

A Mixed-Methods Comparison of Self-Reported and Conversational Trust in Science

Introduction

In the United States and abroad citrus crops are threatened by a disease known as citrus greening (also known as Huanglongbing (HLB) or yellow dragon disease) (USDA, 2020). The disease is “one of the most serious citrus plant diseases in the world” and is said to have “put the future of America’s citrus at risk” (USDA, 2020, para. 1). In Florida alone, citrus acreage has decreased by more than 40% and production has decreased by more than 49% (Alvarez et al., 2016). While scientists work on solutions to combat this disease and save citrus as we know it, it will be science communication that ultimately impacts the success of any solution. As Weingart and Guenther (2016, p. 2) said, “the credibility of science is actually dependent on the credibility of science communication.” The development of science relies heavily on the support from the public (Understanding Science, 2020). When the public does not support a specific scientific issue, further scientific development can be hindered (Arnot et al., 2016). A lack of trust can also lead to higher social control, regulation, legislation, legal action, or market action, and thus raise related costs, lower flexibility, and push for government oversight (Arnot et al., 2016).

When considering science, the public must trust the communication source and medium (Weingart & Guenther, 2016). If the public has any doubt, skepticism, or suspicion about a scientific concept, their ability to make an informed decision is greatly hindered (Weingart & Guenther, 2016). Since the late 1970s, research has shown that Americans believe the benefits of science outweigh the risks (National Science Board, 2018). Additionally, scientists have been repeatedly ranked as one of the most trusted professionals (Lang & Hallman, 2005; Nisbet & Scheufele, 2009). However, some scientific issues, like environment, energy, climate change, genetically engineered foods, nanotechnology, stem cell research and cloning, and animal research have been highly debated (National Science Board, 2018). While literature recognizes that beliefs about science are not necessarily an indicator of trust in science, it is common to see beliefs, opinions, and trust in science discussed collectively (Funk, 2017).

Political beliefs have been found to be indicative of beliefs about and trust in sensitive scientific issues, like those previously mentioned (Kraft et al., 2015; Pechar et al., 2018). However, other research has challenged the role of political beliefs in trust in science and has suggested that other variables could be influencing trust in science (Nisbet et al., 2015). Culture, policy implications of a specific scientific issue, source aversion, and cognitive processing have all been suggested as variables influencing trust in science (Kraft et al., 2015; Pechar et al., 2018). Fischer et al. (2020) suggested that trust could be created toward scientific information, including food labels, if value-oriented messaging could attract consumer attention. Furthermore, some have attributed distrust to be associated with specific scientific issues rather than science in general (Pechar et al., 2018). Others have suggested trust in science is unstable because of poor communication, conflicting findings, discourse between the public and scientists, and even the divergence between fake and real science (Boele-Woelki et al., 2018).

To meet current and future challenges, such as citrus greening, it is important to evaluate and maintain public trust in and support for science (Ravetz & Saltelli, 2015). For instance, scientific evidence reveals that to meet the needs of 9.8 billion people in 2050 (United Nations, 2017), our food production will need to increase by 70% (Alexandratos & Bruinsma, 2012). However, increased food production faces barriers

such as farm land shortage, food self-sufficiency rates, natural resource management, energy consumption, and the challenge of climate change (Roberts et al., 2016). To solve current and future problems, science and technology is needed, but the advancement of science relies on the public's trust and support in the scientific process and technology implementation (Arnot et al., 2016; Understanding Science, 2020) and ultimately the public's trust relies on credible science communication (Weingart & Guenther, 2016). The purpose of this study was to explore trust in science in a general and context specific environment in order to inform future science communication.

Literature Review

Trust is the fundamental component of all relationships between the public and specific people or groups. Trust could be viewed as public confidence in the ability of certain individuals or groups, and the belief in their responsibility of behaviors (Barber, 1987; Sapp et al., 2009; Tschannen-Moran & Hoy, 2000). It is necessary to clarify that trust is not achieved by gaining more knowledge (Ruth, 2018; Schäfer, 2016).

