Introduction

According to the World Health Organization (WHO, 2017), mosquitoes are the most prevalent vectors of disease and have caused nearly 800,000 deaths worldwide each year. In addition to their impact associated with diseases, mosquitoes can negatively impact people's quality of life by preventing them from enjoying outdoor activities during peak mosquito-breeding season (Halasa et al., 2014). Mosquito control is particularly important in Florida, which is home to more than 80 mosquito species (Connelly, 2016). As mosquitoes require water to lay their eggs, Florida's humid climate and wet habitats make it a prime breeding ground (Connelly, 2016). Rising and standing floodwater from hurricanes and tropical storms also contribute to increases in the number of mosquitoes in the state (Connelly, 2016). As such, it is necessary to identify best methods of ensuring appropriate measures be taken to reduce the population of mosquitoes in mosquito-prevalent areas.

The existence of mosquitoes can bring about several mosquito-borne illnesses, such as Dengue, West Nile, and Eastern Equine Encephalitis (American Mosquito Control Association, 2019). It is important residents be aware of the dangers associated with mosquito-borne illnesses and how they can protect themselves when outbreaks occur (Connelly, 2016). Personal responsibility is an important step to eliminating mosquitoes and preventing such outbreaks at the local level. Such responsibility may include eliminating standing water and wearing effective mosquito repellant (Connelly, 2016). However, personal responsibility measures alone are not always sufficient. In extreme cases, an organized approach to mosquito control is needed to mitigate the negative impact of mosquitoes in an area (Connelly, 2016). The Florida Anti-Mosquito Association, now the Florida Mosquito Control Association, was formed in 1922 in response to the recognized need for local, organized mosquito control. This association initiated the collective approach to mosquito control in Florida and sponsored legislation to establish organized mosquito control districts. Currently, many counties across the state operate mosquito control programs and mosquito control technicians conduct integrated pest control management year-around (Florida Mosquito Control Association, 2019).

According to the U.S. Environmental Protection Agency (EPA, 2012), public education about mosquitoes and mosquito control is an important component of mosquito control programs. Despite the commitment of mosquito control programs to educate the public on methods of mosquito control, many groups have expressed opposition to vector control methods (Bloss, Stoler, Brouwer, Bietz, & Cheung, 2017). Opposition to mosquito control is often derived from concerns over human exposure and exposure to non-target organisms (e.g., bees; Latham & Barber, 2007). However, regulations from Florida mosquito control programs and the EPA have dramatically reduced the risk to humans and, in most cases, non-target organisms (Latham & Barber, 2007). Local and state mosquito control associations have implemented public service measures to decrease public fear, including educational workshops and events, promoting environmentally safe control methods, and encouraging scientific advancement (Florida Mosquito Control Association, 2019).

Despite measures to decrease fear, public opposition of mosquito control still exists. Aerial application was scheduled during the Zika disease outbreak of 2016 to help eliminate mosquitoes that could possibly infect residents in Miami-Dade County. In response, concerned residents in the county held protests to stop the spraying in their area. Karimi and Visser (2016) interviewed residents in the county and found many believed spraying could have harmful impacts on the environment; residents also expressed feelings of uncertainty regarding what was being sprayed. Although aerial spraying continued despite pushback from some sectors of the

public, residents continued to raise questions (Karimi & Visser, 2016). The Florida Department of Health thus recognized the need to better communicate to residents about mosquito-borne illnesses and mosquito control. To do so, they partnered with the Florida Department of Agriculture and Consumer Services to commission the Center for Public Issues Education in Agriculture and Natural Resources at the University of Florida to produce an informational media campaign primarily for social media communication. Communicating about mosquito-related topics via social media should be analyzed to determine which types of content are most effective and what messages best engage audiences.

