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The Power of Movement: Testing Animated Infographics on Water Conservation Knowledge

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Abstract

Water is a finite resource, necessary for sustaining all facets of life; however, it is often taken for granted. Recognizing a level of risk associated with a diminishing water supply, communicating with the public about their contributions to water issues so they will reduce unnecessary consumption is of utmost importance. This study used an experimental design to test recall of key water facts after engaging with an animated infographic, static infographic, or receiving no visual. The study utilized the Risk Information Seeking and Processing Model and the Critical Thinking Style literature as a foundation to further inform how and why individuals process water information and the impact of targeted communication efforts. The findings indicated an animated infographic significantly impacted information recall. In addition, critical thinking style did not moderate the effect. The findings implied the inclusion of strategic communication materials may engage individuals in risk-laden topics to draw attention and increase recall of information. Recommendations for future research include the further examination of how individuals store information for future information processing and reasoning, how critical thinking style may impact media channel selection, and if critical thinking style alters information gathering capacity. Regardless of critical thinking style or type of infographic, this study provided evidence for the creation and use of engaging information visualizations when providing scientific information with the intent of informed decision making around significant issues, like water, in the future.

Introduction

A safe and abundant water supply is crucial for urban and rural communities, especially given the growing world population and agricultural demand (Fischer et al., 2018). Despite decades of effort in educating and communicating about water issues; water stress, scarcity, and pollution still impact households, health, education, economics, and the integrity of the natural environment (United Nations, 2021). United Nations International Children's Emergency Fund (UNICEF) reported one in five children worldwide lack sufficient water for their daily needs (UNICEF, 2021) and the World Health Organization (WHO) identified one in three people globally have problems accessing drinking water (WHO, 2019).

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Despite the ongoing crisis, it is easy for those who have access to safe and abundant water to take it for granted (Gleick, 1998). In the United States (U.S.), many consumers are unaware of the severity of water scarcity or have limited knowledge on how to conserve water, highlighting the need for effective water education (Moglia et al., 2018). To increase awareness of water issues and encourage water conservation practices, water education initiatives and programs have been offered and operated at the regional (e.g., Midwest water quality program, Central Florida Water Initiative), national (e.g., USDA National Water Quality Program, USDA Rural Development Water and Environmental Programs), and global (e.g., Global Water Initiative, International Initiative on Water Quality) levels. These programs utilize education materials to transfer knowledge, articulate the impact of water, and communicate the urgency of adopting water-conserving practices (Herve-Bazin, 2014). Researchers and conservationists have been applying and testing innovative educational approaches using social media (Getchell & Sellnow, 2016; Pawsey, Nayeem, & Huang, 2018; Silvert et al., 2021), augmented reality (McMillan, Flood, & Glaeser, 2017; Ruiz-Díaz et al., 2017), and virtual reality (Hsu et al., 2018) to enhance water education programs. However, the use of infographics as a tool for increasing knowledge retention about water conservation remains unexplored.

Infographics (also called informational graphics) have been gaining popularity as a means of conveying information via internet (Byrne & Cook, 2013; Fogel, 2013; Segel & Heer, 2010). According to Mashable (2013), a single infographic could reach 15 million people, making it a promising tool for communicating science effectively (Lazard & Atkinson, 2014). The versatility of graphic illustration provides an accessible format for transferring scientific data and processes into graphic drawings and text, allowing individuals to grasp the information more effectively (Afify, 2018).

Infographics can be static, animated, or interactive (Afify, 2018). Selected elements can be highlighted with motion and emphasis with animated infographics while interactive infographics allow the user to move and control the engagement experience (Afify, 2018; Holt et al., 2020). Holt et al. (2020) examined American consumers' information recall after viewing facts about genetic modification via static and animated infographics. Results indicated the animated infographic yielded a greater information recall than the static infographic. The researchers recommended future research on the effectiveness of static and animated infographics when communicating about other agricultural issues (Holt et al., 2020).

Additionally, prior works have documented that infographics reduced cognitive efforts of information processing of scientific and environmental messages, as compared to text-only formats (Lazard & Atkinson, 2014; Martin et al., 2019; Tu et al., 2018). Lazard and Atkinson (2014) further disclosed infographics yielded higher elaboration than text-only materials and concluded that using visuals to explain complex information is "a reliable communication strategy" (p. 27). Additionally, Burnett et al. (2019) compared the effect of the interactive versus static infographics on the elaboration of agricultural information, and found participants who viewed the interactive message had a significantly higher elaboration compared to those who viewed the static message.

Water scarcity is one of the most urgent issues around the globe and it is not temporary (McKim et al., 2018). Agriculture, food, and natural resource educators can play a role in mitigating the water crisis but they need the most effective tools to educate an audience that is constantly inundated with information (McKim et al., 2018). Investigating the effects of infographics on information recall about water issues will help develop effective educational materials for formal and nonformal programs, addressing the 2016-2020 American Association for Agricultural Education (AAAE) National Research Agenda (Thoron et al., 2016). Specifically, priority area five of the research agenda calls for effective methods to communicate agricultural information with diverse audiences (Thoron et al., 2016).

Conceptual Framework

A conceptual framework using the Risk Information Seeking and Processing (RISP) model and critical thinking style literature was developed to examine the cognitive processing of information and explore the impacts of targeted communication using specific approaches to developing and disseminating infographics as a form of information visualization.