Kini and Choobineh (1998) differentiated trust into three approaches: individual trust, societal trust, and relationship trust. Individual trust asserts that trust is a kind of personal trait (Blomqvist, 1997). People's decisions to trust or not is dependent on their own personality or characteristics. Societal trust focuses on the development of trust between individuals and others. Societal trust can be described as "a phenomenon between and within institutions and as the trust that individuals put in these institutions" (Kini & Choobineh, p. 5). Relationship trust focuses on "the factors that create or destroy trust in individuals involved in a personal or work relationship" (Kini & Choobineh, p. 5).

In a meta-analysis, Tschannen-Moran and Hoy (2000) reviewed previous studies, and categorized trust into various facets: willingness to risk vulnerability, benevolence, reliability, competence, honesty, and openness. In short, the construct of trust is complex and diverse. Literature shows varying definitions and measurements of trust (Nadelson et al., 2014; Ruth, 2018; Schäfer, 2016; Tschannen-Moran & Hoy, 2000). For example, Nadelson et al (2014) developed an instrument and examined domain-general trust in science and scientists based on literature and observations of public reactions to science and scientists. Schäfer (2016), however, discussed trust from a sociological perspective and challenged researchers to examine the fundamental character of trust. Specifically, Schäfer (2016) referred to a sociology-based definition of trust established by Engdahl and Lidskog (2014) which defined trust "as the ego's acceptance of dependency on the outer world or the alter's reliability, in order to create an otherwise impossible outcome" (p. 710).

Attitude toward science has been viewed as a main and reliable factor of trust (Ruth, 2018). Roberts et al. (2013) defined attitudes toward science as expressed judgments of the worthiness and favorableness of science and technology (p. 638). Roberts et al. (2013) suggested that if an individual expresses preference toward science and technology, they will tend to be more willing to trust science and technology.

In the food and agricultural sectors, several studies have examined trust. Robinson et al. (2020), found moderate trust in production agriculture, food processing, food retail, and food safety regulation. Those with direct engagement with agriculture had higher levels of trust (Robinson et al., 2020). In another study, trust of information about a genetically modified food product was found to increase with an animated presentation versus static (Lamm et al., 2020). Similarly, Marley et al. (2019) found that the quality of information increased trust.

The National Science Board has published a reliable series of reports regarding public trust in science (National Science Board, 2018). The data reveal that over the past 30 years, Americans' attitudes about science have become more stable or positive. The report also investigated public attitude on some controversial issues and found discrepancies in general and specific interests and concerns. For example, although the results show that Americans express less interest in general environmental pollution, their concern about some specific environmental issues (like pollution of drinking water) is increasing (National Science Board, 2018). The results indicate a positive relationship between exposure to science and technology, knowledge, positive attitude, and engagement (National Science Board, 2018). Although the casual effect has not been confirmed yet, the results support the effectiveness of formal and informal education in science. The results also suggest that general trust in science may not equal trust in specific science issues (National Science Board, 2018). With more complicated and complex issues arising, further investigation and discussion is needed to continue to understand public trust toward general and specific science and technology issues.

Purpose and Research Questions

The advancement of science relies on the public's trust and support in the scientific process and technology implementation (Arnot et al., 2016; Understanding Science, 2020). Science communication plays a vital role in informing consumer trust and support, but research suggests that uniform science communication strategies may not be effective for all scientific contexts. The purpose of this study was to explore trust in science in a general and context specific environment. A convergent mixed-methods design will answer the following research questions:

RQ1: How do self-reported measures of general trust in science change after participating in a focus group discussion about a scientific topic?

RQ2: How does trust in science emerge in conversation about a specific scientific topic?

RQ3: How does general trust in science compare to trust in science displayed in conversation about a specific scientific topic?

Methods

Design and Sampling

A convergent mixed-methods design was used to fulfill the purpose of this study (Creswell & Plano Clark, 2011). In a convergent design the quantitative and qualitative portions of the study are designed and conducted simultaneously. Following data collection, the quantitative and qualitative data are analyzed separately but concurrently. The two sets of results are then compared and contrasted and synthesized. Creswell and Plano Clark (2011) recommend transforming qualitative data into theme counts as a final step in data analysis, so statistical comparisons can be made to the quantitative results prior to interpretation of the merged results.

