be dengue occurred in 1635 in the French West Indies, in 1699 in Panama, and in 1779-1780 in Indonesia, Egypt, and the United States, in Boston and Philadelphia (Gubler, 1998; McGuire, 2010). In Philadelphia, Dr. Benjamin Rush gave the virus its best-known moniker, “break-bone fever” (McGuire, 2010). During the 18th and 19th centuries, the expansion of the shipping industry created ideal conditions for the spread of the disease vector, *Aedes aegypti,* and the accompanying virus, into various global port cities, leading to global epidemics. However, because the transport of disease occurred through slow-sailing ships, intervals of 10 to 40 years typically occurred between outbreaks (Gubler, 1998).

Dengue Hemorrhagic Fever

After World War II, rapid urbanization in Southeast Asia led to faster transmission, setting the stage for a global pandemic (Gubler, 1998). Increased endemic dengue led to the evolution of hyperendemicity for the disease, defined as the presence of several different circulating serotypes of the virus. Researchers began to realize that a second infection with a different serotype placed people at risk for developing a new, far more serious disease, dengue hemorrhagic fever (DHF). Southeast Asia was the first geographical location to experience an epidemic of DHF, which occurred in Manila, Philippines, from 1953 to 1954 (Gubler, 1998). By the mid-1970s, DHF had become a leading cause of hospitalization and death among children in the area. In more recent years, DHF has expanded to India, Sri Lanka, the Maldives, Pakistan, China, the south and central Pacific islands, and throughout the Americas, which have experienced the most dramatic changes in epidemiology (Gubler, 1998).

Dengue in the Americas

Although the presence of DF has been documented in the Americas since the 1700s (Pinheiro & Nelson, 1997), prior to the 1970s epidemic dengue never emerged as a significant public health threat (Gubler, 1997). Little attention was paid to this illness and researchers (Gubler, 1997; Pinheiro & Nelson, 1997) have theorized that the virus was controlled through the *Aedes aegypti* eradication programs put in place by the Pan American Health Organization (PAHO) prior to the 1970s, which were primarily aimed at controlling the spread of yellow fever. Unfortunately, as a result of that success and other pressing demands for resources, the eradication programs were discontinued in the 1970s, and by 1997 the *Aedes aegypti* population had rebounded to levels similar to those of the 1940s (Gubler, 1997), and all countries in the Americas except Bermuda, Canada, and Chile were infested with DF (Pinheiro & Nelson, 1997). Between 1981 and 1997, 24 countries throughout the Americas reported confirmed cases of DHF (Gubler, 1997).

Current Statistics

From 1975 though the turn of the 21st century, dengue fever underwent a dramatic geographic expansion throughout the tropic and subtropical regions. There are now 390 million infections globally per year (Beaumier et al., 2014), with 500,000 cases of hemorrhagic disease resulting in 20,000-25,000 deaths, occurring mainly in children (Gubler, 2006).

Dengue Serotypes

Historically, dengue has carried a relatively low rate of both morbidity and mortality. Compared to malaria, with approximately 400 million cases yearly, and 1 million deaths, the dengue mortality rate is only 26,000 per year; however, the changing

epidemiology of the disease has started to result in greater morbidity (McGuire, 2010). Dengue fever has successfully mutated, forming five different serotypes (DENV-1, DENV-2, DENV-3, DENV-4, and DENV-5) (Tomasulo, 2013). Infection with one serotype *will* protect against a second infection with the same viral serotype through the development of antibodies. However, should a second infection occur with a different viral serotype, those same antibodies can *facilitate* a second infection, by acting as "antibody-dependent enhancement" (McGuire, 2010). The antibodies join together with the new virus, binding together and increasing entry into target cells. This results in higher blood levels of the new virus, often triggering DHF in secondary infections (McGuire, 2010).

Ramifications of hyperendemicity are especially troublesome for vaccination development. While years of work were leading to a potentially viable vaccination covering dengue types 1-4, the fifth viral serotype was discovered in Malaysia in 2013 (Tomasulo, 2013), creating an enormous setback. In addition, there is great deal of concern about what will happen if a live vaccination is given to a person with pre-existing antibodies (McGuire, 2010), for example, which may possibly precipitate a hemorrhagic event. Further, researchers must determine if antibody levels will be maintained at the same level over time for all viral serotypes (McGuire, 2010).

Dengue Public Health Interventions

In the absence of an effective vaccination or treatment, control of the vector, mainly *Aedes aegypti,* is the only realistic option for disease prevention. However, creating an effective public health program to decrease the spread of dengue has proven

to be a difficult task. Multiprong efforts include mosquito control, public outreach and education, and technological/genetic engineering.

The CDC's Denguemap (CDC, 2014; Chang et al., 2009), a worldwide collective report of dengue surveillance, shows outbreaks throughout the world, including India, Thailand, Indonesia, southeast Asia, the western Pacific, Africa, and even a few cases in the typically-too-cold Europe. However, the Americas have the highest rates of dengue fever, with Brazil reporting the greatest number of cases. While resource-limited countries such as Brazil struggle to prevent transmission, even countries with substantial capacity cannot control this resurgence. Notably, both Cuba and Singapore experienced large-scale epidemics in 2014. The following section describes initiatives from Brazil, Cuba, and Singapore.

Brazil. In recent years, Brazil has been contending with recurrent dengue epidemics. Brazil reports approximately 80% of all cases of dengue in the Western Hemisphere. Adults are at high risk for contracting the disease; however children are at greater risk for DHF, constituting 53% of dengue hospitalizations overall, and 65% of those in northeastern Brazil. Children under 10 years of age accounted for 5% of those with DHF in 2001, increasing to 33% by 2008 (Cavalcanti, Vilar, Santos, & Teixeira, 2011).

Public health messages in the country focus on population responsibility for preventing dengue, or a "citizen approach." Control requires a change in individual perceptions, a sense of social responsibilities, and the promotion of knowledge. Multicenter public health projects, evaluated in nine states, are using, among other methods, short televised films. A study (Vieira, Amantes, Sousa do Nascimento, &

Schall, 2013) evaluating the efficacy of these films found that the films had a low impact on participants, and while the films achieved a minimal level of "informative capacity," they had no impact on "change of attitude" for participants. Researchers concluded there was a need to reconsider the films.

Coelho et al. (2014) published results from a new system they developed to aid with surveillance and alert systems. A strong linear relationship was identified between dengue outbreaks and twitter references, with a threshold number of tweets identified. Researchers concluded that using such surveillance systems could allow for instant response to outbreaks and this information feed is now going directly into Rio de Janeiro's Situation Room (Coelho et al., 2014).

Gomez-Dantes and Willoquet (2009) examined dengue in the Americas and concluded that imprecise surveillance has led to drastic underestimates of the magnitude of dengue as a regional health problem. These authors further stated that the perception that dengue is the problem of some other entity contributes to inaction. They found a lack of sustainable control, political commitment, and resources. Among other strategies, researchers suggest the need for community-based initiatives focused on promoting behavioral change and modifying environmental risks.

Cuba. Dengue fever was not clinically identified in Cuba until the 1970s, although a small wave of suspected cases occurred in 1945 (Kouri, Guzman, Bravo, & Triana, 1989). A seroprevalence study conducted in 1975 revealed that only 2.6% of the 2000 people serosurveyed had antibodies. However, in 1977 a major epidemic of DEN-1 resulted in case reports totaling 500,000. A second serological survey, conducted in 1978, just 3 years after the first, revealed a 44.5% population seroprevalence for antibodies to

DENV-1. This set the stage for the 1981 epidemic of hemorrhagic disease (Kouri et al., 1989).

In May of 1981, just after the beginning of rainy season, an epidemic of DEN-2 swept across the country in days. A total of 344,203 cases were reported, with 10,312 severely ill, and 158 deaths, two-thirds of whom were children (Kouri et al., 1989). Within months, the epidemic was controlled. Strategies employed included rapid diagnosis (presumptive diagnosis was provide by health authorities with 24 hours), early hospitalization and appropriate treatment, and most significantly, a successful national campaign to eradicate *Aedes aegypti*. The campaign included adulticide spraying with Malathion, the use of temephos in water tanks, as well as an environmental sanitation campaign. The success of the program resulted from the collaborative efforts of the Ministry of Health, health workers, and community members (Kouri et al., 1989).

In 2006-2007, Toledo et al. (2011) conducted an observational study in the former setting of an *Aedes aegypti* control community trail in Santiago de Cuba. The purpose of this study was to determine if the trail had sustainably remained effective. Researchers found that the control program had decreased vector infestation and impacted disease rates. Despite long standing resource deployment, and proven-effective strategies, 2013-2014 saw another epidemic of the virus, with an estimated 3,500 cases diagnosed in the province of Cienfuegos (Torres, 2014).

Singapore. Singapore is a small island country at the tip of the Malaysian peninsula. Risk factors for dengue include its tropical location, proximity to the dengue-infested countries of India, Thailand, Indonesia, Malaysia, and the Philippines (Denguemap, 2014), the annual cycle of two distinct monsoon seasons, and a 100% urban

setting (CIA World Factbook, n.d.). However, after establishing independence in 1965, the country has become one of the world's most prosperous through international trade. Singapore has a per-capita GDP equal to the leading countries in Western Europe and citizens enjoy the eighth highest life expectancy, the fifth lowest infant mortality, and 100% improved sanitation and water (CIA World Factbook, n.d.). Nevertheless, in Singapore dengue has been endemic since the 1960s, with epidemics occurring in 1966-1968, 1973, 1978, and 1992 (Teng, 1997).

These characteristics make Singapore a country to watch in terms of the fight against dengue, with a high disease burden and deployment of considerable resources. In Singapore, dengue control is the responsibility of the Ministry of the Environment. Two departments participate, the Vector Control and Research Department and the Quarantine and Epidemiology Department. Strategies employed to control dengue include source reduction, public education, legislation, chemical control, and research (Teng, 1997).

As of 2001, Singapore had three pieces of legislation in place to help prevent dengue. The Infectious Disease Act requires doctors and labs to notify the Ministry of Health and Ministry of the Environment within 24 hours of case identification. The Control of Vectors and Pesticides Act prohibits the creation of conditions capable of propagating vectors. Officials have the right to inspect premises, serve orders to owners to take action, require fogging at the owner's expense, carry out any measures, if the owner does not, and recover costs (Boo, 2001). Finally, there is the Environmental Public Health Act, which prevents dengue through mandating the cleaning of public areas. Research on the efficacy of legislation as a control strategy concluded that the method is effective in dealing with recalcitrant offenders, and in emergency situations; however,

sustained control is dependent upon public education and community understanding of the importance of mosquito control (Boo, 2001).

An interesting Singapore-based study (Goh, 1997) found that well-established mosquito control programs over the previous 25 years, incorporating vector reduction, public education, and legislation, had resulted in a paradoxical situation whereby low herd immunity in the population led to an increased rate of outbreaks with greater intensity. A second study (Ooi, Goh, & Gubler, 2006) had similar findings, attributing resurgence of the disease to low herd immunity, shifting demographics, and unsustainable control programs. The authors concluded that new programs must result from careful collection of epidemiological data, while they also lauded Singapore for taking on a leadership role in dengue prevention in Southeast Asia. Nevertheless, despite these remarkable efforts, in 2013 Singapore reported 22,318 cases of dengue fever, and 12,257 cases to date in 2014 (WHO, 2014b), a rate that is on track to be an equally bad year for this progressive country.

Dengue in the United States

Historical Background

The epidemic occurring in 1780 was the first clinically compatible outbreak, described by Philadelphia doctor Benjamin Rush. Dengue then began to circulate in the southern United States, and in 1827 suspected outbreaks occurred in South Carolina, Georgia, Florida, and Louisiana. Accounts of these epidemics not only included classic signs of dengue, but also symptoms now recognized as hemorrhagic, such as bleeding from the mucosa, and obstetric complications. In 1850, a second wave of epidemics

swept through some of the same locations; interestingly, immunity was noted in those people who had become ill in 1827 (Beaumier et al., 2014).

In the time period between 1870 and 1880, two major outbreaks occurred in the southern United States, with 40,000 cases in New Orleans in 1873 and an even larger, widespread outbreak in 1879-80. By 1885, dengue had reached Texas, causing a 16,000 case outbreak in Austin, affecting three-fourths of the city's population. Between 1898 and 1899, outbreaks in Texas and Florida occurred, and were attributed to the movement of military troops training in Cuba. Gulf Coast outbreaks in 1907 and 1918 were, again, attributed to military movement, with troops returning from the West Indies (Beaumier et al., 2014).

In 1922 a major pandemic occurred in Texas, Louisiana, Florida, and Georgia, with 500,000 cases in Texas, and 30,000 in Savanna. In 1934 Florida and Georgia were hit with another epidemic. The last major American outbreaks of dengue occurred in Texas, in 1941, and Louisiana, in 1945 (Beaumier et al., 2014).

North and South American Vector Control Programs

In the early 1900s efforts to eliminate the vector, *Aedes aegypti*, began; however, these were not to control the spread of dengue, but rather to control the spread of yellow fever. In the 18th and 19th century, yellow fever killed 100,000-150,000 people in the United States, mainly in epidemics occurring in Philadelphia, Baltimore, and New York (Patterson, 1992). Strategies consisted of fumigation combined with the removal of standing water (Brathwaite et al., 2012).