Risk Information Seeking and Processing

The RISP model pulls upon several theories and models to understand how and why individuals will search for and act upon receiving information when presented with a topic or issue with some level of risk associated (Dunwoody & Griffin, 2015; Griffin et al., 1999). The RISP model is integral to understanding how an individual cognitively seeks, interprets, and applies information (Dunwoody & Griffin, 2015). Specifically, within the model, how an individual will use media channels to find and interpret information is identified as relevant channel beliefs (Griffin et al., 2004). The RISP model considers individual demographics (*Individual Characteristics*), an individual's perceived ability to find information (*Perceived Information Gathering Capacity*), perceived risks associated with a topic or issue (*Perceived Hazard Characteristics*), an individual's mood or emotional connection to the topic (*Affective Response*), how others in the individual's life view the topic (*Informational Subjective Norms*), an individual's perceived level of knowledge about a topic (*Information (In)Sufficien*cy), the sources individuals use to gather information (*Relevant Channel Beliefs*), and how an individual cognitively processes the information (*Information Seeking/Processing Behavior*) (Dunwoody & Griffin, 2015, Griffin et al., 2004; Griffin et al., 1999).

When utilizing the RISP model to understand the public's behaviors related to environmental impacts of watersheds, namely stream conservation, Slagle et al. (2015) posited that awareness and usable information would be key components to individuals performing conservation behaviors. Researchers have recommended a personal connection should be made to the risk-laden issue to engage individuals' systematic processing of water conservation (Slagle et al., 2015).

Specifically, the RISP model takes into account two variables related to how individuals search for and cognitively process information about a topic with a level of risk associated with it: 1) *Information Seeking* and 2) *Information Processing* (Slagle et al., 2015). *Information Seeking* refers to how an individual selectively searches for information, while *Information Processing* accounts for how an individual cognitively processes information once it is obtained (Slagle et al., 2015). Within information processing, individuals select one of two modes to analyze information presented to them: 1) heuristic or 2) systematic (Chaiken et al. 1989). Within heuristic processing, individuals gather less information to form a judgement, relying upon generalizations and schemata (Chaiken et al., 1989). Within systematic processing, individuals critically analyze information, often with greater cognitive effort than heuristic (Chaiken et al., 1989). While often requiring more motivation, systematic processing does not inherently indicate an individual is more open-minded, unbiased, or capable of considering the information (Chaiken et al., 1989).

Ahn and Noh (2020) explored the relationship between the RISP model and the inclusion of institutional trust. Institutional trust was operationally defined as the trust placed within agencies responsible for making decisions and overseeing the wellbeing of the public during times or events with a level of risk associated (Ahn & Noh, 2020). The researchers found a significant effect of institutional trust and information seeking; possibly indicating that institutional trust may serve as conduit to lessen cognitive effort in processing information delivered by this source (Ahn & Noh, 2020). Research has indicated RISP is a beneficial framework for identifying how individuals seek and process information when an environmental risk spans national and global concerns, especially when examining specific characteristics that may impact information seeking and processing behaviors (Ahn & Noh, 2020).

Critical Thinking Style

Critical thinking has been identified in various contexts over the years. From an educational perspective, critical thinking has been viewed as intellectual standards (Paul, 1995), to a philosophical definition of how individuals engage in "active, purposeful, and organized efforts to make sense of our world by carefully examining our thinking, and the thinking of others in order to clarify and improve our understanding" (Chafee, 1988, p. 29). Identifying how individuals prefer to process information is imperative to be able to design appropriate messaging and information to facilitate informed decision making. An individual's critical thinking style can shed light on a one's preferred method of processing information (Gorham et al., 2014; Lamm, 2015).

Lamm and Irani (2011) indicated individuals typically fall into two categories along a continuum of critical thinking style when processing information: *seekers* or *engagers*. Individuals who are classified as *seekers* actively search for information and are continually looking for opportunities to augment their knowledge. According to Lamm and Irani (2011), a seeker is "a person with a high tendency for seeking information style is aware of their own predispositions and biases, recognizing current opinions and positions have been influenced by who he is, his environment, and experiences" (p. 7). An engager is "an individual [… that] is aware of their surroundings and is able to anticipate situations" (Lamm & Irani, 2011, p. 7). Individuals who follow an engagement style of critical thinking utilize reasoning skills to solve internal issues about a topic. Identifying and recognizing an individual's preferred method of critical thinking can help tailor messages and information to make informed decisions (Gorham et al., 2014; Lamm, 2015).

Critical thinking style has been examined in numerous risk related contexts, including crisis events (Gibson et al., 2021), genetic modification (Wu et al., 2020), and water conservation (Owens & Lamm, 2016). When specifically examining how critical thinking style impacted reactions to receiving messages, Owens and Lamm (2016) concluded that individuals who intentionally sought out information when critically thinking about a topic were more likely to engage in water conservation behaviors related to landscaping. Therefore, identifying how an individual chooses to process and critically engage with information is paramount to understanding their behaviors and future decisions.

