Common Knowledge or Common Sense? Evaluating Scientific and Agricultural Literacies in Higher Education

by

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Abstract

People are unable to adequately describe the modern world's sophisticated, complex agriculture systems and industries. Higher education instructors and students, despite their expertise and elevated knowledge, are not immune to this phenomenon. Given that, among other subjects, agriculture may be studied separately as a subset of science, agricultural literacy can be seen as a form of science literacy. By studying about agriculture and related topics in the college classroom learning environment, students as well as educators may reestablish a relationship with the food they have disconnected with and prevent misinformation spread about the vital industry of food production. To provide a broad overview, multiple surveys were used to scope current agricultural knowledge amongst higher education individuals; sentiment of instructor discussions that spontaneously address agriculture; credibility judgements of graduate students and their past instructors; narratives of misinformation, biases, and other phenomena graduate students have faced academically; and how professional development workshops can train future educators in areas of scientific and agricultural literacy. Abstracted findings across multiple studies conclude that there are many factors that influence knowledge of animal agriculture and food production. In order to mitigate harmful effects of negative media, oral messages, and other methods of communication, continuing education of agriculture into higher education is a powerful, proactive mechanism to consider.

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Table of Contents

List of Tables

List of Figures

List of Abbreviations

AA	Animal Agriculture
AAKPQ	Animal Agriculture Knowledge and Perceptions Questionnaire
ACT	American College Testing
AgSTEM	Agricultural intersections with Science, Technology, Engineering, & Math
AITC	Agriculture In The Classroom
AL	Agricultural Literacy
ARQ	Agriculture Relevance Questionnaire
CES	Cooperative Extension Programs
FFI	Food Familiarity Index
FP	Food Production
GMO	Genetically Modified Organisms
KSA	Knowledge, Skills, and Abilities
KSAQ	Knowledge, Skills, and Abilities Questionnaire
NALO	National Agricultural Literacy Objectives
NASULGC	National Association of State Universities and Land-Grant Colleges
PA	Pedagogical Approaches
PETA	People for the Ethical Treatment of Animals
SC	Science Communication
SL	Science Literacy
SMI	Social Media Influencer
STEM	Science, Technology, Engineering, Math
USDA	United States Department of Agriculture
WV	Worldviews

Chapter 1 – Literature Review: Factors Affecting Agricultural Literacy in Higher Education

Introduction

Over time, the public has become increasingly polarized about how food is produced for the world. Public perception of animal agriculture while vital to the success of the industry, has never been more distorted and diverse. Attitudes toward animal agriculture are not a new issue; however, concerns have increased over the last 100 years (Alonso et al., 2020). Misconceptions and misinformation are primary suspects for filling the void between agricultural and non-agricultural sectors, causing more harm than benefit in the view of animal agriculture (Tobin, 2023). Agriculture-related communicators work to reach and inform consumers within a complex media-driven infosphere, but the knowledge of their audience may be impacted by sources with different worldviews (Anderson-Wise, 2022; Stroud, 2019). In general, a consumer's attitude tends to improve as they learn more about a subject (Sutherland, 2020). Knowledge gaps in the context of agriculture also contribute to mistrust in the agricultural sector. Worldviews, attitudes, and trust in agriculture are frequently created based on ingrained generational, household, and media beliefs (Sutherland et al., 2020; Giblin, 2019).

Statement of the Problem

Little research of agricultural knowledge and perceptions in higher education individuals has been performed recently in the southeast. The best way to understand the motivations for the misperceptions and misunderstandings of animal-derived foods is to investigate trends and themes of agricultural literacy in higher education. A proposed method to narrow the gap between agricultural and non-agricultural tribes includes improving agricultural literacy in higher education, like Agriculture in the Classroom (AITC) efforts in K-12 education (Hillison, 1998;

Malecki et al., 1969, USDA, n.d.b.). While creating programs within educational systems has been attempted and proven to be effective when deployed, corporate involvement in addressing the gap has been limited. Recognizing that millennials have strong feelings about how food should be produced, Monsanto Corporation experimented with a millennial engagement program (Barclay, 2014) and resulted in some degrees of success (Hess, 2017).

Objectives

To proactively understand the perception of animal agriculture from rising and existing generations, investigative research is necessary to gauge the scope of agricultural knowledge of consumers in higher education. The following research objectives seek to provide insight to the stated problem:

1. Determine higher education individuals' perceived involvement with food production, identify agricultural resources utilized by higher education consumers, measure animal agriculture perceptions, and analyze demographic characteristics that influence knowledge and perceptions.
2. Discover the theoretical motives of higher education instructors to introduce agriculture without prompting in a simulated classroom setting.

The Growing Void Between Agricultural and Non-Agricultural Consumers

Compared to generations ago, people cannot describe the complex agricultural systems and industries that exist today. Those that produce food for the world to consume, including direct on-farm producers, compose 1.3% of the US employment, while those employed in agricultural and food sectors make up 10.5% of US employment (Kassel, 2023). These percentages make up the agricultural community. Those that buy their food from the grocery store rather than raising it themselves are considered the non-agricultural community. On average, one farm feeds 166 people annually (American Farm Bureau Federation, n.d.). The growing void between agricultural and non-agricultural tribes reflects societal trends, population shifts, and other historical events positively reinforcing our distance from food production.

Before industrialization, people harvested their own food. During and after industrialization, the need for producing our own food diminished and the need to source it from others grew (Dixon & McMichael, 2017). The cheap food regime was the result of industrializations such as Green Revolution technologies, supermarketization, concentrated population or urban sprawl, global retaining revolutions, and others (Dixon & McMichael, 2017). Several explanations exist for the gap in knowledge where food, fiber, and fuel come from. One is the urban bias theory, where poor people stay poor and urban people are pulled rather than pushed out of agriculture (Dixon & McMichael, 2017; Longhurst et al, 2020). Another explanation is shifts in society due to industrializations and last, improved food production efficiencies (Dixon & McMichael, 2017; Longhurst et al, 2020). Rural and agricultural communities are seen as a source of labor and products, rather than providers of food for the world (Dixon & McMichael, 2017). Urban sprawl and the government support for densely populated areas have "privileged the urban over the rural," (Dixon & McMichael, 2017) thus widening the gap of knowledge, understanding, and appreciation of agriculture between tribes. The gap exists with authorities as well, where individuals of power have the effect of "shaping societal diets, often at the expense of public health" further from natural agricultural products like our ancestors once cultivated (Dixon & McMichael, 2017). Despite the availability of numerous educational programs surround food production, knowledge gaps persist among citizen regarding the origins of food, perceptions of agriculture and perceptions of food production.

Agricultural Perceptions & Information Seeking

Many demographic factors affect the way various populations view agriculture and food production. These qualities contribute to ethical consumerism, or the desire to understand how food is produced (Capper, 2011). Ethical consumerism considers labor conditions, food production methods, low environmental effect, and animal welfare (Capper, 2011). In particular, women, young people, those who avoid consuming meat, highly educated people, and residents of metropolitan areas frequently hold less favorable opinions on contemporary agriculture and its impact on human health and the environment (Liu et al., 2023; Sanchez-Sebate et al., 2019; Clark et al., 2016). Where people receive their information about food or agriculture also influences how these opinions are held by different communities.

Consumers typically use food labels to evaluate and choose wholesome foods (Cha et al., 2014). Consumers may only look for knowledge about how food is produced if they are motivated by personal or news events, which goes beyond food label literacy (Hall et al., 2004). In other words, it can be challenging to pinpoint the sources that people turn to in order to get the truth about where their food originates from. Nonetheless, the reliability of various agricultural resources has been thoroughly examined (Settle et al., 2017). The general public can recognize government organizations, educational initiatives, animal rights groups, associations in agriculture and related industries, and others (Settle et al., 2017). However, trust in each of them varies since, apart from PETA campaigns, non-profit organizations are considered very trustworthy (Settle et al., 2017). In addition, meat processors and other food companies are regarded highly trusted by consumers (Cooper, 2023).

When narrowed down to brand choices in markets, consumers are hyper-aware of company missions and actions when considering between brands (Pino et al., 2022). With sustainability topping charts in popularity, consumers tend to seek out pro-environmental brand strategies (Pino et al., 2022). Consumers purchase products based on sustainability claims, eco-friendliness, reduced environmental footprints, recycling, products are less harmful to the environment, company pledges to conserve energy expenditures, etc. (Pino et al., 2022). Additionally, political motivations streamline consumer behavior due to messaging campaigns (Hydock et al., 2020). Another motivator toward consumption based on sustainability statements, is social media influencers since 75% of marketers utilize social media influencers (Farrell et al., 2022). Social media influencers are content creators that occupy a niche field and have a large following based on their "attractiveness, inspiration, power, and their brand or recommendations are trusting or reliable" (Farrell et al., 2022). For example, social media influencers tend to have followings of similar characteristics based on the media they present. If an influencer were to explain misinformation about a brand, or science, or anything, then it is very likely the influence will be bestowed on his/her following. Algorithms on social networks work in similar fashions (Cacciatore, 2021). This concept threatens animal agriculture, as negative messages about production practices are persistent and emotional. Where people consume media shapes biases and exposures consumers to misinformation about science (Scheufele & Krause, 2019) and especially agricultural science (Brossard & Nisbet, 2006).

Agriculture, amongst other topics, can stand alone as a science, therefore agricultural literacy can also be seen as science literacy. Defined by the National Agricultural Literacy Outcomes program (Spielmaker & Leisling, 2013), agricultural literacy is known as "processing knowledge and understanding of our food and fiber system." Food and agriculture sciences have made massive strides in science communication through the US Cooperative Extension Systems (CES) (USDA, n.d.a.). However, the weight of communicating agricultural sciences cannot stand solely on one leg of the stool. State level AITC programs aim to improve agricultural literacy in PreK-12 grade levels (Hillison, 1998; Malecki et al., 1969, USDA, n.d.b.). Although these programs have been successful in promoting agricultural literacy in youth, it is unknown why agricultural literacy education sometimes ends there.

Stopping agricultural literacy at high school places those students in the exposure or factual literacy proficiency stages. The simplest proficiency level, exposure, is limited agricultural literacy (Joplin, 1981). These learners are likely to identify components of agriculture, draw rudimentary comparisons, and can recall and draw agriculture in artwork (Joplin, 1981; Longhurst et al., 2020). The factual literacy phase includes enough understanding of agriculture to make predictions, make connections between agricultural sectors, and are capable of ordering agricultural steps such as planting, fertilizing, harvesting, and more (Roberts, 2006; Longhurst et al., 2020). The highest level of proficiency described, though the learning never stops, is applicable proficiency. Learners of applicable proficiency can submit practical solutions to introduced problems, while having the ability to explain complex agricultural systems, consequences, and outcomes (Longhurst et al., 2020).

By introducing agriculture and related topics to the college classroom learning environment, students can reconnect with the food they have grown far too distant by becoming proficient to the highest potential. A more comprehensive approach to enabling a more open form of communication through science becomes possible by developing instructors and students to have a greater awareness and understanding of agricultural and associated science issues. Agricultural examples can be beneficial in improving math skills and applicable science skills by presenting real-world problem scenarios (Mabie & Baker, 1996). Incorporating agriculture within other science disciplines in a classroom environment offers a way for students to truly connect with and understand agricultural concepts. Serdyukov (2017) explained that “a focus of educational innovations should be on teaching and learning theory and practice, as well as on the learner, parents, community, society and its culture.” The focus on helping future educators in areas of science and agricultural literacy education will create individuals with higher skills in a knowledge-driven economy (Looney, 2009). It is evident that agriculture serves an important role in global economics and offers other services to other occupations on national and global scales (Jackson-Smith & Jensen, 2009). Economic dependency, agricultural literacy deficits, and other factors reinforce the need for agriculture topics to be incorporated into most, if not all, educational disciplines.

The proliferation of misinformation and the misunderstanding of animal agriculture has resulted in messages with negative motivations, contributing to the gap between agricultural and non-agricultural tribes. Most examples of the knowledge gap can be seen in highlighted, hot-button topics, including genetically modified organisms as well as global warming (Thornton, 2010). How people seek and consume media shapes biases and exposure to misinformation about science and especially agricultural sciences. An example of failed communication efforts is from the 'pink slime' debate (Yadavalli & Jones, 2014). Miscommunication of the components of finely textured lean beef, as well as miscommunications of safety concerns from industry professionals and scientists, have plagued the media and caused hysteria of ground products even years later (Yadavalli & Jones, 2014).

Student Interactions with Agricultural Issues & Topics

Raised urban, suburban, or rurally, students across agricultural and non-agricultural majors will encounter animal issues in some fashion throughout their undergraduate career. Through these encounters, “students are likely to form opinions as they encounter issue-related and other information and incorporate it into their own knowledge structure" in a positive or negative way depending on the situation (Walter & Reisner, 1994, p. 1656). Urban students "tended to be more critical of current animal agriculture practices" and that rural students disagreed more with animal rights activist driven questions (Walter & Reisner, 1994, p. 1657).

As an example of assessment of views about animal agriculture topics by college students from non-ag majors, Schwitzgebel and others (2020) researched student meat-eating behavior as associated to influence by instructors. In this study, students enrolled in an ethics course were divided into sections led by graduate teaching assistants (Schwitzgebel et al., 2020). One section would receive materials on meat consumption as an unethical practice, while the other studied the ethics of charity (Schwitzgebel et al., 2020). Questionnaires were given to all students before and after the semester regarding their meat-eating behaviors and answers were cross-referenced with dining hall vouchers to track their eating decisions (Schwitzgebel et al., 2020). At the end of the semester, those students studying meat ethics expressed that they were likely to avoid eating meat in the future and that "factory farming" was unethical (Schwitzgebel et al., 2020). Though the voucher redemption was low at dining halls, meat ethics students chose non-meat (vegan/vegetarian) options exemplary of the influence from their instructors (Schwitzgebel et al., 2020). The takeaways of this research support a suggestion that higher education courses are an "opportunity for incorporating interesting and productive discussion of issues into their classroom routines" to encourage student discovery and "better able to guide decision, opinion, or action" regarding animal issues in the future (Walter & Reisner, 1994, pp. 1656-1658).

As reported in 1983, roughly 40% of students in the U.S. enrolled in agricultural majors had a farm background (Hasslen, 1983). With an expansion in enrollment numbers and a consistent flux of farm kids enrolling in agricultural majors, the percentage was predicted to decrease. About

30 years later in 2015, it was reported that the trend was consistent with the prediction, where demographics of undergraduate animal science students from regionally dispersed land grant universities provided evidence that the agricultural backgrounds of enrolled students are dwindling (Parrish et al., 2015). Specifically, it was found that students with a farm background enrolled in animal science were 34%, 20%, 2%, and 29% at Kansas State University, University of Missouri, North Carolina State University, and University of Wisconsin, respectively (Parrish et al, 2015). The influx of urban students with no farm experience creates a central challenge for agricultural colleges and instructors of those colleges because of a differences and deficiencies in backgrounds (Helsel & Hughes, 1984).

Beyond the challenge of teaching urban students, another obstacle is the self-doubt presented by urban students studying agricultural sciences (Larke, 1982). Larke (1982) uncovered that students without farm backgrounds perceive themselves as less competent regarding agricultural knowledge, topics, and challenges, and significantly differently than their farm-reared peers. Because agricultural sciences are complex and require field experience to truly grasp the understanding, it is encouraged by advisors for urban students to utilize internship opportunities to catch up to their farm-reared peers (Helsel & Hughes, 1984). Although this is often seen as 'remediation' for lack of experience, internships tend to focus on upperclassmen, which misses those students who may drop out or change majors due to self-doubt (Helsel & Hughes, 1984). Other methods, such as video tutorials for urban, nonfarm background students at the beginning of their education, have helped bridge the knowledge gap (Meisner et al, 1990), however, watching and doing are two completely different experiences.

Worldviews

Worldviews can be defined in a variety of ways, depending on who you ask. Every educational discipline influences a way of looking at the world. A consequence of an agricultural upbringing is that people engaged in agriculture tend to possess views of the world that are shaped by their experiences (Dedieu et al., 2022). According to psychologists and psychotherapists, worldviews are an expression of assumptions and ideas that come from many sources (Goldberg, 2009; Koltko-Rivera, 2004; Ibrahim, 1991; Jackson & Meadows 1991). These ideas have a variety of roots, including aspects of culture and human nature, to mention a few (Goldberg, 2009; Koltko-Rivera, 2004). Worldviews often explain why things exist and why they don't, what constitutes a positive or negative experience, why ideas are known and unknown in the universe, and what makes certain acts desirable (Koltko-Rivera, 2004; Koltko-Rivera, 2000). In essence, the psychologist's perspective on worldviews determines what is accepted or rejected in each individual (Goldberg, 2009). To expand on culture, worldviews provide a justification for opposing viewpoints (Goldberg, 2009). The use of land, for example, will present several arguments from the views of Native American tribes, farmers, city developers, and others (Goldberg, 2009).

Although traditional scientists and psychologists agree that culture is a source from which to infer worldviews, traditional scientists have different ideas about what makes a reliable worldview (Matthews, 2009; Cobern, 1996). Worldviews are viewed by scientists and science educators as a fundamental, rooted comprehension of how the world actually is (Matthews, 2009; Cobern, 1996). Compared to their psychological counterparts, such groups frequently depend on scientific worldviews (Cobern, 1996). Some people find the phrase "scientific worldview" meaningless and instead choose the phrase "scientifically compatible worldview" (Cobern, 1996).

As many science literacy groups work to promote science in education, a good science literacy strategy is based on scientific worldviews (Cobern, 1996).

Global Ignorance: Gapminder

The Gapminder Project is a Swedish organization dedicated to providing accurate, evidence-based worldviews through displaying key patterns in global development using dynamic data and vibrant images (Lang, 2012). Several studies have explained the usability and importance of updating statistical information in a digestible format that the Gapminder Project leads the world in (Le, 2013; Lang, 2012; Rosling & Zhang, 2011). The Gapminder Project measured what people know about the world and found that most do not understand the world around them (Rosling et al., 2019) and do not keep up with statistical changes in key topic areas. When presented multiple choice questions, also called the Global Ignorance Test, people tend to pick answers that constitute a negative worldview or one that predicts the world is the worst place to live (Rosling et al., 2019). These negative answers are motivated by instincts or biases, such as expecting bad news, forgetting the majority, failing to calculate risk or consider size, etc. (Rosling et al., 2019). Even highly educated individuals tend to score low on multiple-choice tests due to their negative world view (Rosling et al., 2019). An identified source of negative world views is media which is flooded with extraordinary events, making it difficult to develop an all-encompassing, unbiased worldview (Rosling et al., 2019). The Gapminder Project explains that a lack of communication surrounding global statistics and extreme perspectives from the media have contributed to a failure to understand basic global statistics (Rosling et al., 2019).

Conceptual Framework

Citizens' access to education, which may help them grasp viewpoints on research related to social issues like vaccinations, bioengineered foods, and more, is closely correlated with their level of scientific knowledge and comprehension. But what happens if the science is misconstrued or presented erroneously as false knowledge, and how can these concepts spread throughout different social groups? Based on the literature and the structure of this thesis work, the conceptual framework is adapted from many different theories including elements from knowledge gap theory and social contagion.

Knowledge Gap Theory

Although pro-agricultural nonprofits and media have tried to fill the gap, groups in opposition to modern agriculture with louder voices have kept the gap wide. With a polarized environment, it can be challenging to reach average consumers about animal agriculture, but a majority of consumers are willing to learn more about the industry and engage with it (*MSU*, 2019; Reus, 2023). According to the knowledge gap theory, the lack of awareness of how food is generated across agricultural and non-agricultural tribes is a result of the unfavorable media coverage as well as other reasons. The lack of knowledge, comprehension, or interest that can be found in the general population or society is explained by knowledge gap theory or hypothesis (Tichenor et al., 1970). Development and rapid growth of Internet technologies and accessibility to information have contributed to the knowledge gaps within society (Wei & Yan, 2010). Social media is a powerful tool for campaigns by animal rights organizations designed to influence customers in negative ways and discourage them from eating meat (Choueiki et al., 2021). Generally, the knowledge gap theory which is dependent upon socioeconomic class, divides the public by educational classes (Bighash & Qamarzadeh, 2021). However, the same framework can be applied to knowledge of our food and fiber system among producers and consumers. The mistrust of the agricultural industry is also influenced by knowledge gaps in the field.

Knowledge deficits in the agricultural industry have an impact on mistrust of the agricultural sector. A person's worldview, or perspective of and trust in agriculture, is frequently shaped by previous home attitudes, media exposure, and generational beliefs (Giblin, 2019; Sutherland et al., 2020). Due to their greater knowledge than the ordinary individual, those with more professional occupations or who are involved in higher education frequently express stronger concerns about the effects of animal agriculture on animal welfare, the environment, and human health (Liu et al., 2023; Modlinska et al., 2020; Clark et al., 2016).

Social Contagion

Being social creatures, humans are prone to social contagion. The incentive to propagate rumors, fads, and dangers as a result of a specific topic's rising popularity is explained by the notion of social contagion (Goldstone & Janssen, 2005). As additional information spreaders begin to engage with each other within the system, a tipping point is quickly reached (Elliot, 2021; Christakis & Fowler, 2012). Social connections, relationships, and other demographic factors might affect the contagiousness of a topic (Konstantinou et al., 2021). Worldview concepts are comparable to those of social contagion. From a scientific standpoint specifically, if a certain threshold of conceptual change is attained, the sheer weight of the concepts will cause a shift in worldviews toward the scientific (Cobern, 1996) or emergent social norms (Delon, 2018). But reaching a threshold might be challenging or simple (Cobern, 1996).

Conclusions

In conclusion, a review of the literature demonstrates the prevalence of knowledge gaps in the agricultural emphasis. College students often face awareness of new issues and experiences when navigating emerging adulthood (Katsiaficas, 2017), and previous literature has found that these issues can be related to agriculture (Walter & Reisner, 1994). Prior studies have also described which groups of people generally have more negative perceptions of animal-derived farming. Investigative study assessing the depth of consumer agricultural knowledge in higher education is required to proactively understand how current and emerging generations see animal agriculture. One way to remediate the damage caused by agricultural misperceptions could be through the development of agricultural literacy in higher education. By achieving their best level of competence and agricultural literacy, students can re-establish their connection to the food they have disconnected from.

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The following pages have been formatted to fit the style and guidelines for the peer reviewed Journal of Applied Communications.

Chapter 2 – Common Knowledge or Common Sense? Identifying Systematic Misconceptions of Animal Agriculture and Food Familiarity in Higher Education Individuals

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Abstract

Knowledge gaps in the context of agriculture contribute to mistrust and negative worldviews of the animal agriculture sector. The purpose of this quasi-experimental survey study was divided into three levels: quantify the perceived connection of participants to food production, assess their understanding, knowledge, and perceptions of animal agriculture (AA) and food production (FP), and determine predictors that may have contributed to their knowledge and perceptions of animal food production. The convenience sample for this study was a southeastern land grant institution, where 265 completed responses were returned. An Animal Agricultural Knowledge and Perceptions Questionnaire, a Food Familiarity Index Questionnaire, and demographic items were included in the electronic survey. The study reported that nearly 50% of the participants showed negative perceptions of animal agriculture ($p < 0.05$), regardless of food familiarity scores. Natural and self-identified demographic characteristics impacted the knowledge and perceptions of AA, including gender, ethnicity, dietary preference, perceived connection to FP and affiliation with the College of Agriculture ($p < 0.05$). By identifying topics and ideas that

are of great concern and little understanding, future perceptions and purchase intentions can be improved. Additional research should be done to replicate the findings with broader question pools and other demographic groups to identify areas that need improvement in agriculture communication efforts designed to dispel misinformation.

Keywords: perceptions, worldviews, consumer concerns, Gapminder, knowledge gap

Introduction and Problem Statement

Within a complex media-driven infosphere, communicators tied to agriculture attempt to reach and inform consumers, but their knowledge can be influenced by diverse worldviews (Anderson-Wise, 2022). A worldview is a set of beliefs, ideals, narratives, and expectations about the world that we live in (Gray, 2011). These beliefs guide all our decisions and actions. In general, a consumer's attitude tends to improve as they learn more about a topic or issue (Sutherland, 2020). In an agricultural context, knowledge deficits also lead to distrust in the agricultural industry. Worldviews or perceptions and trust in agriculture are often formed based on prior household beliefs, exposure to media content, and generational beliefs (Sutherland et al., 2020; Giblin, 2019). Public perception of agriculture is vital to its success as an industry (Alonso et al., 2020). In 2020, 54.1% of consumers focused on environmental contributions of animal agriculture (AA), 82% focused on health considerations, 58.4% on sustainability potential, and 54.3% focused on animal welfare and ethics of food production (FP) (Bryant & Sanctorum, 2021). Some media use less credible sources of information about agriculture and are vectors to communicate risk, or uncertainty of facts, and often mislead audiences (Prodromou, 2015; Gigrenezer et al., 2007). Ultimately, perceptions and concerns of consumers affect the supply and demand of products and affect farming practices or policy actions (Bulut et al., 2021; Ellis, 2021; Knight, 2007; Bruhn, 1970). The disconnect between knowledge of agricultural production among consumers and ubiquitous access to misinformation through the media further distances consumers from their food (Sutherland et al., 2020).

Today, people are less able to comprehend the intricate agricultural systems and industries that exist today compared to generations ago (Balschweid et al., 1997). This, together with additional elements to be examined in our study, has widened the knowledge gap between the two sides of FP. Direct on-farm producers, who make for 1.3% of US employment, along with those working in the agriculture and food industries, account for 10.5% of all US employment (Kassel, 2023). These individuals compose the agricultural community, where most consumers are not directly involved in agriculture (Specht et al., 2014).

Although disconnected, many demographic factors influence how varied populations perceive FP and AA. These characteristics are factors of ethical consumerism or the need and interest to know how food is produced (Capper, 2011). Ethical consumerism considers animal welfare, low environmental impact, labor conditions, and other practices of producing food (Capper, 2011). Specifically, women, young consumers, those who avoid consuming meat, highly educated individuals, and people of urban backgrounds tend to have more negative views about modern farming and its effects on health and the environment (Liu et al., 2023; Sanchez-Sebate et al., 2019; Clark et al., 2016). Factors that shape these perceptions amongst diverse populations are also derived from where people get their information about food or agriculture. In general, consumers use food labels to evaluate and select healthy foods (Cha et al., 2014). Beyond food label literacy, consumers only seek out information about how food is produced if they are motivated by personal or news events (Hall et al., 2004). In other words, it can be challenging to pinpoint the sources to which consumers turn to learn more about the provenance of their food. However, trust has been extensively evaluated in different agricultural resources (Settle et al., 2017). A global infodemic has decreased trust in all news sources (Edelman, 2021). Government agencies, extension programs, animal rights organizations, and some agriculture and allied industry organizations, and others, can be identified by the public (Settle et al., 2017). However, trust in each of these varies since non-profit organizations are perceived as highly trustworthy, apart from the People for the Ethical Treatment of Animals (PETA) campaigns (Settle et al., 2017).

By understanding perceptions and relative knowledge of consumers, as well as sources of agricultural information, animal and related industries can pinpoint weaknesses in communication efforts. Identifying topics and concepts of high concern and low understanding can improve future perceptions and buying intentions.

Conceptual Framework

Scientific knowledge and understanding among citizens are strongly tied to educational exposure of climate moderation, vaccines, bioengineered foods, and more (Ecker et al., 2022; Schmid & Betsch, 2019). Barnes and others (2015) describe science as an epistemology, or theories of knowledge, that arises from personal beliefs. Personal beliefs, in other words, reflect what an individual perceives as the truth (Cook and Lewandosky, 2016). Based on the literature and the design of this research study, the conceptual framework is adapted from the foci of connectivism, knowledge gap theory, and systems thinking.

In contrast to cognitivism and constructivism, connectivism has no restrictions on where learning occurs, as it embraces the concept that information is always accessible on the Internet and the media (Hendricks, 2019; Mallon, 2013; Driscoll, 2000). Negative exposure to the media along with other factors contribute to the gap in understanding how food is produced among agricultural and non-agricultural tribes, which is reflective of knowledge gap theory. Knowledge gap theory or hypothesis explains the lack of knowledge, understanding, or curiosity found within the public or society (Tichenor et al., 1970). Typically, the knowledge gap theory is dependent upon socioeconomic class divisions of the public or educational classes (Bighash & Qamarzadeh, 2021), however the model can be applied to connections to agriculture like the current study. Systems thinking is a dynamic epistemological approach to observe how the world works (Mambrey et al., 2020; Arnold & Wade, 2015). To adapt to the turnover of academia and produce competent, communicative graduates, those found in higher education are cultured in systems thinking methodologies (Eguia, 2022). A Swedish organization called Gapminder aims to educate about misconceptions of the world by leading the audience to approach new information from a fact-based worldview (Rosling et al., 2019; Gapminder, n.d.). This fact-based worldview includes mitigating instincts such as 'The Size Instinct' or 'The Destiny Instinct', otherwise known as our intrinsic biases, by implementing systems thinking (Rosling et al., 2019; Horx & Horx, n.d.).

Purpose

This descriptive and quasi-experimental study describes individuals at a southeastern university and their perceived involvement with food production, where they get their information about food and agriculture, animal agriculture knowledge and perceptions, and if there are demographic characteristics that influence their agricultural knowledge. The following research questions guided this study:

1. How do participants describe their connection to food production and where do they get their information about food production?
2. Do participants have greater knowledge and/or better perceptions of animal welfare, health and nutrition, or environmental sustainability compared to food familiarity?
3. Which demographic predictors influence the level of knowledge and perceptions of food production knowledge and perceptions?