Eradication efforts also occurred in South America. The Brazilian government, in partnership with the Rockefeller Foundation, successfully executed mass eradication

campaigns, along with Paraguay, Colombia, Bolivia, Peru, and Ecuador. In 1947, the Pan American Sanitary Bureau began efforts at eliminating yellow fever throughout South America with the use of the new pesticide, DDT. These efforts successfully continued through till the early 1960s, when programs declined due to funding shortages, loss of public support, and vector resistance to DDT (Brathwaite et al., 2012). The decline in vector eradication programs is a major contributing factor to the resurgence of dengue; however, yellow fever remains relatively rare, most likely because of an effective vaccination.

Hawaii, 2001-2002

Dengue outbreaks occurred on Hawaii in the 1840s, the 1890s, and in 1943-1944. For the 56 years that followed, travel-associated dengue cases occurred in low numbers, with a total of 20 reported cases between 1991 and 2000 (Effler et al., 2005). In September of 2001 a doctor from Maui reported the first case of what would total a 122 case outbreak. The outbreak was caused by locally-infected *Aedes albopictus* mosquitoes, a species ubiquitous to the islands. The outbreak was thought to be related to an epidemic of DENV-1 concurrently occurring in the Society Islands involving more than 33,000 cases, and carrying a DHF rate of 45% in that area. Researchers in Hawaii (Effler et al., 2005) believe that the outbreak was mitigated by the change of vector from *Aedes aegypti* (in the Society Islands) to *Aedes albopictus* in Hawaii. *Aedes albopictus* is a less efficient vector, feeding on humans in addition to other animals. In contrast, *Aedes aegypti* is highly anthropophillic, and often feeds on multiple humans to complete a blood meal (Effler et al., 2005).

Texas, 2005

Texas, with large stretches of land bordering dengue-endemic Mexico, is at increased risk for dengue. However, despite the proximity to Mexico, dengue rates have remained low with only 64 confirmed cases from 1980-1999. During the same time period, 62,514 confirmed cases occurred in the neighboring Mexican states (Center for Infectious Disease Research and Policy [CIDRP], 2013).

In 2005, an outbreak occurred totaling 32 cases, with 25 from Cameron County, Texas, located on the Mexico border. During this outbreak, the first case of locally-acquired DHF in the US was diagnosed. In a follow-up seroprevalence study that year, researchers found that 38% of residents surveyed in the border town of Brownsville, Texas and 77% from the town directly across the border in Mexico, tested seropositive for dengue antibodies, indicating high levels of previous infections, and an increased risk for developing DHF if re-infected (CIDRP, 2013).

In response to this outbreak, Texas public health officials developed the Dengue Public Health Response Guide. While the aim is squarely focused on decreasing dengue, officials stated that other mosquito-borne diseases might also be reduced, including St. Louis encephalitis and West Nile virus. The response consists of four tiers, with surveillance, education, and control measures detailed at each level. Surveillance remains passive, until a case is suspected, at which time active surveillance is initiated. Information and education range from pre-rainy season community outreach efforts, including children, to intensive, publicized control measures, and door-to door provision of educational materials and yard inspection. Control measures include the establishment

of high-risk areas, vector larvae collection, and source reduction efforts including citywide larvacide applications (CIDRP, 2013).

The Texas outbreak provides a reminder that many cases of dengue are asymptomatic, and locations in close proximity to endemic areas may have a higher-then-expected seroprevalence of disease. This is an important consideration with multiple serotypes circulating, as previous infection creates a risk factor for DHF. To date, Texas is the only state to have a case of hemorrhagic disease; however, should another outbreak occur in Florida, unsuspecting residents there may be at risk for serious disease.

Key West, 2009-2010

The earlier outbreak in Hawaii demonstrated the global transport of disease, as well as the remarkable capacity of DF to switch vectors. These troublesome occurrences resonate as risk factors for Florida. Florida is in close proximity to multitudes of hyperendemic/epidemic countries, and has a statewide distribution of *both Aedes aegypti* and *Aedes albopictus* mosquitoes (University of Florida, n.d.).

Prior to 2009, Key West had not reported a case of dengue for 60 years; however, in that year a woman vacationing from New York contracted the virus, which prompted a large investigation. The CDC found that 5% of the serosurveyed population had antibodies indicating a recent dengue infection, and during 2009 five cases from Key West were confirmed (Munoz Jordan, Santiago, Margolis, Stark, 2013). In 2010 the epidemic continued, with the total cases climbing to 63 (Doucleff, 2013).

Researchers at the CDC continued their investigation, analyzing the genetic sequence for the virus isolates. Reverse transcriptase PCR testing confirmed that the virus was DENV type 1, and that the virus isolates had a remarkably high level of genetic

similarity. Researchers concluded that the similarity of the isolates, combined with a lack of international travel within the group of cases, indicated endemic transmission of the virus, as well as a microevolution of the serotype, the Key West DENV-1 strain, which was transmitted over a two-year period of time, or greater (Munoz Jordan et al., 2013).

The 2010 outbreak of locally-acquired dengue in Florida, combined with continued reports of imported cases, prompted the CDC and the Florida Department of Health to develop a Train-The-Trainer model. Ten "physician master trainers" received a 4-hour in-service on recognition and management of dengue. These physicians proceeded to provide 1-hour CME lectures within Florida hospitals. A pre- and posttest study showed overall knowledge improved from 75% pretest to 92% posttest (Jiddou et al., 2012).

Martin County, Florida, 2013

During the summer and fall months of 2013, Martin County, Florida reported a total of 22 locally-acquired cases of dengue fever. Officials from Martin County Mosquito Control reported that since the outbreak began the team had visited 1500 residences and found that up to 30% of the homes had mosquitoes breeding in the yard (Martin County Health Department, 2014). They stated that residents needed to be educated about steps they could take in their yards to reduce breeding sites, stressing that "crews are often finding mosquitoes in the same places every time because residents are not emptying containers that fill with rainwater where the mosquitoes breed" (Sagastume, 2013, p. 1). Teams worked by going door to door providing information, assessing risks, and collecting blood samples to determine the population seroprevalence rate

(Sagastume, 2013). The seroprevalence survey yielded a total of 364 samples, with six having evidence of a current or recent infection (Moody-Geissler, 2014).

The outbreaks and interventions described above, including national and international efforts, portray a formable disease, difficult to combat even with extensive resource deployment. One common theme continually emerges within public health campaigns: community cooperation and support is necessary to control mosquito breeding. The next section provides research indicating that youngsters are effective in contributing to dengue public health campaigns.

Dengue Interventions Targeting Youth

Numerous interventions have targeted schoolchildren owing to the high level of morbidity and mortality the illness carries within this age group. Studies have been conducted on effective interventions in Thailand, Colombia, Honduras, and Sri Lanka. These studies found that schoolchildren were both willing and able to increase their knowledge regarding dengue, and take action to help prevent mosquito breeding.

Thailand

In Thailand, officials have recognized that community participation is required to achieve effective and sustainable control of *Aedes* mosquitoes. Clean-up campaigns, social media, and incentive/reward programs have all met with only limited success due to inconsistency and the nonsustainability of participation. Researchers, therefore, turned to schoolchildren as a means to control dengue. School age children have historically been at greatest risk for the disease and the peak incidence of dengue in Thailand coincided with school openings, suggesting the possibility that disease transmission may

be occurring during school, with daytime *Aedes* mosquito feeding further supporting this idea (Wangroongsarb, 1997).

Researchers provided educational material including information on how DF is transmitted and how to prevent infection. Children participated as health volunteers in vector surveillance and control on the school grounds. The outcome was measured using *Aedes* larval indices, which were reduced by 60-80%, an accomplishment far more significant than those achieved by adult village volunteers. As a result, the Ministry of Public Health revised control strategies, aligning with the Ministry of Education and establishing a national campaign in primary schools in 1992 (Wangroongsarb, 1997).

Colombia

Play-based education was used in a study by Vesga-Gomez and Caceres-Manrique (2010) aimed at improving knowledge about dengue prevention, control, and practice. The methodology involved a pretest/posttest intervention that was implemented with 99 primary-school children. Outcomes were measured at 4-month follow-up visits to the homes. Results indicated a significant increase in the following areas: knowledge of dengue, transmission by mosquitoes, viral causality, recognizing larvae and breeding sites, recognizing symptoms, and washing water containers. Researchers concluded that play-based interventions increased knowledge and preventive practices (Vesga-Gomez & Caceres-Manrique, 2010).

A second study in Colombia used a healthy-schools model to promote a combined campaign reducing diarrheal illness and dengue. Improved water quality, education, vector control, and improved sanitation were promoted in the school environment. Interventions included filters for drinking water, improved hygiene facilities, rubbish

cleanup efforts, and education on hand washing and mosquito breeding (Overgaard et al., 2012). Results showed a decreased number of immature mosquitoes in the schools where the intervention had been implemented. On the third round of data collection, researchers did not find any larva at all in the school locations where the intervention was implemented, compared to the control group, where 40-60 positive containers were found per 100 schools (Kvaloy, 2014).

Honduras

From April to November of 2002, a course on environmental health and dengue was given to primary school children with the intention of creating behavioral changes in their mothers, leading to safer handling of water in the household, proper garbage disposal, and the reduction of breeding sites near the home. Four schools participated, with two receiving the intervention and two serving as controls. Pre- and postintervention surveys included assessment of knowledge, attitude, and practices of the children, their mothers, and teachers (Avila Montes et al., 2004). Significant increases were noted in both the students' and teachers' knowledge of the viral etiology of dengue and the life cycle of *Aedes aegypti*. Significant decreases were found in the number of breeding sites (Avila Montes et al., 2004).

Sri Lanka

Seventh, eighth, and ninth grade students in two schools participated in a school-community intervention program in Sri Lanka where the children acted as agents of change (Jayawardene et al., 2011). These students performed mosquito control and educational interventions in their communities once weekly for a period of 8 weeks. Five actions were tracked and entomological data were collected. A z-test was used to

determine pre-and posttest changes in the entomology surveys. In areas receiving the intervention all larval indices were lowered, with a 73% reduction in urban areas and a 61% reduction in rural areas. Researchers concluded that properly trained schoolchildren could be assets in disease control and that the educational sector should be partnered with DF/DHF control (Jayawardene et al., 2011).

These data support the efficacy of a wide range of schoolchildren in improving dengue risk factors, aiding in mosquito control, and decreasing larval indices. The final section provides research indicating that animations are an effective medium in public health campaigns.

Animations in Public Health Campaigns

A review of literature investigating the efficacy of health education videos in schoolchildren found that they were well accepted by teachers and students, and that they were effective in improving knowledge and attitude, while simultaneously entertaining and engaging students. Further, the videos were found superior to text-based teaching in creating behavioral change, correcting behaviors through direct visual demonstration. Observation of correct behavior, according to behavioral theory, helps to induce behavioral change (Bieri, Gray, Raso, Li, & McManus, 2012).

Animation and Multimedia Learning

Research in the area of multimedia learning identified the key concept of cognitive load (Mayer, 2001). Each item taught to a child is thought to occupy a certain amount of cognitive load, with limits dictated by a child's working memory. The working memory is comprised of both a verbal and visual memory system, each with its own limitation, operating independently of one another. Learners have one capacity for words

and another for pictures. Imagery can be used by educators to "off-load" content from one memory to the other (Mayer, 2001).

Research conducted between 1990 and 2003 (Mayer & Moreno, 2003), demonstrated that information held in both verbal and visual memory is better retained than information held in only one of the two memory systems. Combining pictures to a narration or text, assuming the content was closely aligned, greatly increased initial learning, retention, and transfer of knowledge (Mayer & Moreno, 2003). Researchers caution that visual images that are interesting, but irrelevant, are detrimental. This type of imagery can fill up working memory, thus occupying space unnecessarily (Mayer, 2001), in addition to distracting children from key messages.

The use of animation in public health education is also supported by the theoretical constructs of the HBM. According to the HBM, students must recognize that they are at risk and that they have the capacity to help (Hayden, 2014). Animations and other multimedia technologies can portray real-life situations with which students can identify, facilitating behavioral change (Bieri et al., 2012).

Animations have proven to be one of the most successful advertising styles. They are used extensively on the internet, in video games, and on television, both to entertain and persuade children and adults (Leiner et al., 2004). Further, animations have been proven effective at overcoming barriers caused by age, culture, and literacy (Leiner et al., 2004). Finally, animations can be easily exported for use in different countries, with minimal language adaptions (Leiner et al., 2004), making them a cost-effective and sustainable resource.

Malaysia

Animation was used in a study on oral health in Malaysia. Sinor (2011) found that in 5 and 6 year olds the ability to absorb information was hugely influenced by the medium used. Animations were more effective in delivering health messages than written material. The author recommended that preschool teachers should play a major role in educating children about oral health, stating that they could play a compact disk in the classroom each day, increasing sustainability and standardizing the education (Sinor, 2011).

Disney

Not surprisingly, Walt Disney was a fan of animated cartoons (Disney, 1955). He stated that although the history is comparatively brief, cartoons have conclusively proven that they are effective for instructional purposes. Disney went on to state that the possibilities were almost limitless in the area of education for animated films (Disney, 1955).

China

Bieri et al. (2013) studied the use of an animation in reducing soil transmitted helminth (STH) infections in schoolchildren in China. This very large (n = 1718) cluster randomized trial targeted 9-10 year old children in 38 different schools for 1 school year. Infection rates, knowledge, and practices were assessed before and after the intervention, with students being assigned to either the intervention group or the control group. At baseline, all students were treated with Albendazole, and all students found positive at the end of the study were treated again. Students who received the intervention scored 90% higher than the control group on the posttest knowledge questionnaire. Twice as many

students receiving the intervention washed their hands after using the toilet, and the incident rate of STH infection was 50% lower in the intervention group at the study's ending point. Students who received the intervention watched the animation a total of four times, two times in a row at the beginning of the trial, and two times in a row 6 months into the trial (midway). Additional components of the intervention included a drawing (related to the animation) completion after the first viewing, and an essay after the second viewing.