This research was part of a larger study that examined U.S. citrus consumers' perceptions toward and willingness to accept technologies to combat citrus greening. Because of the larger study's focus on citrus greening, the population of interest included adult consumers who had purchased or consumed citrus products in the last year and who were residents of Apopka, Florida; Chicago, Illinois; Princeton, New Jersey; or Irvine, California.

The areas of residence were selected to include different regions of the U.S. (South, Midwest, Northeast, and West), citrus (Florida and California) and non-citrus (Illinois and New Jersey) producing states, and metropolitan areas covered by major media markets (Nielsen, 2016). Twenty-four participants were recruited in each location.

External marketing firms were used in each location to recruit study participants. Each marketing firm used the same recruitment script to screen and qualify participants. The script screened participants to ensure that they: 1) were a resident of the state; 2) had purchased or consumed citrus in the last year; 3) were social media users; 4) had a neutral to positive trust in science; 5) had the ability to contribute thoughtful articulations and; 6) had not recently participated in other research. If the individuals did not meet all of these qualifications, they were not invited to participate in the study. In addition to these qualifications, the marketing firms recruited participants for each group to include both males and females, a variety of ages (18 and older), income and education levels, and variety of races and ethnicities, with a minimum of two participants of Hispanic ethnicity. These demographic requirements were established based on the demographic trends observed among citrus consumers (The Packer, 2016). Focus group participants were compensated \$70 for their participation in the two-hour focus group.

Survey

The focus group participants received a quantitative pre-test and post-test survey that measured their general trust in science. The pre-test was administered at recruitment and the post-test was given following participation in a focus group. The survey instrument was adapted from the National Science Board's (National Science Board, 2018) Science and Engineering Indicators Report. The findings of interest detailed in the report were formulated by the National Science Board from data collected by NORC at the University of Chicago (2006 - 2016), the National Science Foundation (1979 - 2001), and the University of Michigan Institute for Social Research (2004). The adapted instrument included seven statements on a 5-point Likert-type scale ranging from *strongly disagree* to *strongly agree*. The statements can be found in the results section.

The time between the pre-test and the post-test ranged from 1 day to 14 days, depending on the time of recruitment. Some participants only had a day or two between the two measures because they were recruited last minute to fill the spots of previously recruited participants who withdrew from the study. Participants completed the pre-test via a phone survey. The recruitment screeners read each statement to the participants and asked them to respond using the defined scale. The post-test was completed via a paper survey by each participant at the conclusion of their focus group discussion.

The scale was found to be reliable at both the pre and post-test measures ($\alpha = .86$; $\alpha = .89$). An index for general trust in science was created for each of the two measures. Means and standard deviations were then calculated using SPSS (version 25.0; IBM Corp., Armonk, NY). The two longitudinal measures were compared using a paired samples t-test.

Focus Groups

The qualitative portion of the study employed focus group methodology. Two focus groups were completed in each of the previously mentioned locations, for a total of eight focus groups. A total of 73 individuals participated in the focus group discussions. There were 18 participants in Florida, 16 in California, 16 in Illinois, and 23 in New Jersey. Each focus group discussion lasted 90 to 120 minutes. The focus group discussions were guided by a structured moderator's guide and a team of researchers trained in focus group methodology.

The moderator's guide was reviewed by a panel of experts prior to data collection. The moderator's guide led participants through a discussion of citrus purchasing and familiarity, citrus greening, proposed technologies to combat citrus greening and acceptance associated with the proposed technologies, and presentation of four messages about the technologies. Much of the topics discussed during the focus groups, including the proposed technologies and messages, were included for purposes secondary to the data presented in this manuscript. However, the nature of these technologies and messages are described below so that readers can understand the context of the discussions and how these may have influenced conversation about and changes in trust in science.

Three technologies to combat citrus greening were introduced during the focus group discussions. These technologies all included a mixture of four protein molecules found to kill the bacteria that causes citrus greening. Each technology applied the protein mixture in a different way. The first application discussed was a topical spray of the protein mixture onto the citrus trees. The second application discussed was a genetic alteration of the citrus trees so that the trees would produce the protein mixture. The third application was viral infection of the citrus tree that would cause the trees to naturally produce the proteins.