Conceptual Framework and Review of Literature

Communication methods to reach wide and mass audiences have traditionally included newspapers, radio, television, and magazines. However, the internet has become a widely used form of mass communication since the 1990s (Telg & Irani, 2012). These internet-based communication channels include websites, online videos, and social media (Telg & Irani, 2012). Communication through social media can be disseminated through many different platforms, such as blogs, podcasts, video, wikis, or websites (e.g., Facebook, Twitter, Instagram, etc.; Telg & Irani, 2012).

Two of the most widely used social media platforms for reaching a broad audience are Facebook and Twitter (Carter, 2018). While Facebook is the overall leader in number of users, Twitter is the front-runner for millennials and world leaders (Carter, 2018). Lau (2019) indicated that Facebook is the best platform to distribute videos and curated content, whereas Twitter is ideal for dissemination of news, blog posts, and GIFs.

All forms of communication, including social media, are often given specific context or frames, which inevitably shape social structures and views (Carrier, 2004; Eko, 1999). Entman (1993) described framing as selecting material representative of a perspective and making such material salient in communication to generate attention to the definition of a particular problem, interpretation of the cause, and evaluation of information being framed based on that perspective. Frames can be used to shape and organize information to situate the message for a certain perspective (Eko, 1999).

Frames can be organized by the party disseminating the message, but can then be interpreted by individuals based on their perspectives (Eko, 1999). The process of an individual receiving a message and interpreting the message based on their own perspectives is known as reception (Perry, 2004). The message is said to be *preferred* if the meaning of the message is perceived to be in alignment with the person's viewpoints (Perry, 2004). The message is *negotiated* if its meaning is perceived by a person neutral to the concepts being presented (Perry, 2004). If the perceived meaning of the presented message is in opposition to the message receiver's beliefs, then he or she may use a decoding process to determine if the message is in fact in opposition to his/her beliefs and values (Perry, 2004). The position of the frame (e.g. positive or negative) influences the receiver of the message, later affecting his or her decisions, outcomes, and perceived risk (Dunegan, 1993; Hornig, 1992).

According to Scheufele (1999), frame building, frame setting, individual-level effects of framing, and the linkage between individual and media frames comprise the framing process. Frame building is the process of developing frames in which your message will be presented (Scheufele, 1999). Frames being developed can be influenced by mass media personnel's beliefs and opinions, the mass media platform's political affiliation, and external opinion leaders (Scheufele, 1999). Frame setting is the process of developing the frame to ensure salience of the characteristics of the issue rather than the issue alone (Scheufele, 1999).

Forbes Agency Council (2018) noted developing messages that resonate with the public involve (a) trends and the impact of those trends, (b) education through authority, (c) content the developer would want to see or read, (d) a central focus for the content, (e) authentic accounts from people, (f) good storytelling, (g) locally driven issues, and (h) engaging material. Messages that visualize data to show impact, offer practical examples, and provide content that make it easiest for the consumer to understand and comprehend are also tools for developing content that resonates with the targeted audience (Wainwright, 2017). In addition, Hofstetter (2014) maintained that disseminating content across multiple platforms can resonate with multiple audiences.

Quantifying and calculating engagements is a numerical way to measure communication via social media messages to determine if relationships have been developed and messages are engaging audiences (Kerpen, 2015; Paine, 2011). The measure of engagement was originally developed to determine the level at which consumers became enthralled with a brand and consequently developed a relationship and generated engagement with that brand (Kerpen, 2015; Paine, 2011). The term *engagement* has evolved to quantify the number of social media functions (e.g. clicks, comments, likes, retweets, and shares) in which a consumer is engaging on social media platform(s) (Paine, 2011). Engagement is necessary for developing relationships with consumers, gaining publicity, and obtaining feedback for improvement (Kerpen, 2015; Paine, 2011). People can be engaged with media on a five-point scale where one represents *lurking* and five represents *loyal* (Paine, 2011). Success of engagements can be determined through an increase in sales, increased engagements, or improved relationships or reputation depending on the purpose for disseminating social media content (Paine, 2011).