Previous interventions support the idea that using animated films within the schoolchildren population may be an effective means of improving knowledge, attitude, and practices regarding dengue. Modifications related to social, cultural, and economic differences within various populations could easily be applied. Adaptions of the program could include attention to local conditions around homes, availability of resources (such as improved water and sanitation), and cultural differences related to transmission of disease (i.e., crowding in the home, caring for sick family members, type of clothing worn).

Summary

While the world has experienced dengue fever for thousands of years, the United States has only suffered from the disease for a relatively short period of time spanning from the 1700s to the mid-1900s, with Florida, Louisiana, Georgia, and Texas the states that were primarily affected. However, a recent uptick in American cases, along with several locally-acquired outbreaks, indicate that the US is again at risk for the disease.

Research on public health initiatives to decrease dengue fever is abundant, yet the rapid increase and expansion of the disease requires additional research and resources.

Overriding problems include: a lack of vaccination and treatment, rapidly evolving vector resistance/mutation, a public perception that mosquito control is not their responsibility, ineffective existing materials in some areas and very limited materials in most areas, and program sustainability. The need for effective tools is urgent.

Despite these many challenges, children have emerged as a successful target audience for dengue prevention campaigns. Moreover, animations have been proven to be both effective and user-preferred modalities. An educational children's animation regarding dengue could sustainability contribute to community resources.

CHAPTER 3. METHODOLOGY

Overview

The methods chapter provides a description of the research design, a discussion of the population and sample, and a description of the study setting. Next, data collection procedures and the Shuaib et al. (2010) tool are discussed. The making of the animation, "Dengue Fever Comes To Town" is detailed, followed by specific statistical methods used for data analysis. Finally, validity and reliability are addressed, and the chapter concludes with a discussion of ethical considerations.

Research Design

In this quantitative, quasi-experimental, pre/posttest design, a modified version of the Shuaib et al. (2010) Dengue Fever Knowledge, Attitude, and Practices Survey was used to evaluate efficacy of the animation developed, which was entitled "Dengue Fever Comes To Town."

Population/Sample, Inclusion and Exclusion Criteria

The study sample was drawn from a population of children at a summer camp in Florida. The camp used an inclusive, sliding scale to calculate student fees, making the sample a fair representation of the socioeconomic demographic.

Parents of campers were passively consented with a take-home information sheet, delivered the week before the study. Any child entering third to fifth grade (age 8-12

years) who assented to participate in the study, and whose parent did not object through the passive parental consent procedure, was included in the study. While a plan was developed to include students with learning disabilities, no students with learning disabilities participated in the study. Fifty-four passively consented and assented third to fifth grade campers in Florida participated in the study.

Instrument/Measures: The Knowledge, Attitude, and Practices Tool.

Shuaib et al. (2010) developed a tool to evaluate KAP regarding dengue fever. Their study consisted of a one-time survey design. These researchers rigorously validated this tool as having appropriate content to evaluate KAP within the adult population.

Modifications

Many different KAP tools have been developed and utilized in dengue studies; however, no tools exist for the US population. The Shuaib et al. (2010) tool provided excellent content coverage; however, modifications related to social, economic, and cultural factors were required. Overall, the modified tool contained changes necessary to make it suitable for the study population, which was young children.

First, modifications addressed the younger age range. The Shuaib et al. (2010) study was conducted on an adult population while the "Dengue Fever Comes To Town" study was conducted on third to fifth grade students, requiring minor content modification in subject matter and terminology. The animation was designed to provide education on dengue fever, but in its more serious forms, dengue hemorrhagic fever and dengue shock syndrome, which were included in the Shuaib et al. (2010) tool, were not covered. These conditions posed little risk to the study population and would have required considerable medical explanation. In addition, the coverage of this material may

have unnecessarily stressed participants. This would have constituted an ethically questionable design, as participants would bear a burden for which they would be unlikely to benefit (Atwood & Panicker, 2014).

Second, the Shuaib et al. (2010) study examined current KAP and was administered as a single assessment. The "Dengue Fever Comes To Town" study required minor modifications within the practices section of the tool. Pretest questions containing actions were phrased in the current tense. Corresponding posttest questions reflected *planned* behavioral change; e.g., "I now intend to…"

Knowledge

The knowledge section of the survey contained questions divided into five categories. The subcategories included symptoms, treatment, transmission, exposure to mosquitoes, and mosquito breeding sites.

Attitude

The attitude section consisted of three questions:

1. Dengue fever is a serious illness (scored 1 = *I'm not sure*, 2 = *Strongly Disagree*, 3 = *Disagree*, 4 = *Agree*, 5 = *Strongly Agree*).

2. Dengue fever can be prevented (scored 1 = *I'm not sure*, 2 = *Strongly Disagree*, 3 = *Disagree*, 4 = *Agree*, 5 = *Strongly Agree*).

3. Which answer best describes your attitude about your ability to help prevent dengue fever (scored 1 = *I'm not sure what to do*, 2 = *I don't think I can make a difference*, 3 = *I know some things to do, but I usually don't do them*, 4 = *I know some things to do and I do them*, 5 = *I know what to do and I do it*).

Practices

The practices section of the survey contained items that related to either mosquito exposure or mosquito breeding. On the pretest students were asked to check practices they, or their families, currently engaged in, while on the posttest they were asked to check practices they intended to engage in.

Data Collection

The study was conducted during the last two weeks of July 2014. During the week of July 21-25, 2014 campers entering grades 3-5 and their parents/guardians were informed by camp counselors that the study would take place the following week, and passive consent forms were provided. During the week of July 28-August 1, 2014 the study was conducted.

Recruitment

Recruitment of third to fifth grade students took place on the day of the study. No parents opted out of the study, so all third to fifth grade students present were escorted into the designated research room and the recruitment message was read. After reading aloud the recruitment message, students who wished to participate in the study remained in the research-designated room, while those students who did not wish to participate joined other campers in alternative activities.

Several forms of incentive were considered including candy, pizza, coloring books, or other small toys. A $5 gift card for Toys R Us was ultimately chosen in order to avoid potential problems with food allergies, parental objections, and gender differences

in incentivization. Parents and children were informed that children would receive the gift card in exchange for study participation.

Campers who wished to participate were then formally assented. Campers followed along with the Child Assent Form, while the researcher read the Researcher's Guide to Child Assent Form. Once the document was read, campers decided if they wanted to participate in the study. They were instructed to sign the form if they wanted to, or let the researcher know if they preferred to join the other campers and not be in the study. Campers were instructed that they had two copies of the assent form, that one was for the researcher, and one was for them to keep. When the assent process was complete, data collection began. A child psychologist was on-call during the study in the event that one of the students experienced distress.

Study Protocol

The researcher performed the study as follows:

1. Student surveys were administered using paper test packets and pencils.

2. Each student was given one manila envelope containing a pretest and posttest, clearly marked as such, and two pencils. A second, smaller manila envelope was also given, which contained their gift certificate ($5 for Toys R Us), and a poststudy information sheet with links to dengue information and the researcher's contact information. Students were instructed to place their copy of the informed consent document into the smaller manila envelope, and then to put that envelope away in their backpacks. They were told that the small manila envelope was theirs to keep.

3. The students were then instructed to remove the pretest, and the entire test (directions, questions, and answer choices) was read aloud by the researcher. After all the

students had answered a question, the next question was read aloud and so forth throughout the test.

4. When the pretest was complete, the students were instructed to return it to the manila envelope.

5. The 8-minute animation was shown using a CD player and a movie screen.

6. When the animation was complete, the students were instructed to remove the posttest. The posttest was administered in the same manner as the pretest, with the researcher reading the questions and answer choices aloud to the students.

7. When the students had finished the posttest, they were instructed to return it to their manila envelope.

8. The researcher then collected the envelopes.

Data Storage

Data protection and storage took place as follows:

1. The manila envelopes, containing the paper data, were stored in a locked, fireproof filing cabinet in the researcher's home office in Wellington, Florida. Electronic data were password protected.

2. All the data will be saved for 7 years. After 7 years, the paper data will be shredded and the electronic data will be deleted.

3. Data are accessible by the researcher and Capella University officials including dissertation committee members, Institutional Review Board members, and designees from the Research Compliance Committee.

Data Cleaning

Data cleaning is the process of detecting and editing faulty data (Van den Broeck, Cunningham, Eeckels, & Herbst, 2005). A three-phase process of evaluating data is recommended: screening, diagnosis, and treatment. Screening techniques include using algorithms, graphical explorations, and summary statistics, among others. In order to assure clean data in the screening process of the "Dengue Fever Comes To Town" study, the double data entry technique was used.

The diagnostic phase examines the true nature of outlying data points and classifies each as one of the following: an error; a true extreme; a true normal, in which case researchers expectations were inaccurate; or finally, idiopathic (outlying with no explanation). In this phase, researchers may apply predefined cutoffs, for example disregarding data that is biologically impossible. These strategies were not necessary in this study as participants had only multiple-choice selections with confined parameters.

The treatment phase addresses errors, missing values, and true values (either normal or extreme) with three possible solutions: correcting, deleting, or leaving unchanged problematic data. Within this study, some missing data points occurred. Analysis took place by adjusting the number of data points within the calculation. Outlying data points were not possible given the multiple-choice design.

Treatment/Intervention

The development of "Dengue Fever Comes To Town" took place as an iterative process. Idea development began with a literature review, which supported targeting schoolchildren and the use of animations. Next a book was created with content derived from standardized material provided by the CDC and the Florida Department of Health.

Subject matter experts and educational experts provided input on age-appropriate content. Content was also aligned with the theoretical foundation of the study. Once all the book edits were complete, a still frame animation was produced.

Content Development

Information provided by the Dengue Branch of the CDC and the Florida Department of Health was used to inform the "Knowledge" components of "Dengue Fever Comes To Town." Specifically, information regarding signs and symptoms, transmission, and preventive measures was gathered from the two websites. Characters were depicted conveying factual information.

Empowerment theory, combined with the Health Belief Model, guided the components of the book/animation directed toward attitude and practices improvements. Children were depicted as fighting back, and taking action to protect themselves and their communities. Further, the book/animation was created using simplistic imagery, a principle of the Cognitive Theory of Multimedia Learning, as opposed to excessive "entertainment," which is thought to detract from key messages (Mayer, 2001). Finally, specific actions were visually depicted, a research-supported strategy in promoting behavioral change (Mayer & Moreno, 2003).

The children's book was piloted with three subject matter experts. One primary care physician and two infectious disease physicians provided expertise on DF. These experts helped to shape the book by prompting inclusion of key points, and adding entomological information. Further suggestions were included regarding what information might not be appropriate for children, such as the inclusion of information about DHF.

Next, the children's book was piloted with four certified elementary school teachers from Florida in order to determine the optimal age range for viewers, make language adjustments, and confirm the appeal of the imagery. All of the teachers were in agreement that the fourth grade would be an optimal age given the content, pace, and characters. They also noted that the animation would most likely be effective and interesting to students both somewhat older and somewhat younger. Therefore, the study was designed to evaluate efficacy for the third to fifth grade range (8-12 years old) and results were stratified by age.

Animation Creation

The following process was used to create the final animation:

1. Story Jumper Website was used to write and illustrate a children's book.
2. The book was made into a Portable Document Format (PDF).
3. The PDF was edited using Adobe Illustrator.
4. The final animation was rendered using Camtasia software.

Data Coding and Entry

Demographic data in the study was entered into the SPSS software analysis program and presented in a graph form depicting percentages. Data presented in this section included gender, grade level, leisure time activities, sources of standing water in the yard, status of windows (screens vs. air conditioning), and preferred method of communication.

Knowledge data was coded as one (1) for correct answers and zero (0) for incorrect answers, for a maximum of 31 points issued over 12 questions. Some questions contained lists with "check all that apply" instructions; therefore points were given for

each correct subcomponent. Attitude questions contained a 5-point Likert-type scale. Practice section information was coded as one (1) if preventive behaviors were practiced (pretest), or intended to be practiced (posttest), and zero (0) if not practiced (pretest), or not intended to be practiced (posttest), for a total of 10 possible points issued over two questions.

Data Analysis

Data analysis took place under the tutelage of a statistics professor, using SPSS software.

Knowledge Statistical Tests

Mean scores in the Knowledge section were compared pre and posttest using a Two-tailed Paired Sample t-test at alpha = 0.05. The Knowledge section was analyzed in terms of overall changes, and then broken down and analyzed by subcategory: symptoms, treatment, transmission, exposure, and breeding sites.

Attitude Statistical Tests

Attitude data were analyzed, question-by-question, using a Wilcoxon Matched Pair Signed Rank test with alpha = 0.05.

Practices Statistical Tests

Practices data were analyzed using a chi-square with alpha = 0.05. Results were calculated for each of the ten items in this section and graphed according to "reducing contact with mosquitoes" and "reducing mosquito breeding sites."

Stratification Statistical Tests

Results were then stratified according to gender and grade level.

Gender. Differences in Overall Knowledge scores according to gender were analyzed using Levine's Test. Attitude and practices differences were analyzed using a Kruskal-Wallis Test. Alpha level was set at 0.05.