Methods

The research design was descriptive quasi-experimental survey research using convenience sampling to fulfill the stated research questions and purpose. The target population was undergraduate students, graduate students, and faculty at a southeastern land grant institution. Study elements including survey questionnaires and all Institutional Review Board (IRB) documentation were submitted and approved in October 2022 through Auburn University's IRB office under protocol #22-481 EX 2210. The approval verifies that all participants were at low risk and that anonymity was maintained. Data were collected over a period of three months beginning November 2022 and concluding January 2023 using a researcher-developed, expert-validated online survey through Qualtrics Survey platform (Version 2022, Provo, Utah, U.S.). The survey was distributed to participants using the appropriate methodologies described by Dillman et al. (2014), since recruitment emails were delivered through university-issued emails containing the survey link. The survey consisted of the following: an information letter, a multiple-choice questionnaire on animal agriculture knowledge and perceptions (AAKPQ), a 10-point Likert-type scale Food Familiarity Index (FFI), and demographic questions. The convenience sample resulted in 324 responses, of which 265 remained after removing the unfinished questionnaires.

Participants

The demographic characteristics of the participants are separated by natural and self-identified characteristics. Natural characteristics include descriptors that are natural to the participant which involves gender, age, ethnicity, and upbringing. Self-identified characteristics include descriptors that reflect the choices made by the individual in his life, such as academic role, dietary preference, affiliation with the College of Agriculture, and perceived connection to FP. Table 1 presents the summary of demographic results. There were more males than females

(52.5%) and millennials (43.4%) for the participant body. The participants were mostly white (75.8%) and were raised in suburbs (61.5%). Most participants were graduate students (43.4%) that do not work or study in the College of Agriculture (89.8%) and consume meat (89.4%).

Table 1.

Natural and self-identified demographic characteristics of participants.[z]

Natural Characteristics	*n*	%	Self-Identified Characteristics	*n*	%
Gender			Academic Role		
Female	120	45.3	Undergraduate Student	81	30.6
Male	139	52.5	Graduate Student	115	43.4
Other	6	2.2	Faculty	69	26.0
Age[y]			Study/Work in College of Agriculture		
Generation Z (18-26)	90	34.0			
Millennial (27-42)	115	43.4	Yes	27	10.2
Generation X (43-59)	42	15.8	No	238	89.8
Baby Boomers (60-77)	18	6.8			
Ethnicity			Dietary Preference		
Caucasian/White	201	75.8	Omnivorous	237	89.4
Hispanic/Latino	9	3.4	Flexitarian	9	3.4
African American/Black	11	4.2	Pescatarian	9	3.4
Asian/Pacific Islander	31	11.7	Vegetarian	6	2.3
Mixed/Other	13	4.9	Other	4	1.5
Upbringing			FFI Group[x]		
Urban	40	15.1	Low	30	11.3
Suburban	163	61.5	Medium	182	68.7
Rural	62	23.4	High	53	20.0

[z] Survey responses utilizing Qualtrics (n = 265) for student and faculty knowledge and perceptions of animal agriculture and connection to food production.
[y] Generations defined by Research Guides at University of Southern California (2023)
[x] Low contained scores ≤ 40, medium contained scores 41-79, and high contained scores ≥ 80

Animal Agriculture Knowledge and Perceptions Questionnaire (AAKPQ)

The multiple choice AAKPQ contained twelve questions sourced from evidence based, public resources regarding knowledge of animal agriculture, specifically topics of animal welfare, nutrition, and the environment. Each question was presented with three possible answers weighted in a positive, negative, or extremely negative perception weight as described in Table 2. If a person had to choose at random, a score of 4 questions answered correctly (33%) is likely, whereas scores below 4 reflect a negative worldview, and scores 5 and above reflect a positive worldview.

Questions and answers were randomized to combat survey bias and fatigue.

Table 2.

Questions and answer choices presented to participants in the Animal Agriculture Knowledge and Perception Questionnaire.[z]

Welfare & Wellness[yxw]

1. How old are veal calves when they are harvested?
- a. 2 months old
- b. 4 months old
- c. 6 months old*

2. How much square footage is provided per beef animal in a feed yard?
- a. 50-100 sq ft (comparable to a walk-in closet, roughly 8ft x 8ft)
- b. 100-150 sq ft (comparable to a small bedroom, roughly 12ft x 12ft)
- c. 150-250 sq ft (comparable to a large bedroom, roughly 15ft x 15ft)*

3. Most animal-sourced proteins are sourced from ___.
- a. Factory farms
- b. Family-owned farms*
- c. Corporate-owned operations

4. Why are dairy calves removed from their mothers earlier than beef calves?
- a. Calves get sick soon after birth
- b. To keep the udder undamaged*
- c. The stress makes them produce more milk

Diet & Health[yv]

1. About how many vitamins and minerals are provided in 3.5 ounces of beef?
- a. 5-7
- b. 8-10
- c. More than 10*

2. When compared in ounce equivalents, plant-sourced proteins are ____ in protein content compared to animal-sourced.
- a. Greater
- b. Equal
- c. Lesser*

3. One 8-ounce serving of milk has the same amount of calcium compared to how many cups of kale?
- a. 1 cup
- b. About 3 cups
- c. More than 5 cups*

4. According to the CDC, there has been a reduction in E. coli related reports derived from ground beef of ___.
- a. 25%
- b. 60%
- c. 90%*

Table 2 Continued.
Environment & Sustainability[v]
1. If 10% (39 million people) of the US population were to go vegan, how much of an environmental impact will this have on the carbon footprint?
a. Reduced 0.26%*
b. Reduced 2.6%
c. Reduced 5.5%
2. What percent of water in a beef animal's diet is not provided by rainwater?
a. 6%*
b. 15%
c. 38%
3. What percent of US greenhouse gas emissions are attributed to livestock?
a. 3.9%*
b. 14.5%
c. 20.7%
4. What percent of animal-sourced foods end up in landfills?
a. 10-20%*
b. 30-40%
c. Higher than 40%

* Denotes correct answer choice
[z] Modeled after Global Ignorance Test (Gapminder Foundation, 2018) and modified for food production knowledge and perceptions.
[y] Animal Agriculture Alliance, 2022
[x] Compassion in Food Business, 2013
[w] Beef Checkoff, n.d.
[v] Everett, 2021

Food Familiarity Index (FFI)

The FFI is a 12-item, 10-point Likert-type scale questionnaire developed by researchers to measure and then summarize a person's perceived relationship to FP while considering the participants' interests in the origins of their food, perceived familiarity with FP, and other factors. (Hiltbrand, 2023). Current FFI questions were modified from another questionnaire to better fit a general involvement with FP (Tarpley et al., 2020; Wann & Branscombe, 1970). Participants were asked to rate their level of agreement with 12 statements where 0 = *Strongly Disagree,* 5 = *Neutral,* and 10 = *Strongly Disagree*. An additive score described that the participants were connected to their food at a low, medium, or high level with scores ≤ 40, 41-79, and ≥ 80, respectively.

Questions and answers within this section of the survey were randomized to combat survey bias and fatigue.

Table 3.

Food Familiarity Index (FFI) Questions (Hiltbrand et al., 2023) presented to students and faculty.

FFI Item
I go out of my way to accommodate purchase of preferred foods.
I am emotionally connected to procedures and conditions in which food is produced/grown.
I would say I know something about how a majority of the food I eat is raised.
I would devote time and energy to learning about different food systems and current agricultural practices used in food production.
When food is a topic of conversation, I am willing to share my knowledge about how food is grown/produced with others.
I devote time to growing my own food and/or food for others (people or animals) to consume.
I would be concerned if I were not able to study and learn about food and agriculture.
I support agriculture and food production systems.
I make buying decisions based on how and/or where a specific food item was produced.
I seek out others who also know or care about where their food comes from.
I buy goods based on the nutritional composition and health implication.
I am familiar with safety, quality, and marketing factors of food.

Data Collection and Statistical Analysis

Quantitative data were analyzed using SPSS statistical software (Version 28). Descriptive statistics were calculated to summarize demographic information and FFI scores. Frequencies and chi-square tests of independence were computed to analyze resources identified in information seeking behavior and AAKPQ scores. One-way ANOVAs were performed to compare the effect of natural and self-identified demographic predictors on AAKPQ scores. Multiple alpha and significance levels were defined for this study. The first, $\alpha_1 = 0.05$, was defined such that differences were declared when $p < 0.05$. The second, $\alpha_2 = 0.10$, was defined such that trending differences among responses were declared when $0.05 \leq p < 0.10$. The exact *p*-values are presented to allow the reader to develop independent interpretations. The inventory of knowledge, perception, and food familiarity was found to be reliable (27 items; $\alpha = 0.788$).

Results

Connection to Food Production

With completion of the FFI, cumulative scoring places an individual involved with FP in three classifications: low, medium, and high. The largest body of participants was those who identified themselves as involved in agriculture or FP on a medium level. In Table 4, descriptive comparisons are shown among each level. Of the 12 questions, 120 possible points could be awarded according to the involvement in FP, and the mean for the medium group (M = 61.71) is almost exactly average for the FFI.

Table 4.

Frequencies and percentages of Food Familiarity Index (FFI) score placement.[z]

FFI Score[y]	*n*	%	*M*[x]	*SD*[w]
Low	30	11.3	30.38	6.87
Medium	182	68.7	61.71	11.16
High	53	20.0	93.85	8.87

[z] Survey responses utilizing Qualtrics (n = 265) for student and faculty knowledge and perceptions of animal agriculture and connection to food production.
[y] Low scores = 0-40, medium scores = 41-79, high scores = 80-120
[x] *M* = mean
[w] *SD* = standard deviation

Resourcing Information Regarding Food Production & Agriculture

Frequencies for resources that participants use to find information about FP and agriculture are presented in Table 5. The most common sources of information on agriculture identified by participants were food labels (22.1%), news resources (18.6%), and social networks (17.8%). More people were expected to indicate that they do not seek agricultural resources, but our sample revealed that very few (0.9%) do not actively seek this information. Very few participants identified specific titles of resources (0.5%) including Alabama extension articles, RFD-TV, Clarkson's Farm, and others.

Table 5.

Sources of information about food production and agriculture and food production selected by participants.[z]

Resources for Information Seeking	*n*	%
I ask farmers or other people who work in the industry.	52	7.1
I actively seek out information about agriculture through "googling."	53	7.2
I ask my parents / guardians / family.	50	6.8
I read / learn about agriculture across social media.	131	17.8
I read / learn about agriculture in the news.	137	18.6
I actively seek out articles regarding agriculture.	38	5.2
I read food labels.	163	22.1
I hear about it in classroom settings.	48	6.5
I read signs / billboards / other public landmarks.	48	6.5
Other - I don't seek out agriculture.	7	0.9
Other - Specific resources (shows, extension, etc.).	4	0.5
Other - Other people (friends, professors, significant other).	6	0.8

[z] Survey responses utilizing Qualtrics (n = 265) for student and faculty knowledge and perceptions of animal agriculture and connection to food production.

Knowledge and Perceptions of Food Production

To determine whether participants have a negative perception of the AA industry, the frequencies of the total AAKPQ scores were computed and are presented in Table 6. The participants sampled in this study demonstrated a largely negative worldview of AA overall, as 49.1% of the participants produced an AAKPQ score of three or less. These participants selected answer choices that reflect a negative perception of AA. Worldview estimations were also compared on a food familiarity basis. A score of 0 or the most negative worldview is demonstrated by the low FFI group, where 3.3% of individuals connected to FP on a low level scored 0 correct on the AAKPQ. No individuals in the high FFI group scored a 0 on the AAKPQ. Of the 49.1% of participants that demonstrate a negative worldview of AA, the low FFI group showed the greatest percentage of negative worldviews through a score of 3 or less (56.6%) compared to medium (49.1%) and high (43.4%) FFI groups. A score of 5 or more indicates a more positive worldview, where 36.2% of participants demonstrate a positive worldview toward AA. The high FFI group had the highest percentage of positive worldviews (41.6%) in comparison to the low (33.4%) and medium (37.8%) FFI groups.

Table 6.

Percent Correct Scores for Animal Agriculture Knowledge and Perceptions Questionnaire Based on Food Familiarity Index (FFI) Group Placements.[z]

Score	FFI Group				Cumulative %
	Low[y]	Medium[x]	High[w]	Full Sample[v]	
	%	%	%	%	
0	3.3	1.6	0.0	1.5	1.5
1	16.7	8.8	5.7	9.1	10.6
2	3.3	22.5	15.1	18.9	29.4
3	33.3	16.5	22.6	19.6	49.1
4	26.7	12.6	15.1	14.7	63.8
5	3.3	9.3	5.7	7.9	71.7
6	6.7	8.8	7.5	8.3	80.0
7	0.0	6.0	5.7	5.3	85.3
8	0.0	6.6	13.2	7.2	92.5
9	6.7	2.2	1.9	2.6	95.1
10	0.0	2.2	0.0	1.5	96.6
11	0.0	2.7	3.8	2.6	99.2
12	0.0	0.0	3.8	0.8	100.0

[z] Survey responses utilizing Qualtrics (n = 265) for student and faculty knowledge and perceptions of animal agriculture and connection to food production.
[y] n = 30; Low scores = 0-40, ,
[x] n = 182; Medium scores = 41-79
[w] n = 53; High scores = 80-120
[v] n = 265

Participants were found to have varying levels of knowledge and perceptions about animal welfare, diet, and health of animal foods, and the environmental or sustainability impacts of AA. Specifically, the welfare category was identified as the category with the most correct answers and the environment category as having the least correct answers from the participants. The diet category was shown to have the most completed section, where participants correctly answered all four questions in the diet category (n = 17) in contrast to the welfare and environment categories (n = 14). Shown in Table 7, the chi-square test of independence revealed that there is a relationship between FFI group placement and animal welfare or wellness knowledge and perceptions with a large effect, [$\chi^2(15) = 279.09$, $p < 0.001$, $V = 0.591$]. Similarly, an association was found for FFI score and diet and health concepts of animal-derived foods with a large effect [$\chi^2(15) = 269.57$, $p < 0.001$, $V = 0.581$]. A clear association and a large effect were discovered between the FFI score and the notions of environmental impacts of AA practices was discovered [$\chi^2(15) = 271.48$, $p < 0.001$, $V = 0.583$].

Table 7.

Frequencies and Percentages of Correct Scores in Welfare, Diet, and Environment Categories Based on Food Familiarity Index (FFI) Group Placement.[z]

Question Category & FFI Group	Number Correct										Total	
	0		1		2		3		4			
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Welfare[y]												
Low	7	19.4	11	11.3	11	12.9	1	3.0	0	0.0	30	11.3
Medium	25	69.4	70	72.2	56	65.9	23	69.7	8	57.1	182	68.7
High	4	11.1	16	16.5	18	21.2	9	27.3	6	42.9	53	20.0
Diet[x]												
Low	10	15.4	11	12.4	4	6.5	4	12.5	1	5.9	30	11.3
Medium	42	64.6	62	69.7	44	71.0	22	68.8	12	70.6	182	68.7
High	13	20.0	16	18.0	14	22.6	6	18.8	4	23.5	53	20.0
Environment[w]												
Low	10	11.2	12	14.8	5	9.6	1	3.4	2	14.3	30	11.3
Medium	63	70.8	56	69.1	35	67.3	20	69.0	8	57.1	182	68.7
High	16	18.0	13	16.0	12	23.1	8	27.6	4	28.6	53	20.0

[z] Survey responses utilizing Qualtrics ($n = 265$) for student and faculty knowledge and perceptions of animal agriculture and connection to food production.
[y] $\chi^2(15) = 279.09$, $p < 0.001$, $V = 0.591$
[x] $\chi^2(15) = 269.57$, $p < 0.001$, $V = 0.581$
[w] $\chi^2(15) = 271.48$, $p < 0.001$, $V = 0.583$

Predictors of Food Production Knowledge and Perceptions

To better understand what factors are important in forming perceptions about AA, demographic predictors were analyzed for AA category scores and general AAKPQ scores based on natural and self-identified levels.

Natural Characteristics: Gender, Ethnicity, Upbringing, & Age

The ANOVA results for effects of natural demographic characteristics are presented in

Table 8. There was an effect of gender on knowledge and perceptions at the $p < 0.05$ level for the three gender groups with a small to medium effect [$F_{(2, 262)} = 6.453$, $p = 0.002$, $\eta^2 = 0.047$]. Tukey's HSD test for multiple comparisons revealed that women had improved AA knowledge and perceptions ($M = 2.915$, $SD = 0.266$) compared to men ($M = 2.305$, $SD = 0.092$), but not between other genders. The ANOVA findings showed that there was a significant influence of ethnicity on knowledge and perceptions [$F_{(4, 260)} = 4.663$, $p = 0.016$, $\eta^2 = 0.046$]. Post hoc comparisons using Tukey HSD test indicated that the mean score for white participants ($M = 2.787$, $SD = 0.196$) was significantly higher than the mean scores for Asian participants ($M = 1.870$, $SD = 0.325$). There were no differences between other ethnicities. There were no differences for upbringing [$F_{(2, 262)} = 1.764$, $p = 0.173$], and no differences were observed between different age groups or generations of participants [$F_{(3, 261)} = 0.091$, $p = 0.965$].

Table 8.

ANOVA Summary Table of Animal Agriculture Production Knowledge and Perceptions by Gender and Ethnicity.[z]

	SS[y]	*df*	MS	*F*	η^2	*p*-value
Gender						
Between Groups	86.937	2	43.468	6.453*	0.047	0.002
Within Groups	1757.124	262	6.707			
Total	1844.060	264				
Ethnicity						
Between Groups	84.157	4	21.039	4.663*	0.046	0.016
Within Groups	1759.903	260	6.769			
Total	1844.060	264				

[z] Survey responses utilizing Qualtrics ($n = 265$) for student and faculty knowledge and perceptions of animal agriculture and connection to food production.
[y] SS = sum of squares; df = degrees of freedom; MS = mean square; F = F-statistic; η^2 = eta-square.
* Denotes Welch's *F*-statistic reported.

Self-Identified Characteristics: Dietary Preference, Academic Role, FFI Group, & College

The one-way between subjects ANOVA results for effects of self-identified demographic characteristics are presented in Table 9. The ANOVA results report that the knowledge and perceptions of AA are affected by the selection of the diet of the participants with a small effect [$F_{(4, 260)} = 2.657$, $p = 0.033$, $\eta^2 = 0.039$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for omnivores ($M = 4.41$, $SD = 2.640$) was different from pescatarians ($M = 2.11$, $SD = 4.856$). No other differences were observed between other eating patterns. The ANOVA results for academic role, undergraduate student, graduate student, or faculty revealed that there was no significant effect on AA knowledge or perceptions [$F_{(2, 262)} = 0.830$, $p = 0.437$].

Table 9.

ANOVA Summary Table of Food Production Knowledge and Perceptions by Upbringing and Meat Consumption Habits.[z]

	SS[y]	*df*	MS	*F*	η^2	*p*-value
Dietary Preference						
Between Groups	72.419	4	18.105	2.657	0.039	0.033
Within Groups	1771.642	260	6.814			
Total	1844.060	264				
FFI Group						
Between Groups	39.040	2	19.520	2.833	0.021	0.061
Within Groups	1805.020	262	6.889			
Total	1844.060	264				
College						
Between Groups	26.133	1	26.133	3.781	0.014	0.053
Within Groups	1817.927	263	6.912			
Total	1844.060	264				

[z] Survey responses utilizing Qualtrics (n = 265) for student and faculty knowledge and perceptions of animal agriculture and connection to food production.
[y] SS = sum of squares; df = degrees of freedom; MS = mean square; F = F-statistic; η^2 = eta-square.

Different FFI groups tended to respond differently to knowledge and perceptions of food production as presented in Table 9 ($p = 0.061$). Participants in the high-scoring group ($M = 4.87$, $SD = 2.909$) tend to score higher on the AAKPQ ($p = 0.053$) and have better perceptions than the low-scoring group ($M = 3.47$, $SD = 2.080$). A participant's affiliation with the College of Agriculture tended to have different worldviews of AA than those who are not affiliated with the College of Agriculture ($p = 0.053$). Participants who worked or studied at the College of

Agriculture tended to score better on the AAKPQ (M = 5.19, SD = 2.690) than participants outside of the College of Agriculture (M = 4.15, SD = 2.622).

Discussion

Messages with unfavorable intentions have been produced due to the spread of false information and ignorance of animal agriculture, which has widened the divide between agriculturalists and non-agricultural communities (King et al., 2022; Folta, 2018). As they meet information about animal issues and other topics, students are likely to acquire opinions and, depending on the circumstance, incorporate that information either positively or negatively into their own knowledge structures (Walter & Reisner, 1994). This study sought to describe knowledge and perceptions of animal agriculture, how people are involved in food production, where information about agriculture is sourced, and if higher education roles or perceived connection to food production influenced perceptions of animal agriculture production.

Understanding where people get their information about food and agriculture is crucial to understanding how members of industry can communicate with consumers. Social media was the third most identified source of agricultural and food production information (Table 5). Social media is one of the main vectors for misinformation about animal agriculture (Thew, 2021), as well as a source of learning through connectivism (Hendricks, 2019). Animal rights campaigns use social networks to hold significant power over consumers and adversely affect, influence, and demotivate meat intake (Choueiki et al., 2021). In addition, through this study it was discovered that even among people who use social media to follow information about the origins of food, most had a weaker personal connection to knowing where their food comes from.

Knowledge gaps in the context of agriculture also contribute to the mistrust of the agricultural sector. Participants were found to be less knowledgeable about animal agriculture, but their lack of knowledge was also shown to be worse in perceptions (Table 6 & 7). Almost half of the total responses had poor perceptions of the animal agriculture industry (Table 6). These poor perceptions could be explained by previous and repeated exposure to misinformation, preconceived biases, or that the responses fall within the knowledge gap range (Cook and Lewandosky, 2016; Kendler, 2015; Rozin & Royzman, 2001; Trichnor et al., 1970). Some of the main perceptions to measure were animal welfare, diet and health implications, and environmental impacts. This was motivated based on previous research that indicated central public concerns. Consumer attention in 2020 was focused on the effects of animal agriculture on the environment (54.1%), health issues (82%), sustainability (58.4%), and animal welfare and food production ethics (54.3%) (Bryant & Sanctorum, 2021). In this study, it was found that, although in general consumers are concerned about the effects of environment and sustainability of animal agriculture, their knowledge of these topics is not reflected in the survey results. In general, participants had better knowledge of topics related to welfare and diet than those related to the environment. This is expected since processing large, global numbers can be difficult since oftentimes negative perceptions are carried by large data statistics presented in the wrong context (Rosling-Rönnlund, 2019; Prodromou, 2015). We hypothesized that university individuals had greater knowledge of welfare because of the meat paradox. The meat paradox explains that consumers are concerned about animal welfare practices, yet still consume meat that was harvested from animals (Kopplin & Raush, 2021; Aaltola, 2019).

Shown in our results, there are several demographic characteristics that explain the level of knowledge of an individual about how animal-derived food is produced. Regarding natural demographic characteristics, the significant result for gender is less consistent with previous literature (Table 8). Specifically, women tend to be more avoidant of animal fat consumption and aware of animal welfare practices than men due to their nurturing lifestyles, thus contributing to negative perceptions of contemporary agriculture (Modlinska et al., 2020; Sanchez-Sabate et al., 2019; Clark et al., 2016; Davy et al., 2006; Wardle et al., 2004). Although women may be more aware, it was inconsistent with previous findings that women in this study had better perceptions of animal food production than male or other gender counterparts. There is less information or clarity to compare the results when addressing the differences among races (Table 8) discovered in this study (Birkenholz et al., 1994). Food and agriculture are seen as an intercultural communication system among different ethnic and cultural groups (Fomenko et al., 2020). However, these results may reflect a sociological phenomenon in which people of minority races may have tried to separate themselves from the agricultural sector, which has been perceived as a dirty, labor-intensive industry with low economic returns and historical ties to slavery (Birkenholz et al., 1994). In various societal and educational contexts, more research on the importance of the racial variations in agricultural literacy should be explored. Upbringing has previously been shown to influence perceptions of animal agriculture, especially in areas of welfare concern (Clark et al., 2016), however this study revealed upbringing has no effect on knowledge or perceptions. Similarly, welfare concerns are more prominent in young people (De Boer et al., 2017; Clark et al., 2016), but the results of the current study reveal that there are no differences between age groups in understanding food-animal production.

Self-identified demographics, such as dietary preference, resulted in a significant influence on agricultural and food production knowledge. Omnivores or meat-eaters were more knowledgeable and had better perceptions than those who ate less eat meat less or not at all in this study, which was consistent with findings in the previous literature. Individuals who avoid meat in the diet (i.e., vegans and vegetarians) have poor perception of animal agriculture, as their perspective of animal agriculture is a source of ethical and environmental concern (Liu et al., 2023; Clark et al., 2016; Kiefer et al., 2005). The academic role did not produce differences in knowledge about animal agriculture production, which may be explained by the fact that all are involved in higher education. Individuals who have more professional careers or are involved in higher education tend to have greater concerns about the welfare, environment, and health-related impacts of animal agriculture due to having more knowledge than the average person (Liu et al., 2023; Modlinska et al., 2020; Clark et al., 2016). Because the comparison was made among university individuals and without the comparison of those not involved in higher education, the similarity in responses among groups is logical. There is less published research to explain why those who are more familiar with food production have a more positive perception of how animal-derived food is produced. Individuals who are more involved in food production should be more knowledgeable and have better perspectives on animal welfare, the health of animal-based foods, and the environmental impacts of animal agriculture. These results imply that the Food Familiarity Index shows signs of being a reliable tool for future research to describe perceived connection to or involvement in food production, thanks to prior research by Tarpley et al. (2020). The same effect can be seen by the affiliation with the College of Agriculture. As expected, studying or working within the College of Agriculture provided greater knowledge and perceptions about animal-derived food production than studying or working in any other discipline. Nevertheless, there are some natural limitations to the prior two explanations. Demographics of agricultural majors have changed across the last 60 years, where there has been a shift of student backgrounds with fewer incoming students having prior farm experience (Kenealy, n.d., Mollet & Leslie, 1986; Helsel & Hughes, 1984). In addition to the challenge of educating them, urban students who want to major in agricultural sciences present another barrier (Larke, 1982). According to research, students who have not grown up on a farm feel much less competent and have more self-doubt than their farm-raised counterparts in terms of agricultural knowledge, themes, and obstacles (Helsel & Hughes, 1984; Larke, 1982).

Humans are social beings and are susceptible to social contagion. The theory of social contagion explains the reasons underlying the motivation to spread rumors, fads, and risks as a result of the growing popularity of a particular topic (Barrios-O'Neill, 2020). A tipping point is quickly achieved as more information spreaders begin to interact within the system (Elliot, 2021; Christakis & Fowler, 2012). Social ties, friends, and other demographic variables can influence the level of contagion of a topic (Konstantinou et al., 2021). Although previous work has investigated contagiousness on vaccination status and social media (Konstantinou et al., 2021; Barrios-O'Neill, 2020), misinformation about agriculture is the topic at hand for the present study, which follows the same trends of social contagion.

Limitations

There were a few limitations to our study, including the non-response error. To minimize nonresponse error, early and late responses were compared (Lindner et al., 2001; Miller & Smith, 1983). No significant differences were found between early and late responses, considering all demographic variables. The second limitation would be that the respondents would answer aimlessly, potentially skewing the results and decreasing the validity of the study. Lastly, if participants answer dishonestly, especially regarding their perceived connection to their food, this could also skew the results.

Conclusions and Recommendations

Animal and related businesses can identify communication gaps by examining customer views, relative knowledge, and information sources about agriculture. Future impressions and purchase intentions can be improved by identifying issues and concepts of high concern and low understanding. As agricultural communicators, it is important to understand communication approaches that need adaptation to deflect the negative consequences of misinformation and misunderstanding of the most vital industry in the world. This study, in support of other research, identified characteristics that influence knowledge and perception of animal agriculture and food production in consumers. Effective and positive messages communicated through social media are viewed as a mechanism to bridge knowledge gaps that exist between agricultural and non-agricultural tribes. The Food Familiarity Index has also shown promise as a reliable tool for research by consistently measuring involvement in food production. This instrument could be used to segment the audiences of agricultural communicators to tailor specific messages based on their perceived involvement with food production and agriculture, but further research is necessary to understand the potential effects.

Regarding recommendations for future research, only university individuals were sampled; however, a more holistic understanding could be provided by sampling other groups of people. Specifically, the higher education individuals sampled in this study could be compared to samples from primary or secondary school, major household grocery shoppers, occupations, or others. Comparing multiple groups along with the level of connection to food production using the Food Familiarity Index would provide context and potential consistency to our study. Another opportunity would be to expand the knowledge and perceptions questionnaire to contain more questions within each category. Rather than focusing on a restricted number of questions, we may investigate whether there is consistency in increased understanding and, subsequently, perspectives of welfare, health, and sustainability of animal agriculture themes.

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The following pages have been formatted to fit the style and guidelines for the peer reviewed journal Natural Sciences Education.

Chapter 3 – The Use of Simulated Discussion Prompts to Assess Sentiment Toward Agriculture in Higher Education Instructors

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Abstract

Higher education instructors may include interdisciplinary subjects in the classroom to encourage diverse, yet balanced learning. Agriculture is a challenging study subject that includes elements of art, engineering, and science. Teachers may discover valuable information in this area. Although it is important to know if teachers in higher education incorporate agriculture in their lectures, it is more useful to comprehend the attitudes or opinions that are expressed. The purpose of this study was to determine whether higher education instructors mention agriculture in simulated discussion prompt generation and, if so, indicate the responses of positive, negative, and neutral sentiment towards agriculture. Teaching faculty from multiple land grant institutions served as participants in this study, where 59 completed responses were returned. Through electronic surveys, instructors were asked to respond to a randomized prompt related to their declared area of interest. Qualitative methodologies included open response coding, and reliable and validated thematic coding served as the primary analysis. The study reports that 25 of the 59 responses included comments about agriculture and 72.0% of the responses were neutral. The rest painted agriculture in positive (8.0%) or negative (20.0%) interpretations. The results of the study reveal the challenges that teachers face in making interdisciplinary leaps, including agriculture in

the classroom, without risking the spread of inaccurate information. Additional research should be conducted to understand the impacts of loaded language on students' perceptions of agriculture using the results produced by the current study.