Information Visualization

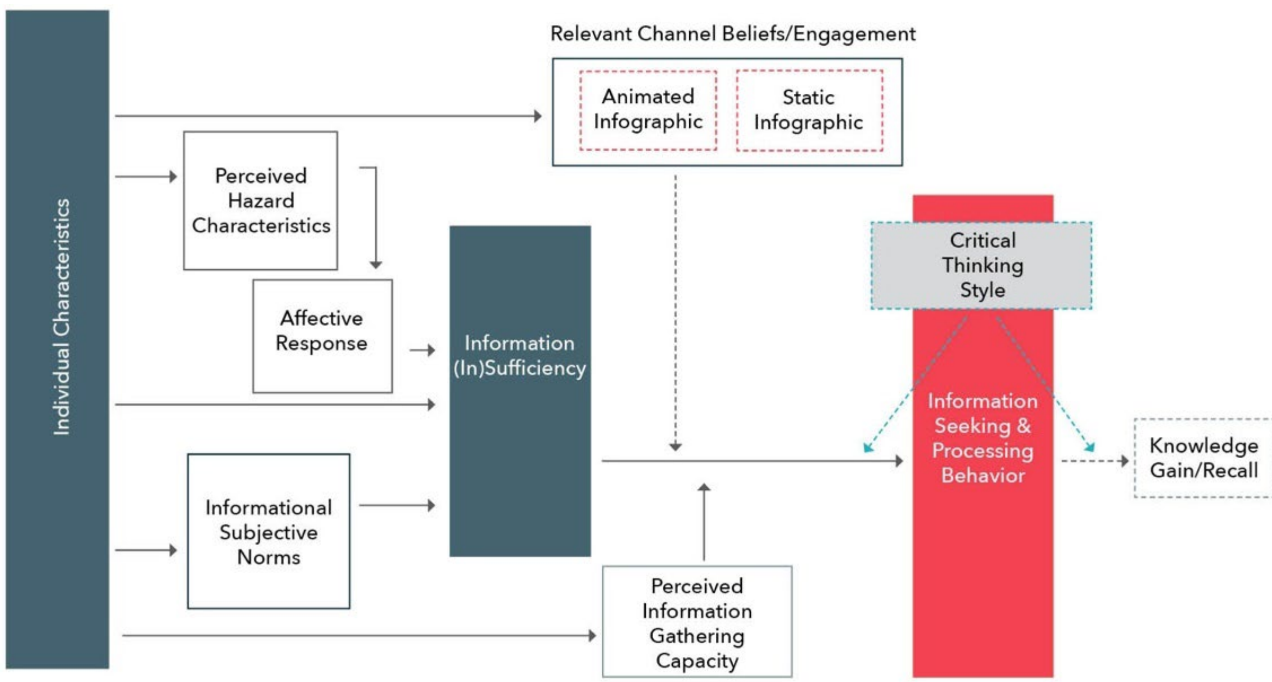
Several categories of distinguishing visualizations (data visualization, science visualization, information visualization, etc.) exist. The visualization categories can, and often, take on different definitions depending on author and or discipline. For clarity, information visualization in the current study is defined as the graphical representation of information to create comparisons, identify connections, and recognize changes through the use of a defined visual system (Chen, 2010; Khan & Khan, 2011). "Like art, information visualization aims to communicate complex ideas to its audience and inspire its users for new connections" (Chen, 2010, p. 387). Information visualization systematically integrates components from graphic design and computer science to reinforce cognitively processing data in meaningful and logical ways; however, a flaw has been noted within the field that is not replicable by software – emotion (Lengler & Vande Moere, 2009). Emotion, a precursor for forming and solidifying beliefs (Pooley & O'Connor, 2000), has yet to be authentically recreated by technology or algorithms (Lengler & Vande Moere, 2009); therefore, information visualization can be applied to create connections and meaning for abstract ideas (Chen, 2010). Two types of information visualization are used to create connections: functional and aesthetic. Functional visualization communicates a specific message to the user based on the data; however, aesthetics relies upon the creator to interpret and convey an interpreted meaning of the data to inspire an emotionally triggered reaction (Chen, 2010).

The ultimate goal of information visualization is for the viewers of the content to gain new insights or ideas as a result of the graphic (Chen, 2010). More specifically, the intent is to create and inspire action by the user as a response to engaging with the information presented graphically (Chen, 2010). Inherently, persuasion is at the heart of infographics (Lengler & Vande Moere, 2009). By utilizing digital representations of complex issues in relevant and relatable ways to the public, information visualizations have the ability to link data and evoke personal emotions (Chen, 2010). "Good visualizations with external data focus are designed to be appreciated by interpretation, with the intention of invoking persuasion. Animated infographics with intent of persuasion provide only possibility of interpretation" (Lengler & Vande Moere, 2009, p. 586). Implementing animation into a design directs attention and minimizes the gap between cognitively processing information and creating a meaningful connection to an individual's emotion with the information (Lengler & Vande Moere, 2009; Holt et al., 2020; Lamm et al., 2020).

Recognizing the interplay between RISP, CTI, and information visualization, the conceptual model below was created. The current study examined the specific channel of infographics, both animated and static, in addition to critical thinking style as a moderating variable on information processing behavior on knowledge gain/recall. The conceptual model indicates the tested variables with dashed lines and arrows.

Figure 1

Conceptual Framework Model utilizing RISP (Griffin et al., 1999).



Purpose and Research Objectives

The purpose of this study was to determine if knowledge about water use is impacted by the receipt of an animated or static infographic and if the impact was moderated by critical thinking style. The following research objectives and hypotheses were used to guide the study:

RO1. Describe respondents' knowledge levels of water use when receiving no infographic, a static infographic or an animated infographic about water use.
RO2. Determine if a respondent's knowledge level of water use is predicted by receiving no infographic, a static infographic or an animated infographic about water use.