Grade level. Grade level differences in Overall Knowledge scores were analyzed using a one-way ANOVA and a Tukey post hoc test was performed on all significant ANOVA comparisons. Grade level differences in attitude and practices were analyzed using a Kruskal-Wallis test. Alpha level was set at 0.05.

Internal and External Validity and Reliability

Validity and reliability are constructs created to help researchers consider if they are measuring what they intend to measure, if causality can be established, and if results can be recreated. These constructs can have multiple points of relevance in a study, and can be applied to the overall design, the intervention, and the measurement tool. In the following section, validity and reliability are discussed with regard to the overall study, the animation, and the assessment tool design by Shuaib et al. (2010) as applicable.

Internal Validity

Overall. The internal validity refers to the validity of making causal inferences about the intervention (Drost, 2011). Common threats include selection bias, history, maturation, test-retest, differential attrition, and extraneous variables (Michael, n.d.). Study design is able to control for these threats by including elements such as a control group, and randomly assigning participants.

Several threats to internal validity were present in this study. The sample was convenience, and children were repeatedly informed that participation was voluntary and that they would be rewarded with a $5 gift card to Toys R Us. It was presumed that some

amount of selection bias would be present within the group of participants. However, the one group design eliminated a threat for subjects to self-select either into the experimental or control groups.

History, normally a threat in one-group pre/posttest designs, had a minimal effect on the study due to the very short time frame. However, some participants did drop out of the study prior to completion because their parents arrived to pick them up during the one-hour long intervention. Maturation, or "changes in the dependent variable due to normal developmental processes operating within the subject as a function of time" (Michael, n.d. p. 11), did occur to a small degree, with subjects beginning to become restless towards the end of the intervention.

The effects of pretest sensitization undoubtedly affected posttest scores. Students were pretested, and then immediately shown the animation, then posttested. While it was unlikely that the pretest in and of itself influenced posttest scores, the interaction of the pretest and the intervention may have dramatically increased posttest scores, with participants well aware of what information to look for within the animation. Experimental mortality, instrumentation, design contamination, compensatory rivalry, and resentful demoralization are threats to internal validity (Michael, n.d.) that did not occur during the study

Dengue Fever Comes to Town. The content validity of the animation was well established, as one of the best ways to do so is through the use of subject matter experts (Melnyk & Morrison-Beedy, 2012). Construct validity was supported in the animation through the process of hypothesis testing (Melnyk & Morrison-Beedy, 2012), which

overwhelming supported the alternative hypothesis that the animation would improve scores.

Shuaib et al. (2010) tool. Measurement validity refers to how accurately the tool measures the outcome an intervention is designed to affect. Researchers conducted an extensive literature review and then completed three Delphi review rounds verifying questions and responses. Next the questionnaire was pretested in two groups of 14 residents from the study location (Shuaib et al., 2010). While validity was clearly established by these researchers for their given population, testing for modifications made for Florida's population did not occur; possible implications are presented in Chapter 5, Discussion.

External Validity

External validity deals with how generalizable study results are to the population (National Center for Technology Innovation [NCTI], n.d.). External validity can be divided into population validity (results generalize across the population) and ecological validity (results generalize across the setting).

Within the Florida population, the sample was drawn from a highly representative, large group. However, pretest sensitization is of concern. A second study may be helpful in determining the extent of pretest sensitization by including a control group. If it is determined that pretesting had a major impact on the scores, pretesting may be included as a part of the intervention in terms of policy recommendations.

Both the population and ecological validity of this intervention are hypothesized to be very high, and further studies would be helpful in determining, more precisely, the

parameters of efficacy. The presence of other extraneous confounding variables was extremely low, with no other explanation of test score changes.

Internal Reliability

Overall. Internal reliability is a construct concerned with consistency of procedures. Consideration is therefore given to the consistency of data collection, analysis and interpretation (Drost, 2011). The study had a very simplistic design, a short timeline, basic statistical analyses, and straightforward conclusions. The study could be easily replicated.

Dengue Fever Comes To Town. Internal reliability of the animation was high, with recreation held consistent with the animation's digital form. This ensures that future studies would convey identical information, which could help to further establish internal validity.

Shuaib et al. (2010) tool. The internal reliability of the Shuaib et al. tool refers to the consistency of items across the test. Inter-rater reliability, or the degree to which scores are consistent among participants, was very high. This is evidenced in the small range of standard error noted on analysis.

External Reliability

External reliability is concerned with the capacity of an intervention to recreate similar results over time. Often this is evaluated by using a test-retest design, whereby subjects are given the same test at different time intervals. Test-retest reliability on the intervention was not established during this study. Recommendations regarding test-retest reliability are discussed in Chapter 5.

Dissemination of Results

Written results of the study were disseminated to all stakeholders involved in the study including the camp owner, subject matter experts, and Capella University officials. In addition, the animation was provided to the Dengue Relief Foundation (DRF), and posted on YouTube.

Ethical Considerations

Children as Research Subjects

Although this study involved little risk to participants, special consideration was given to children as research subjects. Children are protected under subpart D of the Department of Health and Human Services regulations (Hicks, 2011). This subsection includes additional criteria for exemptions, a four-level hierarchy of risk/benefit, specifications about parental consent and assent, and criteria for waivers of assent (Hicks, 2011). Although this study meets two of the listed categories for exemption including research in a common educational setting, and research about an educational test/tool, it also involves a survey, which may not be exempted (Hicks, 2011).

Obtaining a waiver of parental rights to informed consent may be an attractive option for researchers, as gaining consent generally relies on children to obtain signatures. Research that involves no more than minimal risk, may qualify for this waiver; however Capella University expressly states that waiver of consent is not permitted. Alternatively, Capella University permitted the use of a passive consent procedure.

Campers in this study were provided with the goals and objectives of the study, in writing. Participation was clearly stated to be voluntary, with no penalty for children who

did not wish to participate. Alternative activities were made available for those opting out of the study. Participating campers signed an informed assent and parental permission was secured with passive consent, one week prior to the study date.

Risk of Harm

Risk of harm in research consists of social, psychological, economical, legal and physical harm. When evaluating the risk of harm, consideration was given both to the probability and magnitude of harm. Further, the principle of beneficence, dictating that risks of harm are reasonable when compared to the possible benefits (Atwood & Panicker, 2014), was also considered**.**

The "Dengue Fever Comes To Town" Study contained information about the signs and symptoms, transmission and prevention of dengue fever. Ethical considerations included the possibility that subjects may have been disturbed to learn about the disease and may have felt anxious or fearful; an effect anticipated to be minimal in terms of probability and magnitude. The movie was constructed to decrease these feelings and concentrate on empowerment of students through the use of animated characters and a focus on preventive practices. While no children in the study experienced any type of adverse reaction, a child psychologist was on-call during the study in case any of the participants were disturbed. Further, the "Dengue Fever Comes To Town" animation study served to benefit those who participated, as opposed to a separate population. Finally, privacy and confidentiality were maintained, as no identifying information was collected during this study.

Learning Disabilities

Many studies have been done regarding the efficacy of mainstream inclusion of students with learning disabilities (LD). Results on this topic are mixed, with an earlier review of literature finding that mainstreaming was not effective (Harrington, 1997), and more recent, strategy-specific studies supporting the practice (Katz & Mirenda, 2002). The *Belmont Report* (U.S. Department of Health and Human Services, 1979) was also considered; specifically Part B, Basic Ethical Principles; Section 1, Respect for Persons; and Section 2, Beneficence. Students with LDs were considered to have (or potentially have) diminished autonomy and were afforded special protection from harm and assurance of well being.

In seeking to protect students with LDs, the researcher recognized that damage could occur either through exclusion or through exposure to disturbing material. The benign nature of the film, with nondisturbing imagery, was less likely to cause harm to most students than excluding them from participation. Students with LDs were to have the option to opt-out, to participate fully, or to participate by watching the film only (no testing). The informed consent process with students with LDs was to be the same as other students, with parents being passively consented and students providing assent. No students with LD participated in the study.

CHAPTER 4. RESULTS

Research Questions and Hypotheses

RQ1: Is the animation, "Dengue Fever Comes To Town," effective at increasing knowledge, improving attitude, and improving practices regarding dengue fever in third to fifth grade students in Florida?

Ho1: The animation, "Dengue Fever Comes To Town," *will have no effect or decrease* knowledge, attitude, and practices regarding dengue fever in third to fifth grade students in Florida.

Ha1: The animation, "Dengue Fever Comes To Town," *will* increase knowledge, improve attitude, and improve practices regarding dengue fever in third to fifth grade students in Florida.

RQ2: Are there differences in the efficacy of the animation related to gender?

Ho2: There *will not* be differences in the efficacy of the animation related to gender; differences between male and female scores will not be significant.

Ha2: There *will* differences in the efficacy of the animation related to gender; differences between male and female scores will be significant.

RQ3: Are there differences in the efficacy of the animation related to grade level?

Ho3: There *will not* be differences in the efficacy of the animation related to grade level.

Ha3: There *will* be differences in the efficacy of the animation related to grade level.

Sample Demographics

A total of 54 students participated in the study, 26 females, and 26 males (Figure 1). The sample was comprised of 15 third graders, 18 fourth graders, and 21 fifth graders (Figure 2). The demographic data collected included gender, grade level, free time activities, and communication preferences. Participants were asked to check off all the activities that they enjoyed in their free time (Figure 3). The most popular free time activities were playing video games or watching television, playing sports, and going to the movies.

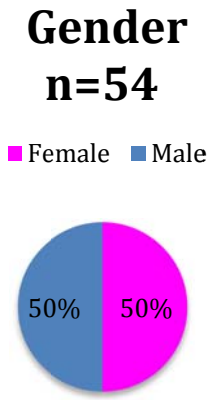

Figure 1. Participants by gender.

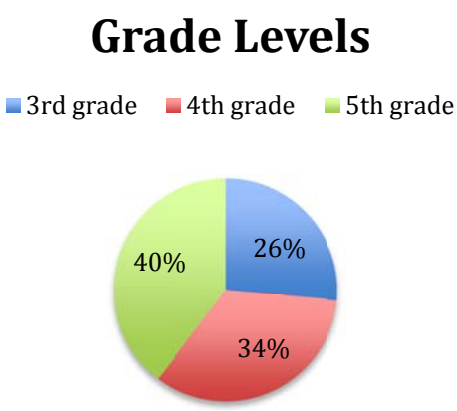

Figure 2. Participants by grade level.

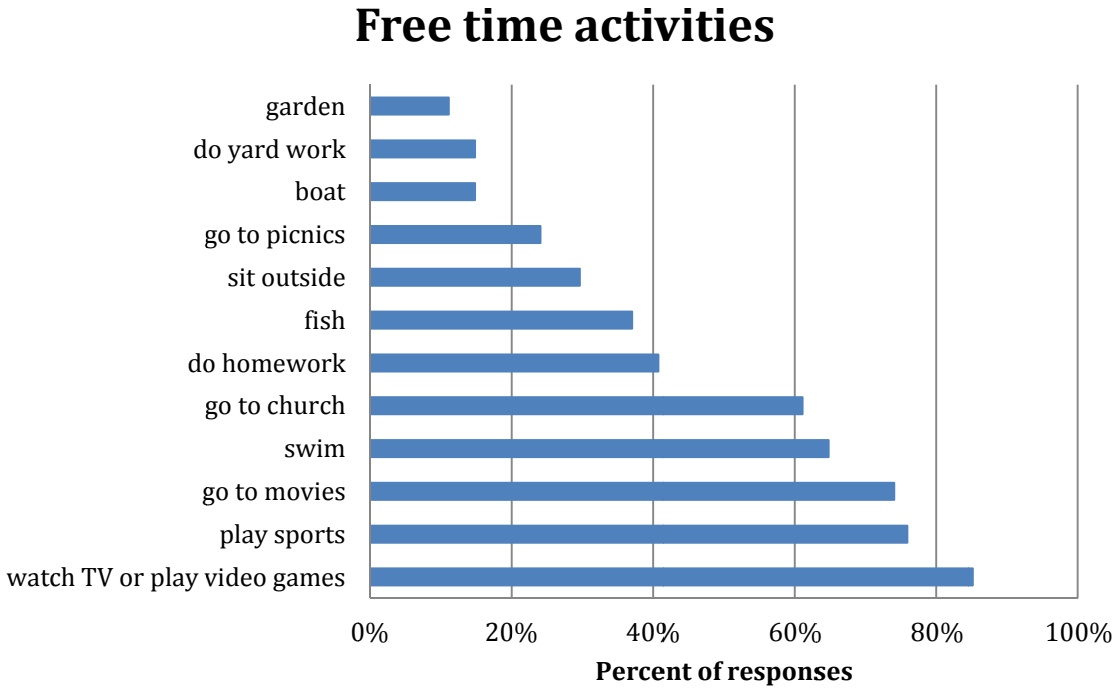

Figure 3. Free time activities preferred by participants.

Yard and Home Assessment, Communication Preference

Participants' risk for proximity to mosquito breeding was assessed by surveying sources of standing water occurring in their yards (Figure 4). Participants indicated that natural collections of water, gardening supplies, and tools were most commonly found around their homes. In-home risk for mosquito exposure was assessed by questioning whether participants kept windows open or used air conditioning (Figure 5). More than 50% of respondents indicated that air conditioning was always used in their home. Next, participants indicated communication preferences, checking all answers that applied (Figure 6). Despite the young age of respondents, social media was the preferred method of communication.