Engagement rates may also be impacted by the organization disseminating information through social media. Professionals or organizations believed to be experts in their field are seen as more influential communicators than those not perceived as experts (Telg, Irani, Monaghan, Chiarelli, Scicchitano, & Johns, 2012). Lamm, Owens, Telg, and Lamm (2016) determined source credibility and framing were particularly important when communicating about issues related to agriculture and natural resources. They also found that science organizations are more trusted when communicating about negatively framed topics.

Purpose and Objectives

The purpose of this study was to explore follower engagement of a social media campaign employed to inform Florida residents about mosquito control. Two objectives guided this study:

1. Describe the social media engagement frequency by content type; and
2. Describe the social media engagement frequency by content frame.

Methods

A social media campaign that could be used by organizations or public officials communicating with the public about mosquitoes and mosquito control was curated. To develop this campaign, the Center for Public Issues Education in Agriculture and Natural Resources partnered with the Center for Risk Communication and conducted focus groups with Florida residents and decision makers to determine their concerns and questions related to mosquito control. The Center for Public Issues Education in Agriculture and Natural Resources also worked with an expert panel of scientists with specializations in entomology and public health to gain insight about mosquito control and mosquito-borne illnesses. Findings from preliminary focus groups and input from the expert panel helped determine four frames of the social media

campaign: (a) personal responsibility; (b) nuisance and economic impact of mosquitoes; (c) disease outbreak; and (d) mosquito control/aerial application.

Findings from the focus groups also helped inform the graphically illustrated artwork developed for the social media campaign. The artwork included two characters: Dr. Diaz, who was depicted a Hispanic female health professional; and Brad, who was depicted as a white male mosquito control technician (see Figure 1).

The depiction of Dr. Diaz was chosen to appeal to families and Hispanic audiences in Florida. The depiction of Brad was chosen to appeal to professional audiences. Four weeks of material (i.e. one week of social media posts and graphics per topic area) were developed and

Figure 1. Example of Dr. Diaz and Brad.

included in five types of content posts: (a) text graphics without the two characters (Figure 2); (b) text graphics with the two characters (Figure 3); (c) graphics without the characters (Figure 4); (d) graphics with the characters (Figure 5); and (e) and a kinetic typography video, a form of video comprised of animated text.

Figure 2. Example of text graphic without characters.

Figure 3. Example of text graphic with characters.
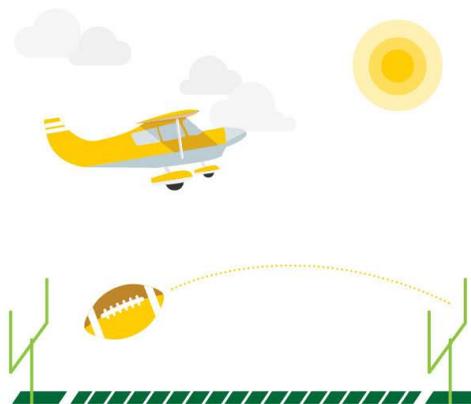
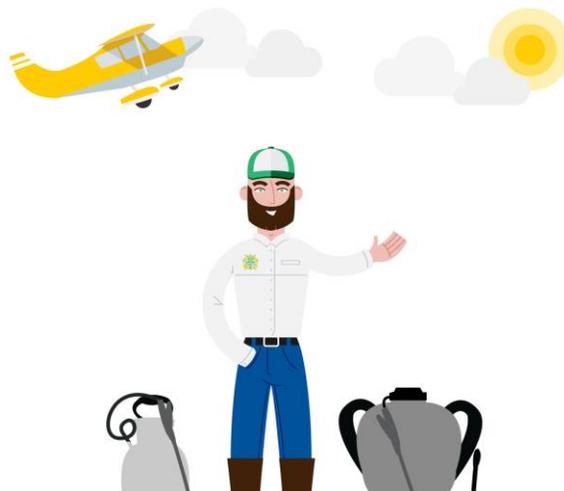*Figure 4.* Example of graphics without characters.