H1. Respondents viewing an infographic related to water use will exhibit greater knowledge levels than respondents not receiving an infographic.
H2. Respondents viewing an animated infographic will exhibit greater knowledge levels than respondents viewing a static infographic.
RO3. Describe respondents' critical thinking style.
RO4. Determine if differences in a respondents' knowledge level of water use based on the type of infographic viewed (none, static or animated) were moderated by critical thinking style.
H3. Regardless of type of infographic viewed (none, static or animated) respondents' knowledge level of water use will be moderated by critical thinking style.

Figure 2.

Static Infographic

Methods

An experimental design was used to address the research objectives using an online survey. U.S. residents age 18 or older were identified as the population of interest. The research presented here was part of a larger study exploring the most appropriate ways to communicate with the public about water issues and climate change. Three sections of the survey were germane to this study: knowledge level, critical thinking style and demographic characteristics.

Prior to answering any questions about water or climate change, respondents were randomly assigned to one of three treatment groups. Depending upon their treatment group, respondents did not receive an infographic (control), received a static infographic, or received an animated infographic. The static and animated infographics were identical except for the introduction of movement in the animated version. Figure 1 shows the static version of the infographic. Animations included timed and coordinated animations to follow the reader from top to bottom, with emphasis added to the data presented with fade in and expansion of the text. Additionally, each set of data presented moved in from the side, with the number and visual graphic associated with the information appearing at different time intervals to draw attention to key elements and help pace the flow of information presented. Water droplets were used in the background to remind and emphasize the purpose of the infographic. The droplets faded into view with timing and from top to bottom to help direct the viewer through the infographic. The static version of the infographic provided the same information in design and content but with no animations.

To ensure respondents spent a minimum amount of time deemed necessary to view the entire infographic, a timer was set on both treatments. Once they viewed the infographic, respondents were asked to indicate what the visual at the very bottom of the page was using a multiple-choice question. There was only one correct response from the three presented. Respondents were also allowed to indicate they were unable to see the infographic. If the question was not answered correctly, or they were unable to view the infographic, they were dismissed from the survey and their responses were not included in the analysis.

Table 1

Knowledge questions and possible responses

Question	Possible responses (Correct response is in bold)
How many gallons of water does it take to grow enough cotton for one t-shirt?	205 **485** 706
How many gallons of water are used to make a 12-ounce jar of peanut butter?	**90 gallons** 50 gallons 150 gallons
By fixing leaking pipes in your house, a farmer could grow enough peanuts to fill how many jars of peanut butter with the water you saved in that year?	12 **73** 134
How many gallons of water does it take to grow enough wheat to make a loaf of bread?	**262 gallons** 505 gallons 75 gallons
In one year, a farmer would have enough water to grow enough wheat for 9 more loaves of bread if you reduced your shower by how many minutes?	10 minutes **5 minutes** 7 minutes

Knowledge level of water use was measured using five multiple-choice questions (see Table 1). When a respondent answered a question correctly, they received a score of one; an incorrect response resulted in a score of zero for that question. The scores for the five questions were summed to create an overall knowledge score. A zero indicated a respondent did not respond correctly to a single question. A score of five indicated a respondent answered all five questions accurately.

Respondents were then asked to complete the University of Florida Critical Thinking Inventory (CTI; Lamm & Irani, 2011). The CTI is a measure of critical thinking style. The CTI is made up of 20 items combined to measure critical thinking style on a continuum. The literature suggests all individuals are critical thinkers (Facione, 1990), however, when presented with a problem that does not have a definitive right or wrong answer, individuals may engage in the process of critical thinking differently (Gay et al., 2015; Lamm, 2015). The level an individual engages with others when critical thinking is on one side of the continuum while the level an individual seeks out information is on the other end. Research has shown each person personifies both sides of the continuum at different levels (Lamm, 2015; Putnam et al., 2017). Therefore, those who engage with others more when thinking critically are considered engagers while those who seek information more when thinking critically are considered seekers (Lamm & Irani, 2011).

The CTI (Lamm & Irani, 2011) is a thoroughly vetted a reliable scale that measures critical thinking style by requesting respondents indicate their level of agreement or disagreement with 20 statements on a five-point Likert-type scale (1 = *Strongly Disagree*; 2 = *Disagree*; 3 = *Neither Agree nor Disagree*; 4 = *Agree*; 5 = *Strongly Agree*). Possible overall CTI scores can range from 26-130 with seekers identified as those with scores of 78.5 and above and engagers with scores of 78.4 and below (Lamm & Irani, 2011).

An expert panel specializing in water issues, environmental science communication, critical thinking styles, public opinion research and survey design reviewed the instrument for content and face validity and suggested minor changes. When the instrument was finalized, Institutional Review Board approval was obtained from the University of Georgia. The panel of experts included an assistant professor from Iowa State University, an assistant professor from the University of Missouri, a professor, an associate professor, and an extension evaluation specialist from the University of Georgia.

Non-probability opt-in sampling was used to recruit respondents geographically representative of the U.S. public. Qualtrics, a public opinion survey research company, was contracted to obtain the sample. Quotas were set *a priori* to align respondents with the 2010 U.S. Census. Non-probability samples are commonly accepted as a sampling technique in agricultural communication research (Lamm & Lamm, 2019) and are used in public opinion research to overcome issues with non-response bias but can introduce limitations to generalizability (Baker et al., 2013). The current study utilized an experimental design with the random assignment of treatments, therefore the typical adjustments needed with non-probability samples was not required. However, since weighting techniques to adjust for error introduced in nonprobability sampling have been found to yield results as good and sometimes even better than probability-based samples (Abate, 1998; Twyman, 2008; Vavreck & Rivers, 2008), the research team chose to weight the dataset *post hoc* using post-stratification methods (Kalton & Flores-Cervantes, 2003).