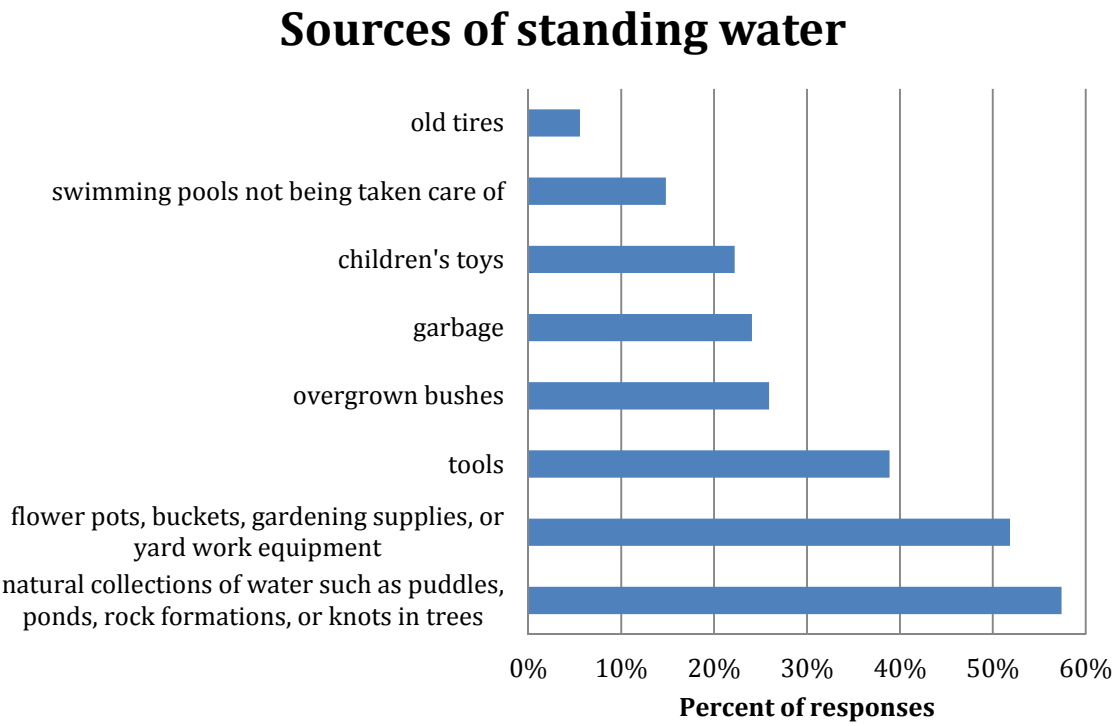

Figure 4. Sources of standing water in participants' yards.

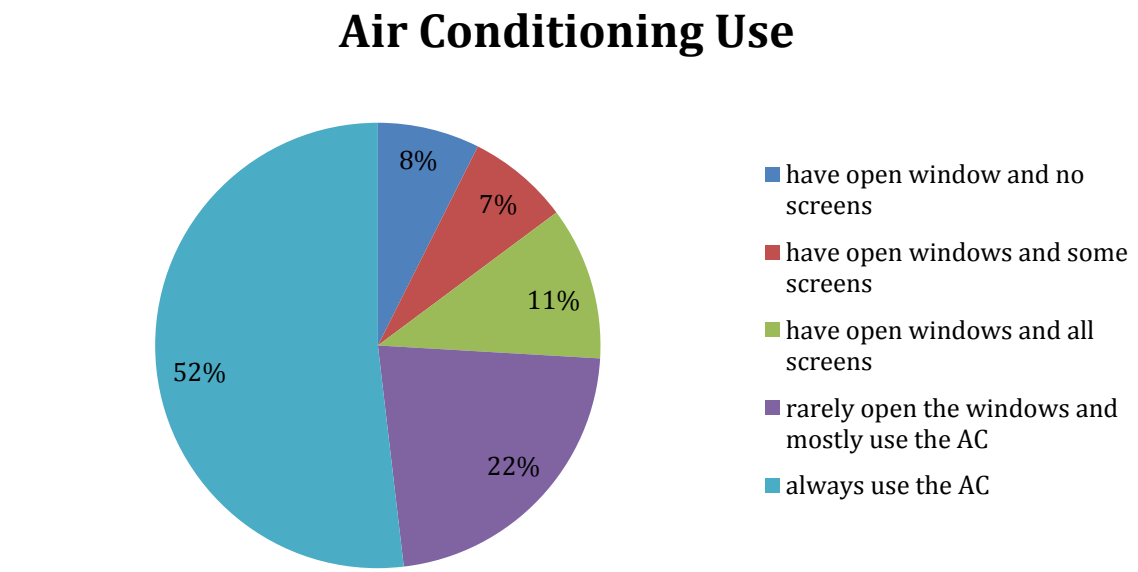

Figure 5. Use of windows verses air conditioning (AC) within participants' households.

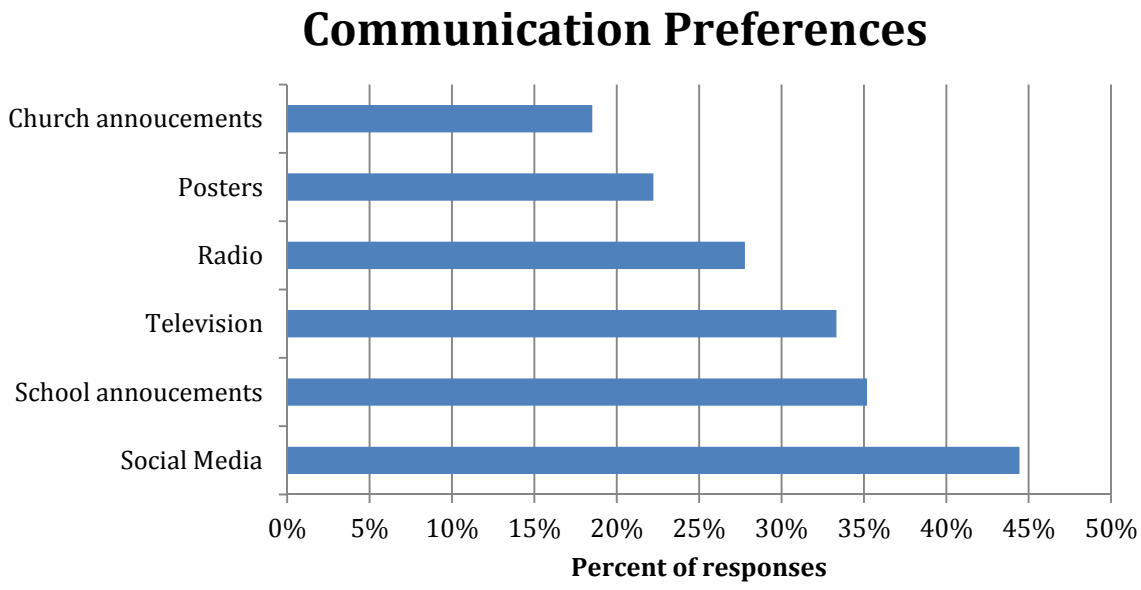

Figure 6. Communication preferences among students expressed as percent of respondents.

Knowledge

Knowledge Overall

The raw pretest score mean was 12.89+/-0.457 standard error (SE) and the posttest score mean was 24.15+/-0.603 SE with 54 tests per group (Figure 7). Posttest scores increased from pretest scores by 11.26+/-0.59 SE points. This change was statistically significant ($p < 0.001$).

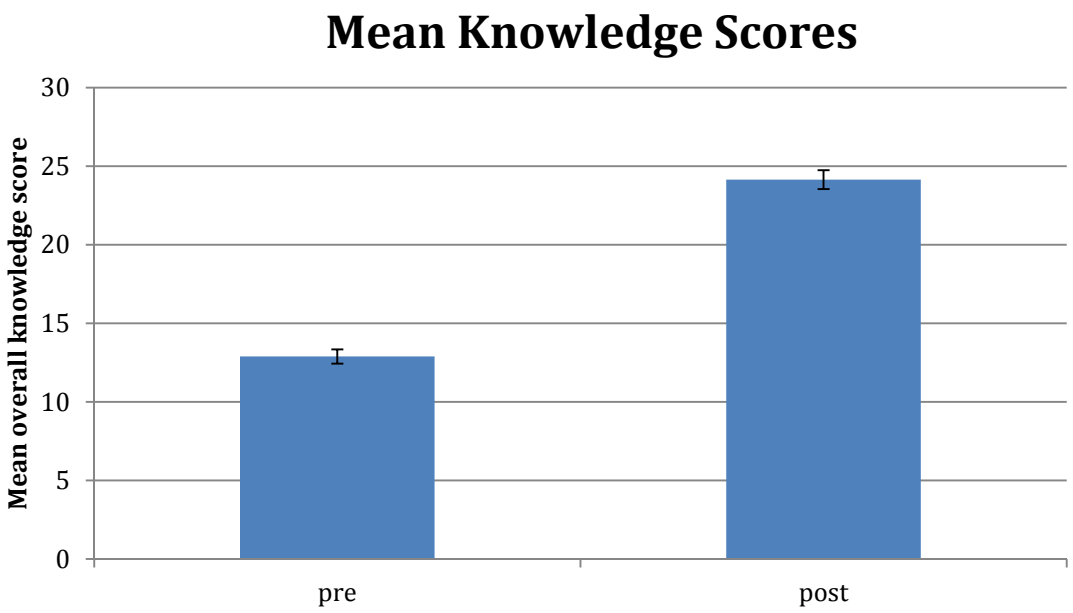

Figure 7. Overall knowledge scores pre and posttest represented as mean +/- SE.

Knowledge Results by Category

The Knowledge section of the survey was divided into the following five categories: symptoms, treatment, transmission, exposure to mosquitoes, and mosquito breeding sites.

The pretest/posttest differences were significant in all five subcategories when examined independently (Figure 8):

1. Symptoms ($p < 0.001$). Participants checked the symptoms that they believed were related to DF.

2. Treatment ($p < 0.001$). Participants chose from a list of actions to take if they suspected DF, and they were asked if a treatment was available.

3. Transmission ($p = 0.029$). Participants chose from a list of disease vectors.

4. Exposure ($p < 0.001$). Participants indicated what time of day dengue mosquitoes were most likely to bite, if insecticides helped with prevention, if window screens helped with prevention, and if mosquito repellents helped with prevention.

5. Breeding ($p < 0.001$). Participants indicated where they believed mosquitoes lay eggs, if covering water containers can help prevent breeding, if removing standing water can help prevent breeding, and if cutting down bushes can help prevent breeding.

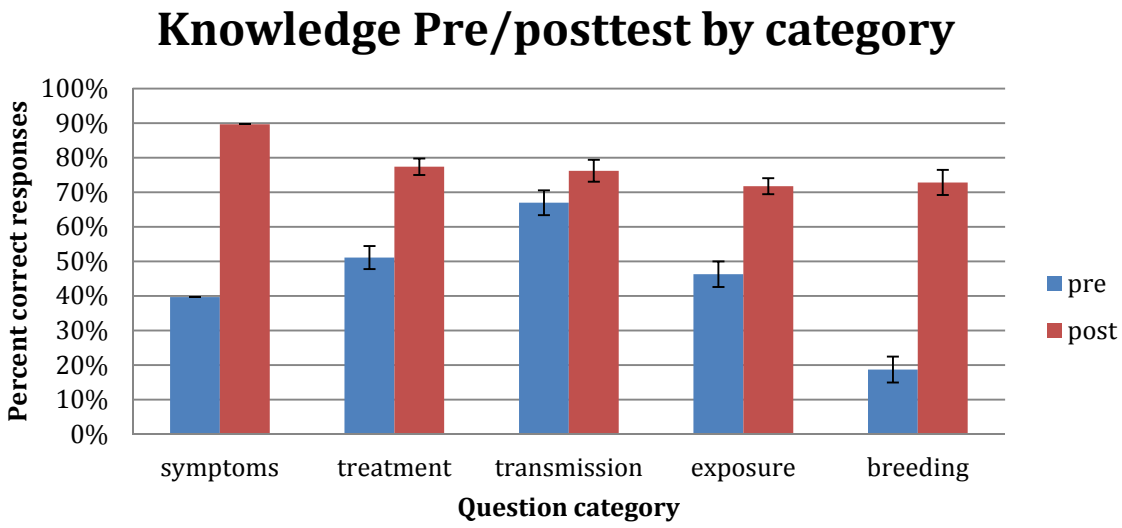

Figure 8. Knowledge scores pre and posttest, represented by category, as mean +/- SE.

Stratification by Gender

When results were stratified according to gender, no difference was demonstrated between male and female Knowledge pretest scores ($p = 0.170$) or posttest scores ($p = 0.585$) (Figure 9). Pretest, males received a score of 12.259 +/- 0.631 and females 13.519 +/- 0.650. Posttest, males received a score of 24.482 +/- 0.916 and females 23.815 +/- 0.797.