Figure 4. Example of graphics with the characters.

Text graphics were defined as graphics mainly consisting of text. Other graphics were primarily composed of graphical artwork. The typography video was a short graphical video with text that portrayed the intended message.

Content was developed by Center for Public Issues Education in Agriculture and Natural Resources staff who had career experience in biology education and science communication. Content was provided to the science experts and edits were made accordingly. The content was then posted to the Center for Public Issues Education in Agriculture and Natural Resources Facebook account between May 30, 2018, and June 28, 2018. During this timeframe, the Facebook account for the Center for Public Issues Education in Agriculture and Natural Resources had 2,435 followers. The followership was primarily made up of Extension professionals, agriculture and natural resources-related researchers, university faculty, and other audiences with interests related to agriculture. The followership audience was a limitation as the content was created for audiences, such as homeowners or public officials who may have limited knowledge about mosquito control. Each post was analyzed using Facebook insights and analytics reported through the social media platform. Descriptive statistics were used to meet objectives one and two. Engagement rate frequencies were calculated for post frames and post types. The following formula was used to determine the rate of engagement for posts (Laurence, n.d.; Popsters, 2017; Yamaguchi, 2014): Engagement Rate = sum of engagements / total number of followers x 100. It is important to consider that engagement is a continuous variable and largely depends on the numbers of followers, but does not account for engagement outside of the followership. Social media content can have high engagement scores with low actual engagement if the followership is also low (Yamaguchi, 2014).

Results

Objective One

Objective one was to describe the social media engagement frequency by content type. Posts that included a text graphic without a character post yielded the highest overall engagement rate (8.13%). These posts also had the highest frequencies of engagement in terms of likes, comments, and shares (see Table 1). Posts that included a text graphic with a character yielded the lowest overall engagement rate (0.33%), as well as had the lowest frequency of engagement in terms of likes. The typography video was the type of post that produced the lowest amount of share engagements (see Table 1).

Table 1
Frequencies of Audience Engagement in Mosquito Campaign Posts Based on Content Type

	n	Like	Comments	Shares	ER (%)
Text graphic without character	10	149	6	43	8.13
Text graphic with character	2	5	0	3	0.33
Graphic without character	10	42	3	19	2.63
Graphic with character	10	63	2	16	3.33
Typography video	1	9	0	2	0.45

Objective Two

Objective two was to determine the social media engagement frequency based on content frame. The personal responsibility frame encouraged the public to take preventative measures, such as wearing insect repellant and eliminating mosquito-breeding locations at their homes, to protect themselves and their families from mosquitoes. The mosquito-borne illness frame informed the public of the importance of combatting disease transmitted by mosquitoes. The nuisance and economy frame informed the public on the negative effects mosquitoes have on Florida's economy and the public's ability to enjoy outdoor activities. The application methods frame explained the application methods used by mosquito control programs to control mosquito populations.

The post frame that generated the highest frequency of engagement in terms of shares was the personal responsibility frame (3.0%). Posts in the nuisance and economy frame yielded the lowest overall engagement rate (1.56%; see Table 2).

Table 2
Frequencies of Audience Engagement in Mosquito Campaign Posts Based on Content Frame

	n	Like	Comments	Shares	ER (%)
Personal Responsibility	6	54	0	19	3.00
Mosquito-Borne Illness	7	40	2	16	2.38
Nuisance and Economy	7	28	0	10	1.56
Application Methods	9	38	4	14	2.30