A total of 1,049 responses were obtained after the attention filter was used. Respondents varied in age from 19 to 93 representing a wide distribution (M = 45.04, SD = 17.55). Additional detailed demographics of the respondents can be found in Table 2. Data was analyzed descriptively, using frequencies and means, and inferentially using an ANOVA and an ANCOVA to address the research objectives and test the hypotheses.

Results

Knowledge level based on treatment

Respondents were randomly assigned to the three treatment groups. One received the static infographic, one the animated infographic, and one was a control receiving no infographic. Respondents in the first two groups then viewed their respective treatment with a time filter ensuring they spent enough time to actually view the entire thing before clicking on to the next question. They were then asked to answer a multiple-choice question asking them to indicate what they viewed at the bottom of the infographic as an attention filter. The correct answer was “farm” for both treatment groups. If the respondent did not answer the question correctly, thereby failing the attention filter, they were removed from further completion of the survey and their response was not used in data analysis. If the respondents answered the question correctly or were in the group receiving no treatment, they were asked to respond to five multiple-choice questions with answers that were present on both the static and animated infographic. Each question had only one correct response. The accuracy of respondents’ responses can be seen in Table 3. Respondents in the control group answered the least number of correct responses to all five questions. Respondents in the static group had a lower number of correct responses to all five questions than those in the animated group.

Table 2

Demographics of Respondents (N = 1,049)

	n	%
Sex		
Male	525	50.0
Female	524	50.0
Race		
White	759	72.4
Black	148	14.1
Asian or Pacific Islander	102	9.7
American Indian or Alaska Native	33	3.1
Other	22	2.1
Hispanic Ethnicity	99	9.4
Education		
Less than 12th grade	22	2.1
High school	202	19.3
Some college	204	19.4
2-year college degree	109	10.4
4-year college degree	272	25.9
Graduate or Professional degree	240	22.9
Political Beliefs		
Very Liberal	146	13.9
Liberal	206	19.6
Moderate	384	36.6
Conservative	188	17.9
Very Conservative	125	11.9

An overall score was then obtained by summing the responses to the three recall questions. Each correct response received one point; an incorrect response received zero points. Therefore, an overall information recall score could range from zero to five. The control group had the lowest mean score (M = 2.14, SD = 1.13). The static treatment group had a lower overall mean score (M = 2.54, SD = 1.22) than the animated group (M = 2.95, SD = 1.35). An ANOVA was used to determine if the difference in overall scores between the three treatment groups had a statistically significant difference. The results indicated a statistically significant difference in knowledge scores between the three groups ($F_{2,\,1046} = 35.55$, $p < .00$, $n_p^2 = .064$). The findings confirmed the first hypothesis (H1) indicating knowledge is greater when a respondent views an animated infographic than a static infographic. It also confirms any type of infographic results in greater knowledge level than not receiving an infographic. Based on Cohen's (1988) guidelines, the effect size is medium and 6.4% of the change in knowledge level is associated with the treatment received.

Table 3

Knowledge level after receiving no treatment, viewing a static infographic or viewing an animated infographic

	Correct Answer %			
Question	Static n = 354	Animated n = 232	Control n = 463	X^2
Gallons of water it takes to grow enough cotton for one T-shirt	57.9	59.9	48.6	10.87**
Gallons of water used to make 12-ounce jar of peanut butter	38.4	53.4	25.5	53.75***
Jars of peanut butter filled in a year by fixing leaky pipes	56.5	60.8	44.7	19.87***
Gallons of water it takes to grow enough wheat for a loaf of bread	39.0	52.6	38.2	14.68**
Grow enough wheat for 9 more loaves of bread if you reduced your shower by 5 minutes	62.1	68.5	57.0	8.80*

Note. *$p < .05$; **$p < .01$; ***$p < .001$.

Critical Thinking Style

Respondents' overall critical thinking style scores were similar to previously reported population averages (M = 78.28, SD = 4.21). However, there were more engagers (62.2%) in the group than seekers (37.8%).

Table 4

Critical thinking style scores by treatment groups

	n	*M*	*SD*
Control	354	78.23	3.93
Static infographic	232	78.46	3.97
Animated infographic	463	78.23	4.54

Level of knowledge after being presented with no information, a static infographic or an animated infographic moderated by critical thinking style

An ANCOVA was used to determine if critical thinking style moderated knowledge level based on treatment group. Respondents' knowledge level was not moderated by CTI score ($F_{3, 1045}$ = .61, p = .44). The finding did not confirm the second hypothesis (H2) indicating the effect of the treatment group on information recall was not moderated by critical thinking style.

Conclusions

Water is essential for sustainable economic development, a healthy environment, and the food system (Fischer et al., 2018). While programs and initiatives exist to inform individuals about the complexities surrounding the allocation, abundancy, and preservation of the water supply, many consumers are unaware of how they can conserve water, indicating new educational strategies are needed to increase water conservation knowledge (Moglia et al., 2018). Therefore, this study sought to explore if static versus animated infographics impacted consumers knowledge level related to water and if critical thinking style influenced the associated knowledge level. The findings from this research build upon previous literature highlighting the potential for utilizing strategic education materials to ensure the importance of water in sustaining life is widely known (Dickson, 2005; Lamm et al., 2015).