Keywords: sentiment, instructors, higher education, agriculture, simulated classroom

Introduction & Study Purpose

Previous literature has summarized the benefits of multidisciplinary actions of educators (Butler, 2022; Sommier et al., 2022; Svensson et al., 2022; Turner et al., 2022). Specifically, there is a variety of evidence that addressing scientific agreement or context within societal issues can improve perception of scientific consensus and consequently key beliefs (van der Linden et al., 2016). Though beneficial to students and the scientific community, interdisciplinary efforts have the potential to fail.

Opinion-based teaching, political bias, and science polarization can cloud educators' judgment when making interdisciplinary leaps (Harrington, 2022; Linvill & Havice, 2011; Barry et al., 2008). As an example, the proliferation of media involving intensive animal agriculture has resulted in messages with negative motivations regarding key impacts of food production (Happer & Wellesley, 2019) and these perceptions have spread to all agricultural practices. The pleasant experience of eating meat is outweighed by the pronounced negativity bias resulting from the contemplation of animal pain, slaughter, and suffering (Baumeister et al., 2001). Instructors have a remarkable influence on their students and previous research illuminates the bias against agriculture. In the control and treatment groups, the meat eating habits of college students were studied (Schwitzgebel et al., 2020). Students who studied animal ethics were found to be more likely to say that they would stop consuming meat in the future than their counterparts who studied charity (Schwitzgebel et al., 2020). Another example includes "nudging" students to consume plant-blended burgers or educational methods that influenced willingness to consume all-beef burgers (Prusaczyk et al., 2021).

It is clear that agriculture plays a significant role in world economics and provides various services to other professions on both a national and international level (Jackson-Smith & Jensen, 2009). By studying agriculture and related topics in a college classroom setting, students can improve their agricultural literacy. Understanding what professors in higher education teach about agriculture can help us develop interventions against false information about animal agriculture. This descriptive observational study describes whether higher education instructors will introduce agriculture when provided the opportunity to create discussion posts on a discipline-related topic. The following research questions (RQ) guided this study:

1. If given a prompt, will instructors introduce agriculture in simulated discussion posts?
2. If agriculture is introduced, is it framed in a positive, negative, or neutral perspective?

Conceptual Framework

There are numerous entities that influence perceptions of agriculture and perspectives of introducing agriculture into education. The conceptual framework is based on the literature and the design of this research study, and it is influenced by the emphases of social contagion, student-teacher relationships, and belief polarization.

As gregarious beings, humans are prone to social contagion. The incentive to propagate rumors, fads, and dangers as a result of a specific topic's rising popularity is explained by the notion of social contagion (Goldstone & Janssen, 2005). Once additional information spreaders begin to engage with one another inside the system, a tipping point is rapidly reached (Elliot, 2021; Christakis & Fowler, 2012). Social connections, relationships, and other demographic factors might affect how contagious a topic is (Konstantinou et al., 2021; Burgess et al., 2018). Although earlier research examined contagiousness on social networks and vaccination status (Konstantinou et al., 2021; Barrios-O'Neill, 2020). Due to their better knowledge than the typical individual, those with more professional occupations or those who work or are enrolled in higher education frequently express greater doubts about the welfare, ecological, and health effects of animal agriculture (Liu et al., 2023; Modlinska et al., 2020; Clark et al., 2016). Personal beliefs are perceptions of the truth held by an individual (Cook and Lewandosky, 2016). As a group of professional educators, these trends in concerns could be considered contagious in nature.

The student-teacher connection is an additional important topic to discuss when addressing misinformation in higher education. Many organizations that govern the trust between students and their professors explain this relationship (Platz, 2021; Basch, 2012). Simply defined, the institutional environment in which instructors work and the idea of paying for a more advanced, sophisticated education support students' trust in their teachers (Platz, 2021). Students seek specialized knowledge and pursue academic achievement when they enroll in college, which strengthens teachers' authority (Platz, 2021). In college, students learn about and engage in epistemic competence, which improves the ability of the instructor to guide their constituents (Platz, 2021; Bash, 2012). It is also observed that when a positive relationship between student and their instructor is present, there generally are higher success rates amongst the students (Platz, 2021). Also, it has been found that students succeed more frequently when they have a good working relationship with their teacher (Platz, 2021). Although positive relationships between educators and students are opportunities to improve learning, educators' opinions shared in the classroom can jeopardize the positive experience. Sharing opinions can alter the social climate in the classroom (Pennycook et al., 2018; Rodriguez et al., 2016a; Rodriguez et al., 2016b). Students may feel challenged or intimidated by the change in "safe spaces" or conditions for discussion, as well as fear of the potential repercussions if they express their divergent viewpoints (Flensner & Von der Lippe, 2019).

People experience a phenomenon known as belief polarization when they learn similar information, and as a result, their opinions deviate (Cook and Lewandosky, 2016). Teachers have strong opinions that may be politically motivated or influenced by other factors. It is imperative to emphasize that instructor epistemologies affect students' receptivity to information (Barnes et al., 2015). A subcategory of belief polarization, scientific polarization is the propensity for public acceptance of a topic to be driven by popular opinion (van der Linden et al., 2017). Particularly in times of uncertainty, the public looks to professionals in the field, authorities, or politically motivated opinions presented as facts for advice (van der Linden et al., 2017). Polarized science is frequently politically motivated, according to people with valued opinions (van der Linden et al., 2017).

Methodology

Study Design

This study uses qualitative data using an observational approach. The questions were crafted by research personnel and validated by instructors in each discipline. Study elements including survey questionnaires and all Institutional Review Board documentation were submitted and approved in November 2022 through Auburn University's IRB office under protocol #22-517 EX 2211. The approval verifies that all participants were at low risk and that anonymity was maintained. University instructors at land grant universities within the 50 US states were invited to participate in a study testing their ability to craft impromptu discussion prompts that foster student learning. Instructors were contacted through email by the first author, which contained the Qualtrics survey (Version 2022, Provo, Utah, U.S.) link using appropriate methodologies explained by Dillman et al. (2014). To ensure that teaching instructors were sampled, participants were requested to provide their position appointments prior to survey. Participants who responded with zero percent in “teaching” and “extension” categories were not permitted to take the survey. However, the participants who responded with position appointments with greater than zero percent in “teaching” or “extension” categories were allowed to take the survey. Data collection ranged from December 2022 to February 2023. The survey consisted of the following: an information letter, demographics, discipline selection, and generation of discussion prompts. Incomplete responses were first removed from the data analysis, leaving 59 findings for statistical analysis and interpretation.

Discipline Selection & Discussion Prompt Generation

Discipline selection involved participants choosing the area of interest in which they teach provided by the American College Testing guidelines in 2022 (ACT, 2023). To measure the frequency with which agriculture is introduced as a discussion prompt, we did not ask instructors to explicitly craft an agriculture-based prompt. Instead, we asked instructors to write a prompt related to a topic within their area of interest that fosters student engagement and learning. Participants were asked to write a discussion prompt or post if online that they would be likely to use in their classroom. To provide further details, participants were given the opportunity to include an example student response to the prompt they created. With the selection of disciplines, a topic was provided to keep the responses within certain limits, as presented in Table 1. Each had the potential to address agriculture, but did not explicitly ask to address agriculture directly. For example, participants who select agriculture, natural resources conservation, or sciences as their area of interest were provided the topic, “climate change.” Animal or plant-focused agriculture could be addressed when discussing climate change, but is not always discussed as a cause or solution.

Table 1.

Discussion topics assigned based on declared area of interest.

ACT Area of Interest[z]	Discussion Topic
Agriculture & Natural Resources Conservation Sciences: Biological & Physical	Climate change
Architecture Repair, Production, & Construction	Urban sprawl and/or imminent domain
Area, Ethnic, and Multidisciplinary Studies Education	Challenges facing rural communities
Business	International trade
Communication	Product marketing of food
Community, Family, & Personal Services Health Administration & Assisting Health Sciences & Technologies	Dietary choice
Computer Science & Mathematics	Agricultural census
English & Foreign Languages	Migrant workers
Philosophy & Religion	Ethical or theological reasonings toward dietary choice
Social Sciences & Law	Politically policy ramifications of the Animal Welfare Act
Engineering Engineering Technology & Drafting	Genetically engineered products
Arts: Visual & Performing	Incorporation of natural landscapes and environmental elements into the arts

[z] ACT = American College Testing; (ACT, 2023)

Statistical Analysis

Demographic data were analyzed using SPSS (Version 26). Open response questions served as qualitative measures in which focused and thematic coding (Saldaña, 2016) were analyzed using ATLAS.ti (ATLAS.ti, Web Version, 2022). Responses were organized by the first author, which produced a transcript consisting of 19 pages of single-spaced text. Following guidelines by Saldaña (2016), four agriculture professionals reviewed and validated the transcribed text, themes, and codes to ensure dependability and reliability (Cypress, 2017). If there were differences in interpretation, the coders worked together to ensure steady responses by combining codes with comparable meaning into one code using second-cycle coding. Second-cycle coding was followed by categorization and grouping of codes into themes (O'Sullivan & Jefferson, 2019). These coding techniques produced reliable results upon which the notions of reliability and validity are predicated in the research study (Seale, 1999).

Participants

Participants in this study included faculty members from land grant institutions across the United States with position appointments of teaching or extension roles. The information summarizing the major demographic information of the participants is shown in Table 1, separated by personal and academic characteristics. Personal characteristics include gender, age, ethnicity, and upbringing, while academic characteristics include descriptors of their profession including their academic rank and position appointments. Of the 59 responses, the participants were evenly split in terms of gender. Sample majorities include that the participants were millennials (49.2%), white (89.8%), and grew up in a rural area (47.5%) or a suburban area (45.8%). Additionally, the participants had diversified university ranks, with assistant professors (33.9%) and professors (27.1%) composing more than 50% of the group. Position appointments were summarized from numerical responses, and many of the respondents had large roles (>70%) of teaching or extension work.

Table 2.

Personal and academic demographic characteristics of participants.[z]

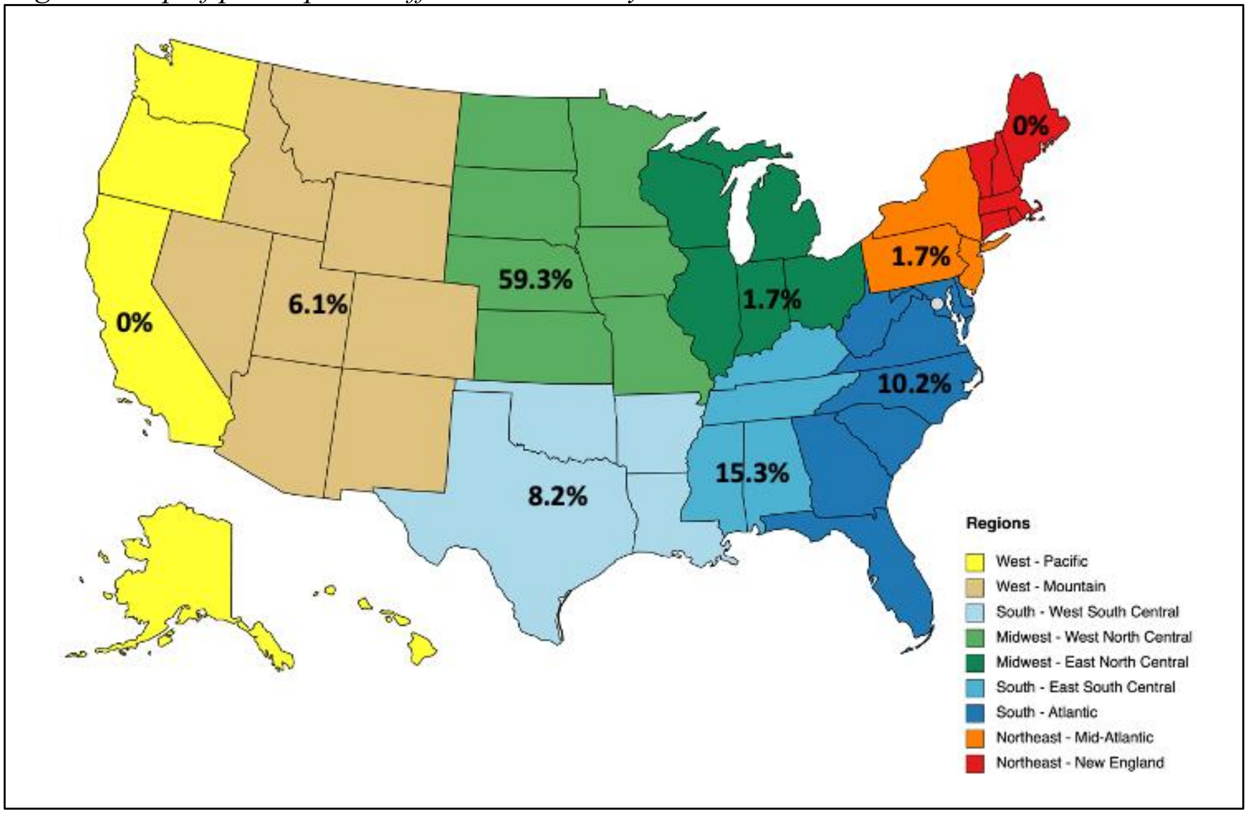
Personal Demographics	*n*	%	Academic Demographics	*n*	%
Gender			University Role or Rank		
Female	28	47.5	Instructor or Lecturer	8	13.6
Male	30	50.8	Assistant Professor	20	33.9
Third Gender/Non-Binary	1	1.7	Associate Professor	9	15.3
Age[y]			Professor	16	27.1
Millennial (27-42)	29	49.2	Professor of Practice	3	5.1
Generation X (43-59)	22	37.3	Other	3	5.1
Baby Boomers (60-77)	8	13.6	Position Appointment		
Ethnicity			Majority Teaching or Extension	37	62.7
Caucasian/White	53	89.8			
Hispanic/Latino	2	3.4	Majority Research with Some Teaching or Extension	9	15.3
African American/Black	1	1.7			
Asian/Pacific Islander	1	1.7			
Mixed/Other	2	3.4	Majority Administration with Some Teaching or Extension	6	10.2
Upbringing					
Urban	4	6.8			
Suburban	27	45.8	Evenly Split Teaching or Extension and Research	7	11.9
Rural	28	47.5			

[z] Survey utilizing Qualtrics (*n* = 59) for teaching faculty introduction and sentiment toward agriculture.
[y] Generations defined by Research Guides at the University of Southern California (2023).

Figure 1 displays the regions which participants indicated house their institution. To protect the identities of the land grant institutions, states and university names were not collected. Most of the respondents worked at land grant institutions in the Midwest, particularly the north central Midwest (59.3%) followed by the central Southeast region (10.2%).

Figure 1.

Regional map of participants' affiliated university.



Note: United States map with Census areas and divisions shown. extensively used region concept for data collecting and analysis from US, 2023). *n* = 59 teaching faculty.

Results

Prompts Mentioning Agriculture

The first round of coding involved sorting the responses that mentioned agriculture. The themes are bolded, while codes are capitalized for readability. The **Agriculture** codes contained codes related to addressing specific sectors of agriculture, mentioning the word "agriculture," or highlighting specific agricultural products such as meat and milk. Of the 59 responses, 34 did not mention agriculture and 25 continued with coding analysis. Shown in Table 3, most of the responses came from the area "Agriculture & Natural Resources Conservation," but it is not clear why this captured the highest response.

Table 3.

Area of interest, frequencies, and code words in prompt formation.[z]

ACT Area of Interest[y]	*n*	Code Words for **Agriculture**
Agriculture & Natural Resources Conservation	14	BEEF, FOOD PRODUCTION, FARM PRODUCTION ENTERPRISES, HORSE INDUSTRY, CROPPING SYSTEMS, LIVESTOCK PRODUCTION, GROW FOOD, RUMINANT
Sciences: Biological & Physical	1	ANIMAL AGRICULTURE
Business	1	FOOD SUPPLY, SUPPLY CHAIN
Communication	1	DAIRY MILK
Health Sciences & Technologies	1	GLOBAL AG PRODUCTION, FRUITS, VEGETABLES, MEAT
Computer Science & Mathematics	2	AG CENSUS DATA, FARM, FARM MODEL
English & Foreign Languages	1	FARM LABORERS
Philosophy & Religion	1	INDUSTRIAL FARMING, MEAT CONSUMPTION
Social Sciences & Law	2	ANIMAL RIGHTS, COCK FIGHTING RING
Engineering Technology & Drafting	1	GMO FOOD[2]
Total	25	

[z] Survey utilizing Qualtrics ($n = 59$) for teaching faculty introduction and sentiment toward agriculture. The **themes** are bolded, while CODES are capitalized for readability.
[y] American College Testing = ACT

Sentiment Analysis for Prompts Mentioning Agriculture

Further analysis of participant-generated discussion prompts and example answers included sentiment analysis. Sentiment analysis through cyclical coding methods resulted in **Positive**, **Negative**, and **Neutral** themes. Frequencies for sentiment analysis are displayed in Table 4. In general, the majority of prompts mentioning agriculture were positioned with neutral sentiment (72.0%), followed by negative (20.0%), and positive (8.0%) sentiments. The sentiment analysis artificial intelligence mechanism through ATLAS.ti coded responses in a similar way.

Table 4.

Sentiment frequencies for responses that mention agriculture.[z]

Sentiment	*n*	%
Positive	2	8.0
Negative	5	20.0
Neutral	18	72.0
Total	25	100.0

[z] Survey utilizing Qualtrics (n = 59) for teaching faculty introduction and sentiment toward agriculture.

Positive responses contained codes such as NATURAL CYCLE, SUSTAINABILITY, AG SOLUTIONS, HEALTH BENEFITS, and others. Respondents who demonstrated positive remarks towards agriculture framed different sectors of industry as sustainable sources of healthy foods. Furthermore, respondents indicated that agriculture is not the main driver of climate change, rather it is a solution and should be used as a tool to reduce the temperature of the Earth. There were two responses that had positive sentiment, with one response from the areas of "Agriculture & Natural Resources Conservation" and "Communications." The most common codes for positive responses presented in Table 5 encompassed the pro-agriculture language (PRO-AG) and that agriculture could solve (AG SOLUTIONS) the issue of climate change in a sustainable way (SUSTAINABILITY). In Table 6, shortened positive discussion prompts are provided.

Table 5.

Code words and frequencies for ***positive*** *sentiment responses found in land grant instructor discussion prompts mentioning agriculture.*[zy]

Code Words	n	%
NATURAL CYCLE	1	8.3
SUSTAINABILITY	3	25.0
AG SOLUTIONS	3	25.0
PRO-AG	4	33.3
HEALTH BENEFITS	1	8.3

[z] Survey utilizing Qualtrics of 59 higher education instructors (n = 25 for mentioning agriculture) introduction and sentiment toward agriculture. The **themes** are bolded, while CODES are capitalized for readability.
[y] n = 2 (n = 1 for Agriculture & Natural Resources Conservation; n = 1 for Communications)

Table 6.

***Positive** sentiment prompt responses and code words from land grant instructors amongst different areas of interest.*[zy]

Area of Interest[x]	Example Quotes
Agriculture & Natural Resources Conservation	"When considering the percentage of green house gas emissions the agriculture sector is responsible for compared to other industries, it seems the blame is not justified. Those in the livestock industry argue that, livestock can actually be part of the climate change solution with their ability to sequester and recycle carbon from the earth's atmosphere and help lower earth's temperature… Based on your own research in conjunction with what you have learned in this course about livestock production and stewardship of land, discuss what you think options are for sustainable solutions to climate change are in the agriculture industry."
Communication	"You are working with an integrated marketing and communications team to increase the reach of your social media campaign focused on the health benefits of dairy milk to consumers… What would be one strategy you would recommend for the company to pursue? How would you measure the success of the strategy?"

[z] Survey utilizing Qualtrics of 59 higher education instructors (n = 25 for mentioning agriculture) introduction and sentiment toward agriculture. The **themes** are bolded, while CODES are capitalized for readability.
[y] n = 2 (n = 1 for Agriculture & Natural Resources Conservation; n = 1 for Communications)
[x] (ACT, 2023)

Negative responses contained codes such as CLIMATE CHANGE CONTRIBUTORS, REDUCED MEAT INTAKE, and others. Respondents demonstrating negative themes posed agriculture as an industry destructive to the planet in terms of environmental impact and nudged that reduced meat intake could solve this issue. The codes for the negative responses are displayed in Table 7. Most of the negative responses were attributed to the blame of agriculture for immeasurable contributions to climate change (CLIMATE CHANGE CONTRIBUTORS, MASSIVE EFFECTS). Other positions negative to agriculture included prompts for consumers to declare that current global agriculture producers do not meet demand of producing fruits, vegetables, or meat for the world to consume (UNDERPRODUCING). Examples of negative discussion prompts are presented in Table 8.

Table 7.

*Code words and frequencies for **negative** sentiment responses found in land grant instructor discussion prompts mentioning agriculture.*[zy]

Code Words	*n*	%
CLIMATE CHANGE CONTRIBUTORS	6	40.0
MASSIVE EFFECTS	4	26.7
JUSTIFYING EXTREMIST ANIMAL RIGHTS ASSOC.	1	6.7
UNDERPRODUCING	3	20.0
REDUCED MEAT INTAKE	1	6.7

[z] Survey utilizing Qualtrics of 59 higher education instructors (*n* = 23 for mentioning agriculture) introduction and sentiment toward agriculture. The **themes** are bolded, while CODES are capitalized for readability.
[y] *n* = 5 (*n* = 2 for Agriculture & Natural Resources Conservation; *n* = 1 for Sciences: Biological & Physical; *n* = 1 for Health Sciences & Technologies; *n* = 1 for Philosophy & Religion)

Table 8.

***Negative** sentiment prompt responses and code words from land grant instructors amongst different areas of interest.*[zy]

Area of Interest[x]	Example Quotes
Sciences: Biological & Physical	"Assuming you believe in climate change, how large a role do you think animal agriculture plays in the general warming of the planet?"
Philosophy & Religion	"PETA argues that we should be vegan because industrial farming is harming the environment. Suppose they are right (and they might be--Milford reservoir has been closed to fishing and swimming due to green algae blooms for at least a month of the summer in most of the past 10 years in consequence to nitrogen pollution). Does PETA's argument justify government policies designed to decrease stockyard pollution by decreasing the demand for meat?"

[z] Survey utilizing Qualtrics of 59 higher education instructors (*n* = 23 for mentioning agriculture) introduction and sentiment toward agriculture. The **themes** are bolded, while CODES are capitalized for readability.
[y] *n* = 5 (*n* = 2 for Agriculture & Natural Resources Conservation; *n* = 1 for Sciences: Biological & Physical; *n* = 1 for Health Sciences & Technologies; *n* = 1 for Philosophy & Religion)
[x] (ACT, 2023)

Neutral responses contained codes that inquired about specific topics with no distinct lean toward pro- or anti-agriculture. Some examples of these codes were ECONOMICS, AG ADAPTATIONS, FARM LABOR, FOOD SUPPLY, and others. Respondents demonstrating neutral tendencies may have framed agriculture as a potential problem or resolution, but most of the prompt presented agriculture in a neutral position. Many responses directly mentioned a specific agriculture industry, such as the beef industry (ANIMAL AGRICULTURE) or fruit producers (PLANT OR CROP AGRICULTURE). The largest number of codes, shown in Table 9, were those labeled FACTFUL INSIGHT. This label was applied to instructor responses asking about knowledge or plans of action of their hypothetical classroom audiences. In Table 10, examples of neutral discussion prompts are provided.

Table 9.

*Code words and frequencies for **neutral** sentiment responses found in land grant instructor discussion prompts mentioning agriculture.*[zy]

Sentiment	*n*	(%)
FACTFUL INSIGHT	27	(42.9)
ECONOMICS	3	(4.8)
POLICY ACTIONS	5	(7.9)
AG ADAPTATIONS	4	(6.3)
ANIMAL AGRICULTURE	6	(9.5)
PLANT OR CROP AGRICULTURE	9	(14.3)
AG CENSUS DATA	2	(3.2)
FARM MODEL	1	(1.6)
FARM LABOR	1	(1.6)
FOOD SUPPLY	5	(7.9)

[z] Survey utilizing Qualtrics of 59 higher education instructors (*n* = 23 for mentioning agriculture) introduction and sentiment toward agriculture. The **themes** are bolded, while CODES are capitalized for readability.
[y] *n* = 16 (*n* = 1 for Agriculture & Natural Resources Conservation; *n* = 1 for Communications)

Table 10.

***Neutral** sentiment prompt responses and code words from land grant instructors amongst different areas of interest.*[zy]

Area of Interest[x]	Example Quotes
Agriculture & Natural Resources Conservation	"For this assignment, please provide a 5-minute video discussion of the issue of methane production by ruminants and its effects on the environment. Frame this discussion as if you were talking to an audience of dieticians at a human nutrition conference. You should discuss some data (with sources), as well as how those data should be interpreted in the context of the current debate in the public square."
	"How might a changing climate in Florida impact an invasive species like citrus greening and therefore impact Florida's citrus industry?"

Table 10 Continued

English & Foreign Languages	"How does Pam Munoz Ryan's young adult novel *Esperanza Rising* depict migrant workers compared with your own perceptions of them? In your response, you can discuss your perspective in terms of experience (direct or observational), research or studies, assumptions or stereotypes, and opinions based on media depictions (including social media, news sources, films/shows, etc.)."
Business	"When considering supply chain issues in the food service industry; What attributes can influence a food products ability to enter the United States? How does this effect your production, menu design, and pricing structure?"

[z] Survey utilizing Qualtrics of 59 higher education instructors (*n* = 23 for mentioning agriculture) introduction and sentiment toward agriculture. The **themes** are bolded, while CODES are capitalized for readability.
[y] *n* = 13 (*n* = 9 for Agriculture & Natural Resources Conservation; *n* = 1 for Business; *n* = 1 for English & Foreign Languages; *n* = 1 for Social Sciences & Law)
[x] (ACT, 2023)

Discussion

To promote unique, yet balanced learning, higher education instructors can introduce interdisciplinary topics in the classroom. Agriculture, a complex field of study with elements of art, engineering, and science, can be a source of information for instructors. Agriculture is a relevant topic to draw from and understand, as it is evident that agriculture contributes significantly to global economy activity and offers a range of services to other industries on a local, national, and global scale (Jackson-Smith & Jensen, 2009). Teaching concepts about agriculture reinforces efforts to improve agricultural literacy (Looney, 2009). Agricultural literacy is defined by the National Agricultural Literacy Outcomes (NALO) program (Spielmaker & Leisling, 2013) as the capacity to digest information about and comprehend our food and fiber system. By illustrating actual-world problem scenarios, agricultural examples in the context of other disciplines can help students develop their mathematical and scientific application skills (Mabie & Baker, 1996). It is important to know if higher education instructors introduce agriculture in classrooms, but it is more powerful to discern the position or attitudes in which the information is presented.

In our investigation, it was discovered that instructors in subjects other than agricultural science may discuss agricultural issues. Specifically, these intersections of agriculture and other disciplines were largely framed with neutral attitudes. To handle complicated issues and advance information literacy, interdisciplinarity as a knowledge regime is important (Svensson et al., 2022; Felt et al., 2012). Consistent with previous literature, it was revealed in our results that instructors present may agriculture in negative perspectives, but less frequently than neutral positions. These negative perspectives could be influenced by opinion-based teaching in higher education (Kunkle & Monroe, 2018; Linvill, 2011), the motivation to share preconceived biases (Schwitzgebel et al., 2020; Linvill & Havice, 2011), science polarization (van der Linden et al., 2017), or belief polarization (Cook and Lewandosky, 2016).

Instructors formulated negative perspectives on agriculture and food production in the fields of biological or physical sciences, human health sciences, philosophical and religious studies, and agriculture or natural resources sciences. Some traditional science instructors promote less conservative instruction on climate change by making unfounded claims that agriculture is the only cause of it, while others instruct the opposite (Kunkle & Monroe, 2018; Gil-Perez et al., 2003). The work of Kunkle and Monroe (2018) illustrates a division in teaching science, also coined science polarization. Science polarization is the propensity for public acceptance of a subject to be determined primarily by popular opinion on the subject (van der Linden et al., 2017). Other examples of disparities of agriculture and science educators include conversations of genetically modified foods (Mohapatra et al., 2010), reducing meat consumption to mitigate pollution of the planet (Fonseca & Vizachri, 2023), or having a negative impression of agriculture education (Malecki et al., 2004).

Regarding human health sciences, there are discrepancies in perspective between scientists and agriculturalists. Many nutritionists or medical professionals claim that in addition to reducing emissions, minimizing red meat intake can prevent heart disease, cancer, premature death (Misra et al., 2018; Christoherson & Huag, 2011), and limit higher body mass indices (Hobbs-Grimmer et al., 2021). Other nutrition and health scientists argue the benefits of eating red meat, including but not limited to the benefits of satiety, the maintenance of lean body mass, complete protein composition (Ribas-Agustí et al., 2021; Jampolis et al., 2016; Wyness, 2016), improvement of cardiac function (Pereira & Vicente, 2013), and benefits to the neurological system (Riesberg et al., 2016; Szcześniak et al., 2014). A specific benefit and one of the most important benefits of consuming red meat that is less discussed includes the neurological, growth, and developmental gains of children consuming red meat (Leroy et al., 2023; Hawthorne et al., 2022; Krebs et al., 2011) Philosophical studies and religious studies can also have qualms with agriculture. These groups admire utilitarian efforts, which is the ethical mindset that whatever is morally right is the best action to produce good (Driver, 2014). This view includes avoiding harvesting animals for consumption purposes, minimizing planet pollution, maintaining natural resources, abstaining from genetically modified foods, and avoiding the use of synthetic resources to promote crop development (Theisen, 2020; Barnhill & Doggett, 2018; John & Flores, 2018; Thompson, 2016; Korthals, 2008; Zwart, 2000). Addressing the negative comments of agricultural sciences and natural resource sciences, natural resources sciences tend to have the same perspectives on agriculture as traditional science fields, but many have opposite perspectives (MacDonald et al., 2015). As discussed earlier, agricultural communicators have shown poor efforts to combat negative messages against agriculture. Therefore, it was unexpected that agricultural instructors create discussions that paint their own industry in a negative light. This phenomenon demonstrates the need to educate agriculturalists about effective, positive messaging strategies, especially in educational settings.