Conclusions and Recommendations

When analyzing engagement by the type of content used, text graphics without a character had the highest engagement rate percentage, followed by graphics with the characters. Posts that included both texts graphics and a character yielded the lowest engagement rate percentage. Forbes Agency Council (2018) indicated using authority figures for education can be used as a technique to resonate with an audience. However, the characters developed to portray authority and educate audience members through this social media campaign (i.e., Dr. Diaz, the medical professional, and Brad, the mosquito control technician) did not generate the highest engagement. This finding could mean the authority figures were not the most effective and that other characters may resonate more effectively with the intended audience. Forbes Agency Council (2018) identified many other content factors that will resonate with the intended audience, including the impact of trends, storytelling, and locally-driven issues. Future research should determine if these other factors have a greater impact on resonating with audiences when compared to the use of authority figures when communicating about mosquito-related topics. It is recommended that future research determine if other types of opinion leaders, beyond the health care professional and mosquito control technician, could be used for mosquito-related communication. It could be determined that other types of technical professionals are effective spokespeople when communicating about mosquitoes for this audience or if the spokespeople used in this study can more effectively resonate with different audiences. Determining effective opinion leaders will inform what characters will be most compelling in communication materials, including social media. In addition to testing the authority figures that are being used, future research should test the visual components of this campaign. Because this campaign used text, graphics, characters, text, and kinetic typography videos, future research should investigate

if the use of photographs or detailed illustrations are more effective when communicating about mosquitoes and mosquito control.

The graphic with character posts yielded the second to highest engagement rate, which was 4.8% difference in engagement rate from the most engaged content type. The text graphic with character posts curated the lowest number of engagements of all the posts types. According to Yamaguchi (2014), engagement rates are difficult to compare due to the factors that contribute to the engagemnt rate and could explain why the engagement rates in this study were relatively low. Overall low engagement scores could be because the content included in this study was different than the content usually shared by Center for Public Issues Education in Agriculture and Natural Resources. Future research should test this social media content on other social media pages with audiences that may be interested in mosquito control and mosquiot-borne illnesses and should explore other methods of evaluation.

The frames for this social media campaign were created with input from scientists, Florida residents who participated in focus groups, and local decision makers. The frame that yielded the highest engagement rate with the Center for Public Issues Education in Agriculture and Natural Resources' Facebook audience was the personal responsibility frame. This may be due to the possibility that personal responsibility was the only frame audience members felt was in their own control. Mosquito-borne illness, nuisance and economy, and application methods were out of their direct control as citizens. The mosquito-borne illness and application methods frames followed the personality responsibility frame in audience engagement, with nuisance and economy as the least engaged theme. This may be because illness and application methods frames could pose a direct impact to the audience, either by contracting a mosquito-transmitted disease or by being affected in some way by mosquito control application methods. The nuisance and economy frame could be perceived as the frame that had the least personal relevance to the audience in this study, resulting in a low engagement rate. Four specific topics were addressed in the social media campaign. However, future research should determine if these same mosquito-related topics should be addressed in other states and regions in the United States and globally and what additional topics may be appropriate to address in other regions.

Recommendations for future research include posting the content to a social media site that has a followership more aligned with the intended audience. It should be determined if the developed content resonates more with the intended audiences and if the audiences have more effective engagement rates. Future research should also include testing the frames that were used in the social media campaign. In-depth focus groups could be conducted to learn more about what messages resonate with various audiences, what topics audiences want more information about, and what messages may lead to change in behavior.

Future research could also determine if the messages used in this social media campaign resonate with audiences differently when mosquitoes are in season, out of season, or have recently occurred due to a natural disaster, such as a hurricane. It should be determined if certain messages may be more effective based on the season, time of year, and climate being experienced in certain regions. It is further recommended that future research be conducted to determine how other organizations communicating about mosquito-related topics are using social media and what methods have been most effective for them. To address this need, it is recommended that future research include an analysis of social media content of national health organizations, mosquito control programs, and other entomological organizations across local, state, and national levels.

Per the findings of this study, practitioners should use personal responsibility frame when communicating to the Florida public about mosquito-related topics A personal responsibility frame may be effective to convey a message in a way that allows the public to feel as if they have control. It is also recommended that communication professionals consider the types of spokespeople they use to communicate about mosquito-related topics and to find opinion leaders who audiences recognize as authoritative.

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