The first research objective examined the ability of individuals to correctly answer water knowledge questions. A control group received no infographic and answered the least number of questions correctly about water usage. The group receiving the static infographic answered less questions correctly than the group receiving an animated infographic; therefore, the group receiving the animated infographic had the strongest level of information recall. This finding supports existing literature that recommended the inclusion of infographics to increase engagement and recall among respondents (Burnett et al., 2019; Holt et al., 2020). Agriculture, food, and natural resource educators should incorporate animated infographics into their lessons about water conservation to help draw attention to key points and increase recall. Websites and other online platforms for information about water conservation and protection are preferred by consumers (e.g., Dewald et al., 2018), allowing for easy application of animated inforgraphics as an educational tool in asynchronous programs. Even utilizing a static infographic increased respondents' ability to recall key facts about water usage compared to receiving no message; therefore, the current study supports the utilization of information visualization or infographics to increase recall and sharing of information related to water education. Agriculture, food, and natural resource educators could enhance youth programming related to water conservation by having the students design infographics that could be used in local contexts to further elicit emotional responses. For example, students could design a static inforgraphic that is printed and hung on bulletin boards around the community. Older students could create animated infographics that are featured on the school website or by local businesses with animated signs.

The second research objective sought to understand if critical thinking style moderated the ability to recall water information. The findings failed to accept the second hypothesis, in that critical thinking style did not have a significant impact on ability to recall information. When examining critical thinking style, whether a person falls into a *seeker* or *engager* category, did not have a significant impact on ability to recall key information given in the infographic. The finding aligns with Gibson et al. (2021) who examined critical thinking style, mainstream information sources, and social media in the context of U.S. consumers belief of the origin of COVID-19 and found critical thinking style was not a significant predictor of consumers belief of the origin of COVID-19. Risky information, such as water scarcity, may cause individudals to engage in information differently than their normal processing tendency. Therefore, this finding directly applies to the RISP model for information processing.

Based on the literature, a *seeker* is identified as someone who is constantly searching for information to better understand the world while an *engager* is someone who prefers to rely upon his/her reasoning skills to understand the issues presented (Lamm & Irani, 2011). Critical thinking style relates directly to an individual's characteristics and his/her *information seeking and processing behavior* within the RISP model illuminating an interesting avenue for exploration between critical thinking style, engagement, information seeking and information processing. Further research is needed to identify specifically how an engager identifies *information sufficiency*, relying solely on his/her reasoning to move toward information processing. Seekers, by definition, would move laterally through the RISP model from characteristics, information (in)sufficiency, to information seeking and information processing. This presents an opportunity to further exploration of how and when individuals, namely engagers, receive information through various sources (*relevant channel beliefs* and *perceived information gathering capacity*), and store information for future rationale and information processing behaviors.

Additionally, critical thinking style could be impactful to understanding whether or not an individual is heuristically or systematically processing information. Systematic processing requires an individual to exert greater cognitive effort to analyze information (Chaiken et al., 1989). Based on the framework for critical thinking style, *engagers* process information systemically because they rely more upon reasoning skills than seeking information, hence we proposed hypothesis two. However, this hypothesis was not accepted. Further examination is needed to understand if the channel (static versus animated) had a greater impact on information processing than an individual's critical thinking style. This finding merits further examination to inform the creation of impactful messaging that will transfer information related to water usage.

The current study provided further evidence for the inclusion of information visualization about water usage. Regardless of animated or static, information visualization significantly impacted the ability to recall key facts about water usage. This highlights the value of strategic visual communication materials to inform the public about topics with a level of risk associated (Holt et al., 2020; Lamm et al., 2015). Overall, the study further elucidated the need to create and distribute effective visual scientific information especially surrounding topics of great importance to the public. Water is a finite resource and the development and dissemination of key, strategic communication could positively impact the type and quality of information individuals have when making decisions about its importance and protection.

References

Ahn, J. & Noh, G. Y. (2020). Determinants of environmental risk information seeking: An emphasis on institutional trust and personal control. *Health, Risk & Society,* 22(3–4), 214–230. https://doi.org/10.108/13698575.2020.1813261

Ahteensuu, M. (2012). Assumptions of the deficit model type of thinking: Ignorance, attitudes, and science communication in the debate on genetic engineering in agriculture. *Journal of agricultural and environmental ethics*, *25*(3), 295–313. https://doi.org/10.1007/s10806-011-9311-9

Thoron, A. C., Myers, B. E., Barrick, R. K. (2016). *American Association for Agricultural Education national research agenda: 2016-2020*. In Roberts, T. G., Harder, A., & Brashears, M. T. (Eds). Gainesville, FL: Department of Agricultural Education and Communication. http://aaaeonline.org/resources/Documents/AAAE_National_Research_Agenda_2016- 2020.pdf

Burnett, E., Holt, J., Borron, A., & Wojdynski, B. (2019). Interactive infographics' effect on elaboration in agricultural communication. *Journal of Applied Communications, 3*(103). https://doi.org/10.4148/1051-0834.2272

Byrne, D., & Cook, G. (2013). *The best American infographics 2013*. Boston, MA: Houghton Mifflin Harcourt.