The four communication messages each provided a message about the protein treatment and its ability to save citrus. Two messages were presented in mock Facebook pages and two were presented by the moderator. One of the messages presented in a mock Facebook page included a personal frame, while the second message had an economic frame. One of the two messages presented by the moderator included a lot of scientific jargon to describe the technology while the second compared the protein treatment to similar processes used to treat cancer. Descriptions of citrus greening, the protein mixture, and each application were provided to the participants and read by the moderator. Additionally, the messages in the mock Facebook pages were also provided to the participants. At the conclusion of each focus group, member checking was employed to ensure that the research adequately and correctly heard and understood the participants' discussion (Lincoln & Guba, 1985).

Each focus group discussion was audio recorded and notes were taken by at least one note taker and the moderator to capture the data. These three methods of data recording offered triangulation of the data (Lincoln & Guba, 1985). Following each focus group, the team of researchers participated in peer debriefing to improve the trustworthiness of the results (Lincoln & Guba, 1985). Each audio recording was transcribed verbatim by a third party for data analysis. Field notes were used to identify participants and assign pseudonyms. MaxQDA (version 18.1.0; VERBI GmbH, Berlin) was used to analyze the focus group discussions and keep an audit trail of the analysis. The quantitative general trust in science scale items were used to guide *a priori* coding. Additionally, open coding was used to examine data for elements of trust or distrust that fell outside of the item discussed in the general trust in science scale. Following analysis, the codes were collapsed into themes. To aid in the transferability of the findings the participants are described in the results and quotes are provided to support the resulting themes. The quotations from the focus groups are presented according to their location.

To answer the final research question, theme counts were established for the qualitative data to allow for comparison to the quantitative data (Creswell & Plano Clark, 2011). Descriptive comparisons were made between the quantitative and qualitative data, but no statistical comparisons were able to be made due to the nature of the data.

Researcher Subjectivity

The researcher who primarily conducted the qualitative analysis had an agricultural background in livestock production and row crops and was trained in agricultural

communication. A fellow member of the research team confirmed the findings of the analysis through peer debriefing (Lincoln & Guba, 1985). All members of the research team had no direct ties to the citrus industry but did have a passion for helping the agricultural industry to communicate and educate about agricultural science and related food issues.

Results

Background of Respondents

The highest number of participants were between the ages of 45 – 65 ($n = 31$). More females ($n = 41$) participated in the research than males ($n = 32$). The majority of participants had some college ($n = 27$) education or an undergraduate degree ($n = 32$). In addition, the majority of participants in all groups were making more than \$50,000 a year. Most of the participants were employed full time ($n = 39$), while others were employed part time, self-employed, stay at home parents, unemployed, retired, or a student. Thirty-five of the participants were white and 13 were African American. Eighteen of the participants were Hispanic. New Jersey was the only location to not have any Hispanic representation.

Pre and Post-test Trust in Science

A paired samples t-test was conducted to compare the participants' general trust in science before and after focus groups were conducted. There was no significant difference in the pre ($M = 4.52$, $SD = 0.50$) and post-test measure of general trust in science ($M = 4.43$, $SD = 0.56$; $t(72) = 1.688$, $p = .096$). The data were then split up by focus group location, to determine if there were any differences in the longitudinal measures of general trust in science among each location. There were no significant differences in general trust in science based on their location, as seen in Table 1. The data did indicate that all the means did decrease from the first measure to the second measure; however, this decrease was not significant.