On the other hand, agricultural and natural resource scientists and communication instructors presented positive outlooks on agriculture. As previously discussed, agricultural instructors should and are expected to communicate balanced evidence-based facts regarding their own industry. People who are more involved in food production are obligated to know more and think more clearly about issues like animal welfare, the safety of foods derived from animals, and the effects of animal agriculture on the environment. Regarding the positive response from the communications area, the instructor decided to use the prompt to educate others about agriculture. Specifically, communicating about the health benefits of dairy milk (González-González et al., 2022; Ali et al., 2021) can reach millions of people through social media mechanisms (Farrell et al., 2022). The existing connections between managing the land for wildlife, crops, and animals for production may lead to a more favorable impression or relationship with agriculture for natural resources and conservation sciences (NRCS Conservation Programs, n.d.). To maintain the quality of the land for both agriculturalists and conservationists, there are several conservation tactics in place (NRCS Conservation Programs, n.d.).

Conclusions, Limitations, and Recommendations

Instructors and leaders in higher education are highly trusted individuals; therefore, it is crucial to study precise language used during teaching sessions referring to the most vital industry in the world, food production. When presenting agriculture in positive or negative perspectives, higher education instructors have the influential potential to alter student perceptions of agriculture (Prusaczyk et al., 2021; Schwitzgebel et al., 2020). In this study, we were able to quantify the possibility that instructors would introduce agriculture and conduct sentiment analysis to examine the perspectives on agriculture and food production. However, the study had some limitations.

First, was sample size, where more responses would give a larger representation of simulated discussion generation (Galesic & Bosnjak, 2009; Deuskens et al., 2004). Considering these constraints, more research is required to determine the motivations and effects of introducing agriculture in higher education classrooms. To conduct a further study, a larger sample should be recruited, resulting in a greater variety of disciplines to measure. Additionally, recommendations include using the current study prompts, specifically positive and negative-positioned discussion prompts, and surveying students responding to the discussion prompts. This would allow for measures of impact on the student based on the positioning of agriculture in higher education discussion settings. Lastly, instructors who make interdisciplinary leaps by immersing agriculture in classrooms can be difficult and may result in the spread of misinformation. As a potential intervention to agricultural misinformation and to provide background knowledge of agricultural concepts, the inclusion of modules, training, or workshops in teacher education or faculty development programs is another option for additional research.

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Chapter 4 – Literature Review: Where Scientific and Agricultural Literacies Connect and Suggesting for Enhancing These in Higher Education

Introduction

Since the ability to communicate about scientific advancements and education have not advanced, research has demonstrated that science educators must adapt to strengthen science literacy (Barnes et al., 2015; Schuh, 1986). There is evidence that ineffective science communication and science literacy have created a divide between scientists and the public (Shamos, 1995). The inclusion of agriculture, a significant and multifaceted scientific topic, in conventional science classes is one suggested improvement. Improved scientific literacy contributes to better decision-making capabilities among citizens and facilitates navigation through citizen challenges. Societal attitudes that oppose scientific consensus, such as with safety of a technological advancement in food production, safety, health and medicine, can be costly (Light et al., 2022). The lack of agricultural literacy that affects much of the population today is the driving force for this shift, since combining science and agriculture might remind people where their food originates. Promoting agricultural literacy through incorporation of agriculture into science instruction can minimize misinformation, fulfill original missions of land grant universities, and bring people closer to how their food is produced.

Statement of the Problem

Research on viewpoints on recognizing student deception and trustworthiness through assessments of professors in higher education is little understood. Although previous, older research has reported experiences of challenges between instructors and students (Linvill & Havice, 2011), an updated surveillance report is overdue. In addition, a unique and much needed topic of study is reporting the perspectives of future educators at the intersections of science and agriculture. It is vital to know where future educators stand on conventional science to attenuate the spread of misinformation about agriculture in classrooms and increase agricultural literacy. This reasoning is based on the mental model that the growth of future generations of global citizens depends on knowledge of science, food, and agriculture, as well as the ability to evaluate the validity of information and the credibility of the source.

Objectives

Exploring baseline patterns and viewpoints is essential to identify scientific bias, false information, and similar occurrences in higher education. The following research objectives seek to provide insight into the stated problem:

1. Investigate trends and perceptions related to misinformation, credibility, trust, bias, and others in graduate students and on a graduate program basis.
2. Report the perspectives and testimonies of graduate students who experience misinformation and other obstacles in higher education.
3. Report the effectiveness of a professional development workshop designed to improve agricultural literacy in higher education.
    I. Identify the change in confidence and capacities in complex science fields after attending a professional development workshop.
    II. Understand the motivations of future teachers to teach science and the willingness to infuse agriculture into their curriculum before and after a workshop.
    III. Measure retention of learning through post-post-workshop surveys.

Information Literacy

The speed at which information is spread, whether accurate or inaccurate, has relevant variables. One of the most significant threats worldwide is misinformation (Del Vicario et al., 2016; Howell, 2013). Although misinformation and disinformation have distinct differences, their definitions sometimes mix. Both phrases refer to the spread of false or debunked information, albeit with different motives and objectives (Gebel, 2021). Misinformation is defined as false or context-free information that is provided as fact without any intentional attempt to deceive (Gebel, 2021; Brahm & Jenert, 2019). Even the term "digital wildfire" has been used to describe misinformation (Howell, 2013). Similarly to how misinformation influences its frequency and exposure, bias is defined as a tendency of temperament or attitude (Merriam-Webster, n.d.a).

Risk is a significant component in the propagation of false information. While calculating risk involves measuring apprehension toward a topic, bias and risk go hand in hand (Prodromou, 2015). Individuals are more likely to remember and accept as real information that is perceived as "risky" to them or their society (Prodromou, 2015). Specifically, the vector of these misconceptions is through the media like social networks and similar platforms. It is estimated that globally 3.6 billion people consume social networks (Farrell et al., 2022). For example, increased popularity of social media networks, such as Twitter, allows an "enhancement of the visibility" of science globally (López-Goñi & Sánchez-Angulo, 2017). Although using social media could be an opportunity to improve accessibility to learn and appreciate science, there are threats to spreading misinformation on scientific topics to promote a biased perspective to create an army of followers (Kirkpatrick, 2021).

Science Communication

There are many studies that address the importance of proper science communication, although there is less research focused on agriculture from the agricultural perspective. Instructors are seen as influencers for undergraduate students (Maynes & Hatt, 2015); therefore, they should be role models in accurate science communication. The combination of exercising scientific communication and opportunities to discuss topics through unbiased means contributes to students' confidence in future science communication (Train & Miyamoto, 2017). Train and Miyamoto (2017) revealed significant differences in student confidence prior to and after the seminar. In addition to student confidence, learning sufficient science communication skills is a foundational piece of critical thinking skills (Beardsworth, 2020). Competency in science communication and critical thinking can be compared to fluency in two languages. Propagating complex topics into digestible information to a larger audience is an effective skill students can attain through practicing science communication (Beardsworth, 2020). These studies demonstrate that the ability of instructors to communicate science has a statistical impact on their students.

Students can search or "Google" any needs or curiosity they may have via the Internet. Therefore, it is critical today to be able to critically sift, digest, and recommunicate relevant and evidence-based science material (Fischloff & Scheufele, 2019; *NAS*, 2018). When educators acquire improved science communication skills, they will not only convey emergent research in a classroom but also improve understanding among a broad group of citizens. Enhanced science communication among teacher influencers at multiple levels is critical for supporting the next generation of the workforce and increasing public support for research, and it communicates to taxpayers that there is a return on their investment. This is important because it is taxpayers who support education, fund investments in next-generation scientific research, and facilitate science-informed decision making. Equipping future and current educators with the ability to communicate complex sciences, such as food and agriculture, provides students with excellent science communicators to model. Competent teachers create competent students with excellent science communication skills, thus creating competent graduates who are highly desired in today's competitive job market.

While science communication is an overarching term for anything related to sharing science with others, traditional pedagogies for communicating science seem to be limited to similarly traditional formats. These include presenting lectures on virtual slides, students writing papers, or creating a digital poster. Science communication is challenging, as there are multitiered dialogues that bridge perspectives of "[the] scientist, the science teacher, and the science learners together" (Strauss et al., 2011). Untraditional strategies are needed to engage diverse audiences of learners (Scheufele & Krause, 2019). In most General Education curricula, future teachers must take writing classes, which often do not build the specific skills needed for effective science communication. Students who have developed some measure of analytical thinking and cognitive discernment strategies would be considered more scientifically literate.

Science Literacy

Science literacy goes beyond knowledge and understanding of science topics. It can be defined as a complex thought process including knowledge and understanding of science processes as well as the ability to problem-solve in real time action (Barnes et al., 2015). Another definition, provided by Hurd (1998), states that science literacy is cognitive abilities for using knowledge from science and technology in human affairs and for social and economic advancement. Research has exhibited reform efforts for science educators because, although science is advancing, our teaching and communicating science has not followed the same trend (Barnes et al., 2015). A portion of these reform efforts specifically target science literacy as a primary goal for advancing science education from kindergarten through postsecondary studies (Barnes et al., 2015).

Without science literacy, there is weakness in explaining how research, science, animal production, etc. affects our stakeholders, the public. This weakness taints the heritage of land grant institutions. Land grant colleges and universities were federally created to provide public access to higher education (NASULGC, 1995). All land grants were originally intended to educate classical studies, military strategy, mechanic skills, and agriculture to provide working-class people access to the same educational possibilities as the upper classes valued in the past (NASULGC, 1995). Fortunately, land grant missions collectively have shifted due to benefits in technology and access to scientific discoveries. However, with scientific and similar knowledge in science advancing exponentially, communication skills to translate science to the public have not followed the same exponential trend (Schuh, 1986). Rhetorically, what good is forging ahead in these complex fields when the rest of the world is left behind, lacking the simplest idea of what researchers and scientists know? Barnes et al. (2015) reported that both explicit and relative instruction is critical to connecting these gaps. Therefore, the need is high for employed instructors at land grant universities to understand the basics of science communication to extend these same skills to current and future students, no matter the discipline.

The Importance of Measuring Higher Education Individuals

The Demand for a College Education

The trending spikes in higher education enrollment can be traced to life expectancy gaps. Using standard life table methods and education information listed on 48.9 million death certificates, Case and Deaton (2021) were able to discover trends in increased life expectancy with higher education levels. Their findings suggest that education beyond a high school diploma results in an improved quality and quantity of life presumably due to socioeconomic benefits with higher education (Case & Deaton, 2021). Since 2008, about 20 million students have been enrolled in public higher education institutions each year (Hanson, 2021). Of students enrolled in college, as described by Provasnik et al. (2007), undergraduate students between 18 and 29 years old are more likely to enroll if they are from urban or suburban locales. This trend can be translated to the overall enrollment rate of universities, in that most students enrolled in undergraduate programs do not have rural backgrounds and likely have minimal interaction with animal agriculture. The described generation includes Generation Z, particularly college-age students. Entering college students are specifically highlighted since they are pursuing permanent decisions as part of transitioning into adulthood (Duckworth et al., 2016). Following a historical trend, students entering college come from urban or suburban backgrounds in contrast to rural backgrounds (Provasnik et al., 2007). The chances of urban and suburban students interacting with animal agriculture are slim, in addition to their trips to the grocery store, and will base their perspective of animal agriculture on those they interact with.

Opinion-Based Teaching in Higher Education

The source of teaching misinformation in college classrooms comes from opinion-based teaching and political bias. There is evidence supporting the use of teacher positionality in the classroom to support opinion-based instruction (Harrington, 2022). From a STEM (science, technology, engineering, and mathematics) perspective, opinion-based teaching is still evident, for example climate change. Some instructors support more progressive instruction of climate change with false claims that agriculture is the sole contributor to climate change, while others teach the opposite (Kunkle & Monroe, 2018). As science advocates, there is still a divide in teaching when instructors should be coming together to educate consistent, factual evidence. Evidence of this divide can be seen in the Kunkle and Monroe study (2018) where science instructors across many states were identified and surveyed about their climate change beliefs and strategies. It was found through open-ended response, that conservative instructors believe teaching misinformation is possible, and that more progressive instructors will fall victim especially with topics like climate change (Kunkle & Monroe, 2018). Kunkle & Monroe's work is reflective of science polarization. Science polarization is the tendency for popular opinions toward a topic to be the driving force of public acceptance (van der Linden et al., 2017). Specifically, the public looks for guidance, especially in times of uncertainty from expert authorities of a field or perhaps others which are politically motivated individuals with opinion stated as fact (van der Linden et al., 2017). People with strong beliefs frequently see divided science as being politically motivated (van der Linden et al., 2017).

After analyzing student responses, it was found that students in the communications and public speaking course (non-STEM) were perceptive of bias taught by instructors in the classroom (Linvill, 2011). There is the possibility that those who cannot detect the bias are more likely to conform to the instructor's beliefs to not stand out or differ in beliefs (Linvill, 2011). Linvill's study is an example of the influence of the instructor and why bias should be limited as much as possible. The results suggest that instructors should reflect on their own biases and offer unbiased discussion instead of teaching one side (Linvill, 2011). Through more "open-minded inquiry… students can grow both intellectually and developmentally" (Linvill, 2011, p. 54). The relevance of studies like Linvill (2011) is that perceptions of agriculture have some political and ideological ties in that when instructors lean more liberal or more conservative, one may have predestined opinions. Moreover, university instructors tend to be more liberal (Gross, 2014), which is not necessarily a bad thing. However, these more liberal opinions on animal agriculture can be spread in the classroom and add to the misinformation crisis.

The proliferation of media messages related to intensive animal agriculture has resulted in messages with negative motivations about key impacts of food production. In 2020, 54.1% of the focus was on environmental contributions of animal agriculture, 82% focused on health considerations, 58.4% on sustainability potential, and 54.3% focused on animal welfare and ethics of food production (Bryant & Sanctorum, 2021). Due to inflamed media towards animal production practices, biases can be detected by well-informed experts. Bias is characterized as a temperamental, behavioral, or attitudinal inclination (Merrian-Webster, n.d.a). These biases are observed in research that is predominantly focused on educational settings.

Intrinsic biases are those that are conscious and subconscious biases within the intrinsic beliefs of the individual. Negativity bias is an occurrence of individuals placing higher emphasis on negative traits than positive ones (Rozin & Royzman, 2001). In agriculture, the prominent negative bias stems from the consideration of animal pain, slaughter, and suffering outweighs the pleasant experience from eating meat (Baumeister et al., 2001). Negativity bias can also be seen in prosocial and anthropomorphic messages (Choueiki et al., 2021). Specifically, the comparison of animals to humans, like in animal rights campaigns, has a high influence on consumers who have a negative impact on meat consumption (Choueiki et al., 2021). Implicit bias is typically described as a legal metaphor as motions of prejudice (NIH, n.d.). However, implicit bias occurs at the subconscious level, where the individual favors a judgment or dismissal whether they notice it or not (NIH, n.d.). Constant exposure to media or decades-old imagery can shape implicit bias, where the more often a particular phenomenon like misinformation or misrepresentation about cattle feedlots appears to an individual, the more likely they would side with the argument. Like implicit biases, confirmation bias is the tendency to accept and/or seek information in favor of one's beliefs (Michel & Peters, 2021). Using the same example as before, the media can use algorithms to promote an idea that has been frequently visited, therefore, if a person trusts that idea, the more likely they are to believe, confirm, and agree with the information. Similarly, information established as true to the individual will be highly sought out in contrast to the frequency of seeking out information opposite to their belief (Michel & Peters, 2021).

Research has been conducted to understand the influence in specific research topics. However, some of the research described illuminates bias against agriculture, typically in the ethics of eating meat. As described above, Schwitzgebel et al. (2020) investigated student meat-eater behavior in control and treatment groups. The results of the study showed that those students studying meat ethics expressed that they were more likely to avoid eating meat in the future compared to their charity-studying counterparts (Schwitzgebel et al., 2020). Another example includes whether biased "nudging" individuals to consume plant-blended meat burgers or educational methods were successful compared to control groups (Prusaczyk et al., 2021). Both nudging and educational methods were found to reduce the willingness to consume all-beef burgers (Prusaczyk et al., 2021).

Theoretical Framework

Scientific knowledge and understanding among citizens are strongly tied to educational exposure, which can enable people to understand views about science connected to social topics of climate moderation, vaccines, bioengineered foods, and many more topics. Barnes and others (2015) described science as an epistemology, or theories of knowledge, that arises from personal beliefs. Personal beliefs, in other words, reflect what an individual perceives as the truth. Based on the literature and the structure of this thesis work, the theoretical framework is adapted from the theories of truth.

Correspondence Theory of Truth

The Correspondence Theory of Truth, or correspondence, is the earliest and straightforward of the theories. If there is a correspondence between a statement and an existing equivalent, the theory labels that statement as true (Elsby, 2016). Although this theory is the simplest, it is limited to those who have experienced the phenomenon in the world (Seale, 1999). Some label being-in-the-world is existential to the correspondence theory. Essentially, what is experienced or not shapes what is seen as true.

To provide an agricultural context, many people in the world do not partake in agriculture production and therefore expectation would differ from those who have experienced agriculture. Correspondence is based on what is real to the individual or is based on existing elements. For those who have never stepped foot on a farm and only consumed information about farms through social networks, it would be difficult to decipher truths based on animal welfare practice. If it does not seem possible to treat animals fairly, regardless of the conditions, then the individual will evaluate true statements as those that are negative welfare claims of animal agriculture production.

Coherence Theory of Truth

The Coherence Theory of Truth, coined coherence, considers the individual's current beliefs known to be true when encountering new information. Specifically, the statement will be interpreted as the truth when "it fits well with other things we know confidently about the world" (Kendler, 2015, p. 1115). Kendler (2012) notes that what is perceived as true seems more realistic when framed in context of current understanding or worldview. Similarly, Candlish et al. (2021, para. 39) explained that coherence "can be deduced from his views or a consequence of current views.” Ability to update beliefs described by Bayes' theorem is reliant on the probability that the provided information is based on true earlier beliefs (Cook and Lewandosky, 2016). Coherence justifies truth if it makes sense within one’s web of beliefs. However, considering radical or biased perspectives, coherence can become complicated as those beliefs are extremely different from what others believe to be true.

Like the mechanisms of confirmation bias, new beliefs about agriculture that are seen as falsely true are reliant on current beliefs about agriculture. For example, if prior beliefs suggest that red meat is unhealthy and contributes to disease, information on health benefits of beef consumption would be less likely to be adopted. However, if health complications regarding beef consumption were presented, it is more likely that people would perceive this information as true.

Pragmatic Theories of Truth

The Pragmatic Theories of Truth, also called pragmatism, are the most recent justifications of truth that stem from American philosophers. Pragmatic truths allow evidence to shape true beliefs. According to William James, true ideas are those that we can assimilate, validate, corroborate, and verify (Legg & Hookway, 2021). Another philosopher, John Dewey described that truth is what works (Sorrell, 2013). Lastly, Charles Peirce inquired that truth is truth until science proves otherwise (Legg & Hookway, 2021; Capps, 2019; McCarthy, 2000).

Pragmatism uses logistical evidence to distinguish true and false, which is why it is dominant in the world of research (Heikkien, 2001). Like research, understanding the truth is comparable to solving a puzzle, where a new piece of knowledge is true when its puzzle piece fits into the big picture (Heikkien, 2012). Sometimes, when researchers find a puzzle piece that has a strange shape, it appears to not belong to the complete puzzle. This is a paradigm commonly found in research. Specifically, scientists look at problems and research questions too concretely and tend to ignore societal problems that are also important to the big picture (Kuhn, 1970). Although the puzzle piece has a peculiar shape, it has its place in the puzzle. Pragmatism concludes that with new scientific ideas and discoveries, scientists are constantly being exposed to new knowledge, therefore, constant reshaping of perspectives and beliefs is crucial to understanding the truth.

Unfortunately, politics interferes with the ability to deflect bias in science. Belief polarization is a phenomenon in which when people receive similar information, views are essentially opposite (Cook and Lewandosky, 2016). Similarly, politicization of science occurs when presented information that is credible and accepted by those with similar agendas and yet is dismissed by those with opposing agendas (van der Linden et al., 2017). Teachers have rooted beliefs that can be politically motivated or motivated based on other factors. For an agricultural example, if extreme environmentalism fits their agenda, then they are more likely to accept this information based on coherence and will accept the information as true with science to back up the claims. It is crucial to note that instructor epistemologies, or investigations of what distinguished justified belief from opinion, affect student receptivity to information, so there must be a way to reliably collect epistemology information for professional development (Barnes et al., 2015).

Framework in Context

Each theory of truth, correspondence, coherence, and pragmatic contributes to instructor bias, teaching and propagating misinformation, and failure to promote science and agricultural literacy. In an echo chamber, especially in an education focus, there are many factors that directly influence what is perceived to be true about agriculture. Conscious or subconscious biases contribute to the theories of truth, where repeated exposure, one’s upbringing, political ideology, or existence in the academic sphere can negatively impact what is understood as true. Media exposure is one of the leading vectors of bias in recent times, where negative headlines, misinformation, and anti-ag campaigns flood social media feeds. Often, negative perceptions are carried out by large data statistics presented in the wrong context (Prodromou, 2015). It is difficult to interpret “big data,” which contributes to bias and the media is commonly a vector of risk.

Risk and bias coincide, since gauging risk is measuring fear toward a topic (Prodromou, 2015). Individuals who encounter information that is “risky” to themselves or a community, are more likely to remember and adopt this information as true (Prodromou, 2015). Adults are constantly evaluating and comparing risks, such as the statements ‘beef does or does not contribute to heart disease’, and typically the “safer” option is what gets adopted. Also, the riskier the information, the more likely it will be shared, reshared, and spread through word of mouth or social networks.

Exposure to biased misinformation suggests to the individual that the misinformation or bias exists, confirming Correspondence. Again, if exposure is repetitive, individuals remember their experiences, which fit in with their web of beliefs, confirming Coherence. In the perspective of educators, if believable, but bad science defends the misinformation, educators and researchers are more likely to adopt the misinformation as true (Dahlstrom, 2021).

As sharers of science and information, instructors lean on pragmatic theories to explain what is true. Consequently, students taught by these instructors also play a crucial role in the conceptual framework. This is due to the inevitable student-teacher relationship. This relationship is described by several entities that control trust between students and their instructors (Platz, 2021). Simply put, the institutional setting in which instructors work and the concept of paying for a higher level, more intricate education reinforces the level of trust that students have in their instructors (Platz, 2021). Students attend college wanting to receive niche truths and have goals of academic success, thus reinforcing trust in instructors (Platz, 2021). In college, students are exposed to and practice epistemic confidence, which contributes to the instructor's epistemic competence to lead their constituents (Platz, 2021). It is also observed that when a positive relationship between the student and their instructor is present, there are generally higher success rates among students (Platz, 2021). Teachers are professional communicators within their own discipline, and these perceptions are often taught in college classrooms through the biased opinion of instructors that is perceived as factual. As a result, students may develop negative perceptions about animal agriculture based on the spread of misinformation in the classroom. In summary, instructors are more likely to share "the truth" with their students with possible motivations of risk and bias, which in turn misinform students about agriculture, degrades agricultural literacy, and further distances students from understanding food systems.

Proposed Modes of Improving Science & Agricultural Literacy to Reduce Misinformation: A Multidisciplinary Workshop Model

Often, instructors in non-science disciplines lack exposure and training for embedding science within their classroom lessons. For non-science, non-agriscience teachers to embed or infuse science and agriculture concepts and examples into their lessons requires training and incentivization to lead classroom discussion of the unfamiliar topics. At the same time, well-read science instructors are capable of understanding and implementing science into their classes but do so in a way that does not foster science communication in constituent student bodies. Our reasoning is drawn from a mental model that scientific, food, and agricultural knowledge, and the ability to discern evidence credibility are crucial for the future generations of global citizens. Society will need to have some connectivity to science as discerning consumers and practitioners of citizenship in an ever-changing science-laden society. Our current research indicates that communicating science and agriculture using effective messaging modalities can improve science communication, science literacy, and agricultural literacy in a professional development workshop.

As defined by Merriam-Webster, a workshop is typically a “brief intensive education program for a relatively small group of people that focuses especially on techniques and skills in a particular field” (Merriam-Webster, n.d.b). In other words, workshops are time-efficient, niche methods to induce change in a specific arena. Workshops are frequented in the academic sphere, where each sequential workshop contributes to the professional development of that individual (Figland et al., 2019). Professional development workshops, when successful, advance teachers’ knowledge, include training in specific areas, and improve learning effectiveness (Borko, 2004). Workshops are evaluated, redesigned, and reevaluated in cyclical motion to constantly improve and generate better results with each delivery. Due to niche application, workshops are often relevant to participating educators, with expectations met or exceeded, and find the content of the workshops useful and innovative (Lawton et al., 2017). Workshops are also seen to positively impact students, where workshops “reinforce student values and awareness” (Ooi & Tan, 2015).

Land grant institutions, especially those of R1 or the highest research tier, seek to build their portfolio of research in all disciplines, but especially STEM fields. Educating workforce-ready graduates and the public about scientific innovations is a critical component of this mission. Furthermore, R1 institutions aim to enhance current and future faculty traits and capabilities as well as equip well-rounded graduates to enter the workforce. Previous discussion of literature summarized the benefits of multidisciplinary actions such as incorporation of agriculture within a context of other disciplines. Specifically, there is a variety of evidence that addressing scientific agreement or context within societal issues can improve perception of scientific consensus and consequently key beliefs (van der Linden et al., 2016). Workshops have the potential to influence participants, less in a propagandistic way and more in a self-evaluation method. Influence can occur in a matter of seconds, as described by many influence analysis models (Zheng et al., 2020). Science is evolving; therefore, truths evolve, and the potential to influence is possible. Workshops focused on unbiased interpretations of science can minimize future misconceptions, including interventions such as inoculation theory. Inoculation theory helps people develop immunity to persuasive information that can be misleading in a sustainable way (Cook et al., 2017).

Conclusion

Past literature summarized the growing need for focused science communication, science literacy, and agricultural literacy skills. Undergraduate students who learn and practice science communication methods leave college resilient, knowledgeable, and confident in their skills. More importantly, addressing agriculture-related scientific topics and issues from a more urban or suburban background provides resourceful evidence-based information on which students can draw their opinions. When educators learn stronger science communication abilities, not only will they more effectively explain emergent findings in a classroom, but they will also increase knowledge across a broad spectrum of citizens. A return on taxpayers' investment is communicated to them via improved science communication among teacher influencers at all levels, which is essential for supporting the next generation of the workforce and raising public support for research. To reduce misinformation, it is important to provide current and future educators with the skills necessary to communicate complicated scientific concepts, including agriculture. This will give students access to role models who are outstanding science communicators. For students to properly connect with and comprehend agricultural subjects, other science disciplines should be integrated with agriculture in the classroom setting. Now this is the right time to share how manufacturers and livestock producers are attempting to increase the sustainability of their product lines by utilizing science and creativity (Van Eenennaam & Werth, 2021).

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The following pages have been formatted to fit the style and guidelines for the peer reviewed journal Educational Sciences.

Chapter 5 – Credibility Judgments in Higher Education: A Quantitative Approach to Detecting Misinformation from University Instructors

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Abstract

Given the convenience with which information can now be acquired, it is crucial to analyze cases of potential misinformation and disinformation in postsecondary education. Instructor credibility judgments were measured using descriptive survey research, and the main objective was to investigate trends related to misinformation, credibility, trust, bias, and others in graduate students and on a graduate program basis. Participants were surveyed from a land grant institution in the southeast United States where 186 graduate students completed an electronic survey on the detection of misinformation and similar experiences. Graduate students were divided according to the type of graduate program into STEM (sciences, technology, engineering, and mathematics) and non-STEM groups. Quantitative methodologies included questionnaires developed by researchers containing Likert-type scale questions. Chi-square tests of independence and frequencies served as primary analyses. Participants in both STEM and non-STEM graduate program types detected the following: misinformation, bias, challenges, intimidation, risk of measurable consequences, pressure to conform, and skepticism from post-secondary instructors. There were significant differences between the type of student for trust in claims ($p < 0.05$), while the perception of potential consequences tended to be different between the types of graduate

students ($0.05 < p < 0.10$). Participants representing both disciplines indicated they have experienced perception bias in the way that teachers have presented material related to science, but students in STEM disciplines have reported bias less frequently than students in non-STEM disciplines.

Keywords: misinformation; university; instructors; credibility judgment; survey; graduate students; land grant; STEM and non-STEM; bias

Introduction

There are contributing factors that increase the speed at which information, correct or incorrect, is shared. Misinformation is viewed as one of the most important global risks to trust and reliability in societal relationships (Del Vicario et al., 2016; Howell, 2013). There are clear differences between misinformation and disinformation, but often have combined definitions. With different intentions and goals, both terms include the dissemination of false or disproved material (Gebel, 2021). False or out-of-context information that is given as reality, without any deliberate attempt to mislead, is referred to as misinformation (Gebel, 2021; Brahm & Jenert, 2019). Misinformation that is intentionally misleading and intended to confuse or mislead is known as disinformation (Gebel, 2021). Similarly to how misinformation affects its frequency and exposure, bias is defined as "an inclination of temperament or outlook" (Merriam-Webster, n.d.). One of the main factors contributing to spreading misinformation is risk. Risk and bias pair together since gauging risk is measuring fear toward a topic (Prodromou, 2015). Individuals that encounter information that is “risky” for themselves or a community are more likely to remember and adopt this information as true (Prodromou, 2015). The riskier the information, the more likely it will be shared, reshared, and spread through word of mouth. Adults are constantly assessing and comparing risks, as information is consistently provided to the public.