Chaffee, J. (1988). Thinking critically. Boston, MA, Houghton Mifflin.

Chaiken, S., Liberman, A., & Eagly, A. H. (1989). Heuristic and systematic information processing within and beyond the persuasion of context. In J. S., Uleman & J. A. Bargh (Eds.), *Unintended thought* (pp. 212–252). Guilford Press: New York, NY.

Chen, C. (2010). Information visualization. *WIREs Computational Statistics, 2*, 387–403. https://doi.org/10.1002/wics.89

Chmielewski, T. C., & Dansereau, D. F. (1998). Enhancing the recall of text: Knowledge mapping training promotes implicit transfer. *Journal of Educational Psychology*, *90*(3), 407. https://doi.org/10.1037/0022-0663.90.3.407

Cuddihy, E., & Spyridakis, J. H. (2012). The effect of visual design and placement of intra-article navigation schemes on reading comprehension and website user perceptions. *Computers in human behavior*, *28*(4), 1399–1409. https://doi.org/10.1016/j.chb.2012.03.002

Dewald, S., Leggette, H. R., Murphrey, T. P., Berthold, A. & Wagner, K. (2018). Communicating to landowners in the Texas Little River watershed: A descriptive analysis of their communication preferences for receiving water-related information. *Journal of Agricultural Education, 59*(2), 343–369 https://doi.org/10.5032/jae.2018.02343

Dickson, D. (June, 2005). The case for a 'deficit model' of science communication. An editorial based on a presentation on Public Communication of Science and Technology Working Symposium on 'Strategic Issues in Science and Technology Communication', Beijing, China. Retrieved from https://earthscience.rice.edu/wp-content/uploads/2018/01/dickinson-2005-deficit-model-scinet.pdf

Dunwoody, S., & Griffin, R. J. (2014). The role of channel beliefs in risk information seeking. In J. Arvai & L. Rivers (Eds.), *Effective risk communication* (pp. 220–233). Routledge-Earthscan.

Eagly, A. H. & Chaiken, S. (1993). The Psychology of Attitudes. Harcourt Brace Javanovich College Publishers: Fort Worth, TX.

Fischer, L. M., Cummins, R. G., Gilliam, K. C., Baker, M., Burris, S., & Irlbeck, E. (2018). Examining the Critical Moments in Information Processing of Water Conservation Videos within Young Farmers and Ranchers: A Psychophysiological Analysis. *Journal of Agricultural Education*, *59*(2), 1–15. https://doi.org/10.5032/jae.2018.02001

Fogel, B. (2013, October 18). *Show, not tell: The rise of the infographic.* Science Friday. Retrieved from http://www.sciencefriday.com/blogs/10/18/2013/shownot-tell-the-rise-of-the-infographic.html?series=20

Getchell, M. C., & Sellnow, T. L. (2016). A network analysis of official Twitter accounts during the West Virginia water crisis. *Computers in Human Behavior, 54*, 597–606. https://doi.org/10.1016/j.chb.2015.06.044

Gibson, K. E., Sanders, C. E., & Lamm, A. J. (2021). Information Source Use and Social Media Engagement: Examining their Effects on Origin of COVID-19 Beliefs. *SAGE Open*, *11*(4). https://doi.org/10.1177/21582440211061324

Gleick, P. H. (1998). The human right to water. *Water Policy, 1*(5), 487–503. https://doi.org/10.1016/S1366-7017(99)00008-2

Gorham, L. M., Lamm, A. J., & Rumble, J. N. (2014). The critical target audience: Communicating water conservation behaviors to critical thinking styles. *Journal of Applied Communications, 98*(4), 42–55. https://doi.org/10.4148/1051-0834.1092

Griffin, R. J., Dunwoody, S., & Neuwirth, K. (1999). Proposed model of the relationship of risk information seeking and processing to the development of preventive behaviors. *Environmental Research, 80*, S230–S245. https://doi.org/10.1006/enrs.1998.3940

Griffin, R. J., Neuwirth, K., Dunwoody, S., & Giese, J. (2004). Information sufficiency and risk communication. *Media Psychology, 6*(1), 23–61. https://doi.org/10.1207/s1532785xmep0601

Herve-Bazin, C. (Ed.). (2014). Water communication. IWA Publishing.

Holt, J., Lamm, A. J., Gibson, K., Lamm, K. W., Ellis, J. D., & Rumble, J. N. (2020). Animating science communication: Measuring U.S. consumers' recall about genetic modification with animated infographics. *Journal of Applied Communications, 104*(3). https://doi.org/10.4148/1051-0834.2327

Houts, P. S., Doak, C. C., Doak, L. G., & Loscalzo, M. J. (2006). The role of pictures in improving health communication: a review of research on attention, comprehension, recall, and adherence. *Patient education and counseling*, *61*(2), 173–190. https://doi.org/10.1016/j.pec.2005.05.004

Hsu, W. C., Tseng, C. M., & Kang, S. C. (2018). Using exaggerated feedback in a virtual reality environment to enhance behavior intention of water-conservation. *Journal of Educational Technology & Society*, *21*(4), 187–203. https://www.jstor.org/stable/10.2307/26511548

Lamm, A. J. (2015). Integrating critical thinking into extension programming #3: Critical thinking style. Florida Cooperative Extension Service Electronic Data Information Source AEC546. https://10.0.126.217/edis-wc208-2015

Khan, M., & Khan, S. S. (2011). Data and information visualization methods, and interactive mechanisms: A survey. *International Journal of Computer Applications*, *34*(1), 1–14.