Table 1
Participants' Pre and Post-Test Trust in Science

State	Pre-Test		Post-Test	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
All	4.52	.50	4.43	.56
Illinois	4.63	.37	4.56	.49
Florida	4.57	.38	4.44	.53
California	4.51	.48	4.49	.45
New Jersey	4.42	.66	4.29	.68

Emergent Conversational Trust in Science

Trust

The items from the trust in science survey served as *a priori* codes. Therefore, the focus group transcripts were first coded for thoughts that aligned with the items in the survey instrument. For example, one of the items from survey was *developments in science help make society better*. The focus group transcripts were coded for thoughts that aligned with the notion of scientific developments leading to a better society. This process was repeated for all items in the survey instrument. The analysis revealed that few of the ideas behind the general

trust in science items carried through the participants' conversations. Some quotations were observed that supported the notion that modern science does more good than harm, scientists contribute to the well-being of society, developments in science help make society better, and new technology used in medicine allows people to live better lives.

The idea that modern science does more good than harm was observed in all of the focus group locations. A participant from Illinois recounted the belief that science has beneficial outcomes and should be supported. "If there's something out there, an insect that's killing our ability to have citrus products, and scientists have found something to stop it, something to stop this from happening, obviously, I'm pro this technology." Despite hesitations on whether the protein technology to combat citrus greening was good or not, the conversation in one of the California focus groups allowed a participant to recount beneficial outcomes to science. "I don't know if I'm against [gene modification if the citrus tree] or not" said the California participant,

part of me wants to say, 'Oh, don't mess with it.' At the same time, scientists have messed with a few things, inserting genes and making things weird, but it's been beneficial. I don't know if I should say no or yes, because it could be good in a way.

In a Florida focus group, a participant became excited when presented with the message that compared the citrus greening protein treatment to cancer treatment. The participant excitedly proclaimed, "Makes me want to go, 'Go science!'" The proclamation, verbal tone, and non-verbal cues of the participant made it clear that this participant believed in the good of science. Toward the end of each focus group discussion, the participants were asked for any final thoughts and a New Jersey participant shared a persistent belief in science. "There seems to be a push these days on science.... I think science is very important," said the participant. Another New Jersey participant discussed a situation similar to citrus greening, that extended her trust to the topic. The participant recounted a story about bananas that she had read. The participant said,

I've read that bananas used to be half the size. Then all we did was only plant the crops that had bigger bananas. Now we get a giant banana that tastes sweeter. It's not super weird for fruit to change over even just decades.

Belief in scientists and their contribution to society was also observed in all four focus group locations. In an Illinois focus group, a participant shared a reaction to one of the messages presented in a mock Facebook page. The participant's reaction made it clear that there was established trust in scientists' ability to do good things. "I kind looked at [the Facebook news story] and was like, 'Cool, scientists got it figured out.'" A New Jersey participant discussed trust in scientists to combat citrus greening. With a hint of hesitation, the participant said, "I kinda trust what scientists do, and I think, if you can make a tree be healthier genetically, that might not be too bad for me..." In California, a participant in one of the focus groups, expressed faith in the scientists' ability to figure out how to combat citrus greening. With a tone of reassurance, the participant said, "I think they'll probably figure something out.... They're gonna find out. They're gonna fix it, whether it's a pesticide or some kind of predator toward that insect. They'll probably figure something out."

The remaining codes aligned with the general trust in science scale predominately came from the Illinois focus group discussions along with two strong quotes from the Florida discussions. In the Illinois discussions, conversations focused momentarily on the ability of new technologies in medicine to have beneficial outcomes. Flu shots and antibiotics were brought up as examples. The participants shared that they knew others did not agree with flu

shots or antibiotics, but they believed both had beneficial outcomes. “Flu shots can be very beneficial. Sure, there are certainly some that would say that antibiotics shouldn’t be used, or doses of virus. I think in the case of flu, it’s been proven safe.” Another participant echoed this belief and favored the viral-based technology to combat citrus greening. This participant said, “I think I’m actually gonna go with virus, because I think virus would be a more natural way to get rid of something. Don’t they inject viruses into us?” Perhaps the richest account of the benefit of technologies in medicine came from a Florida participant who initially had negative reactions toward the citrus greening technology. He changed his opinion when he remembered that a medicine, he was taking, included proteins that sounded similar to the proteins used in the technology to combat citrus greening. Once this connection was made the participant exuded a renewed trust and said,

As we were going along, I started thinking about protein, and I actually take something called Prevacen, which is a memory enhancing pill, and it has a protein that’s derived from a jellyfish, so they say. I’m believing what they’re saying. I’m ingesting this protein each and every day, and it’s actually helping me in my memory situation. Yeah, after going through this [focus group], I have a more favorable view than when we first started.