The source of misinformation spread about science is traced back to inaccurate science communication through numerous platforms. For example, virtual media and news are currently identified as some of the major vectors of spreading misinformation (Karnowski et al., 2017). The increase in popularity of social media networks, such as Twitter, allows an "enhancement of the visibility" of science globally (López-Goñi & Sánchez-Angulo, 2017, p. 3). Although this is an improved opportunity and availability to learn and appreciate science, there are threats to spreading misinformation and disinformation on scientific topics to promote a biased perspective to create an army of followers (Kirkpatrick, 2020). There is a disconnect in this example of science communication to the public, where hot topics from social media, such as genetically modified organisms or global warming, are shared in the global infosphere (Thornton, 2020). Numerous studies have investigated the ability of post-secondary students to interpret and judge online information as fake or fact, and most reveal that there is difficulty determining the credibility of these sources (Majerczak & Strzelecki, 2022; Evanson & Sponsel, 2019; Svrovatkova & Pavlicek, 2021; Wineburg & McGrew, 2021; Nygren et al., 2020).

One platform for misinformation and disinformation spread is the college classroom. Previous research has shown that instructors have a large influence on their students, where their words and actions can have long-lasting impacts on students (Schwitzgebel et al., 2020). Specifically, political bias, opinions, and personal beliefs or biases can interfere with material taught in higher education classrooms (Linvill, 2011; Kunkle & Monroe, 2018; Cook & Lewandowsky, 2016; van der Linden et al., 2017). From a STEM (science, technology, engineering, and mathematics) perspective, opinion-based teaching is still evident. Some instructors support more progressive instruction on climate change with false claims that agriculture is the sole contributor to climate change, while others teach the opposite (Kunkle &

Monroe, 2018). Through open response, self-identified conservative instructors were found to believe teaching misinformation is possible and that more self-identified liberal instructors may fall victim, especially with topics such as climate change (Kunkle & Monroe, 2018). More often than expected, these opinions can change the social environment of the classroom (Pennycook et al., 2018; Rodriguez et al., 2016a, 2016b). The switch to environments or "safe spaces" for discussion can make students uncomfortable, including feelings of challenge or intimidation with the anticipation of possible consequences if students were to share their differing opinions (Flensner & Von der Lippe, 2019). Since instructor epistemologies have a significant impact on student receptivity to learning, there must be a reliable mechanism to gather information on epistemology for professional growth (Beardsworth, 2020).

Another crucial element to discuss regarding misinformation in higher education is the student-teacher relationship. This relationship is described by several entities that control trust between students and their instructors (Platz, 2021). Simply put, the institutional setting in which instructors work and the concept of paying for a more intricate, higher-level education reinforces the trust students have in their instructors (Platz, 2021). Students attend college seeking to receive niche truths and have goals of academic success, thus reinforcing trust in instructors (Platz, 2021). In college, students are exposed to and practice epistemic confidence that contributes to the instructor's epistemic competence to lead their constituents (Platz, 2021). It is also observed that when there is a positive relationship between the student and his instructor, there are generally higher success rates among students (Platz, 2021).

Though there is an argument that introducing science in a nonscience space is distracting or a destination for misinformation spread, there are numerous benefits if practiced correctly. A fundamental component of critical thinking is developing adequate science communication skills

(Beardsworth, 2020). This begins with educator efforts to blend science into nonscience classrooms. When educators acquire better science communication skills, not only will they more effectively convey emergent research in a classroom, but also will improve understanding among a broad group of citizens (Amin et al., 2022; Kompella et al., 2020). The purpose of this study was to measure the perception of graduate students of higher education instructors' challenges and share stories of memorable moments in which instructors presented inaccurate information.

Theoretical Framework

As sharers of science and information, instructors lean on Pragmatic Theories of Truth, also called pragmatism, to explain what is truthful. Pragmatism is the most recent justification of truth originating in American philosophers. Pragmatic truths allow evidence to shape true beliefs. According to William James, true ideas are those that we can assimilate, validate, corroborate, and verify (Legg & Hookway, 2021). Another philosopher, John Dewey described that truth is what works (Sorrell, 2013). Lastly, Charles Peirce inquired that truth is truth until science proves otherwise (Legg & Hookway 2021; McCarthy & Sears, 2000). Pragmatism uses logistical evidence to distinguish true and false, which is why it is dominant in the world of research (Heikkinen et al., 2001). Understanding the truth is like piecing together a puzzle, where a new piece of information is true when it fits into the larger picture (Heikkinen et al., 2001). When jigsaw pieces with odd shapes are discovered, they frequently do not seem to fit in the finished product. This paradigm is prevalent in research (McCarthy & Sears, 2000). In particular, scientists frequently ignore social concerns that are important in the larger context in favor of problems and study topics that are overly narrowly focused (Kuhn, 1970). Although it has a strange shape, the puzzle component fits in its proper position. Pragmatism concludes that with new scientific ideas and discoveries, scientists are constantly being exposed to new knowledge, therefore, constant reshaping of perspectives and beliefs is crucial to understanding the truth. In summary, instructors are more likely to share "accurate information" with their students with possible motivations for risk and bias, which in turn can influence or misinform students about science and ultimately demotes science literacy.

Study Purpose, Research Objectives, and Research Questions

Research on perspectives on detecting misinformation in students and credibility judgments of instructors in higher education has not yet been explained. This study sought to discreetly explore trends and perspectives in the detection of misinformation and bias in past classrooms of graduate students on a graduate program basis. Graduate students with declared programs involving science, technology, engineering, and mathematics were labeled STEM, while graduate students that do not are labeled non-STEM. General and science-specific misinformation, as well as pseudoscientific evidence were researched in this study; therefore, it was anticipated that graduate students of STEM disciplines and non-STEM disciplines would yield differing results. The research questions (RQ) that this study answers were as follows:

RQ1. What do STEM and non-STEM graduate students perceive and rank as credible sources of scientific information?

RQ2. Is there a relationship between graduate program (STEM and non-STEM) and perceived value of incorporating science into non-science classrooms?

RQ3. Is there a relationship between graduate program (STEM and non-STEM) and sense of misinformation, bias, challenge, intimidation, consequences, or pressure to conform?

RQ4. How often is credible, evidence-based science discussed in nonscience college classrooms?

RQ5. If science was introduced in nonscience classrooms, then the scientific concepts claims perceived as trustworthy by graduate students (STEM and non-STEM) or are graduate students skeptical the claims could be misinformation?

Materials and Methods

Study Design and Analysis

This study used survey data (n = 186) following a quantitative approach. The questions were designed by research personnel, approved by a panel of three science educators, and internal consistency was tested. The reliability analysis resulted in a Cronbach alpha of 0.647 which is lower than the standard value; however, considering the smaller sample size and fewer items, this was deemed sufficient for continued analysis. Study elements including survey questionnaires and all Institutional Review Board (IRB) documentation were submitted and approved in May 2022 through Auburn University's IRB office under protocol #22-223 EX 2205. The approval verifies that all participants were at low risk and that anonymity was maintained. The electronic survey using Qualtrics Survey software (Version 2022, Provo, Utah, U.S.) was distributed to graduate students by email using methodologies suited for web-based questionnaires (Dillman et al., 2014). Data collection ranged from July 2022 to August 2022. After scrubbing incomplete responses, statistical analysis was performed on 186 of 327 findings.

For the purposes of this study, demographics and questionnaires developed by questionnaires developed by the researcher about detecting misinformation were analyzed. The first section was presented to all survey respondents with a 7-item Likert-type design (Table 1) and a 'select-all-that-apply' question. These questions asked how often graduate students experienced misinformation and bias on science-related topics during their undergraduate and graduate student careers. Additionally, this section inquired whether graduate students had different opinions than their instructors or most of the class, with resulting feelings of challenge, intimidation, potential consequences, and pressure to conform to the opposite opinion.

Table 1.

Likert-type scale presented to graduate student survey respondents inquiring about value incorporating science and experiences of misinformation, bias, challenge, intimidation, consequences, and conformity.

Do you think there is value or importance in incorporating science topics into the nonscience classroom? (For example, in a basic writing course receiving a prompt to advocate for climate change policy.)
Level of Importance 1 – Yes, always. 2 – It is appropriate in some areas, but not in others. 3 – No, there is no need to incorporate science into non-science curricula.
As a student, have you ever witnessed or sensed misinformation taught outside of your discipline?
Level of Misinformation 1 – I never sensed misinformation. 2 – I sensed some misinformation, but it didn't bother me. 3 – I sensed some misinformation. 4 – I sensed misinformation in equal amounts to accurate information. 5 – I experienced more misinformation than the average student.
Similarly, have you ever witnessed or sensed bias of a **science related topic** presented by instructors?
Level of Bias 1 – I never experienced or sensed bias. 2 – I sensed very little bias. 3 – I sensed some bias. 4 – I sensed a high degree of bias. 5 – I experience bias very often in a highly intentional manner.
Similarly, have you ever been in a classroom setting that made you feel challenged because you had different perspectives on a **science** topic?
Level of Challenge 1 – I didn't have different opinions than the class majority or instructor. 2 – I never sensed a challenge, even with differing opinions. 3 – I sensed some challenge, but it didn't bother me. 4 – I was challenged more than expected with my differing opinions. 5 – I was always challenged because of my differing perspectives.
Have you ever been in a classroom or learning environment where either the attitudes or articulated views of classmates or the instructor was enough to intimidate you?
Level of Intimidation 1 – I didn't have different opinions than the class majority or instructor. 2 – The challenge didn't intimidate me. 3 – I felt challenged and slightly intimidated.

Table 1 continued.

4 – I was challenged and intimidated enough to not participate in the class.
5 – I was challenged and intimidated enough to want to drop the class.
6 – I was challenged and intimidated enough to conform to the majority opinion.

Have you ever felt as though sharing or voicing your differing opinions in a classroom or learning environment could result in measurable consequences (grade suffering, judgment, etc.)?

Risk of Consequences
1 – I didn't have different opinions than the class majority or instructor.
2 – Even with differing opinions, I did not feel at risk of consequences.
3 – I sensed some potential consequences.
4 – I felt at risk for consequences because of my differing opinions.

The second section was not presented to all respondents as it was contingent on the participant's response to whether they had experienced science presented by instructors in nonscience classrooms (Table 2). This section was a four-item Likert-type design that probed perceived trust or skepticism of scientific claims. Quantitative data collection involved descriptive statistics and chi-square tests of independence that were analyzed using SPSS (Version 28). The α-level for mean differences was set at 0.05, and tendency for differences was set at 0.1. When effects had $p < \alpha$, differences or tendencies were discussed.

Table 2.

Likert-type scale presented to graduate student survey respondents inquiring about their experiences of instructors introducing science in non-science classrooms and their perceptions of evidence presented, trust in claims, and skepticism in claims.

During your collegiate studies have you had instructors or professors address scientific topics in a non-science classroom? (For example, discussing artificial intelligence or other scientific topics in a public speaking course.)

Frequency
1 – Yes, in many non-science classrooms.
2 – Yes, sometimes in non-science classrooms.
3 – Yes, maybe once in non-science classrooms.
4 – No, I have not experienced this phenomenon.

Because you indicated yes to the previous question, did the instructor provide any credible sources with their scientific claims? (Credible sources include those chosen in the question, *What do you consider as credible sources of scientific information?*)

Frequency
1 – Yes, always.
2 – Yes, sometimes.

Table 2 Continued.

	3 – No, never. 4 – I don't recall or remember if they did.
Please indicate the amount of trust you had in those scientific claims at that moment.	
	<u>Level of Trust</u> 1 – Very Low 2 – Low 3 – Neither Trust or Distrust 4 – High 5 – Very High
Were you ever skeptical that the scientific information shared could be misinformation?	
	<u>Level of Skepticism</u> 1 – Not Skeptical At All 2 – Low Skepticism 3 – Medium Skepticism 4 – High Skepticism

Participants

Participants in the current study were sampled using convenience sampling at a land grant institution in the southeastern United States. Graduate students were selected as the participant body because they typically have a unique higher education workload, including but not limited to research, teaching, enrolled in courses and working with the community (Swanson et al., 2021; Scully & Kerr, 2014; Oswalt & Riddock, 2007; Graybill et al., 2006; Longfield et al., 2006). Implementing web-based survey methodologies (Dillman et al., 2014), emails were distributed to full-time, part-time and distance-level graduate students. Shown in Table 3, the main demographic descriptors of the participants were between ages 20-29, white, identified as democratic or preferred to not state political affiliations and were raised in a suburban area. The specified degree programs varied in this sample, with Master of Science and Doctor of Philosophy grouping the largest portions of the sample. The roles of graduate students were also diverse, with graduate students primarily dedicated to research, teaching, or other roles. Demographic characteristics are compared on a STEM and non-STEM discipline basis since detection of misinformation and science misinformation comprise the core of this study. The categorization of STEM and non-

STEM was performed through the declaration of the graduate program of study, in which research personnel were classified as each falling into one category or the other.

Table 3.

Demographic characteristics of graduate student survey participants from STEM (sciences, technology, engineering, and math) and non-STEM disciplines.[z]

	STEM		**Non-STEM**		**Full Sample**	
	N	**%**	***N***	**%**	***N***	**%**
Gender						
Female	65	43.6	26	70.3	91	48.9
Male	81	54.4	10	27.0	91	48.9
Third Gender/Non-Binary	2	1.3	1	2.7	3	1.6
Prefer not to say	1	0.7	0	0.0	1	0.6
Age						
20-29	111	74.5	24	64.9	135	72.5
30-39	29	19.5	5	13.5	34	18.3
40-39	4	2.7	3	8.1	7	3.8
50-59	2	1.3	4	10.8	6	3.2
60 or older	3	2.0	1	2.7	4	2.2
Ethnicity						
Caucasian/White	97	65.1	28	75.7	125	67.2
Hispanic/Latino	13	8.7	2	5.4	15	8.1
African American/Black	6	4.0	5	13.5	11	5.9
Asian/Pacific Islander	31	20.8	0	0.0	31	16.6
Mixed/Other	2	1.3	2	5.4	4	2.2
Political Affiliation						
Democratic	38	25.5	18	48.6	56	30.1
Republican	27	18.1	8	21.8	35	18.8
Independent	27	18.1	6	16.2	33	17.7
Libertarian	6	4.0	1	2.7	7	3.8
Prefer not to say	51	34.2	4	10.8	55	29.6
Upbringing						
Urban	33	22.1	6	16.2	39	21.0
Suburban	84	56.4	22	59.5	106	57.0
Rural	32	21.5	9	24.3	41	22.0
Degree Program						
Graduate Certification	9	6.0	2	5.4	6	3.2
Masters	59	39.6	15	40.5	72	38.7
Doctor of Philosophy	80	53.7	20	54.1	100	53.8
Postdoctoral Studies	1	0.7	0	0.0	1	0.6

[z] Survey utilizing Qualtrics of 186 graduate students (*n* = 149 for graduate student programs in STEM disciplines; *n* = 37 for graduate student programs in non-STEM disciplines) and credibility judgment questionnaire.

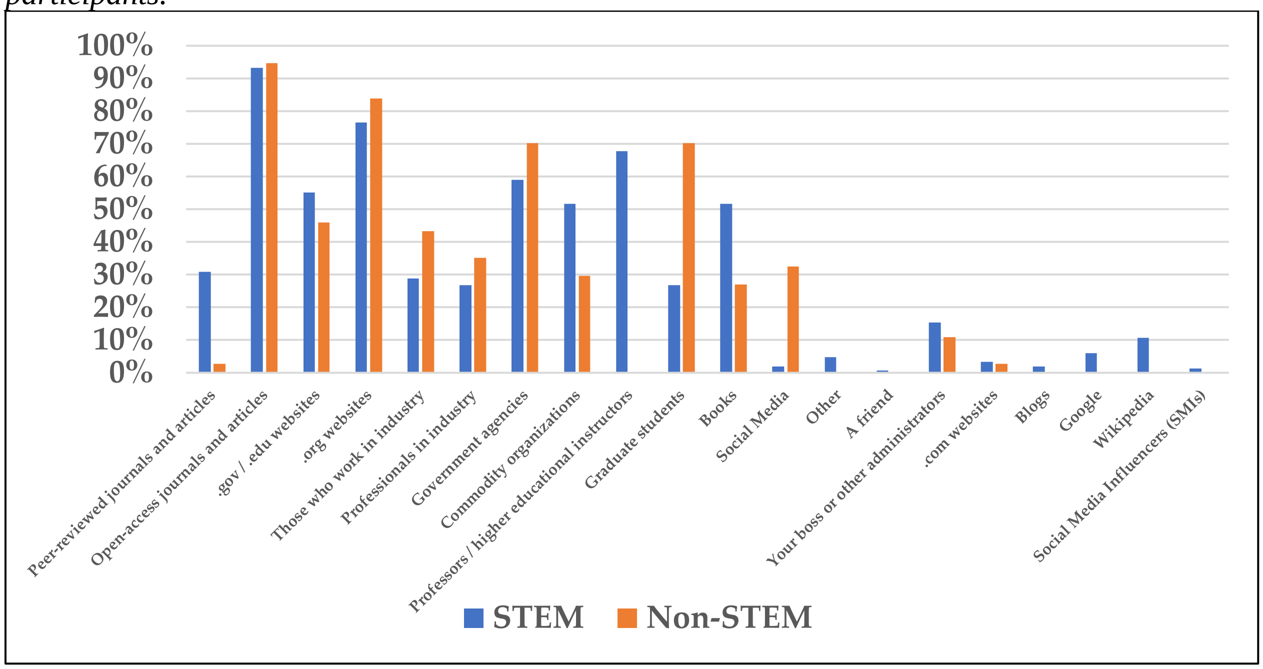
Results

Credible Sources of Information Identified by Graduate Students (RQ1)

The types of credible sources of scientific information selected by the STEM and non-STEM graduate student groups are shown in Figure 1. Popular selections for both groups were peer-reviewed or open-access journals and articles, government- or educational-based websites, and industry professionals. An interesting observation was that seven categories were not viewed as credible by non-STEM disciplined graduate students. Commodity organizations, social media and influencers, friends, blogs, Google, and Wikipedia were not selected as credible sources of information by non-STEM students. The "other" sources of credible information included textbooks, journal search engines, news, and extension publications.

Figure 1.

Credible sources of scientific information identified using check-all multiple-choice options for STEM (sciences, technology, engineering, and math) and non-STEM graduate student participants.



Note: Survey utilizing Qualtrics of 186 graduate students (*n* = 149 for graduate student programs in STEM disciplines; *n* = 37 for graduate student programs in non-STEM disciplines) and credibility judgment questionnaire in response to, "*What do you consider as credible sources of scientific information? (Check all that apply)*"

Perceived Value or Importance of Incorporating Science into Nonscience Classrooms (RQ2)

Both STEM and non-STEM graduate students indicated that there is some value in incorporating science into non-science classrooms (Table 4). The chi-square test of independence revealed that there is no association between the type of graduate program type and the perceived value of incorporating science into non-science classrooms, ($\chi^2(2) = 3.68$; $p = 0.16$).

Table 4.

Perceived value of incorporating science in non-science classrooms of a sample of STEM (sciences, technology, engineering, and math) and non-STEM graduate students.[zy]

	Value incorporating science topics into non-science classrooms			
Group	Yes, always	Yes, sometimes	No, never	Total
STEM	88	57	4	149
Non-STEM	17	20	0	37

[z] Survey utilizing Qualtrics of 186 graduate students ($n = 149$ for graduate student programs in STEM disciplines; $n = 37$ for graduate student programs in non-STEM disciplines) and credibility judgment questionnaire.
[y] $\chi^2(2) = 3.68$, $p = 0.16$

Graduate Students Sensing Misinformation, Bias, Challenge, Intimidation, Consequences, and Pressure to Conform (RQ3)

Students in both graduate program groups indicated that they have sensed misinformation taught outside of their disciplines to some degree, with nearly 20% of each group reporting that they experience equal amounts of correct and misinformation. However, the results did not indicate differences between the groups in sensing misinformation ($\chi^2(4) = 5.73$; $p = 0.22$). Similarly, both groups have detected bias in the teaching of science-related topics though not significant ($\chi^2(4) = 6.28$; $p = 0.18$). Approximately 20% of each group witnessed or sensed bias often, while 17.7% of STEM disciplined students never sensed bias compared to non-STEM disciplines (8.1%). In addition, both types of graduate programs have sensed challenges ($\chi^2(4) = 1.50$; $p = 0.83$) because of differing perspectives on science topics, with the majority indicating that the challenge did not bother them. Both groups also detected intimidation to some capacity ($\chi^2(5) = 3.95$; $p = 0.56$), but most were not intimidated by differing opinions. For non-STEM graduate students, 5.4% were intimidated enough to withdraw from a class, while 1.4% of STEM graduate students were intimidated enough to conform to the majority opinion. Both STEM and non-STEM students tended to sense consequences differently with medium effect ($\chi^2(3) = 6.92$; $p = 0.08$; Table 5). Although most graduate students did not feel at risk of suffering measurable consequences (grade suffering, judgment, etc.) because of their differing opinions, STEM students felt greater risk than non-STEM students. Though no effect was presented for pressure to conform ($\chi^2(3) = 2.38$; $p = 0.50$), non-STEM students reported that they were more pressured to conform than STEM students, with 2% of STEM students indicated they were heavily pressured to conform because of potential consequences, intimidation, etc.

Table 5.

Sensing potential consequences with differing opinions than class majority or instructor of a sample of STEM (sciences, technology, engineering, and math) and non-STEM graduate students.[zy]

	Risk of Potential Consequences Witnessed or Sensed				
	Did not have differing opinions	Did not feel at risk, even with differing opinions	Some	Felt at risk	Total
STEM	18	69	50	12	149
Non-STEM	0	24	11	2	37

[z] Survey utilizing Qualtrics of 186 graduate students ($n = 149$ for graduate student programs in STEM disciplines; $n = 37$ for graduate student programs in non-STEM disciplines) and credibility judgment questionnaire.

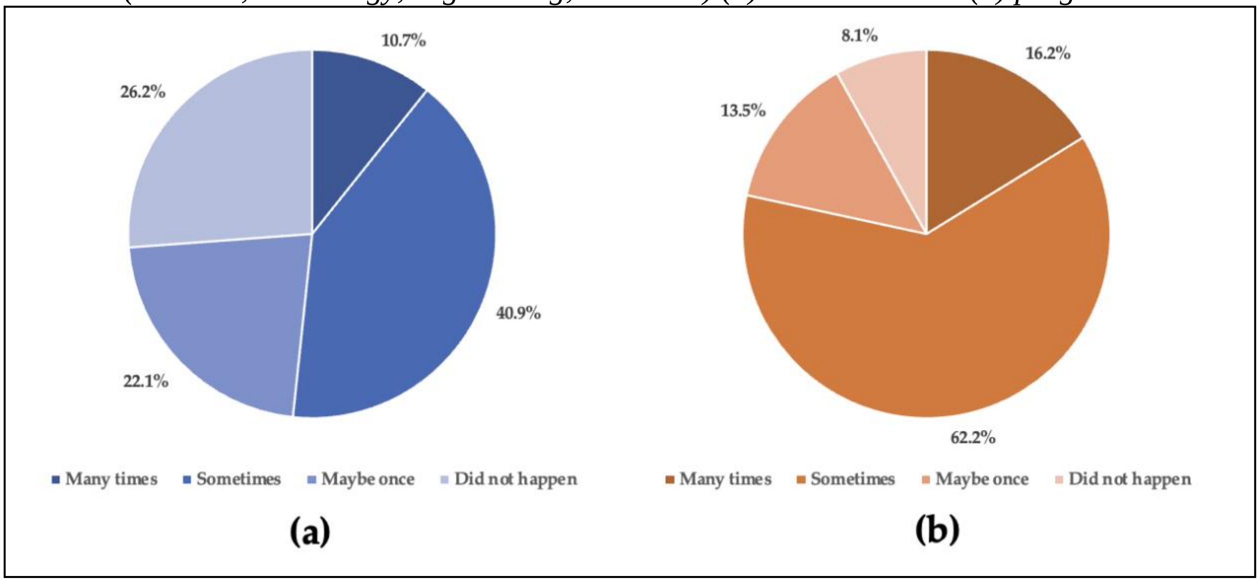
[y] $\chi^2(3) = 6.92$, $p = 0.08$, $V = 0.19$

Frequency of Evidence Based Science Introduced in Nonscience Classrooms (RQ4)

To analyze the frequency that graduate students experienced instructors in non-science university level classroom address science, Likert-type scale responses were counted. Out of 186 participants, 42 graduate students indicated that they had not previously experienced this phenomenon. Presented in Figure 2, about 11% and 16% of STEM and non-STEM graduate students, respectively, have had science introduced to non-science classrooms multiple times (Figure 2). Chi-square tests revealed that there is a relationship between the type of graduate program and the experience of science in nonscience classrooms with medium effect ($\chi^2(3) = 9.07$, $p = 0.03$, $V = 0.22$).

Figure 2.

Frequencies of experiencing science addressed in non-science classrooms for graduate students in STEM (sciences, technology, engineering, and math) (a) and non-STEM (b) programs.

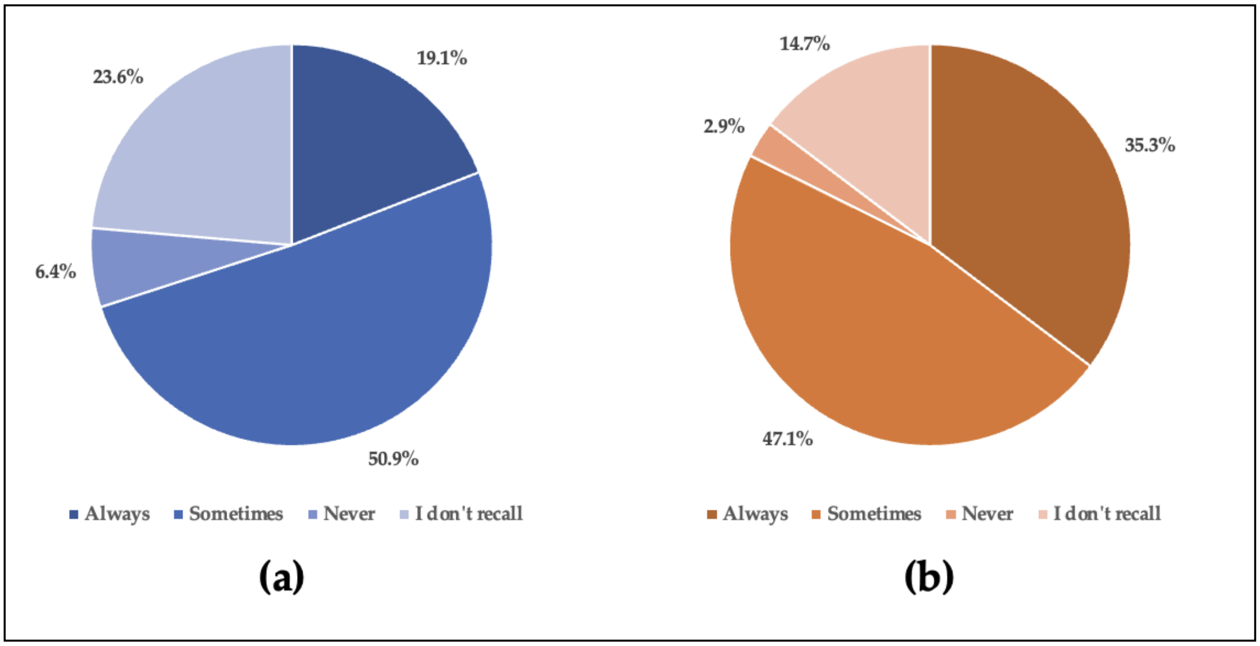


Note: Survey utilizing Qualtrics of 186 graduate students (n = 149 for graduate student programs in STEM disciplines; n = 37 for graduate student programs in non-STEM disciplines) and credibility judgment questionnaire in response to, *"During your collegiate studies have you had instructors or professors address scientific topics in a non-science classroom? (For example, discussing artificial intelligence or other scientific topics in a public speaking course.)"* $\chi^2(3) = 9.07$, $p = 0.03$, $V = 0.22$.

To understand how many of these scientific claims (n = 144) were supported by credible sources at the time they were presented, the frequencies of Likert-type responses were collected, analyzed, and displayed in Figure 3. Some participants were unable to recall whether sources were provided at all, with 24% and 15% of participants from STEM and non-STEM disciplines, respectively. Typically, credible sources were provided most of the time, if not always, for both disciplines. Approximately 6% of STEM graduate students and 3% of non-STEM graduate students indicated that these scientific claims were never backed by credible sources ($\chi^2(3) = 4.56$, $p = 0.21$).

Figure 3.

Frequencies of graduate students in STEM (sciences, technology, engineering, and math) (a) and non-STEM (b) disciplines that report if instructors provide credible evidence with scientific claims made inside non-science classrooms.



Note: Survey utilizing Qualtrics of 186 graduate students where 144 responded ($n = 110$ for STEM graduate students; $n = 34$ for non-STEM graduate students) and credibility judgment questionnaire in response to, "*Because you indicated yes to the previous question, did the instructor provide any credible sources with their scientific claims? (Credible sources include those chosen in the question, 'What do you consider as credible sources of scientific information?')*" $\chi^2(3) = 4.56$, $p = 0.21$.

Credibility or Possibility of Misinformation in Scientific Claims (RQ5)

For those students who had experienced instructors introduce science to nonscience classrooms ($n = 144$), participants were asked to assess their perceived level of trust and skepticism about whether the scientific claims made were misinformation. Graduate students were found to experience varying levels of trust in scientific claims with large effect ($\chi^2(4) = 10.39$; $p = 0.03$; $V = 0.27$: Table 6). Specifically, all non-STEM graduate students either trusted the statements to a somewhat to very high amount or had no opinion. However, 8.4% of STEM graduate students indicated that they responded with somewhat low to very low trust in these scientific claims. It was also found that graduate students had varying degrees of skepticism that the scientific claims could be misinformation. Both STEM and non-STEM graduate students reported similar results of skepticism, where the largest majority were skeptical at a low to medium level ($\chi^2(3) = 4.70$; $p = 0.18$).