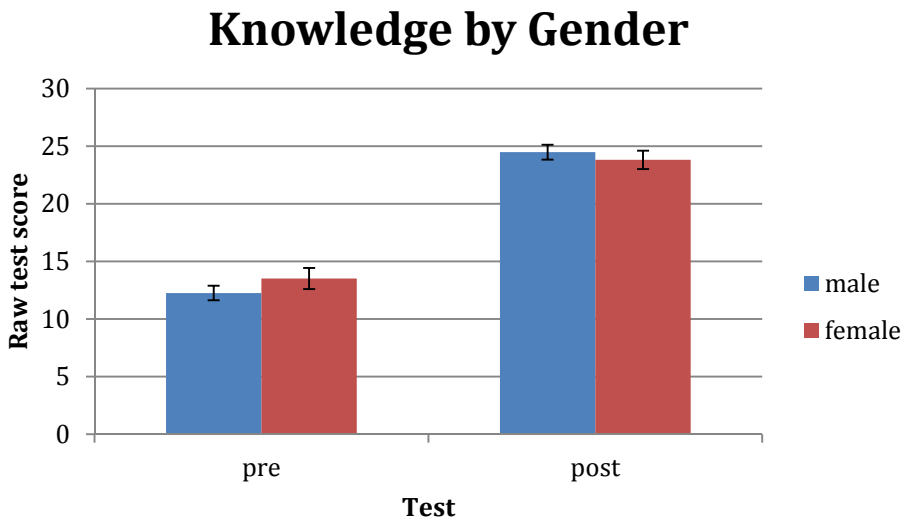

Figure 9. Knowledge scores pre and posttest, represented by gender, as mean +/- SE.

Stratification by Grade Level

When grade levels were evaluated individually, all three grade levels had highly significant changes from pretest to posttest scores, third graders ($p < 0.001$), fourth graders ($p < 0.001$), and fifth graders ($p < 0.001$) (Figure 10).

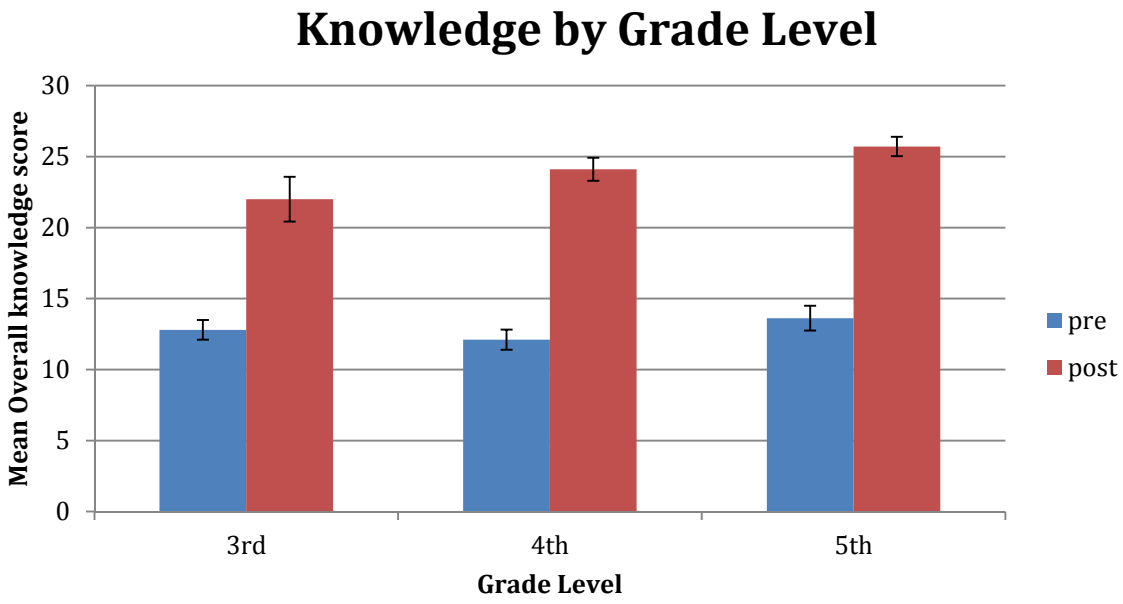

Figure 10. Knowledge scores pre and posttest, represented by grade level, as mean +/- SE.

Overall Knowledge posttest results revealed a significant difference between grade levels ($p = 0.043$) (Figure 11). Fifth grade students achieved a higher mean score (25.714+/-0.680) compared to third graders (22.000+/-1.570). There was no difference between fourth graders (24.111+/-0.812) and either third or fifth graders in overall knowledge posttest scores.

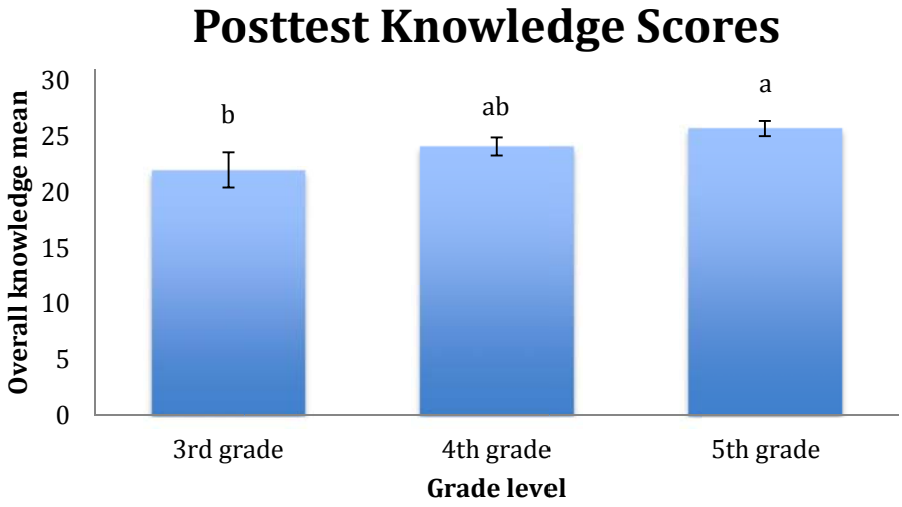

Figure 11. Knowledge scores posttest, represented by grade level, as mean +/- SE. Different letters denote significant differences at $p = 0.05$.

There were no differences in overall knowledge pretest scores between grade levels ($p = 0.381$). Participants had the following mean/SE scores: third graders 12.800+/-0.691, fourth graders 12.111+/- 3.008, and fifth graders 13.619+/-4.006.

Attitude

On the pretest only, participants were asked if they found mosquitoes to be a problem, and 52 out of 54 replied, "yes" (Figure 12). Next, participants indicated their feelings about statements regarding dengue. Attitude was measured using a 5-point Likert Scale. Each of the attitude questions was analyzed individually.

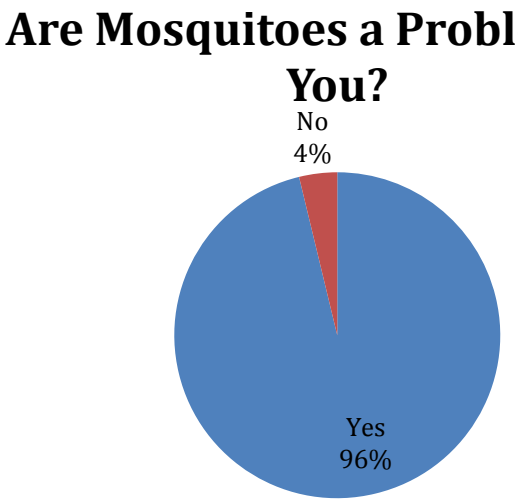

Figure 12. Participant's perception of mosquitoes.

Attitude Results by Question

The attitude analysis measured the movement of responses, from pretest to posttest, regarding the belief that dengue is serious, that it can be prevented, and that children can help to prevent dengue. All three attitude questions yielded significant results as follows:

1. "Dengue fever is a serious illness" ($p = 0.018$) (Figure 13). A positive change was defined as a posttest response moving toward "*strongly agree*" (Likert 5), a negative response was defined as posttest movement toward "*I don't know*" (Likert 1), with *strongly disagree, disagree,* and *agree* comprising the remainder of the scale. Participants demonstrated statistically significant movement toward the belief that dengue fever is a serious illness.

2. "Dengue fever is preventable" ($p = 0.001$) (Figure 13). A positive change was defined as a posttest response moving toward "*strongly agree*," a negative response was

defined as posttest movement toward "*I don't know.*" Participants demonstrated statistically significant movement toward the belief that dengue fever is preventable.

3. "Describe your attitude about your ability to help prevent dengue fever" ($p <$ 0.001) (Figure 13). A positive change was defined as a posttest response moving toward, "*I know what to do and I will do it*," and a negative response was defined as posttest movement toward, "*I'm not sure what to do.*" Participants demonstrated statistically significant movement toward the belief that they can help to prevent dengue fever.

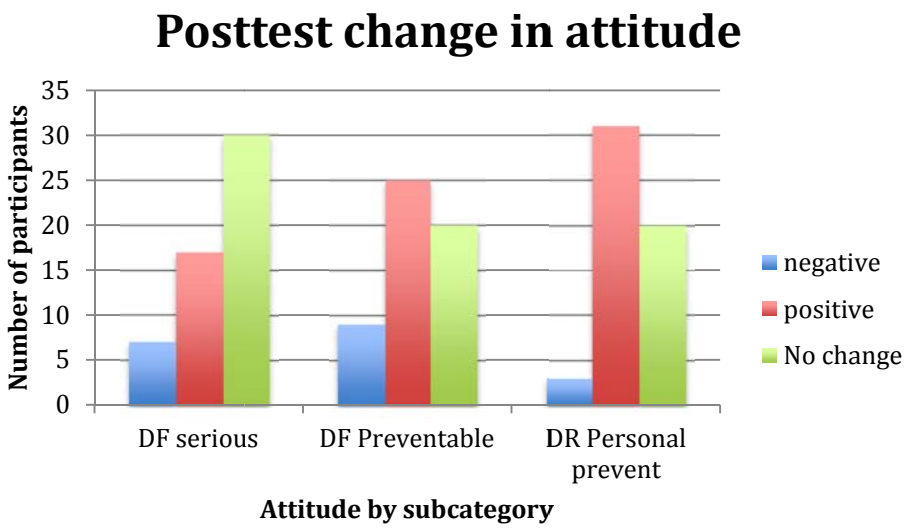

Figure 13. Change in participant's attitude posttest subdivided by test question.

Stratification by Gender

The three attitude questions were individually analyzed according to gender. Males had greater positive movement on posttest scores than females on Question 2. Dengue fever can be prevented, posttest ($p = 0.005$) (Figure 14). There were no differences between males and females within the other questions: Question 1. Dengue

fever is a serious illness, pretest ($p = 0.412$), posttest ($p = 0.344$); Question 2. Dengue fever can be prevented, pretest ($p = 0.839$); and Question 3. Describe your attitude toward your ability to prevent dengue fever, pretest ($p = 0.734$), posttest ($p = 0.699$).

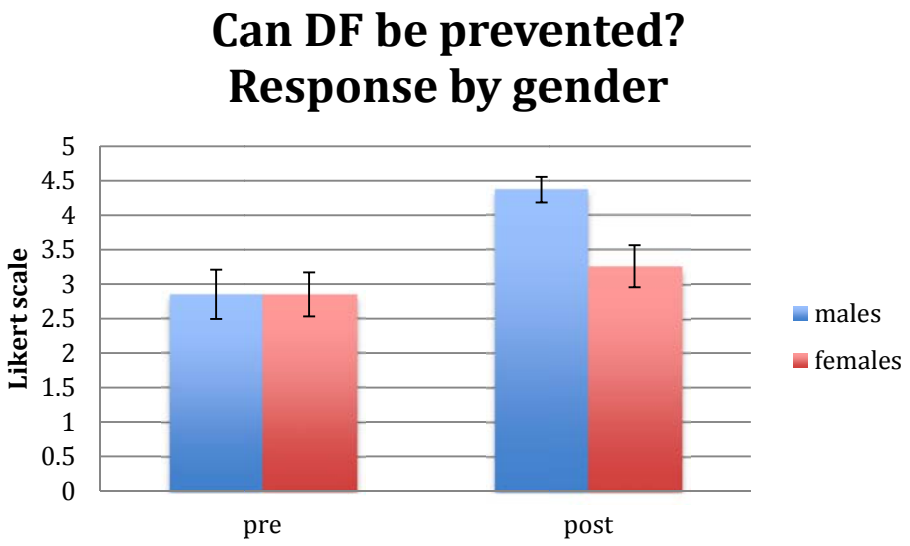

Figure 14. Attitude question 'Can DF be prevented?' pre- and posttest by gender, represented as mean +/- SE, measured on a Likert scale.

Stratification by Grade Level

There was no significant difference found between grade levels on the Attitude section of the survey. A Kruskal-Wallis was completed on each question within the Attitude sections as follows: 1. Dengue fever is a serious illness (pretest $p = 0.876$, posttest $p = 0.578$); 2. Dengue fever can be prevented (pretest $p = 0.348$, posttest $p = 0.121$); and 3. Describe your attitude about your ability to help prevent dengue fever (pretest $p = 0.413$, posttest $p = 0.552$).

Practices

Practices Results by Questions

In order to evaluate the Practices section of the survey, a chi-square test was run on each of the 10 individual questions. Questions fell into two broad categories: (a) what have you, or your family, done to reduce contact with mosquitoes, and (b) what have you, or your family, done to reduce mosquito breeding.

Reducing contact with mosquitoes. There was a significant change in no to yes responses for using mosquito repellant ($p = 0.014$), having your home professionally treated ($p < 0.001$), and wearing protective clothing ($p < 0.001$). There was *not* a significant difference regarding placing screens in windows/always use AC pre and posttest ($p = 0.275$) (Figure 15).