Florida participants discussed the belief that science can make society better. One participant recounted the need for science and technology to feed a growing population while the other recounted societal traditions and the need for science to preserve those. To summarize thoughts about the focus group discussion, a Florida participant expressed gratitude that scientists were trying to solve citrus greening “because I can’t imagine my grandchildren not being able to eat an orange.” “I don’t want them to have to buy a fruit cup at Publix in 50 years, and not ever experience peeling an orange or getting messy, that’s part of childhood,” said the participant.

After analyzing the focus group data for the *a priori* codes, the data were analyzed for other elements of trust or distrust. Additional trust codes were identified. After further examination and peer debriefing, it was determined the additional codes fit within the existing themes established *a priori* for general trust in science. These codes were collapsed into those themes.

Distrust

The secondary coding of the focus groups revealed that there were far more (> 5 times more) codes that related to distrust than trust. These codes may best be described as barriers to trust. The themes that resulted from these codes were Lack of Information, Skepticism, Fear, and Lack of Benevolence. These themes and their definitions can be found in Table 2.

Table 2
Distrust Themes

Theme	Definition
Lack of information	Not enough information or too many questions left unanswered to establish trust.
Skepticism	Feeling that some information is being withheld or that the information is not transparent or honest.

Fear	Scared by the information or fear due to similar sounding instances in history.
Lack of benevolence	Belief that science or big agriculture is pursuing profits and consumer concerns are not a consideration.

Lack of information. was the most frequently occurring theme among all of the focus group discussions. Nearly every participant expressed frustrations with the lack of information provided about the technologies. They had many questions that needed answered before they were able to determine trust in the technologies. A participant in a Chicago focus group said, “Yeah. It’s vague to actually respond to. What is the gene? How is it developed?” A fellow Chicago participant echoed these sentiments and said,

I think it just comes back down to the side effects. What are the side effects? How long have they been researching this? Like everyone was saying, it’s kinda like throwing out there, “What is this? How long has this been researched? What are we doing about it? What have we been doing about it?”

In a California focus group, a participant expressed the many questions that hindered trust in the technology. He said,

Does the gene go in the tree, or in the seed, so the gene grows with the tree? How would you put it directly into the tree? I would say maybe inside the seed to stop the bacteria from the beginning. I don't know which way they're going—all that does play a big role.

A participant in Florida simply said, “I’m gonna need more information.” New Jersey participants felt the same way and a participant said, “This, to me, would require a lot of research either way. There are too many unknowns. Either treatment, there’s too many unknowns.” In their quest for more information, the participants requested honest and transparent information as well as information about the long-term effect of the citrus greening treatment. “Are you sure all these methods aren’t gonna cause cancer? Other issues, health issues?” said a Chicago participant.

Skepticism. Many participants were skeptical that information was being withheld from them. Much of their skepticism was rooted in the fact that the majority of them had never heard of citrus greening. A New Jersey participant proclaimed “My question would be, if this is such a big deal, why isn’t this plastered all over the news? I’m not hearing it. I haven’t heard anything about citrus greening till now.” Because of unfamiliarity with the problem, many participants felt the technologies to combat the disease were not necessary.

I think we’re focused on fixing something that we’re not even too sure is a problem. There’s like, ‘Here, do this.’ It doesn’t really sound good, because we don’t see it as a problem to be fixed. We just see it as an additive.

Skepticism was also rooted in the feeling that “[the technology] is already in oranges.” A California participant echoed this feeling and said, “At the same time, we don't know. There's no visibility of what's being done right now on Farmer Joe's farm. He could be doing this to all of his trees, and nobody's gonna know the difference.”