Table 6.

Perceived trust in claims when instructors introduced science in a non-science classroom of a sample of STEM (sciences, technology, engineering, and math) and non-STEM graduate students.[zyx]

	Level of Trust in Scientific Claims					
	Very low	Somewhat low	Neither trust or distrust	Somewhat high	Very high	Total
STEM	2	9	29	64	6	110
Non-STEM	0	0	10	17	7	34

[z] Survey utilizing Qualtrics of 186 graduate students ($n = 149$ for graduate student programs in STEM disciplines; $n = 37$ for graduate student programs in non-STEM disciplines) and credibility judgment questionnaire.
[y] $n = 144$ ($n = 110$ for STEM graduate students; $n = 34$ for non-STEM graduate students)
[x] $\chi^2(4) = 10.39$, $p = 0.03$, $V = 0.27$

Discussion

Most of the research in previous studies was dedicated to detecting misinformation in news, social media, and other online resources **(**Majerczak & Strzelecki, 2022**;** Evanson & Sponsel, 2019; Svrovatkova & Pavlicek, 2021; Wineburg & McGrew, 2021; Nygren et al., 2020). Previous research investigated trends in student-identified credible resources, where most of the students claimed that the first level was attributed to the relevance of the topic being researched (Rieh & Hilligoss, 2008). Others investigated elements to constitute a credible source, including information content, authorship and similar denotations, layout and structure, domain of the website, usage, quality, academic language, and more (Liu, 2004). Consistent with these claims, the evidence in the current research identified that almost all STEM and non-STEM students classify peer-reviewed journals as credible, followed by domains '.org' and government agencies. These resources are specific, digestible, and have been through extensive review processes to be accessible to readers, which is reflective of previous research claims.

Instructors offer opinions about science material while teaching (Kunkle & Monroe, 2018; Cook & Lewandowsky, 2016; van der Linden et al., 2017). Students in these situations or neutral classrooms may have different opinions about the course material (Rodriguez et al., 2016a), the instructor, or the majority opinion of the class. Recurring misinformation or if the information is provided in a context of anecdotes can affect acceptance as misinformation (Rodriguez et al., 2016b; Pennycook et al., 2018). Oftentimes, when instructors want to initiate discussion on potentially sensitive topics, they use the term “safe-space” (Flensner & Von der Lippe, 2019). The safe-space is presented to promote inclusion and to provide a safe space to share opinions that are vulnerable to students (Flensner & Von der Lippe, 2019). Depending on the university or the size of the class, this can be difficult to accomplish. Typically, in smaller classroom settings, students feel more welcome to participate than in larger ones (Wright et al., 2017). Regardless of classroom size, students can feel challenged or intimidated because of their outstanding opinions and often debate consequences and conformity risks voicing those opinions.

To bridge knowledge gaps, “explicit and relative instruction” of science by instructors is necessary (Beardsworth, 2020). Both STEM and non-STEM students see value and importance in incorporating science into non-science classrooms. The combination of exercising scientific communication and opportunities to discuss topics through unbiased means contributes to students’ confidence in future science communication (Train & Miyamoto, 2017). In addition to student confidence, learning sufficient science communication skills is a foundational component of critical thinking skills (Beardsworth, 2020; Barnes, 2015). Competency in science communication and critical thinking can be compared to fluency in two languages. Propagating complex topics into digestible information to a larger audience is an effective skill that students can attain by practicing science communication (Beardsworth, 2020). The results of this study indicated that students tend to favor interdisciplinary actions in support of critical thinking and improved science communication, but instructors need to make an effort to integrate science into their classrooms.

In this study, the sense of challenge, the feeling of intimidation of the said challenges, the risk of consequences, and the pressure to conform were measured. Both disciplines had experienced each of the listed phenomena. Some of the obstacles that graduate students faced also challenged their trust in these claims. In general, non-STEM graduate students expressed greater trust in claims than STEM students, while both groups were equally represented as skeptical that the claims could be misinformation.

Teachers are professional communicators within their own discipline, and these perceptions are often taught in college classrooms through biased opinions of instructors (Linvill & Havice, 2011), which can be seen in the results of the current study. Research has been conducted to understand the influence of example opinions. An example of evidence in educational research illuminates bias against agriculture, typically in the ethics of eating meat. Schwitzgebel et al. (2020) investigated student meat eating behavior under the influence of instructors. In that study, students enrolled in an ethics course were divided into sections led by graduate teaching assistants (Schwitzgebel et al., 2020). One section would receive material about meat consumption as an unethical practice, while the other studied the ethics of charity (Schwitzgebel et al., 2020). Questionnaires were given to all students before and after the semester on their meat-eater behaviors and the answers were cross-referenced with dining hall vouchers to track their eating decisions (Schwitzgebel et al., 2020). At the end of the semester, those students who studied meat ethics expressed that they were likely to avoid eating meat in the future and that 'factory farming' was unethical (Schwitzgebel et al., 2020). Although voucher redemption was low in dining halls, meat ethics students chose non-meat (vegan/vegetarian) options exemplary of the influence of their instructors (Schwitzgebel et al., 2020). Another example includes whether 'nudging' to eat plant-blended burgers or educational methods were successful compared to control groups (Prusaczyk et al., 2021). Both the nudging and educational methods were found to reduce the willingness to eat all-beef hamburgers (Prusaczyk et al., 2021). Politics interferes with the ability of the instructor and student to deflect bias in science. Belief polarization is a phenomenon in which when people receive similar information, views are essentially opposite (Cook & Lewandowsky, 2016). Similarly, science polarization occurs when presented information that is credible and accepted by those with similar agendas and yet is dismissed by those with opposing agendas (van der Linden et al., 2017). Teachers have rooted beliefs that can be politically motivated or motivated based on other factors. It is crucial to note that instructor epistemologies affect student receptivity to information, so there must be a way to reliably collect epistemology information for professional development (Barnes et al., 2015). All of which can induce instructors' need to share 'accurate information' with students.

Related to influence potential, there are key factors that contribute to a student's level of acceptance of misinformation. It was hypothesized that there would be significant differences in perception of trust and skepticism between STEM and non-STEM groups of graduate students. In this study, student trust in random scientific claims depended on STEM or non-STEM perspectives. Specifically, STEM students exuded lower amounts of trust than non-STEM students, but both groups were equally represented, as skeptical the claims could be misinformation. Mechanisms that facilitate the acceptance of these claims include knowledge of the problem, information processing, and media dependence (Hwang & Jeong, 2022). Acceptance of possible misinformation or skepticism can be based on prior knowledge to validate or disprove scientific claims (Hwang & Jeong, 2022; Schawrz & Jalbert, 2020). Similarly, students must know how to judge the credibility or validity of the information, which means that analytical, systematic, and curious people will be less accepting of potential misinformation (Hwang & Jeong, 2022). Trust was specified to trust in scientific claims in a nonscience environment, where non-STEM students would generally have less prior knowledge about the claims than STEM students. Typically, non-STEM students would be dependent on other sources of scientific information to internally debate trustworthiness, and often sources of media fill this role.

Conclusions, Limitations, & Recommendations

Through this descriptive research study, we were able to quantify the experiences of credibility judgments of university instructors from the perspectives of a diverse sample of graduate students. Graduate students in both STEM and non-STEM disciplines have sensed or witnessed misinformation at some point during their academic career as a student. Similarly, both disciplines have often witnessed bias presented by instructors on science-related topics, with STEM-disciplined students having fewer accounts of bias on a frequency basis than non-STEM disciplines. However, our study did have several limitations. First, more graduate student responses would give a larger representation of the experiences (Galesic & Bosnjak, 2009; Deutskens et al., 2004). Furthermore, the length of the survey contributed to many incomplete responses due to survey fatigue (Deutskens et al., 2004; Herzog et al., 1981). A consideration for the future would be to shorten the duration of the survey to reduce survey fatigue and bias. Amongst these limitations, more research is needed to understand the effects of misinformation and influence between university instructors and students. Additional research includes sampling multiple universities and groups of student bodies to periodically measure improvement or impairment of instructor credibility. To decrease the incidence of bias and misinformation about science topics, possible interventions must also be investigated. The results of the current study reflect the importance of continually measuring student perceptions and the urgency to put efforts toward mitigating and minimizing bias and misinformation at higher education institutions.

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The following pages have been formatted to fit the style and guidelines for the peer reviewed journal Educational Sciences.

Chapter 6 – Credibility Judgments in Higher Education: A Qualitative Approach to Detecting Misinformation from University Instructors

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Abstract

Spread of misinformation deteriorates science literacy efforts and taints the quality of learning from land grant institutions. Instructors are a potential vector of spreading misinformation, but there is less supportive research to quantify it. To explore instructor credibility judgments, 186 graduate students at a land grant university in the southeastern United States completed an electronic survey about detecting misinformation and similar experiences. The main objective was to report the perspectives and stories of graduate students who experienced misinformation and other obstacles in higher education. Graduate students were divided into STEM (sciences, technology, engineering, and mathematics) and non-STEM categories based on the type of graduate program in which they were enrolled. Qualitative methodologies included optional open responses boxes to provide supporting details or narratives. Reliable and validated thematic coding served as the primary analysis. Students disciplined in STEM and non-STEM faced misinformation, bias, challenges, intimidation, risk of measurable consequences, pressure to conform, and skepticism from post-secondary instructors. Graduate students reported consistent instances of misinformation and bias about science and agriculture topics in both science and nonscience-focused classrooms.

Keywords: misinformation; university; instructors; credibility judgment; survey; graduate students; land grant; STEM and non-STEM

Introduction

Science literacy extends beyond familiarity with and comprehension of scientific subjects. Individuals who are science literate are competent outsiders with respect to science (Feinstein, 2010). These individuals have mastered the ability to recognize the circumstances in which science is relevant to their needs and interests and to interact with sources of scientific knowledge in a way that advances their own objectives (Feinstein, 2010). The quest for science literacy, then, is not just about detecting relevance; rather, it is fundamentally about learning to recognize how science is or may be significant to things that citizens care about most (Feinstein, 2010).

On the other hand, facilitators of learning environments are involved in the process of gathering information, analyzing it, and disseminating it. Chronic misinformation is to blame for the failure of this procedure (West & Bergstrom, 2021). Although misinformation and disinformation have distinct differences, their definitions sometimes mix (Gebel, 2021). Both phrases refer to the dissemination of false or disproven information, although with different motives and objectives (Gebel, 2021). Misinformation is the accidental dissemination of false and misleading information (CSI Library, 2023). Disinformation is the purposeful spread of false or incorrect information with the intent of damaging a person or group (CSI Library, 2023). Bias refers to a preference for (or opposition to) a specific concept, individual, or object based on one's own feelings or values (CSI Library, 2023).

Opinion-based instruction and political prejudice are the main sources of misinformation and disinformation in college courses (Linvill, 2011; Kunkle & Monroe, 2018). When people acquire comparable information, a phenomenon known as belief polarization occurs when their opinions are virtually in conflict (Cook & Lewandowsky, 2016). Similarly to this, when information is supplied that is credible and accepted by individuals with similar intentions but rejected by others with opposing agendas, science becomes politicized (van der Linden et al., 2017). Research has concluded that there are influential relationships between opinionated instructors and students. Specifically, students were influenced by their instructors, which impacted their daily lives (Prusaczyk et al., 2021; Schwitzgebel et al., 2020). Giving present and future educators the skills necessary to explain scientific concepts gives students outstanding role models in the field of science communication. By developing their scientific communication skills, instructors can better explain emerging research to students, which will increase understanding among a wide range of citizens (Amin et al., 2022; Kompella et al., 2020). Competent graduates are widely sought after in today's competitive employment environment because competent professors produce competent students with great science communication abilities (Beardsworth, 2020). Science communication and critical thinking proficiency can be likened to speaking two languages fluently (Beardsworth, 2020). The interaction between students and teachers is an important topic to cover when talking about misinformation in higher education. Several organizations that manage the trust between students and their professors explain this relationship. Simply put, the institutional environment in which instructors work and the idea of paying for a more advanced, complex education support the trust of students in their teachers (Platz, 2021; Basch, 2021). Students seek specialized knowledge and pursue academic achievement when they enroll in college, strengthening students' faith in their professors (Platz, 2021; Basch, 2021). In college, students learn about epistemic confidence and put it into practice, which helps the instructor guide their constituents with epistemic competence (Platz, 2021). Furthermore, it has been observed that students succeed more frequently when they have a good working relationship with their teacher (Platz, 2021).

Research has shown reform efforts for science educators because, although science is advancing, our teaching and communication of science has not followed the same trend (Barnes et al., 2015; Schuh, 1986), revealing knowledge and ability gaps. A portion of these reform efforts specifically target science literacy as the main goal of advancing science education from kindergarten through postsecondary studies (Barnes et al., 2015; AAAS, 2001). Barnes et al. (2015) reported that both explicit and relative instruction is critical to narrowing these gaps.

Theoretical Framework

Teachers rely on Pragmatic Theories of Truth, often known as pragmatism, to explain what is true in their dissemination of science and information (Legg & Hookway, 2021). The most recent defense of truth to emerge from American philosophers is pragmatism. True beliefs can be shaped by evidence due to pragmatic truths (Heikkinen et al., 2001). Pragmatism is prevalent in the field of research because it employs logistical facts to discriminate between true and untrue (Heikkinen et al., 2001). According to pragmatic thinking, knowing the truth requires ongoing reshaping of perspectives and beliefs, as scientists are always exposed to new knowledge due to emerging scientific concepts and discoveries (Kuhn, 1970). In conclusion, teachers are more likely to tell their students "correct information" due to potential risk and bias, which might eventually degrade science literacy by influencing or misleading students about science.

Study Purpose, Research Objectives, and Research Questions

Research on experiences recognizing false information in students and credibility assessments of professors in higher education is not well understood. This study aimed to covertly investigate patterns and viewpoints in the identification of false information and prejudice in previous graduate student classrooms at a land grant school in the southeastern United States. Graduate students are classified as STEM (science, technology, engineering, or mathematics) or non-STEM depending on their graduate program of study. Specifically, this study sought to report on the perspectives and stories of graduate students who experience misinformation and other obstacles in higher education. Sharing the narratives of students who likely otherwise would have kept quiet about these sensitive topics would be informative to educational administrators and higher education curriculum curators. The research questions (RQ) that this study answers are as follows:

RQ1. What are the perspectives of including science in nonscience classrooms?

RQ2. What are the experiences of misinformation, bias, challenge, intimidation, risk of consequences, pressure to conform, trust, and skepticism between STEM and non-STEM graduate students?

Materials and Methods

Study Design and Analysis

This study (*n* = 120) followed a qualitative approach using survey data. A group of three science educators reviewed and approved the questions once they had been developed by research staff. Under procedure #22-223 EX 2205, the Institutional Review Board (IRB) office at Auburn University received and approved all study components, including the survey questions. The clearance confirms that anonymity was preserved and that there was little risk to any of the participants. The electronic survey was delivered to graduate students by email using Qualtrics Survey software (Version 2022, Provo, Utah, U.S.) and methods appropriate for online surveys (Dillman et al., 2014). The data collection period was from July to August 2022. After the first removal of incomplete responses, statistical analysis, and interpretation of 120 of 327 outcomes were performed on the data.

For the purposes of this study, demographic data, and questionnaires on the detection of false information were analyzed. After each survey item, participants had the opportunity to share experiences related to each question asked or provide context with their responses. The first section contained seven questions and was presented to all survey respondents as optional opportunities to expand on specific instances or summaries of witnessing misinformation, bias, or other similar experiences (Table 1). As it depended on the participant's answer to whether they had encountered science presented by instructors in non-science classrooms, the second portion was not shown to all respondents. This section contained two open-response questions asking about their experiences of instructors introducing science in non-science classrooms and their perceptions of evidence presented, trust in claims, and skepticism in claims (Table 2).

Table 1.

Open-response questions presented to graduate student survey respondents inquiring about value incorporating science and experiences of misinformation, bias, challenge, intimidation, consequences, and conformity.

If you would like to justify your answer to the previous question, *"Do you think there is value or importance in incorporating science topics into the non-science classroom?"* please be encouraged to provide your response in the box below.
If you would like to justify your answer to the previous question regarding your sensed level of misinformation, please be encouraged to provide your response in the box below.
If you would like to justify your answer to the previous question regarding your sense of bias, please be encouraged to provide your response in the box below.
If you would like to justify your answer to the previous question regarding feeling challenged, please be encouraged to provide your response in the box below.
If you would like to justify your answer to the previous question regarding being intimidated by an instructor or class, please be encouraged to provide your response in the box below.
If you would like to justify your answer to the previous question regarding potential consequences, please be encouraged to provide your response in the box below.
If you would like to justify your answer to the previous question, "Have you ever conformed to an opposite opinion than your own because of potential consequences, intimidation, etc.?" please be encouraged to provide your response in the box below.

Table 2.

Open-response questions presented to graduate student survey respondents inquiring about their experiences of instructors introducing science in non-science classrooms and their perceptions of evidence presented, trust in claims, and skepticism in claims.

If you would like to justify your answer to the previous question regarding your perceived level of trust in their claims, please be encouraged to provide your response in the box below.
If you would like to justify your answer to the previous question regarding your level of skepticism, please be encouraged to provide your response in the box below.

Quantitative data analysis of demographic characteristics involved frequency statistics, which were analyzed using SPSS (Version 28). Open-response questions served as qualitative measures, and thematic coding was analyzed using ATLAS.ti (ATLAS.ti, Web Version, 2022). Optional comments were organized by discipline groups by the first author, which yielded a transcript consisting of 17 pages of single-spaced text. As encouraged by Saldaña (2016) three different coders read, annotated, and coded the transcript. Dependability and reliability were achieved by having three experienced personnel review and validate the transcribed material, themes, and codes (Cypress, 2017). To ensure stable responses, coders collaborated if there were discrepancies in interpretation, where codes of similar meaning were combined into one code through second-cycle coding. The codes were then classified and grouped into themes after second cycle coding (O'Sullivan & Jefferson, 2019). These coding methods resulted in trustworthy results that the research study is based on the concepts of reliability and validity (Seale, 1999).

Participants

Participants for the current study were randomly recruited and selected using convenience sampling. Because graduate students often have a unique higher education workload, including, but not limited to, research, teaching, enrolling in courses, and engaging with the community (Swanson et al., 2021; Scully & Kerr, 2014; Oswalt & Riddock, 2007; Graybill et al., 2006; Longfield et al., 2006), they were chosen as the participant body. Emails were sent to full-time, part-time, and distance learning graduate students using the web-based questionnaire development and delivery methods described by Dillman et al. (2014). The participants were mainly between the ages of 20 and 29; they were white; they identified as Democrats or opted not to indicate their political affiliations; and they were raised in a suburban environment (Table 3). The sample's defined degree programs varied, with the largest percentages of the sample falling within Doctor of Philosophy programs. Since the crux of this study was the detection of disinformation and science deception, demographic features were compared between STEM and non-STEM disciplines. Research personnel classified participants as either STEM or non-STEM categories according to the declaration of the graduate program of study.

Table 3.

Graduate student participant demographics based on STEM (sciences, technology, engineering, and math) and non-STEM program types.[z]

	STEM		**Non-STEM**		**Full Sample**	
	N	**%**	***N***	**%**	***N***	**%**
Gender						
Female	40	47.6	23	63.9	63	52.5
Male	43	51.2	12	33.3	55	45.8
Third Gender/Non-Binary	1	1.2	1	2.8	2	1.7
Age						
20-29	62	73.8	20	55.6	82	68.3
30-39	13	15.5	7	19.4	20	16.7
40-39	4	4.8	7	19.4	11	9.2
50-59	3	3.6	2	5.6	5	4.2
60 or older	2	2.4	0	0.0	2	1.7
Ethnicity						
Caucasian/White	65	77.4	28	77.8	93	77.5
Hispanic/Latino	6	7.1	2	5.6	8	6.7
African American/Black	4	4.8	5	13.9	9	7.5
Asian/Pacific Islander	9	10.7	0	0.0	9	7.5
Mixed/Other	0	0.0	1	2.8	1	0.8
Political Affiliation						
Democratic	24	28.6	16	44.4	40	33.3
Republican	13	15.5	7	19.4	20	16.7
Independent	13	15,5	4	11.1	17	14.2
Libertarian	4	4.8	1	2.8	5	4.2
Prefer not to say	30	35.7	8	22.2	38	31.7

Table 3 Continued.						
Upbringing						
Urban	11	13.0	4	11.1	15	12.5
Suburban	47	56.0	25	69.4	72	60.0
Rural	26	31.0	7	19.4	33	27.5
Degree Program						
Graduate Certification	3	3.6	1	2.8	4	3.3
Masters	36	42.9	15	41.7	51	42.5
Doctor of Philosophy	45	53.6	20	55.6	65	54.2

[z] Survey utilizing Qualtrics of 120 graduate students (n = 84 for graduate student programs in STEM disciplines; n = 36 for graduate student programs in non-STEM disciplines) and credibility judgment questionnaire.

Results

Graduate Student Perspectives of Including Science in Nonscience Classrooms (RQ1)

From 62 total responses, 51 of the comments were respondents from STEM disciplines and 11 from non-STEM disciplines. The themes are bolded, while codes are capitalized for readability. The themes that emerged were **Interdisciplinary Efforts**, **Personal and Professional Development**, and **Interferences**. For the theme **Interdisciplinary Efforts**, the codes for the participant responses included CONNECTIONS, USEFUL, PERSPECTIVE, EXPOSURE, AWARENESS, and others (Table 4). These responses indicated positive support for including science into non-science classrooms as respondents saw opportunities to advance quality education by immersing science into classrooms. For example, one STEM student explained, “It’s important for everyone to have some understanding of how different aspects of how our world works whether it be related to agriculture, medicine, construction, or any other important sector of human lives so that they understand why some practices are adopted.” The theme **Personal and Professional Development** resulted in codes such as CRITICAL THINKING, WRITING, SOCIAL ISSUES, GLOBAL & HUMAN APPLICATION, RELEVANT, and IMPROVE OR ENHANCE. Responses within this theme described specific instances in which incorporating science can positively improve students both personally and professionally. A positive perspective from a

STEM student indicated "If we practice more integration of topics and how different schools of thought intersect to create deeper knowledge, there would be better base knowledge in society and that would lead to better outcomes in many areas." The last theme, **Interferences**, describes responses that were hesitant to incorporating science in nonscience classrooms with anticipating disruptions of learning or students losing interest. Codes under this theme included INAPPROPRIATE, LESS ENGAGING, PERSONAL ANECDOTES, POLITICS, STUDENT INTEREST, and OPINIONS. One STEM student indicated the distractions of incorporating science in nonscience classrooms in that "If people wanted to learn science, or learn about science, they would take science classes or sign up for a science major." A non-STEM perspective includes, "A topic like climate change can be politicized, I think it's important for teachers to think about not only what they teach, but how they teach it," in hesitance to incorporating science in nonscience classrooms.

Table 4.

Themes*, frequencies of CODES, and supportive in vivo codes from STEM (sciences, technology, engineering, and math) and non-STEM disciplines in response to providing more context to their answer of perceived value incorporating science into non-science classrooms.*[zy]

Themes & CODES	*n*	In Vivo Codes
Interdisciplinary Efforts		
CONNECTIONS	27	all fields/life/subjects/classes; incorporation; well-rounded; science impacts everyone; multiple issues; expanded worldview; multi\interdisciplinary
USEFUL	11	"useful"; everyday life
EXPOSURE	6	good exposure; increases knowledge
PERSPECTIVE	5	additional perspective; scientific perspective; broaden perspective; non-STEM perspective
AWARENESS	7	engaging; conscious; need to be; should be
Professional & Personal Development		
CRITICAL THINKING	13	encourages critical thinking; foundational; outside-the-box thinking; deepened reasoning; problem solving; create deeper knowledge; think independently
WRITING	13	classes/topics/prompts/courses; discussion of material; science psychology
SOCIAL ISSUES	2	society

Table 4 Continued		
GLOBAL & HUMAN APPLICATIONS	4	aspects of our lives; how the world works together; multiple sectors; human life
RELEVANT	2	"relevant"
IMPROVE OR ENHANCE	2	better; valuable
Interferences		
INAPPROPRIATE	7	feels forced; unnecessary; out of place; not applicable; unrelated; irrelevant
LESS ENGAGING	3	students lose interest; difficult to be informed; consider student interests
PERSONAL ANECDOTES	2	own spin; off track
POLITICS	2	controversial topics; science politicized
OPINIONS	3	pushed personal agenda; distracting opinions; support opinions than facts

[z] Survey utilizing Qualtrics of 120 graduate students (*n* = 84 for graduate student programs in STEM disciplines; n = 36 for graduate student programs in non-STEM disciplines) and credibility judgment questionnaire. The **themes** are bolded, while CODES are capitalized for readability.
[y] *n* = 62 (*n* = 51 for STEM graduate students; *n* = 11 for non-STEM graduate students)

Experiences of Misinformation, Bias, Challenge, Intimidation, Risk of Consequences, Pressure to Conform, Trust, and Skepticism (RQ2)

Additional comments regarding the researcher-developed questionnaires about detecting misinformation and similar items were organized by STEM and non-STEM disciplines and coded in a cyclic manner by research personnel. Overall, STEM graduate students shared a greater number of experiences than non-STEM graduate students. In total, 168 responses were recorded across multiple categories, with 134 responses from graduate students in STEM and 34 responses from graduate students not in STEM. Repeated themes across multiple experiences include **Memorable Experiences**, **Consistencies**, and **Natural Instructor/Student Tendencies**.

Experiences with Misinformation

The two themes that emerged were **Chronic Consistency** and **Memorable Points of Misinformation**. **Chronic Consistency** contained codes such as INFLUENCE, REPETITION, IRRELEVANT, FAST, CORRECTED, and BOTHER (Table 5). Respondents demonstrating this theme showed irritation toward the frequency they have experienced misinformation or how often instructors were corrected by students. As an example, one STEM student explained, "I had an undergrad professor who was often corrected by students." Similarly, another non-STEM student recalled, "Having taken classes outside my main discipline, misinformation is common in places where scientific information is not formally studied. Often this is a result of misunderstanding the information or simply not being interested." The other more discussed theme, **Memorable Points of Misinformation**, includes codes such as MISINFORMATION TOPICS, POLITICS, COVID-19, and PERSONAL ANECDOTES. These codes represent the specific instances the respondents recalled experiencing misinformation. Graduate students in both STEM and non-STEM groups experienced persistent misinformation as students and had similar examples. STEM-disciplined graduate students recalled misinformation about agriculture, climate change, health and diet culture, quantum mechanics, and fish health, to name a few. Non-STEM graduate students mention climate science, animal production, and clinician errors. Several respondents described their misinformation experiences outside the classroom, typically through social media. One respondent went as far as explaining, "Sometimes our universities value a highly accomplished individual in an industry over a multi-disciplined industry worker who can speak on different perspectives and impacts of an industry. We often value success over diversity and sound science."

Table 5.

***Themes**, frequencies of CODES, and supportive in vivo codes from STEM (sciences, technology, engineering, and math) and non-STEM disciplines in response to providing more context to their answer of experiencing misinformation.*[zy]

Theme & CODES	*n*	In Vivo Codes
Chronic Consistency		
REPETITION	9	very common; consistent; "all the time"; every day/class
IRRELEVANT	3	"Why?"; off topic
INFLUENCE	1	"influence"
FAST	2	spreads quickly
CORRECTED	5	"corrected"; debunked by students
BOTHER	2	"bother"

Table 5 Continued		
Memorable Points of Misinformation		
MISINFORMATION TOPICS	25	agriculture; quantum mechanics; policy issues; scientific policy issues; health and diet; climate change; fish health; clinical sciences
POLITICS	2	misrepresentations
COVID-19	6	"COVID-19"
PERSONAL ANECDOTES	5	instructor personal stories; off track monologues

[z] Survey utilizing Qualtrics of 120 graduate students (n = 84 for graduate student programs in STEM disciplines; n = 36 for graduate student programs in non-STEM disciplines) and credibility judgment questionnaire. The **themes** are bolded, while CODES are capitalized for readability.
[y] *n* = 42 (*n* = 34 for STEM graduate students; *n* = 8 for non-STEM graduate students)

Experiences with Bias

Themes that emerged from qualitative analysis and cyclic coding regarding experiences of bias were **Chronic Consistency**, **Memorable Points of Bias**, and **Natural Bias** (Table 6). The theme **Chronic Consistency** resulted from multiple codes of REPETITION and FREQUENTLY. Like experiences of misinformation, graduate students reflect on how often instructors presented bias toward science topics in the classroom. For example, a non-STEM graduate student reported, "Biases can be common in places where scientific information is not formally studied." **Memorable Points of Bias** included codes of BIAS TOPICS and POLITICS, reflecting specific memories of bias presented. Bias topics recalled by STEM students were evolution, agriculture, and aerospace concepts. Non-STEM graduate students expressed consistency of bias with specific memories of agriculture and climate-related information. The **Natural Bias** theme contained both negative and neutral statements regarding the inevitable bias instructors will present. The codes that made up **Natural Bias** were OPINION, SELF-DETERMINATION, RECOGNITION, and NOT HARMFUL. Comparing STEM and non-STEM groups, some non-STEM graduate students expressed a greater urgency or magnitude in their experiences, while other STEM graduate students did not see the bias as malicious. Specifically, one non-STEM student reflected, "I've noticed misinformation designed to persuade people to make specific decisions or actions." On the other hand, this STEM student highlighted, "There is always going to be misinformation," while another said, "I have but it is not harmful or persuading, I guess. I like to listen to professors' point of view and opinions and then I can make my own decisions."

Table 6.