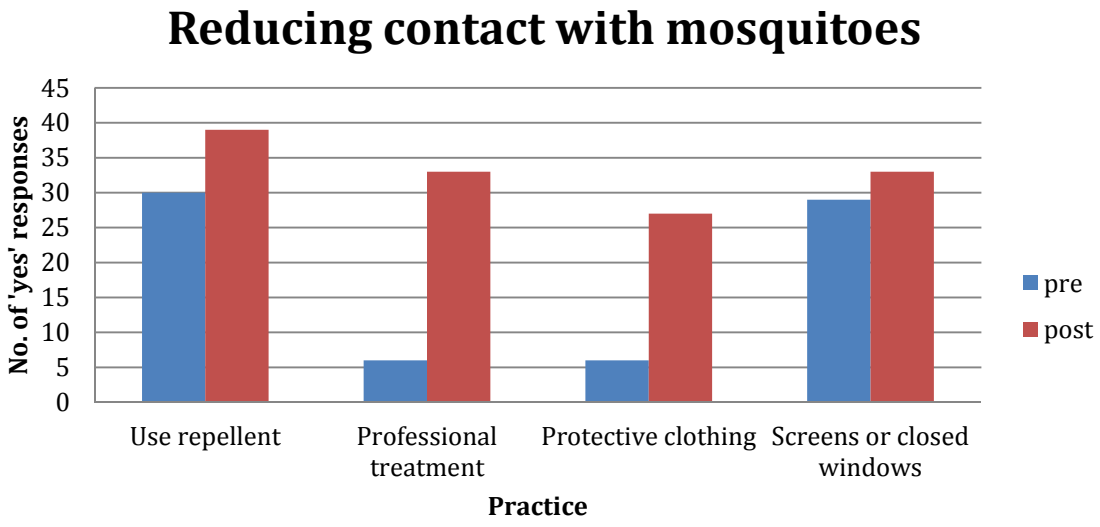

Figure 15. Pre and posttest differences in practices to reduce contact with mosquitoes.

Reduction of mosquito breeding sites. There was a significant change in no to yes responses in all six questions regarding breeding sites: removing standing water ($p < 0.001$), cleaning out gutters ($p < 0.001$), cutting down bushes ($p < 0.001$), covering water collection containers ($p < 0.001$), storing tires and toys in the garage ($p < 0.001$), and taking community action ($p < 0.001$) (Figure 16).

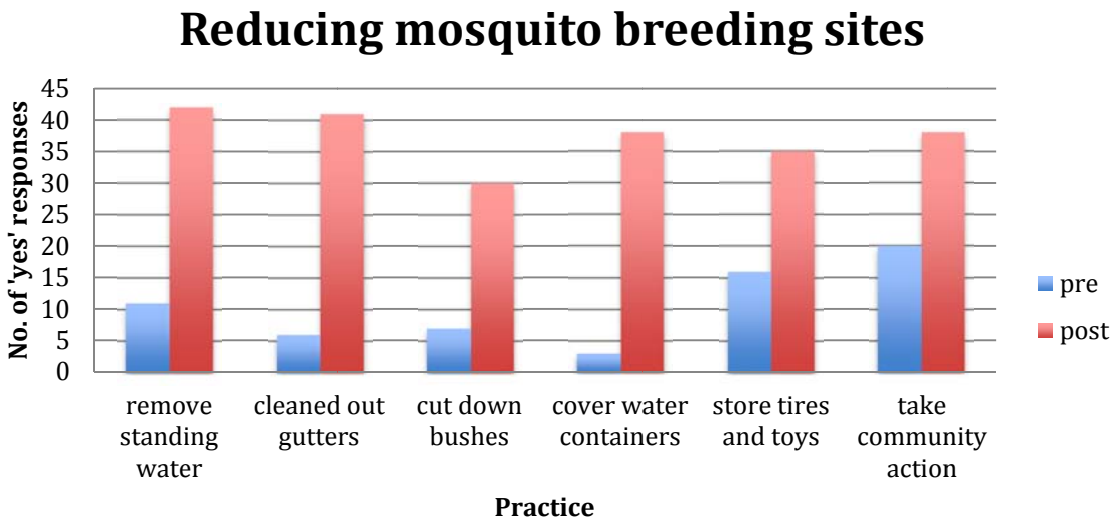

Figure 16. Pre and posttest differences in practices to reduce mosquito breeding sites.

Stratification by Gender

In order to evaluate gender differences within the Practice section of the survey, the three practices with the largest overall pretest-posttest differences were analyzed using a Kruskal-Wallis. No gender differences were found: cover water collection containers (pretest $p = 0.556$, posttest $p = 0.238$), clean gutters (pretest $p = 0.391$, posttest $p = 0.753$), and remove sources of standing water from the yard (pretest $p = 0.094$, posttest $p = 1.000$).

Stratification by Grade Level

In order to evaluate grade level differences within the Practice section of the survey, the three practices with the largest overall pretest-posttest differences were analyzed using a Kruskal-Wallis. Results were as follows: cover water collection containers ($p = 0.971$, posttest $p = 0.022$), clean gutters (pretest $p = 0.658$, posttest

$p = 0.102$), and remove sources of standing water from the yard (pretest $p = 00.010$, posttest $p = 0.358$).

Pretest differences were detected within removing sources of standing water, with a higher number of fourth and fifth graders (median 17, 18 respectively) indicating they engaged in the practice, than third graders (median 8). Posttest differences were found in covering water collection containers, with fifth graders having the highest number of "yes" responses (median 21) compared to fourth graders (median=18), and third graders (median=15).

Conclusion

Scores support rejection of the null and acceptance of the alternative hypothesis, which states the animation will improve knowledge, attitude, and practice scores in primary school children in Florida. Gender differences were found, and therefore within the second research question, the null is rejected and the alternative hypothesis is accepted. The third research question is also answered with the alternative hypothesis, as grade level differences were found.

CHAPTER 5. DISCUSSION

Overall Results

The overall results of the study were significant, with a 99% confidence interval. This study overwhelmingly supports the use of animations in dengue public health campaigns as an effective way of increasing knowledge, improving attitude, and increasing intention to decrease contact with mosquitoes and reduce mosquito-breeding sites. However, these data are insufficient to draw conclusion regarding the impact on dengue fever disease rates.

Demographics/Sample

Recruitment yielded a study sample that was evenly distributed between males and females. More fifth graders participated, followed by fourth, and then third graders. This may indicated that that third graders were more reluctant to participate, fearing perhaps, that they may have to read/or receive grades, even though the procedures were explained. Alternatively, this distribution may in fact represent the overall distribution of students at the camp; however, that data was not collected, so this remains unknown.

The review of free time activities revealed a surprising number of participants who enjoyed homework, and not surprisingly, video games and television. Other high-ranking activities included going to the movies, going to church, swimming, and playing sports. Targeting these activities for dengue campaigns may be an effective way to reach

this audience. For example, the dengue animation could play in the movie theater as a preview, viewing could be assigned as homework, or a church-based campaign conducted. Indeed, in Costa Rica, the World Health Organization and the Pan American Health Organization implemented an initiative distributing a video game entitled "Pueblo Pitanga: Enemigos Silenciosos" (Pitanga Village: Silent Enemy), which stresses safe water management practices to prevent dengue (PAHO, 2013).

When asked if they had heard of dengue fever, most participants said they had not. Of the 54 participants, only five had heard of dengue fever. For those five, the source of information was as follows: one participant, school; one participant, TV/radio; one participant, health worker; one participant did not indicate where they had heard of DF; and one participant wrote in "the internet." All but two of the participants stated that they found mosquitoes to be a problem. These data indicate a decided problem with the vector, yet almost no knowledge of dengue fever. According to the HBM, the participants have a "perceived susceptibility" to mosquitoes. Combined with this educational animation, they may experiences increases in "perceived seriousness," and "perceived benefits," and a decrease in "perceived barriers" as they learn what steps to take. This setting provides an opportune time to initiate proactive education.

Communication preferences indicated that this population prefers information to be delivered via social media. This type of communication was almost removed from the list of choices, as it was viewed to be an unlikely choice within the given age range. Social media should be considered in future campaigns as an effective way to reach this audience. Importantly, these results could not be generalized to developing populations.

Knowledge Section

The animation proved effective in improving knowledge overall, and as measured on each of the individual subsections: symptoms, treatment, transmission, exposure, and breeding. The largest changes occurred within the subcategories of symptoms and breeding, while the smallest, yet still significant ($p = 0.029$) change occurred in transmission.

Several factors should be considered in evaluating the validity of the Knowledge section results. First, the Shuaib et al. (2010) survey was designed as a one-time survey, rather then a pretest/posttest. Survey questions in the "symptoms" and the "breeding" section reflected a wrong answer when they were left unchecked, while in the "transmission" section, an unchecked answer was correct. This most likely accounts for a very large difference in pretest/posttest score in symptoms, and a relatively small difference in transmission. Despite these design flaws, the category of transmission still yielded significant changes in pre- to posttest scores. This could be addressed in future studies by modifying the test questions so equal numbers of unchecked answers were right and wrong. Alternatively, simply adding the choice "*I don't know*" might be sufficient to increase the accuracy of scores. In the Attitude and Practices sections of the survey, validity was increased, reflecting true pretest/posttest differences, as answers were not scored right or wrong; instead, participants simply indicated how they felt, in the Attitude section, and things they did, in the Practices section.

Secondly, the Shuaib et al. (2010) survey was designed for adults, while this study took place with children. Although some content/language modifications were made, the subject matter remains complex and mature. Nevertheless, children were able to improve

their scores dramatically, bolstering the overall validity of the animation. This may be attributed to the efficacy of the medium in general, and/or to the quality of this animation specifically.

Attitude Section

The results indicated a significant improvement in participants' attitude about DF, with an increase in awareness that the disease is serious, and that steps can be taken to help in prevention. An extremely significant change was noted in participants' attitude towards their ability to help prevent DF. According to the HBM, perception of risk is a critical prerequisite to behavioral change. Further, behavioral change is guided by "cues to action," which must be delivered within a conducive-to-change environment (Rosenstock, Strecher, & Becker, 1988). The clear presentation of risk, combined with specifically stated and depicted protective-actions, addresses these requirements. Moreover, Empowerment Theory predicts that children want to work together with adults (Edwards et al., 2011), and numerous studies support that they are competent agents of change (Avila Montes et al., 2004; Jayawardene et al., 2011; Kvaloy, 2014; Overgaard et al., 2012; Vesga-Gomez & Caceres-Manrique, 2010; Wangroongsarb, 1997).

Practices Section

The Practice section results indicated that participants indeed intended to improve their efforts to reduce contact with mosquitoes, and decrease mosquito-breeding sites. Three out of four practices related to reducing contact with mosquitoes yielded significant results, with only the practice of using window screens/or air conditioning not showing a significant change. The lack of significance for this item was most likely due

to the high level of pretest compliance (30 out of 54 "yes" responses were recorded on the pretest). Participant responses indicated an enormously significant change in all six practices related to decreasing mosquito breeding sites. While pretest scores showed little effort within this domain, posttest scores skyrocketed, indicating, perhaps, that increases in knowledge about what to do, resulted in changes in their intended actions.

Stratification Results

Gender

Interestingly, yet not significant, male pretest scores were lower, and posttest scores were higher than females in the knowledge section. Unexpectedly, a difference was seen in the posttest Attitude section scores of males vs. females. While pretest attitude scores were exactly the same, males had a greater improvement in their attitude than females. Explanations for this difference are highly speculative, but might include an increase in desire to "do something," or a greater interest in the animation, dengue fever, or both.

Grade Level

Grade level differences occurred within the knowledge section. Although pretest Knowledge scores had no significant difference between grades, posttest scores were higher for fifth graders than third. There was not a significant difference between third and fourth, or fourth and fifth grade scores. Of greater importance, when each grade level was analyzed alone, all three showed highly significant improvements between the pre- and posttest. This indicates that the range of efficacy has not yet been determined and may extend to both higher and lower grade levels.

Within the Attitude section, no significant differences were found between grade levels, and in the practice section, minor differences were noted, with fifth graders scoring higher on one of the pretest practices and one of the posttest practices. Overall, grade level differences in the practice section were relatively small, and do not seem to contribute meaningfully to the discussion; however, a larger scale study may reveal more dramatic differences. Grade level differences may be important for future policy recommendations.

Contribution to the Field of Knowledge

Many interventions are able to achieve significant results with pretest/posttest study designs. More important variables, in terms of intervention impact on the fight against dengue, include larval indices and disease rates. Bieri et al. (2013) were successful in impacting STH disease rates one year after baseline data were collected. This may be attributed to multiple showings of "The Magic Glasses" animation, with participants viewing the animation a total of four times. While STH campaigns require multi-pronged interventions including education, improvements in sanitation, and pharmacotherapy, dengue is even more difficult to control with no effective pharmacotherapy, and the intractable effects of climate change, entomological evolution, and multiple viral types. However, comparing the two animations in terms of efficacy in improving KAP, both animations were highly effective, with $p < 0.01$ reported on many measures within both studies.

Carefully designed, large-scale, long-term, community-based studies are needed to determine the impact of educational animations on disease rates. Moreover, studies meeting such criteria have been conducted, for example in Singapore (Ooi et al., 2006),

with epidemic dengue sweeping through in cycles and basically negating any measureable improvements. Such events indicate that perhaps special consideration must be given in order to account for dengue transmission patterns, and interventions should be evaluated with different criteria in "epidemic" years, for example, how fast the community was able to contain and control the epidemic, or mortally rate.

The "Dengue Fever Comes To Town" study was aligned with one of the most widely used theoretical models, the health belief model (HBM). According to the HBM, behavioral change occurs when individuals recognize that there is a problem, that they are vulnerable, and finally that the benefits of change will outweigh the cost of changing. The success of "Dengue Fever Comes To Town" may be related to initial buy-in from a population experiencing a problem, as evidenced by a nearly 100% response to the question, "Do you find mosquitoes to be a problem?" Next, attention was drawn to vulnerability, which was promptly followed by specific, easy to follow, behavioral changes to decrease risk. Finally, the messages were delivered using an entertaining and user-preferred methodology.