Fear. Some participants were scared by the information presented while others were scared by similar instances throughout history. “Do you remember that they had something years ago, I think it was called DDT,” said a New Jersey participant, “Nobody knew, at the

time, that it was harmful, and then, all of a sudden, boom, it came out like it's harmful." Although some participants felt the comparison of the technology to the flu shot or cancer was good, others were scared by the comparison. "The drugs that kill cancer, they're really strong. There's a lot of side effects. I'm gonna lose my hair. You'll feel all sick. I don't like the sound of that," said a California participant. "I'm against the flu shots as it is too, because I've had too many people have bad side effects from it. The tree is getting the virus ... I don't think it's a good idea," said a Florida participant. When hearing the different descriptions of the technologies through the focus group discussions, some people would react with negativity and fear. "It's kinda scary," said a New Jersey participant. Despite being "all for science" a California participant acknowledged that "this part scares me a little bit." Fear for personal health and the health of families was discussed as well as comparisons of the technologies to "sci-fi" and the "zombie apocalypse."

Lack of Benevolence. Trust was hindered when participants felt the technologies to combat citrus greening did not have the consumer in mind. Much of these thoughts developed after participants viewed the message with an economic frame. "When you inject profit into as opposed to health and well-being, there's opposite ends of a magnet," said a Chicago participant. A New Jersey participant shared a similar thought and said "I'm in the same boat. It's completely focused on the citrus industry, which is great, but I just keep coming back to, what's important here? Are we focused on the industry, or are we focused on the people benefitting?" A California participant said, "They're just doing it to make money." In a Florida focus group discussion, a participant discussed the need to reduce perceived bias in the research. The participant said,

I think they need to connect it to an educational institution. If UF is doing that, or FSU is doing it, versus Dow Chemical, or Proctor and Gamble, or whoever's doing the research. Then I think it gives it more validity. Because it's not a corporation trying to make a profit.

Comparison of General Trust in Science to Conversational Trust in Science About a Specific Scientific Topic

To compare the quantitative and qualitative results, the means were reported for the quantitative trust statements and the theme counts were reported for the qualitative results (Table 3). The discussion of general trust in science throughout the focus groups seemed to not have an impact on the final quantitative trust measure. The researchers anticipated that the *a priori* themes discussed at the highest frequency in the focus groups would have seen higher mean trust scores on the post-test measure. However, the mean trust in science scores decreased for almost all of the statements between the pre and post-test measures. The only statement that saw an increase in mean score was scientific research should be supported by the federal government. Only one qualitative code was coded to this theme.

Table 3
Qualitative and Quantitative Descriptive Comparison

Trust in Science Statements	Pre-test	Qualitative Count	Post-test
Developments in science help make society better	4.63	54	4.58
Scientists contribute to the well-being of society	4.53	3	4.47

Scientific research should be supported by the federal government	4.18	1	4.33
Scientific research is essential for improving the quality of human lives	4.58	0	4.52
New technology used in medicine allows people to live longer	4.71	0	4.42
New technology used in medicine allows people to live better lives	4.59	16	4.44
Overall, modern science does more good than harm.	4.43	46	4.26
Total	4.52	120	4.43

Discussion and Conclusions

This study sought to explore trust in science in a general and context specific environment through quantitative and qualitative measures in order to inform science communication. General trust in science was measured quantitatively before and after a focus group discussion. A comparison of these measures showed that general trust in science decreased between the pre and post-test measure, but that the change was small and not significant. This finding suggests that baseline general trust in science is not likely to change, or will change very little, among individuals throughout a conversation, exposure to communication, or when presented with contextual information about a scientific topic, such as technologies to combat citrus greening. This finding is consistent with the National Science Board's nearly 50 years of research showing sustained beliefs in the benefits of science (2018). Furthermore, while this finding may be encouraging as researchers consider sustained general trust in science, it also presents a challenge to science communicators who seek to improve general trust in science. In this specific study, participants were recruited based on having a neutral to moderate trust in science. Thus, the participants started with relatively high trust in science and a lack of significant change after a context specific discussion where so much distrust was observed is encouraging. But, if participants with low trust in science were studied the results may have been more concerning or they may have been different. The lack of change in general trust in science presents the opportunity to further explore what, besides communication, could be impacting the sustainability of this construct. Culture, policy implications, source aversion, and cognitive processing could all be variables of exploration (Kraft et al., 2015; Pechar et al., 2018).