Lamm, A. J., Gibson, K., Holt, J., Lamm, K. W., Ellis, J. D., & Rumble, J. N. (2020). Testing the impact of animating infographics on consumer trust and attitude when communicating about genetic modification. *Journal of Applied Communications, 104*(2). https://doi.org/10.4148/1051-0834.2316

Lamm, K. W., Lamm, A. J., & Carter, H. S. (2015). Bridging Water Issue Knowledge Gaps between the General Public and Opinion Leaders. *Journal of Agricultural Education,* 56(3), 146–161. https://doi.org/10.5032/jae.2015.03146

Lamm, A. J., & Irani, T. (2011). CTI manual. Gainesville: University of Florida.

Lazard, A., & Atkinson, L. (2015). Putting environmental infographics center stage: The role of visuals at the elaboration likelihood model's critical point of persuasion. *Science Communication*, *37*(1), 6–33. https://doi.org/10.1177/1075547014555997

McMillan, K., Flood, K., & Glaeser, R. (2017). Virtual reality, augmented reality, mixed reality, and the marine conservation movement. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *27*, 162–168. https://doi.org/10.1002/aqc.2820

Moglia, M., Cook, S., & Tapsuwan, S. (2018). Promoting water conservation: Where to from here? *Water, 10*(11), 1510. https://doi.org/10.3390/w10111510

Owens, C. T., & Lamm, A. J. (2016). Exploring the relationship between critical thinking style and water conservation behavior: Implications for Extension. *Journal of Agricultural Education, 57*(4), 119–130. https://doi.org/10.5032/jae.2016.04119

Paul, R. W., (1995). Critical thinking: How to prepare students for a rapidly changing world. Santa Rosa, CA: Foundation for Critical Thinking.

Pawsey, N., Nayeem, T., & Huang, X. (2018). Use of facebook to engage water customers: A comprehensive study of current UK and Australian practices and trends. *Journal of Environmental Management*, *228*, 517–528. https://doi.org/10.1016/j.jenvman.2018.08.063

Pooley, J. A., & O'Connor, M. (2000). Environmental education and attitudes: Emotions and beliefs are what is needed. Environment and Behavior, 32(5). https://doi.org/10.1177/0013916500325007

Pornpitakpan, C. (2004). The persuasiveness of source credibility: A critical review of five decades' evidence. *Journal of applied social psychology*, *34*(2), 243–281. https://doi.org/10.1111/j.1559-1816.2004.tb02547.x

Ruiz-Díaz, M. S., Mora-García, G. J., Salguedo-Madrid, G. I., Alario, Á., & Gómez-Camargo, D. E. (2017). Analysis of Health Indicators in Two Rural Communities on the Colombian Caribbean Coast: Poor Water Supply and Education Level Are Associated with Water-Related Diseases. *The American journal of tropical medicine and hygiene*, *97*(5), 1378–1392. https://doi.org/10.4269/ajtmh.16-0305

Segel, E., & Heer, J. (2010). Narrative visualization: Telling stories with data. *IEEE Transactions on Visualization and Computer Graphics, 16*, 1139–1148. https://doi.org/10.1109/TVCG.2010.179

Silvert, C. J., Warner, L. A., Loizzo, J., & Shellhouse, J. (2021). Social media split testing and message framing: emerging capacities to encourage residential water conservation. *Applied Environmental Education & Communication*, 1–13.

Slagle, K. M., Wilson, R. S., & Heeren, A. (2015). Seeking, thinking, acting: Understanding suburban resident perceptions and behaviors related to stream quality. *Journal of the American Water Resources Association, 51*(3). https://doi.org/10.1111/jawr.12277

Sturgis, P., & Allum, N. (2004). Science in society: re-evaluating the deficit model of public attitudes. *Public understanding of science*, *13*(1), 55–74. https://doi.org/10.1080/1533015X.2021.1887779

Tremblay, C., & Harris, L. (2018). Critical video engagements: Empathy, subjectivity and changing narratives of water resources through participatory video. *Geoforum, 90*, 174–182. https://doi.org/10.1016/j.geoforum.2018.02.012

UNICEF (March 17, 2021). One in five children globally does not have enough water to meet their everyday needs – UNICEF. [United Nations International Children's Emergency Fund Website]. Retrieved from https://www.unicef.org/press-releases/one-five-children-globally-does-not-have-enough-water-meet-their-everyday-needs

United Nations (2021). What does water mean to you? [United Nations Homepage]. Retrieved from https://www.un.org/en/ on March 23, 2021.

USDA (2021). Water. https://nifa.usda.gov/topic/water

WHO (2019). 1 in 3 people globally do not have access to safe drinking water – UNICEF, WHO. [WHO website]. Retrieved from https://www.who.int/news/item/18-06-2019-1-in-3-people-globally-do-not-have-access-to-safe-drinking-water-unicef-who, on March 23, 2021.

Wu, Y., Rumble, J. N., Lamm, A. J., & Ellis, J. D. (2020). Communication of Genetic Modification Science: Consumers' Critical Thinking Style, Perceived Transparency of Information, and Attitude. *Journal of International Agricultural and Extension Education, 27*(2), 49-61.https://doi.org/10.4148/2831-5960.1117*, 27*(2), 49–61.https://doi.org/10.4148/2831-5960.1117