Policy Recommendations

Addressing the threat of dengue fever in areas with rising disease rates, as well as increasing efforts in countries endemic with the disease, is major public health challenge. In the United States, especially in outbreak locations, effective tools are needed. "Dengue Fever Comes To Town" is available on YouTube and could be linked to websites including the CDC, state and local health departments, and dengue-specific sites.

With increasing disease rates in the state of Florida, the animation is recommended for inclusion in primary school curricula, or as a part of a multiprong campaign. The following rationale help to support the recommendation:

Rationale 1

The animation is proactive, inexpensive, and sustainable, owing to simple production, accessibility, and ease of implementation.

The American Public Health Association (APHA, 2012) filed a brief in 2012 discussing the need to focus health care dollars on prevention. They pointed out that the 20th century brought substantial gains to the average American lifespan, which increased by 30 years, with 25 of those years attributable to public health successes such as vaccinations, improved sanitation, and decreases in tobacco use. However enormous per capita health care expenditures ($7,538 in 2008), combined with a ranking of 24th among the 30 countries participating in the Organization for Economic Cooperation and Development (OECD), indicate that the current approach is ineffective, and clearly unsustainable.

Researchers concluded that given the current set of challenges, and the past success of public health, the United States should double the current $11.6 billion (in 2009) public health budget, which would result in improved health outcomes, and reduced overall health care expenditures (APHA, 2012). Further, according to an article detailing the use of Social Media in public health, online video sharing, which could be used to disseminate "Dengue Fever Comes To Town," scored low on resource usage for both time/staff and cost (CDC, 2011). The low cost, sustainable, preventive focus of the

animation is aligned with current APHA goals and recommendations, as well as the CDC's recommended use of social media.

Rationale 2

The animation is easy for children to understand at multiple grade levels, and it may prove effective for adults, people with learning disabilities, and illiterate populations. Similar methodology could be used at different grade levels to reach a wider audience.

According to the Harvard School of Public Health (HSPH) (n.d.), the average adult American reads at the eighth/ninth grade level, 1 in 5 Americans read at or below the fifth grade level, and 2 in 5 older (over 65 years) or inner city minorities read below the fifth grade level. Accordingly, 20% of adult Americans are functionally illiterate, and another 30% have marginal reading skills, with most health care instruction written at levels that are "over their heads" (HSPH , n.d., p. 3). Researchers found that the challenge of work-arounds for literacy barriers had a major impact on health, with those people with the lowest literacy levels requiring significantly more medical care. In the United States, health organizations are becoming increasingly aware of the impact literacy has on health and health costs. Strategies to improve poor health outcomes in this population include the increasing use of non-printed media (HSPH, n.d.).

George, Moran, Duran, and Jenders (2013) focused on health disparity by conducting a study with a minority, multicultural population, with low health literacy. Results indicated that this population was accepting of animations and found that information communicated using animations improved the ability to participate in meaningful health-related dialog, and to ask questions (George et al., 2013).

This research supports the use of animation as a means of decreasing health disparity, overcoming numerous barriers, and reaching a wide-ranging audience.

Rationale 3

The animation has proven to be effective in improving knowledge, attitude, and practices, thereby informing evidence-based guidelines for policy implementation.

The implementation of evidenced-based approaches in the field of public health is a complex undertaking. According to the CDC (2012b), key elements include community involvement, systematic use of data information systems, the use of peer-reviewed data for decision-making, the use of theory, evaluation, and dissemination of results. The animation included community involvement, the use of theory, systematic evaluation, and dissemination of results as key elements of the study design, thereby aligning with CDC (2012b) recommendations for evidenced based-approaches.

Rationale 4

The animation can be easily adapted to other languages.

According to the *National Profile of Local Health Departments*, linked to the 2000 census, 290 local health departments (LHD) in the United States serviced communities where more than 30 different languages were spoken. The study found that approximately three-quarters of LDH provided some service to attempt to address language variability, most often through the use of community outreach, minority partners, or translated/culturally appropriate materials. “Dengue Fever Comes To Town” can be easily translated, due to short, simple dialog, making its use appealing in multilingual locations. In fact, the book has already been translated into Spanish.

Rationale 5

The animation requires a short duration of attention, and results in little loss of regularly scheduled teaching time.

In a CDC review of social media tools (CDC, 2011), researchers found that when using the "video sharing" tool, length is an important consideration. The length must be appropriate for the target audience and the content, with many sites using this method having time limits for videos. Further, research indicates that users start to lose interest after a short period of time, as little as 3 minutes (CDC, 2011). The animation, which is a relatively short 8 minutes, includes entertaining characters, which successfully hold viewers' attention and effectively convey information, while remaining only a short time commitment.

Rationale 6

The animation could be expanded to a family of animations, with the same characters and different objectives.

In a food advertising analysis featuring 577 food ads, researchers found that 73% of advertisement targeting children used familiar characters (Castonguay, Kunkel, Wright, & Duff, 2013). Further, in 2014, researchers (Danovitch & Mills, 2014) conducted a study to determine the way in which characters influenced 4-year-old children's perceptions about information and products. Children endorsed claims made by familiar characters more than those made by unfamiliar characters, even in the presence of evidence that the familiar character was unreliable. Moreover, children preferred low-quality products with a familiar character's image rather than high quality products with no image, as much as 74% of the time. Authors concluded that children's

judgment is “powerfully influenced by familiar characters” (Danovitch & Mills, 2014, p. 1). These studies support the idea that continual use of familiar characters may increase the uptake of health messages in this population.

Conclusion

The animation should be used as part of a multi-pronged approach, which should include vector control, practitioner training, and community education. Schools using the animation should show it each year, so students view the animation a minimum of six times during primary school years. If an outbreak occurs, the animation should be viewed repeatedly (two times in a row), and at frequent intervals (1-3 months depending on the outbreak severity). These strategies most likely helped to increase the success of the Bieri et al. animation, “The Magic Glasses” (Bieri et al., 2013).

Limitations

Disease Rate Impact

Bieri et al. (2012) did a review of health education videos regarding infectious diseases targeting schoolchildren. Of the 10 videos included in the study, all of them measured and significantly improved knowledge (10/10), and six out of the eight studies measured improved attitude. However, only two out of six measured improved behaviors, and only one out of two measured improved incidence/prevalence rates of disease (Bieri et al., 2012). This review of literature indicates that current health education videos appear effective in improving knowledge and attitude; however the impact they have on disease rates has not been conclusively examined. This may be a result of the substantial resources required to accurately evaluate impact on disease rates, which would include a

long time frame, comprehensive analysis of confounding variables (i.e., disease cycles), and medical involvement (personnel, equipment, laboratory participation, extensive and multiple institutional review, and treatment when appropriate). Such costs make disease-impact evaluations impossible without funding. The ability to impact disease rates was not included in this nonfunded study, for the above-mentioned reasons.

Long-term improvements in disease rates may increase as generations of youngsters consistently practice protective actions. However statistically significant KAP interventions, animations or otherwise, may face additional challenges in decreasing disease rates with diseases that are largely related to "uncontrollable" factors such as epidemic cycles, climate change, and entomological evolution. The Bieri et al. (2012) study, in contrast, evidenced that educational campaigns can translate into improved disease rates, when combined with a multisectorial initiative.

Translating Knowledge Gains Into Practice Gains

Roess et al. (2011) conducted a large-scale evaluation of the efficacy of a film-based community intervention to improve various understanding of monkeypox in the Republic of the Congo. Approximately 23,800 people participated, with a subgroup of 271 participating in a pretest/posttest session. Overall, the percentage of those who had either an improved knowledge, or an increased willingness to take constructive action, such as going to a hospital with an ill family member, was greater than 85%. However, within the practices sections, pretest scores revealed that 11% of those interviewed had eaten or sold a dead monkey found in the forest, and posttest, an unchanged 11% said they would do so again. These findings indicated that gains in knowledge do not necessarily translate to changes in practices. Further investigation revealed that these

behaviors derived from one of two different motives. There was a belief that more protein was needed in those who would continue eating dead monkeys, and poverty was the motive for selling the animals. In both cases, according to theory, stopping the behavior seemed more costly then continuing, despite increased awareness of risk (Roess et al., 2011). This is a telling lesson in public health; however, no such motives play a role in dengue-related risk practices; therefore fewer barriers may exist for behavioral change.

Test-rest Reliability

The short timeframe of the study makes it impossible to draw conclusions about the long-term efficacy of the intervention. Test-retest reliability may be established during future studies if follow-up assessments could be made at predefined time-intervals, for example at 3, 6, and 12 months. Retesting participants at a later date would determine if they were able to retain the information over time (Melnyk & Morrison-Beedy, 2012), and if they actually did implement changes in their practices (rather than stating they intended to).

Directions for Future Research

A number of unanswered questions are generated from this study. Future research may be directed toward defining optimal age parameters, identifying other topics for animation, examining pretesting effect, or considering adherence to the modality and redundancy principles in the animation design. Most importantly, future studies may measure the effects of large-scale, school curriculum inclusion on disease rates.

In order to exam the efficacy age range, the animation could be studied in grades ranging from kindergarten to twelfth grade, and even in college. This animation may well be effective in the adult population, and could potentially be instrumental in reaching

vulnerable populations such as those faced with learning disabilities or illiteracy. Other animations, for example, a combination animation of dengue fever and the closely related chikungunya, may also be effective. Other diseases of public health interest may include human immunodeficiency virus, tuberculosis, chronic diseases, and vaccine preventable diseases.

The effect of pretesting on student's posttest score is hypothesized to be significant. This could be examined by conducing the study with a Solomon Four Group Design. This design, while it requires a lager sample size, is capable of determining the effect of pretest sensitivity on posttest scores, and can also control for other confounding variables (Shuttleworth, 2009). If pretesting was determined to significantly impact posttest score, this intervention should be designed to include such a "priming" in the form of a pretest, or some other "preteaching" component.

According the cognitive theory of multimedia learning, presentations should contain either text, or audio, but not both. "Dengue Fever Comes To Town" could easily be modified, by removing the text from the animation frames. According to the modality and redundancy principles, this would prevent cognitive overload and enhance learning (Negus, 2009). While clearly the animation has proven effective in the age-range tested, removing the text may result in efficacy in a broader audience who may otherwise be "overloaded;" for example younger students, illiterate populations, and those with learning disabilities.

A critical parameter for public health officials is the impact that funding has on disease rates. Therefore, a long-term large-scale study is needed, with time-interval testing to measure retained knowledge, and actual practice changes, rather than intended.

Only with such an expanded scope could an intervention be said to impact larval indices and disease rates.

Conclusion

Dengue fever poses an increasing threat to public health in the United States and around the world. Gaps in research knowledge, combined with complex causality, make this disease enormously difficult to control, some say, "unstoppable" (Taylor, 2014). New tools are needed, which are effective and sustainable. Research supports targeting schoolchildren in dengue campaigns with educational animations. Theory also supports the use of animation within the school-aged demographic, as this medium is capable of increasing learning by combining visual and verbal imagery.

"Dengue Fever Comes To Town" successfully increased knowledge, attitude, and practice scores in both genders and all grade levels tested. Future studies are needed to further define the animation's effective age-range, the extent of generalizability, test-retest effects, and impact on disease rates.

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APPENDIX: STATEMENT OF ORIGINAL WORK

Academic Honest Policy

Capella University's Academic Honesty Policy (3.01.010) holds learners accountable for the integrity of the work they submit, which includes but is not limited to discussion postings, assignments, comprehensive exams, and the dissertation or capstone project.

Established in the Policy are the expectations for original work, rationale for the policy, and definition of terms that pertain to academic honesty and original work, and disciplinary consequences of academic dishonesty. Also stated in the Policy is the expectation that learners will follow APA rules for citing another person's ideas or work.

The following standards for original work and definition of plagiarism are discussed in the Policy:

Learners are expected to be the sole authors of their work and to acknowledge the authorship of others' work through proper citation and reference. Use of another persons' ideas, including another learner's, without proper reference or citation constitutes plagiarism and academic dishonesty and is prohibited conduct (p.1).

Plagiarism is one example of academic dishonesty. Plagiarism is presenting someone else's ideas or work as your own. Plagiarism also includes copying verbatim or rephrasing ideas without properly acknowledging the source by author, date, and publication medium (p.2).

Capella University's Research Misconduct Policy (3.03.06) holds learners accountable for research integrity. What constitutes research misconduct is discussed in the Policy:

Research misconduct includes but is not limited to falsification, fabrication, plagiarism, misappropriation, or other practices that seriously deviate from those that are commonly accepted within the academic community for proposing, conducting, or reviewing research, or in reporting research results (p. 1).

Learners failing to abide by these policies are subject to consequences, including but not limited to dismissal or revocation of the degree.

Statement of Original Work and Signature

I have read, understood, and abided by Capella University's Academic Honesty Policy (3.01.01) and Research Misconduct Policy (3.03.06), including the Policy Statements, Rationale, and Definitions.

I attest that this dissertation is my own work. Where I have used the ideas or words of others, I have paraphrased, summarized, or used direct quotes following the guidelines set forth in the APA Publication Manual.

Learner name and date: Julie Weisenbacher Huthmaker, 10/10/14

Mentor name and school: Dr. Haley Cash School of Public Service Leadership