Themes*, frequencies of CODES, and supportive in vivo codes from STEM (sciences, technology, engineering, and math) and non-STEM disciplines in response to providing more context to their answer of sensing or experiencing bias from instructors on a science-related topic.*[zy]

Theme & CODES	*n*	In Vivo Codes
Chronic Consistency		
REPETITION	9	consistent; often; common
FREQUENTLY	7	spreads quickly; many politicized issues; innate
Memorable Points of Bias		
BIAS TOPICS	13	agriculture; evolution; aerospace topics; climate related discussion
POLITICS	2	controversial topics
Natural Bias		
OPINION	4	"argued their opinion"; "pushed" their agenda; presented as truth
SELF-DETERMINATION	2	gut-check; make my own decision
PERSONAL ANECDOTES	2	own spin; off track
RECOGNITION	3	identified; observed
NOT HARMFUL	4	not malicious; natural; not persuading

[z] Survey utilizing Qualtrics of 120 graduate students (n = 84 for graduate student programs in STEM disciplines; n = 36 for graduate student programs in non-STEM disciplines) and credibility judgment questionnaire. The **themes** are bolded, while CODES are capitalized for readability.
[y] *n* = 27 (*n* = 24 for STEM graduate students; *n* = 3 for non-STEM graduate students)

Experiences with Challenges, Intimidation, Risk of Consequences, and Pressure to Conform

Since sense of challenge, intimidation, risk of consequences, and pressure to conform can rely on each other, these categories were read, organized, and coded together, resulting in three themes. The first theme was **Memorable Challenges and Pressures**, which included codes named CHALLENGE TOPICS, INTIMIDATION TOPICS, EXAMPLE, CONFORM TOPICS, CONSEQUENCES, POLITICS, OPINIONS, IRRELEVANT, and INFLUENCE (Table 7). Both disciplines had experiences to explicitly name, but STEM graduate students provided more evidence of challenges, pressures, and consequences that were frustrating and could have been negatively influential to others. As an example, one STEM student said, "I have received lower grades for writing articles with contradicting views of professor." CHALLENGE TOPICS included origins of Earth, animal rights, production agriculture, secularism, and demonizing industries or practices. However, INTIMIDATION TOPICS were Earth system sciences, chemistries, and health sciences, which were accounted for by STEM respondents. The EXAMPLE codes represented topics that induced measurable consequences, such as agriculture topics and instances where science entered humanities discussions. The examples provided for CONSEQUENCES were suffering grade cuts, judgment from instructors, judgment from peers, and long-term career downfalls. Another theme was **Unexpected Troubles and Caution** where BOTHER, UNSAFE SPACE, SAVING FACE, PRESSURE, AFRAID, and CONFORM were codes comprising the theme. Both STEM and non-STEM students reported that they were less likely to speak up or share their opinions because of potential consequences or that it was easier to deal with potential arguments with classmates and instructors. Specifically, this non-STEM student shared, "Never conformed, but never felt able to have an open discussion without being absolutely teamed up against with a mob mentality that felt threatening (not to physical health but to departmental and work life)." The third theme was **Welcoming Challenge**. **Welcoming Challenge** included codes such as ACCEPT CHALLENGE and PERSPECTIVE. Respondents who welcomed challenges explained that without challenge there is no need for science and that understanding different perspectives was foundational for critical thinking and respect. All respondents who fell under this theme were from STEM disciplines. For example, STEM students responded, "Challenges drive me to excel," and, "Science is all about being challenged and be able to provide information to stand your ground. Without challenge, there would be no science. Everyone would just accept information immediately. Questions are important."

Table 7.

Themes*, frequencies of CODES, and supportive in vivo codes from STEM (sciences, technology, engineering, and math) and non-STEM disciplines in response to providing more context to their answer of sensing or experiencing challenges, intimidation, consequences, or conformity.*[zy]

Theme & CODES	*n*	In Vivo Codes
Memorable Challenges and Pressures		
CHALLENGE TOPICS	11	origins of Earth; agriculture; earth sciences; chemistry; health sciences
INTIMIDATION TOPICS	4	agriculture; health sciences; climate sciences
EXAMPLE	11	lower grades; "cut" grades; judgment
CONFORM TOPICS	5	additional perspective; scientific perspective; broaden perspective; non-STEM perspective
CONSEQUENCES	7	act to save grades; social pressure; walk on eggshells
POLITICS	3	controversial politics
OPINIONS	3	instructor opinions
IRRELEVANT	2	"irrelevant"
INFLUENCE	3	taken as truth; persuasion; "definitely influenced"
Unexpected Troubles and Caution		
BOTHER	3	anxiety; irritated
UNSAFE SPACE	4	teamed up against; ostracized; minority opinion; ridiculed
SAVING FACE	7	avoid shouting match; did not want to debate; prevent sticking out; prevent standing out; stay quiet
PRESSURE	4	aspects of our lives; how the world works together; multiple sectors; human life
AFRAID	4	never felt courageous enough to speak up; scared
CONFORM	3	best to quit arguing; easier to not respond and conform
Welcoming Challenge		
ACCEPT CHALLENGE	4	exciting; "we should be challenged"; important; willing to be enlightened
PERSPECTIVE	4	learn from others; exchange points of view

[z] Survey utilizing Qualtrics of 120 graduate students (n = 84 for graduate student programs in STEM disciplines; n = 36 for graduate student programs in non-STEM disciplines) and credibility judgment questionnaire. The **themes** are bolded, while CODES are capitalized for readability.
[y] n = 65 (n = 51 for STEM graduate students; n = 14 for non-STEM graduate students)

Experiences with Trust and Skepticism

Participants were provided opportunities to explain their experiences of trust toward scientific claims in nonscience classrooms and their experiences of skepticism that information could be misinformation. These responses were analyzed, coded, and condensed into three themes: **Memorable Trust and Skepticism**, **Innate Trust**, and **Passive Tolerance**. **Memorable Trust and Skepticism** contained codes of EXAMPLE, SOCIAL MEDIA, BIAS, and CURRENT EVENTS (Table 8). Both STEM and non-STEM graduate students provided specific examples of topics where their trust in content was questionable. For STEM students, these topics were public policy containing science topics, implications of technological history, and aircraft. For example, "Most professors had some sort of evidence to back up their claims but often times their evidence was from a major news outlet, not scientific journals." For non-STEM students, the topics described included climate change, artificial intelligence, space and astronomy, technology, and psychologies. A non-STEM student said, "I had a few courses that discussed climate change, AI, and also space/astronomy, so needless to say I was hesitant to trust." The **Innate Trust** theme was composed of the codes TRUTH and AUTHORITY. Equally mentioned in both groups, these codes were labels to mention whether instructors at the time were trusted sources of scientific information and did not need to be questioned or skeptic of misinformation. As an example, this non-STEM student said, "Because he is a published researcher and professor in the area he was speaking of, I was not skeptical." **Passive Tolerance** was a theme made up of codes like GUT-CHECK, SELF-DETERMINATION, PRIOR KNOWLEDGE, and CRITICAL THINKING. Both STEM and non-STEM students explained that if science was presented in non-science classrooms, they relied on prior knowledge and gut-level decisions to decide if the information was accurate. Specifically, this STEM student recalled, "Always would take conversations that were had with a grain of salt and follow up to confirm validity." Often, these interpretations did not cause stress or bother to the students; rather, the students tolerated the claims. Only non-STEM students mentioned CRITICAL THINKING, as those students stated that skepticism was an important part of critical thinking skills. To provide further evidence, this non-STEM student said, "Skepticism is an important part of critical thinking. Simply taking a statement as fact or truth is irresponsible and is just not good science. It is important to dig further."

Table 8.

***Themes**, frequencies of CODES, and supportive in vivo codes from STEM (sciences, technology, engineering, math) and non-STEM disciplines in response to providing more context to their answer of level of trust and skepticism toward a science concept introduced in a non-science class.*[zy]

Theme & CODES	*n*	In Vivo Codes
Memorable Trust and Skepticism		
EXAMPLE	7	writing prompts; history; climate change; aircraft; psychology; space and astronomy; artificial intelligence
SOCIAL MEDIA	11	mentioned specific platforms
BIAS	4	"bias"
CURRENT EVENTS	2	"current events"
Innate Trust		
TRUTH	10	reliable; evidence; "seemingly credible sources"; well-educated
AUTHORITY	4	published researcher in the field; established professor; "I had less knowledge than the instructor"
CRITICAL THINKING	4	deepened thinking or reasoning; "critical thinking"
Passive Tolerance		
GUT-CHECK	4	gut feeling; instincts
SELF-DETERMINATION	11	additional research on my own; depended on source credibility; relied on myself; take information with grain of salt; sensed skewed perspectives

[z] Survey utilizing Qualtrics of 120 graduate students (n = 84 for graduate student programs in STEM disciplines; n = 36 for graduate student programs in non-STEM disciplines) and credibility judgment questionnaire. The **themes** are bolded, while CODES are capitalized for readability.
[y] *n* = 34 (*n* = 25 for STEM graduate students; *n* = 9 for non-STEM graduate students)

Discussion, Limitations, & Conclusions

Considering that information is at peak accessibility, it is important to critically question and evaluate instances of possible misinformation in post-secondary classrooms. It is particularly important to judge the credibility of the scientific claims of the instructors to preserve the integrity and mission of land grant universities. As described in previous studies (Schwitezgebel et al., 2020; Prusaczyk et al., 2021) and the current study, instructors are influential individuals that can have long-term impacts on their students beyond the scope of the class. This phenomenon occurs due to the remarkable level of trust and authority between instructors and students, also explained by student-teacher relationships (Platz, 2021; Basch, 2021). An effective way to judge credibility is to survey student perceptions (Ramos et al., 2020). Generation Z and Millennials have reported the highest confidence in their ability to detect misinformation, compared to other generations (Bealor, 2022; Poynter Institute, 2022). The current study revealed that both STEM and non-STEM students reported on the consistency of misinformation and bias and recalled specific topics that they perceived as misinformation or biased in free responses.

Both disciplines had experienced each of the listed phenomena, and the open-response data provided better insight into those experiences. Some of the obstacles that graduate students faced also challenged their trust in those claims. Graduate students reflected that when these situations (instances of misinformation, bias, etc.) occurred, they had less knowledge of credibility than they do now and would have judged the information differently than before. Through qualitative analysis, it was found that with these challenges, graduate students had positive, negative, or neutral reactions. Positive reactions embraced obstacles, negative reactions explained frustration or annoyance with these occurrences, and neutral statements did not express an emotional reaction. Previous research by Linvill and Havice (2011) reports similar findings when interviewing students who have faced unnecessary challenges of bias in higher education. Students were found to encounter bias often, typically in the context of political beliefs and opinions that sometimes did not relate to the topics of the class (Linvill & Havice, 2011). If students wanted to voice their alternative opinions, they felt that grade reduction, ridiculing, and judgment were potential risks (Linvill & Havice, 2011). With the potential risks identified by students, they also felt that it was easier to blend in to avoid standing out (Linvill & Havice, 2011). Students often submit assignments on these topics, if assigned, in favor of the instructor's views in light of receiving full points (Linvill & Havice, 2011). However, it should be emphasized that at the institutional level, teacher political orientation has little to no impact on student political orientation (Mariani & Hewitt, 2008). However, students experiencing bias in higher education reflected that they did not feel they were deprived of all benefits of higher education, but felt that when bias was presented, their class efforts were a waste of time (Linvill & Havice, 2011).

Considering all these answers regarding misinformation, bias, and others, graduate students see numerous benefits with including science in nonscience classrooms. Perceived value or importance of incorporating science into non-science classrooms was attributed to developing critical thinking skills and overall improving science understanding and science literacy. With improved knowledge and understanding of science, student confidence is expected to increase, as well as critical thinking skills and other higher-order thinking skills (Train & Miyamoto, 2017; You, 2017). However, the action of incorporating science in an interdisciplinary fashion requires some skills. Highlighted both in previous research and in the current study, the effective teaching of science in non-science classrooms requires effort of the instructor (Sadler et al., 2013; Goe, 2007). Without positive acceptance from the instructors, there would be a lack of skill, knowledge, and ineffective delivery of science content, which would defeat the purpose of science integration

(Baumert et al., 2010; Hill et al., 2005). Another perspective removes the teacher from this train of thought (Feinstein, 2010). That is, teachers are not the sole party responsible for making science relevant like typical pedagogical tools (Feinstein, 2010). Rather, it is up to the students to learn how to make science relevant through questioning, practice, and providing their own social context (Feinstein, 2010).

Among all the opportunities to provide additional context and information to their answers, the most common topic mentioned was production agriculture. Consistent with public concerns about agriculture, the majority of agriculture topics included the environment and food production or safety (Whitaker & Dyer, 2000). Specifically, the participants reported misconceptions, misinformation, and opinion-based teaching about genetically modified agricultural organisms, the use of antibiotics in livestock, exaggerated inputs to climate change, the use of pesticides, and others. Discussing agriculture outside of agricultural classrooms is not a unique case. Bias against agriculture, typically in the ethics of consuming meat, is a frequent topic for instructors. Schwitzgebel et al. (2020) investigated student meat eating behavior under the influence of instructors. In this study, students enrolled in an ethics course were divided into sections led by graduate teaching assistants (Schwitzgebel et al., 2020). One section would receive material about meat consumption as an unethical practice, while the other studied the ethics of charity (Schwitzgebel et al., 2020). Questionnaires were given to all students before and after the semester on their meat-eater behaviors and the answers were cross-referenced with dining hall vouchers to track their eating decisions (Schwitzgebel et al., 2020). At the end of the semester, those students who studied meat ethics expressed that they were likely to avoid eating meat in the future and that 'factory farming' was unethical (Schwitzgebel et al., 2020). Although voucher redemption was low in dining halls, meat ethics students chose non-meat (vegan/vegetarian) options exemplary of the influence of their instructors (Schwitzgebel et al., 2020). Another example includes whether 'nudging' to eat plant-blended burgers or educational methods were successful compared to control groups (Prusaczyk et al., 2021). Both the nudging and educational methods were found to reduce the willingness to eat all-beef hamburgers (Prusaczyk et al., 2021). Some participants explained that these instances occurred both in STEM and non-STEM classrooms.

Opinion-based teaching is prevalent from a STEM (science, technology, engineering, and math) standpoint, as seen, for example, with the science of climate change. False statements by some professors that agriculture is the only cause of climate change support more progressive training, while other instructors teach the reverse (Kunkle & Monroe, 2018). Through open-ended responses, it was discovered that conservative teachers thought it was possible to spread false information and that more liberal instructors would be particularly vulnerable when teaching about climate change (Kunkle & Monroe, 2018). The source of misinformation in college classrooms is opinion-based teaching and political bias. After analyzing student responses, it was found that students in communication and public speaking (non-STEM) courses were perceptive of bias taught by instructors in the classroom (Linvill, 2011). However, in fear of standing out or having different beliefs, students may not detect bias and are likely to conform to the instructor's beliefs (Linvill, 2011). This study is an example of instructor influence and why bias should be limited as much as possible (Linvill, 2011). The results suggest that instructors should reflect on their own biases and offer unbiased discussion instead of teaching one perspective of a topic (Linvill, 2011). Students can advance both cognitively and developmentally via more open-minded inquiry (Linvill, 2011). The relevance of studies like Linvill (2011) is that perceptions of science have some political ties, where, leaning more liberal or more conservative, one may have predestined opinions. University instructors tend to be more liberal (Gross, 2014) and these more liberal opinions on science topics can spread in the classroom and add to the misinformation crisis.

We were able to convey perceptions of credibility assessments of university teachers from the views of a varied sample of graduate students through this descriptive research study. However, there were certain restrictions on our study. First, more responses from graduate students would provide a wider representation of experiences (Galesic & Bosnjak, 2009; Deutskens et al., 2004; Herzog et al., 1981). The duration of the survey also played a role in the high number of incomplete responses caused by survey wear (Deutskens et al., 2004; Herzog et al., 1981). The duration of the survey could be reduced in the future to reduce fatigue and bias of the survey. It would be more efficient to repeat the study again with many recruitment rounds that included shorter surveys to obtain larger samples. In light of these limitations, more research is required to determine the impact of disinformation and faculty influence on students. To conduct further studies, sample populations from various universities and student bodies are used to assess the trustworthiness of instructors over time. Investigating possible treatments is necessary to reduce the prevalence of bias and misinformation surrounding science topics. The study's findings highlight the importance of investigating potential interventions that reduce the prevalence of bias and misinformation surrounding science topics. Such interventions may be the inclusion of modules or training in science communication that would be included in teacher education or faculty development programs.

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The following pages have been formatted to fit the style and guidelines for the peer reviewed Research in Higher Education Journal.

Chapter 7 – Multidisciplinary Workshop to Improve Science & Agricultural Literacy While Reducing Misinformation: A Case Study

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Abstract

Effective scientific communication has been the subject of extensive research, but less has been reported from an agricultural perspective. By studying agriculture and related topics in the college classroom setting, students can restore a relationship with the food from which they have been disconnected. However, the teacher must make an effort if they want to properly include agriculture in conventional scientific courses. The purpose of this case study was to communicate the effectiveness of a professional development workshop seeking to improve the knowledge, skills, and abilities of five foundations: science literacy (SL), science communication (SC), worldviews (WV), agricultural literacy (AL), and pedagogical approaches (PA). This study sought to report ideas and perspectives on the integration of agricultural topics into the science curricula of future higher education instructors. Three graduate students offered their time to participate in an interactive two-hour workshop and complete two surveys. The pre- and post-workshop surveys, as well as the discussions from the workshop, were captured as data for the study. Descriptive statistics and qualitative methodologies, such as in vivo coding, served as primary analysis for the case study. Participants demonstrated improved knowledge, skills, and abilities with respect to the five foundations pre- to post-workshop, but some elements were maintained weeks following the workshop. Participants identified several opportunities to immerse agriculture and science together in higher education classrooms, including two PA to promote SL and AL. The findings of the current study are encouraging in terms of their applicability for use in teacher training or in education for new academic faculty.

Keywords: future faculty, animal agriculture, professional development

Introduction

Although science is developing, our teaching and communicating science has not kept pace with this development, according to research, which has shown that science educators need to make changes (Barnes et al., 2015). A proposed change would include agriculture, a crucial multifaceted scientific field, in traditional science lessons. This change is motivated by the removed agricultural literacy that most of the public are affected by today as incorporating science and agriculture together could re-center the public with where their food comes from.

Science literacy encompasses more than just scientific knowledge and comprehension. It can be described as a complicated mental process that combines knowledge and understanding of scientific principles with the capacity for problem solving in the present (Barnes et al., 2015). Without science literacy, it is difficult to communicate to our stakeholders, the public, how research, science, animal production, etc., affect them. Science literacy also encompasses the ability to filter through reliable sources of scientific information, as misinformation is abundant in the current age of data and information. One of the main sources of bias now is media exposure, as evidenced by the prevalence of unfavorable headlines, false information, and anti-agriculture campaigns on social media (Kirkpatrick, 2021; López-Goñi & Sánchez-Angulo, 2017). Due to advancements in technology and more access to scientific findings, land grant missions have changed. However, the ability of scientists and others to communicate science to the public has not increased exponentially as scientific understanding (Schuh, 1986). Rhetorically, what use is it to advance in these complicated subjects if the rest of the world is left behind and has no notion what scientists and researchers know? According to Barnes et al. (2015), closing these gaps requires "clear and relative instruction" at both ends. To impart these similar abilities to current and prospective students, regardless of their specialty, employed instructors at land grant colleges need to comprehend the fundamentals of science communication.

Several studies have been conducted on the value of effective science communication, but less has been done from an agricultural perspective. Learning adequate science communication abilities is a core component of critical thinking skills, in addition to student confidence (Beardsworth, 2020). Students' confidence in future science communication is boosted by opportunities to practice their skills and by engaging in unbiased discussions on many subjects (Train & Miyamoto, 2017). Science communication and critical thinking proficiency can be compared to speaking two languages. Students who practice science communication develop effective communication skills that allow them to spread complex ideas to a wider audience (Beardsworth, 2020). These studies show that teachers' science communication skills have a statistically significant effect on their students.

Agricultural literacy can be viewed as science literacy because, among other subjects, agriculture can be studied independently as a branch of science. Agricultural literacy is defined by the National Agricultural Literacy Objectives program as "processing knowledge and understanding of our food and fiber system" (Spielmaker & Leisling, 2013). Through the U.S. Cooperative Extension Programs (CES), the food and agriculture sciences have achieved enormous achievements in science communication. However, the burden of explaining agricultural sciences cannot be supported by one single entity. There are many levels of proficiency in agricultural literacy, and since learning never ceases, applicable proficiency is the highest level of competency articulated. Learners with applicable skills can describe complicated agricultural systems, implications, and results while submitting workable answers to problems that have been presented (Longhurst et al., 2020).

Students can re-establish a connection with food by learning about agriculture and related topics in the college classroom learning environment. A more holistic approach to providing a more open type of communication through science is made possible by developing instructors and students. By illustrating real-world problem scenarios, agricultural examples can help students develop their mathematical and scientific application skills (Mabie & Baker, 1996). Students can better relate to and understand agricultural subjects by integrating agriculture into other science disciplines in a classroom setting. According to Serdyukov (2017), the theory and practice of teaching and learning, as well as the student, parents, community, society, and its culture, should all be the focus of educational innovations. Individuals with greater skills will be produced in a knowledge-driven economy because of the focus on assisting future educators in the fields of science and agricultural literacy education (Looney, 2009).

Instructors in non-scientific subjects frequently lack experience and education necessary to integrate science into their lecture plans (Sadler et al., 2013; Goe, 2007). For non-science and non-agriscience instructors to include science and agriculture concepts into their classes, they need training and incentives to cover unfamiliar topics. Our thinking was based on the mental model that knowledge of science, food, and agriculture, as well as the ability to assess the reliability of evidence, are essential for the development of future generations of global citizens. Being discerning consumers and active citizens in a society that is heavily reliant on science, society will need to be wired to science in some way. According to our recent research, a professional development workshop can improve science communication, science literacy, and agricultural literacy by communicating science and agriculture through effective message modalities.

A workshop is often referred to as a brief intensive instruction program for a relatively small number of people that concentrates mainly on techniques and abilities in a particular profession according to Merriam-Webster (Merriam-Webster, n.d.). In other words, workshops are quick and specialized approaches to bringing about change in a particular area. In the academic world, workshops are common. Each successive workshop advances that person's professional development (Figland et al., 2019). When successful, professional development seminars increase teachers' expertise, involve training in particular areas, and enhance the efficacy of learning (Borko, 2004). To continually develop and produce better results, workshops are assessed, revised, and evaluated once again after each delivery. Due to their niche applicability, workshops frequently meet or exceed participants' expectations and their expectations for the workshops' content (Lawton & Manning, 2017). Workshops optimize students' ideals and awareness, which is thought to benefit learners (Ooi & Tan, 2015).

Land grant institutions, especially those of R1 or the highest research tier, want to expand their portfolio of research (Carlton, 2022). A crucial part of this purpose is to inform the public about scientific advancements while preparing graduates for the job. Additionally, R1 institutions aim to improve the qualities and skills of current and future faculty members, as well as prepare graduates for careers in a variety of fields. The advantages of multidisciplinary actions, such as including agriculture in the context of other disciplines, have already been discussed in previous research reviews. Several studies have shown that addressing scientific context or agreement within societal concerns can enhance perception of scientific consensus and, as a result, key beliefs (van der Linden et al., 2016). Workshops can have an impact on participants, although less propagandistic and more as a self-evaluation tool. Several impact analysis models claim that influence can occur in a couple of seconds (Zheng et al., 2020). Truths change as a result of science's evolution, and influence is a possibility. Workshops centered on objective interpretations of science can reduce misunderstandings in the future, including responses such as inoculation theory. According to inoculation theory, people can "develop immunity to persuasive information" that may be deceptive over time (Cook et al., 2017).

Study Purpose, Objectives, and Research Questions

To combat opinion-based teaching of scientific and agricultural misinformation and foster critical thinking in teacher classrooms, the current study served a wholly unique purpose. This study aimed to report the effectiveness of a professional development workshop designed to improve agricultural literacy in higher education. The following research objectives guided the design of the study:

Objective 1. Identify the change in confidence and capacity in complex science fields after attending a professional development workshop.

Objective 2. Understand the motivations of future teachers to teach science and the willingness to infuse agriculture into their curriculum pre- and post-workshop.

Objective 3. Measure retention of learning through post-post-workshop surveys.

Reporting perspectives of future educators in the areas of science and agricultural intersections is a novel and desperately needed research to be studied. To prevent the spread of misinformation about agriculture and improve agricultural literacy, it is best to understand where future educators stand on conventional science. The research questions (RQ) that this study answers are as follows:

RQ1. Can professional development in science and agriculture communication enable the development of knowledge, skills, and abilities (KSA) of future teachers?

RQ2. What are the needs and motivations to communicate about agriculture inside and outside the classroom from the perspective of future instructors?

RQ3. What topics, pedagogical approaches, and obstacles exist to integrate science and agriculture in future classrooms?

RQ4. What information learned from the workshop is lost, retained, or improved weeks after the workshop?

Methodology

Study Design

This pilot study was conducted face-to-face in February 2023 after recruiting participants from a previous study (see Chapters 5 & 6). The microcredentialing workshop contained discussions and group activities centered on five foundations: science literacy (SL), science communication (SC), worldviews (WV), agricultural literacy (AL) and pedagogical approaches (PA). The workshop was primarily student-led by the first author, with assistance and support by the second and third authors. The presentation and workshop content were reviewed by subject matter expert faculty prior to workshop delivery. Study elements including survey questionnaires and all Institutional Review Board (IRB) documentation were submitted and approved in December 2022 through Auburn University's IRB office under protocol #22-482 EX 2212. The approval verifies that all participants were at low risk and that anonymity was maintained. Data were collected through pre-, post-, and post-post-workshop surveys as well as captured conversation through notetakers. Attending the workshop and completing the surveys was voluntary. In addition to completing the workshop, participants were awarded a digital badge titled *AgSTEM 360: Enhancing Science Communication in Higher Education Organizations*.

Workshop Design

The design of the workshop included elements of instruction along with collaboration and community efforts. As demonstrated by past research (Nguyen et al., 2021; Lamon et al., 2020; Walker, 2003), active learning improves learning and retention of material. Therefore, to help with the uptake of information, the workshop encouraged active learning for participants rather than conventional learning. The workshop was approximately two hours long and had the following basic structure: 1) completion of the pre-workshop survey, 2) short interactive instructional section to provide background on science communication, science literacy, worldviews, agricultural literacy, and pedagogical approaches to incorporate AgSTEM topics with discussions, 3) collaboration of a case study, 4) group reflection, 5) completion of the post-workshop survey.

Workshop Surveys

The recruitment survey using Qualtrics Survey software (Version 2022, Provo, Utah, U.S.) was distributed to graduate students by email using the appropriate methodologies explained by Dillman et al. (2014). At the end of the survey, graduate students provided contact information only if they were interested in a professional development workshop focused on pedagogical approaches to communicating science (Corbitt et al., 2023). Another recruitment email was distributed using the same methodologies, containing the pre-workshop survey. A group of science instructors and instructional designers reviewed and approved the questions after they were developed by study staff. The post-workshop survey and post-post-workshop survey had layered and added dimensions of questions from the survey before. The first portion of each survey had a KSA Questionnaire (KSAQ) of 17 questions that used 5-point Likert-type scales inquiring about their perceived level of knowledge, skills, and abilities regarding the five foundations addressed. The second portion of the surveys contained four questions utilizing 5-point Likert-type scales that measure the perceived relevance of agriculture by participants to their graduate discipline, which comprise the Agriculture Relevance Questionnaire (ARQ). The final portion of the surveys was demographics and questions relevant to the workshop phase.

Case Study Component

To model the PA discussed in the workshop, participants collectively investigated a case study crafted by the first and last authors. This case study, shown in Figure 1, was crafted to assess the scaffolded learning of the participants in each of the five foundations presented during the workshop, including SL, SC, WV, AL, and PA. The case study was presented on a single-page printed document with background information, details of the case, and questions to guide the case study objectives.

Figure 1.

Case Study Presented During the Workshop.

Case Study: "Finding AgSTEM Literacy across a Curriculum"

D. Mulvaney and K. Corbitt

A Bit of Background Research:

Literacy focuses on knowledge and understanding while being literate is concerned with communication and learning through reading, writing, and speaking [1]. The Internet blew up with the news that 7% of American adults believe chocolate milk comes from brown cows. As The Washington Post reported, 7% is the equivalent of a little over 16 million people, which is about the population of the state of Pennsylvania. That's a lot of people to think there's a connection between cows with brown hides and milk with a brown color [2].

Results of a research survey showed that consumers have some confusion about which animal hamburger meat comes from. Although about 80% of respondents correctly answered "false" to the statement, "*Hamburger is made from the meat of pigs*," the rest either didn't know or answered incorrectly. That means that approximately one in every five respondents was unsure about the source of hamburger meat [2].

The knowledge systems which develop and support agricultural literacy may include but are not limited to, food and fiber production, natural resource ecosystems, and socio-economic sustainability of urban, peri-urban, rural, and remote communities [3].

Details of the Case:

Jaycee is in a new instructor role at a learning institution. The administrative head has been attending conferences on the topic of science and agriculture literacy and now has expressed interest in having all students to have improved awareness and knowledge in science and ag literacy. Consequently, Jaycee has been 'charged' to explore the value of infusing contemporary science and agriculture into STEM and non-STEM classrooms. A corresponding plan is also part of the charge.

a. Why could this administrator think it's so crucial to integrate these topics into the curriculum?
b. What may be some potential obstacles for infusion?
c. What are some of the topics that could be identified for infusion?
d. What pedagogical approaches may be used to carry out the administrative "charge" of increasing awareness and learning of AgSTEM topics?
How can this be done well?