The focus group discussion was focused on the science of technologies to combat citrus greening. The trust in science scale items were used as *a priori* themes during qualitative analysis. The researchers approached the data analysis from this perspective under the conceptual hypothesis that the core beliefs influencing participants' trust in science would be evident in their discussion about technologies to combat citrus greening and those beliefs frequently mentioned in conversation would show higher post-test scores. The analysis showed that these core trust in science beliefs were discussed at a minimal level and consequently did not seem to impact the post-test measure. Thus, it seems that general trust in science did not transfer to this context specific conversation about science. This finding confirms suggestions provided by the National Science Board (2018) but differs from the

ideas set forth by Roberts et al. (2013). As science communicators consider communicating about different scientific topics these findings suggest that they should not rely on general trust to be an indicator of trust in specific contexts. Furthermore, the minimal transfer of general trust in science beliefs to the context specific discussion may be explained by the high frequency of distrust observed in the discussion as well as the presentation of specific treatments and messages in the focus groups that were secondary to this data analysis.

Many codes of distrust were found throughout the focus group analysis. The prevalence of these codes may be indicative of the small decrease in general trust in science scores from the pre-test to post-test measure. The themes of distrust were identified as lack of information, skepticism, fear, and lack of benevolence. The participants indicated that they were unable to draw conclusions because they did not have enough information about the technologies. This finding corresponds with the conclusions of Weingart and Guenther (2016). It is possible that if the participants would have had more information, higher elements of trust would have been observed in the conversation. However, previous literature has shown that trust is not achieved by gaining more knowledge alone (Ruth, 2018; Schäfer, 2016). The theme of skepticism was often tied to similar instances or historical references. As Boele-Woelki et al. (2018) indicated, repeated scientific controversies can negatively impact trust. In the case of this study, it seems that observed controversies may be leading to skepticism. Additionally, the themes of fear and lack of benevolence may be indicative of breaks in societal and personal trust (Kini & Choobineh, 1998).

Understanding trust in science, in specific and different contexts, is important to the future of science and societal benefits (Arnot et al., 2016). Although trust is difficult to control (Meijboom et al., 2006), it is important for researchers to continue to explore the gaps in trust that exist between the scientific community and the public (Goodwin, 2013). The future of science and technology depends on the public's ability to understand, value, and support science (Myers et al., 2017).

Future research should explore general trust in science and context specific trust in science in individuals with varying or low levels of trust in science. Additionally, other contexts should be explored. Researchers should examine whether or not offering more information about a problem and the technology to address the problem would remove some of the elements of distrust from the conversation. Additionally, improving the quality of the information presented, adding value-oriented messages, or an animation element may change the results (Fischer et al., 2020; Lamm et al., 2020; Marley et al., 2019). These explorations could offer insights for education and communication tactics. In-depth follow-up interviews should also be conducted with participants to better understand why their general trust in science sustained, or changed minimally, throughout the focus group conversation.

Practitioners should be careful not to mistake general trust in science for context specific trust in science. It should not be assumed that those with high trust in science will trust all science. However, practitioners should take advantage of the little to no change observed in general trust in science. If practitioners can identify the core beliefs that sustain individual's trust in science, they could capitalize on those core beliefs and strategically frame context specific scientific messages to those core beliefs. Literature and the distrust observed in the context specific discussion in this study suggests the opportunity to further explore the impact of formal and informal education on the trust of contextual scientific issues (National Science Board, 2018). Communication practitioners should collaborate with educators and scientists, from a systems perspective, to address trust in science. It is apparent from the results of this study that communication alone is unlikely to make significant changes in trust in science. An approach that integrates the contextual science, education, and communication may be more effective in improving the future trust and support of science. Practitioners can also try to communicate complete and detailed information while also

addressing historical or similar controversies through proactive communication. However, the effectiveness of these strategies is untested but only suggested by participant quotes. Additionally, practitioners should work to identify those who have high trust in science in a specific scientific context and train and encourage them to have conversations with others drawing on the benefits of opinion leadership.

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