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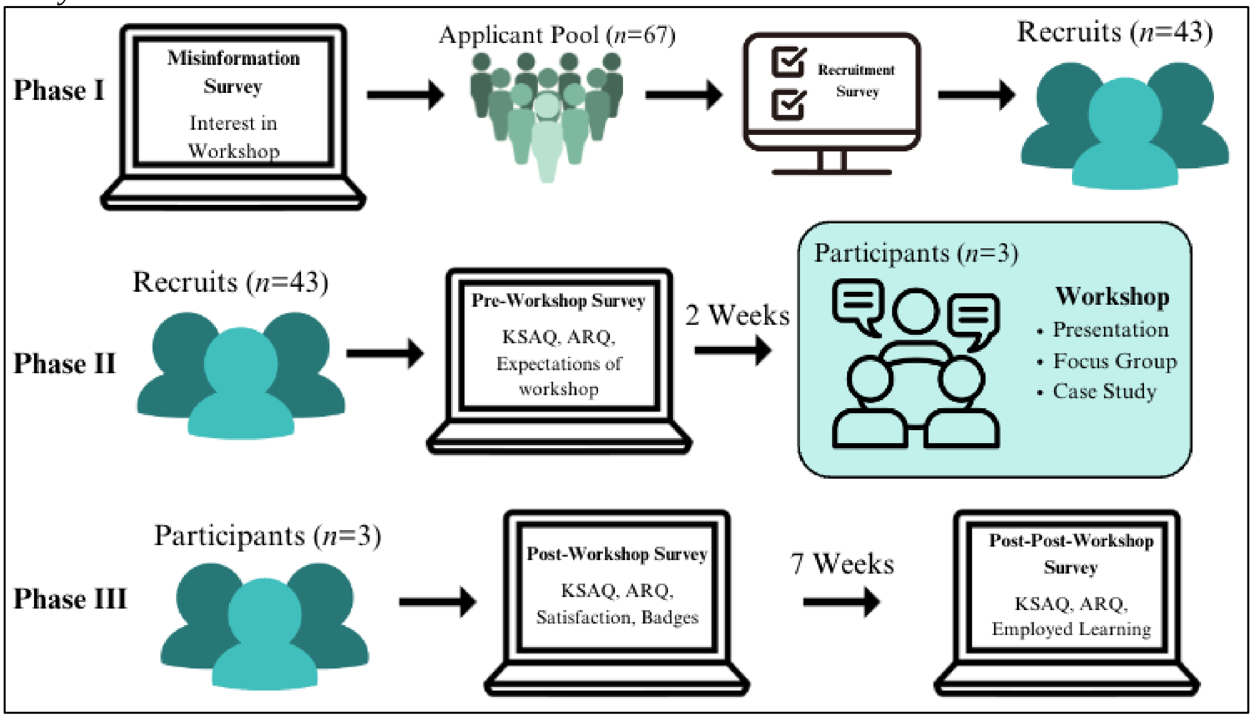
Study Flow

As described above, this study is multifaceted, and elements of the study flow are highlighted in Figure 2. The current study contains three phases. The first phase was the recruitment phase, beginning with the misinformation survey (see Chapters 5 & 6) conducted in July 2022. Survey participants indicated whether they would be interested in a professional development workshop dedicated to future faculty. Sixty-seven potential workshop participants entered the applicant pool, and a later official recruitment survey identified 43 eligible recruits for the workshop. The second phase of the workshop included the pre-workshop survey and workshop, where the 43 recruits were officially invited to participate in the workshop. This email also prompted participants to take the pre-workshop survey containing the KSAQ, ARQ, and inquired about expectations of the workshop. Approximately two weeks later, three participants attended the workshop including a presentation, a group-based discussion like a focus group, and engaged in a case study exercise. The final and third phases of the study were the evaluation portion. Immediately after the workshop ended, participants were asked to complete the first post-workshop survey that contained KSAQ, ARQ, questions regarding their satisfaction of the workshop and, in a separate survey their information for the digital badge certifications. Seven weeks after the workshop, the participants were invited to complete another survey to measure retention of the information taught and to determine if they had employed any of the skills or resources they had learned from the workshop. This post-post-workshop survey included the KSAQ, ARQ, and details of "employed learning."

Figure 2.

Study Flow.



Data Analysis

In this mixed-methods design, quantitative data included data collected through anonymous Qualtrics surveys and qualitative data included open-ended responses in surveys, as well as quotes taken from notetakers during the workshop. Demographic data were summarized using descriptive statistics. Descriptive statistics were also used to evaluate the effectiveness of the workshop at multiple levels: improvements in knowledge, skills, and abilities, perception of relevance of agriculture, and perceptions of agriculture. The discussions during the workshop served as qualitative measures and were analyzed using in vivo or focused coding (Saldaña, 2016) using the software ATLAS.ti (ATLAS.ti, Web Version, 2022). Quotes and notes taken during the workshop by the second and third authors, were organized by the first author, which yielded a transcript consisting of 5 pages of single-spaced text. As encouraged by Saldaña (2016), three different coders read, annotated, and coded the transcript. Dependability and reliability were achieved by having three personnel review and validate transcribed material and codes (Cypress, 2017). To ensure stable responses, coders who were also notetakers during the workshop collaborated if there were discrepancies in interpretation, where codes of similar meaning were combined into one code through second-cycle coding. These coding methods resulted in trustworthy results that the research study is based on the concepts of reliability and validity (Seale, 1999).

Results

Participants

Shown in Table 1, the participants had similar backgrounds and interests in teaching; however, results from the recruitment survey show that motivations are different amongst participants (see Chapters 5 & 6). Each participant had been involved in leading classrooms as a teaching assistant for four or more semesters. However, their comfort levels in teaching science to students within their discipline ranged from average comfort to high degrees of comfort. Each participant had some motivation to teach in the future, but the amount of science to be taught varied among the participants. Specifically, some described their future classrooms as having somewhat regular science instruction, and others labeled their future classrooms explicitly science based. Another unique attribute of these participants was that they had possibly experienced agriculture addressed in previous classrooms or may currently teach about agricultural intersections. From a list of potential social science topics, participants were asked to indicate which topics they had witnessed or taught in classrooms. Participants in the current study indicated the following list: sources of greenhouse gas emissions (human activity, burning fossil fuels, livestock, etc.); chemical usage (nuclear waste, pesticides, etc.); stem cell research; climate change; environment and/or sustainability.

Table 1.

AgSTEM 360 workshop participant demographics.

Age	Upbringing	Graduate Program	Degree Program	Diet	Interest in Teaching	Pseudonym
26	Suburban	Chemical Engineering	Ph.D.	Pescatarian	Possibly yes	Bailey
27	Suburban	Earth System Science	Ph.D.	Omnivorous	Yes	Waverly
30	Suburban	Biology	Ph.D.	Omnivorous	Yes	Logan

RQ1. Can professional development in science and agricultural communication enable the development of knowledge, skills, and abilities of future teachers?

To measure the impacts of the workshop, the knowledge, skills, and abilities of the five foundations were collected pre- and post-workshop through surveys. Two participants showed improvements of the following pre- to post-workshop regarding SC and SL: knowledge of SC principles, knowledge of SC resources, skills to communicate science, skills, and abilities in finding and navigating SC resources, confidence in communicating complex science topics, and abilities to present science to non-science audiences. Two participants also demonstrated better knowledge, skills, and abilities after the workshop in terms of their knowledge of WV, as well as skills and abilities to control their instincts or biases. All participants indicated enhanced knowledge, skills, and abilities regarding AL and PA after completing the workshop. Specifically, participants reported greater knowledge of AL and agricultural resources, skills, and abilities to promote AL and navigate reliable agricultural resources. Also, the workshop enhanced their knowledge of PA to implement in their classrooms, along with improved skills, confidence, and abilities to craft and deliver PA.

RQ2. What are the needs and motivations to communicate about agriculture inside and outside the classroom from the perspective of future instructors?

One method of answering RQ2 was to analyze responses to the second portion of each survey, which inquired about the perceived relevance of agriculture by participants to their graduate discipline. Most of the participants initially had no opinion on whether agriculture was a relevant topic for everyone to understand or whether agriculture was relevant to their respective disciplines. Both showed large changes in their perception after the workshop, that now they strongly agree that agriculture is a relevant topic for everyone to understand as well as to their discipline. One participant had not changed in these two perspectives, as they largely agreed with these statements before the workshop. They recognized that agriculture is a relevant topic to understand and is significant to their discipline, which was maintained through workshop activities and discussions. Two participants originally had no opinion on whether agriculture should be presented and taught within the context of their respective disciplines. Both showed large changes in their perception after the workshop, that now they strongly agree that agriculture should be presented and taught in classrooms in their respective disciplines. One participant agreed that agriculture should be discussed in classrooms of their discipline before the workshop, and the workshop confirmed this further, as their opinion moved to strongly agree. Prior to the workshop, two participants agreed that agriculture could provide new and improved perspectives or sources of learning within their discipline. After completing the workshop, their original thoughts were validated and confirmed as their opinions changed to strongly agree. Agriculture was and still is an opportunity to improve understanding within an array of fields of study. One participant originally had no opinion on if agriculture would add a new dimension of learning while developing students. This participant showed large changes in their perception after the workshop, that now they strongly agree that agriculture could positively impact their students by improving learning and understanding.

Another source of information to answer the current research question came from discussions throughout the workshop. When asked why agriculture is a crucial STEM field for communicating, each participant had a different response. One participant explained that everyone is affected by agriculture and needs to eat, therefore justifying why agriculture should be elaborated in different environments and giving reason to advocate for an essential industry. Another participant did not readily have a specific answer, as they identified that the strongest connection they have to the agricultural industries is purchasing and consuming products from grocery trips. The other participant introduced a new perspective that farmers often face a stereotype that they are not very scientific, or even intelligent, people. This participant expanded that there is much attention to detail and research that goes into advancing food yields.

As part of the case study during the workshop, the first question pertains to motivations for integrating agricultural topics into traditional STEM curricula. As a group, participants collaborated on the perceived benefits of this infusion from the perspective of a higher education administrator. A participant recalled that there is a lot of misinformation on agriculture and food production, even on topics that should be common knowledge for the public. They went further to explain that the introduction of agriculture in some core or general curricula in universities could correct some of the "obvious" misinformation. This participant elaborated that starting with the student could be the first step, then it could move on to educate the student's families or others in their circle, to "teach through another person," and ultimately correct the wrongdoings. If agricultural information could be interpreted in the context of the instructor's field of study, it would be perceived to be more plausible to integrate. Another participant provided a more unique perspective of administrator motivation that it could be more of a confidence issue. Specifically, this participant said:

> "Another perspective could be that this administrator knows his students come from agricultural or impoverished backgrounds. The benefit to including agricultural into STEM disciplines could be a motivational or relational factor. They understand and recognize agriculture and help bridge the gap in both knowledge and confidence."

The same participant continued and recognized that implementing agriculture into non-agriculture classrooms could provide concrete examples that are sustainable across time. They saw this opportunity for infusion as another tool in the toolbox to motivate and foster student learning.

RQ3. What topics, pedagogical approaches, and obstacles exist to integrate science and agriculture in future classrooms?

In workshop discussions, participants proposed several ideas for agricultural topics that could be infused into higher education science courses. Potential topics for the discussion of crop or plant-focused agriculture included plant growth, anatomy, and development, as well as discussions of evapotranspiration from row crops as an influence of precipitation. The animal agriculture examples provided were alternative proteins, particularly lab-grown "meats" as a discussion topic, as well as animal stem cells for human lifespan advancement. Parasite models and preventions for plants and animals were identified as potential topics along with agriculture and ecosystem interactions, such as pollinators or others.

Considering the topics the group had brainstormed, the final element of the case study during the workshop was to visualize PA to immerse science and agriculture. After thirty minutes of design, the group decided on two pedagogical methods. To appease visual learners, the group proposed using side-by-side experiments with ties to agricultural production. Demonstrating soil erosion mechanisms, soil compaction, or food product differences (based on food labels) side by side would provide students with a memorable experience of the information presented, with connections to some element of food production. The other example reflected an already established active learning pedagogy, specifically role-playing. To provide context, the group identified climate change as the central topic. The instructor would then assign roles to the students, such as researchers, teachers, farmers, politicians, or others involved in the science, policies, and regulation of climate change. Students would learn to communicate about the mitigation of climate change from the perspectives of multiple entities, including farmers. The versatility of the role-playing technique across classes would be changing the topic of discussion but retaining the assigned perspective of farmers or other agricultural industry professionals.

Another question during the case study analysis of the workshop inquired about potential obstacles to infuse agriculture and science into higher education. The group identified two main obstacles from the instructor's point of view that could arise. One participant explained that depending on the instructor's or the student's background, introducing agriculture may not be the most relevant example to provide. Specifically, "some people may perceive the use of agricultural examples as being just as far removed than examples they may currently be using." Another participant identified the second obstacle, which is like practicality, in that instructors must be "well-versed enough" in agriculture or willing to implement it in the first place, or else they would create resistance in follow-through.

RQ4. What learned information from the workshop is lost, retained, or improved weeks following the workshop?

The post-post-workshop survey seven weeks after the workshop measured the knowledge, skills, and abilities of participants, the relevance of agriculture to their discipline, and whether the participants have employed what they learned during the workshop in their recent teaching. The results of the survey indicate that all participants retained knowledge, confidence, and competence in SC, SL, and PA to communicate science. However, weeks after the workshop, some participants demonstrate lost knowledge, skills, abilities, and confidence in finding and sharing agricultural information and promoting agricultural literacy. Others indicated that they did not change their confidence and ability to promote agricultural literacy. It was revealed that weeks after the workshop that all participants agree that agriculture is relevant to their discipline. Specifically, each participant agreed or strongly agreed that: Agriculture is a relevant topic for everyone to understand; Agriculture is relevant to my own discipline and that; Agriculture should be presented within context of my own discipline to develop students with an additive dimension of understanding.

Regarding the participant responses to *"Have you used principles of science communication or agricultural literacy since attending the workshop, or plan to?"* There were two themes in responses that emerged. Two participants described that they had not had the opportunity to use the principles they had learned but were excited to introduce these concepts during their classes in the next semester. Another participant indicated that they "have shared with others the impact of what [they] learned in the workshop."

Discussion

Instructors in non-scientific subjects frequently lack experience and education necessary to integrate science into their lecture plans. It takes education and incentives to address foreign subjects for non-science and non-agriscience instructors to integrate science and ag concepts into their classes. At the same time, well-read science professors are capable of comprehending and incorporating science into their classrooms but do it in a way that does not support science communication in component student bodies. Our thinking is based on the mental model that knowledge of science, food, and agriculture, as well as the ability to assess the reliability of evidence, are essential for the development of future generations of global citizens. Being discriminating consumers and active citizens in a society heavily reliant on research, society will need to be connected to science in some way. According to our recent research, a professional development workshop can improve science communication, science literacy, and agricultural literacy by communicating science and agriculture through effective message modalities.

According to Hurd (1998), science literacy is the ability to use knowledge of science and technology for social and economic advancement. State-level Agriculture in the Classroom initiatives seek to increase agricultural literacy and science literacy in PreK-12 grade levels (Malecki et al., 2004; Hillison, 1998; *USDA*, n.d.). Although they have been effective in encouraging young students to become agriculturally literate, it is unclear why education in this area ends there. Students can "Google" any inquiries or needs they may have used the Internet. Therefore, being able to critically evaluate, analyze, and articulate contemporary science information based on evidence is essential in today's culture. Teachers who improve their scientific communication skills will not only better impart new information in the classroom but will also promote a deeper sense of civic responsibility. Improved scientific communication among teacher influencers at all levels is crucial for supporting the upcoming generation of professionals and increasing public support for research. Moreover, it shows to taxpayers that their investment is profitable. This is crucial because taxpayers fund investments in cutting-edge scientific research, public education, and the ability to make decisions based on science. We can provide role models for our students in the realm of scientific communication by training current and future educators to convey complicated sciences, such as those related to food and agriculture, effectively. Because competent teachers develop competent students with excellent science communication skills, competent graduates are highly sought after in today's competitive career landscape.

Even though the term "science communication" is a catchall for everything related to sharing science with others, traditional approaches for communicating science tend to be limited to equally outdated formats. Examples include students writing essays, instructing using virtual slides, and making digital posters. When there are several discourse levels that involve the scientist, the science instructor, and the science learners together, it can be challenging to convey science (Strauss et al., 2005). To engage a variety of learner audiences, unconventional methods are needed. In the General Education curriculum, writing lessons are needed for future teachers, but these workshops usually do not focus on the skills necessary for good science communication. It seems reasonable that students who are more analytically inclined and cognitively astute would be considered to have a greater degree of scientific literacy.

Student confidence, critical thinking skills, and other higher-order thinking abilities are anticipated to increase with enhanced science knowledge and comprehension (Train & Miyamoto, 2017; You, 2017). However, in line with the study's findings, applying science in an interdisciplinary way requires some expertise. It has been noted in both prior research and the current study that effective scientific instruction requires the instructor to exert effort (Sadler et al., 2013; Goe, 2007). Without the support of teachers, science and agriculture integration would be unsuccessful due to a lack of expertise, ignorance, and inefficient delivery of science information (Krauss et al., 2008; Hill et al., 2005). The teacher is excluded from this line of reasoning by another viewpoint (Feinstein, 2010). So, unlike traditional educational methods, instructors are not solely responsible for "making science relatable"(Feinstein, 2010). Instead, it is the responsibility of students to acquire the ability to make science relevant through inquiry, practice, and the creation of their own social context (Feinstein, 2010).

Conclusions, Implications, and Recommendations

To our knowledge and scope of the literature, no other study like this exists. The workshop improved the competencies of future teachers on a variety of topics, including science communication, science literacy, worldviews, agricultural literacy, and pedagogical approaches to promote the former. However, the study did have limitations. A larger sample size would have provided the ability to statistically interpret survey results, as well as to provide additional observations during the workshop component. Repetition of the study with participants studying non-STEM fields would yield insightful data considering willingness to promote agricultural and science literacy in nontraditional classrooms. The results of the current study show promise in its usability and practicality to be implemented as teacher training or education for young faculty in academia.

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Chapter 8 – Conclusions

Given the ease with which information may now be accessed, it is crucial to analyze instances of potential disinformation in postsecondary education. Evaluating the reliability of instructors' scientific claims is essential to upholding the integrity and goals of land grant universities. Students can use the Internet to "Google" any questions or needs they may have. Therefore, it is essential in today's society to be able to critically sift through, comprehend, and explain current and evidence-based science content. Students who practice scientific communication develop good communication skills that allow them to spread complicated ideas to a wider audience.

Instructors in higher education might include interdisciplinary subjects in the classroom to encourage distinctive yet balanced learning. Interdisciplinarity is a key knowledge regime for managing complex situations and advancing information literacy. It has been revealed that students appreciate interdisciplinary activities that promote critical thinking and better science communication, but teachers must make an effort to include science into their lessons. In order to impart these similar abilities to both current and future students, hired professors at land grant institutions must have a firm grasp of the fundamentals of scientific communication, regardless of their field of specialty. Research indicates that science instructors need to adapt since the way that science is currently taught and communicated is not accelerating progress. Previous studies have shown biases towards agriculture that is exhibited in higher education courses, which supports instructor positionality regimes. Because of the trust that exists between teachers and students, students are more likely to harbor preconceptions towards agriculture. Simply put, the institutional environment in which educators function and the idea of paying for a more expensive, advanced education encourage students' trust in their teachers. The faith that people have in higher education must thus be studied and investigated, both within and beyond the framework of agricultural issues.

In the current thesis, we sought to determine animal agriculture perceptions and worldviews of higher education and analyze demographic traits that influence knowledge, perceptions, and attitude. Additionally, we made a concerted effort to replicate classroom settings as we learned about the theoretical explanations employed by university lecturers to convey agriculture without provocation. Along with revealing graduate students' experiences with false information and other difficulties in higher education through their opinions and testimony, other objectives included examining perceptions, tendencies, legitimacy, and others. We also developed a viable intervention against agricultural and science misinformation and sought to assess its efficacy and applicability to future higher education faculty.

In general, individuals possess less knowledge of animal agriculture, especially those who work in higher education, yet research has shown that their perceptions are worse due to a lack of awareness. Several, but not all, higher education professionals and students had negative attitudes about the animal farming sector. These views may be attributed to prior and repeated exposure to misinformation, preconceived biases, or reactions that fall within the range of the knowledge gap. It was evident that individuals were less knowledgeable about environmental issues than they were about welfare and dietary topics. An individual's degree of knowledge and worldviews regarding how animal-derived food is generated can be explained by demographic traits such as gender, ethnicity, dietary preference, relationship to food, and others. Additionally, post-secondary professors mislead students in STEM and non-STEM disciplines and subjected them to barriers, intimidation, hurdles, and skepticism, according to the most current data. Graduate students reported frequent instances of misunderstanding and discrimination about science and agricultural subjects in both scientifically oriented and non-science focused situations. The topic of production agriculture was widely raised. To combat and reverse damage explained by current graduate students, a professional development workshop in the realm of science and agricultural literacy shows promise in success. The training enhanced the abilities of aspiring teachers in a variety of areas, such as science literacy, science communication, worldviews, agricultural literacy, and pedagogical methods to support and share scientific information.

Future research must be explored in order to address the extra questions that the current thesis raises. Future research may examine the possible impact of the current instructors' discussion topic suggestions. Although we are aware that agriculture is discussed outside of classrooms that are solely devoted to it, it is unclear if students will be able to spot bias, incorrect information, or negative sentiments. Another avenue for innovative and important research would be to repeat the study in populations that do not participate in higher education. It may be necessary to compare trends and themes between higher education and other groups of individuals in order to understand why higher education might have more negative perceptions of modern livestock systems. Land grant institutions no longer prioritize agriculture as much as they did when they were founded. It would be beneficial to carry out further research on the prerequisites and motivators for adding agricultural sciences or food production courses back to the core curriculum. The answer to our problems may lie in reconnecting people with their food through the eventual restoration of agriculture into the core curriculum.

Appendix

Appendix 1. *"Common Knowledge or Common Sense? Identifying Systematic Misconceptions of Animal Agriculture and Food Familiarity in Higher Education Individuals"* Survey Material

Agricultural Knowledge Survey

Information Letter: You are invited to participate in a research study to gauge the public's level of general knowledge about agriculture. The study is being conducted by Katie Corbitt, an Animal Sciences Masters Student, which is housed within the College of Agriculture at Auburn University. She is under the advisement of Dr. Don Mulvaney, Associate Professor in the Department of Animal Sciences. You are invited to participate because you are a student or faculty member at Auburn University at least 18 years of age.

What will be involved if you participate? Your participation is completely voluntary. If you decide to participate in this research study, you will be asked to complete an electronic survey on general agricultural knowledge and descriptive demographic information. Your total time commitment will be less than 15 minutes.

Are there any risks or discomforts? This is a completely voluntary, anonymous study which can be exited at any time. There are no risks or discomfort associated with taking this survey and the subject matter you as a participant will be questioned on should not cause any strong physical or emotional responses. At any time during the duration of the survey you may choose to stop completing the survey or may choose to skip any questions that you may find uncomfortable to answer.

Are there any costs? If you decide to participate, there are no costs to you other than the estimated 10-15 minutes required to complete the survey.

Will you receive compensation for participating? Compensation or reward is not guaranteed, but there are potential benefits as described in the paragraph below.

What are the potential benefits for taking this survey? If you choose to do so, a giveaway for $25 Amazon gift cards will be available for you to enter at the end of this survey. Entering the giveaway will require you to enter your email in order to be contacted if you are selected as a winner, however, your email will not be associated with any of the answers you provide during the survey. However, there is no guarantee that you will receive any of the benefits described. Your chance of winning a gift card is 1 out of 10, where 10% of completed surveys will receive a gift card. There is a 10% chance of receiving a gift card for both student and faculty responding groups.

If you change your mind about participating, you can withdraw at any time by closing your window browser. Once you've submitted anonymous data, it cannot be withdrawn since it will be unidentifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University.

Any data obtained in connection with this study will remain anonymous. We will protect your privacy and the data you provide by maintaining all data on single password-protected computers accessible only by study approved personnel. Information collected through your participation may be used for presentations at academic conferences or for publication in academic journals.

If you have questions about this study, please contact Katie Corbitt, GRA in the Department of Animal Sciences advised by associate professor Dr. Don Mulvaney at kec0139@auburn.edu.

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Research Compliance or the Institutional Review Board by phone (334) 844-5966 or e-mail at IRBadmin@auburn.edu or IRBChair@auburn.edu.

Having read the information above, you must decide if you want to participate in this research project. If you decide to participate, please click on the arrow below. You may create a copy of this letter to keep.

End of Block: Information Letter

Start of Block: GapMinder

Q167 The first portion of the survey refers to general knowledge of agriculture. Please answer the following multiple choice questions to the best of your ability. Do not use outside references or sources as this is an evaluation of the baseline of your knowledge without outside help.

---

1 How old are veal calves when they are harvested?

- ○ 2 months old (1)
- ○ 4 months old (2)
- ○ 6 months old (3)

---

2 What percent of animal-sourced foods end up in landfills?

- ○ 10-20% (1)
- ○ 30-40% (2)
- ○ Higher than 40% (3)

3 Most animal-based proteins are sourced from _____.

- ○ Factory farms (1)
- ○ Corporate-owned operations (2)
- ○ Family-owned farms (3)

4 Why are dairy calves removed from their mothers earlier than beef calves?

- ○ Calves get sick soon after birth (1)
- ○ The stress makes them produce more milk (2)
- ○ To keep the udder undamaged (3)

5 About how many vitamins and minerals are provided in 3.5 ounces of US beef?

- 5-7 (1)
- 8-10 (2)
- More than 10 (3)

---

6 When compared in ounce equivalents, plant-sourced proteins are _______in protein content compared to animal-sourced.

- Greater (1)
- Equal (2)
- Less (3)

---

7 One 8 ounce serving of milk has the same amount of calcium compared to how many cups of kale?

- 1 cup (1)
- About 3 cups (2)
- More than 5 cups (3)

---

8 According to the CDC, there has been a reduction in E coli related reports derived from ground beef of ______.

- 25% (1)
- 60% (2)
- 90% (3)

---

9 If 10% (39 million people) of the US population were to go vegan, how much of an impact will this have on carbon footprint?

- Reduced 0.26% (1)
- Reduced 2.6% (2)
- Reduced 5.5% (3)

---

10 What percent of water in a beef animal's diet is not provided by rainwater?

- 6% (1)
- 15% (2)
- 38% (3)

---

11 What percent of US greenhouse gas emissions are attributed to livestock?

- 3.9% (1)
- 14.5% (2)
- 20.7% (3)

---

12 How much square footage is provided per beef animal in a feedyard?

- 50-100 sq ft (comparable to a walk-in closet, roughly 8ft x 8ft) (1)
- 100-150 sq ft (comparable to a small bedroom, roughly 12ft x 12ft) (2)
- 150-250 sq ft (comparable to a large bedroom, roughly 15ft x 15ft) (3)

End of Block: GapMinder

Start of Block: Connection to Ag / FFI

Q168 The final portion of the survey asks about some various demographic information. Please answer the following demographic questions to the best of your ability, hitting continue as you go.

Q92 Select which of the following describe your connection to agriculture. (Select all that apply)

- ☐ I have no relation to agriculture other than buying and consuming food at the grocery store. (1)
- ☐ I personally raise crops and/or animals for protein sources. (3)
- ☐ My family raises crops and/or animals for protein sources. (2)
- ☐ I know my grandparents or earlier generations farmed. (10)
- ☐ I was exposed to agriculture in K-12 classrooms at least once. (4)
- ☐ I was exposed to agriculture in college classrooms at least once. (5)
- ☐ I work in an agricultural-related field. (9)

Q94 Where do you get your information about agriculture? (Select all that apply)

- ☐ I read / learn about agriculture across social media. (6)
- ☐ I read / learn about agriculture in the news. (7)
- ☐ I actively seek out articles regarding agriculture. (8)
- ☐ I actively seek out information about agriculture through "googling." (4)
- ☐ I read food labels. (9)
- ☐ I ask my parents / guardians / family. (5)
- ☐ I hear about it in classroom settings. (10)
- ☐ I ask farmers or other people who work in the industry. (2)
- ☐ I read signs / billboards / other public landmarks. (11)

☐ Other (12) ____

Q126 Using the sliders provided below and your current knowledge of food production, please indicate your level of support for the following areas of **production animal agriculture**.
Middle: No opinion of support, neither trust or distrust
Left: Unsupportive, distrust in farmers
Right: Supportive, trust in farmers

	I do not support farmers' actions in this area.	I have no opinion of support of farmers' actions in this area.	I am highly supportive of farmers' actions in this area.
Animal Wellness & Welfare ()			
Environmental Stewardship of Animal Agriculture ()			
Use of Animals for Food ()			

Page Break

Q2 For each statement on the left, please indicate your level of agreement or disagreement on the right.
0 = Very Strongly Disagree
5 = Neutral / Neither Agree or Disagree
10 = Very Strongly Agree

	Very Strongly	1 (14)	2 (15)	3 (16)	4 (17)	**Neutral** 5 (18)	6 (19)	7 (20)	8 (21)	9 (22)	**Very Strongly**

	Disagree 0 (13)										Agree 10 (23)
I go out of my way to accommodate purchase of preferred foods. (12)	○	○	○	○	○	○	○	○	○	○	○
I am emotionally connected to procedures and conditions in which food is produced/grown. (13)	○	○	○	○	○	○	○	○	○	○	○
I would say that I know something about how a majority of the food I eat is raised. (14)	○	○	○	○	○	○	○	○	○	○	○
I devote time and energy to learning about different food systems and current agricultural practices used in food production. (15)	○	○	○	○	○	○	○	○	○	○	○
When food is a topic of conversation, I am willing to share my knowledge about how	○	○	○	○	○	○	○	○	○	○	○

food is grown/produced with others. (16)												
I devote time to growing my own food and/or food for others (people or animals) to consume. (17)	○	○	○	○	○	○	○	○	○	○	○	
I would be concerned if I were not able to study and learn about food and agriculture. (20)	○	○	○	○	○	○	○	○	○	○	○	
I support agriculture and food production systems. (21)	○	○	○	○	○	○	○	○	○	○	○	
I make buying decisions based on how and/or where a specific food item was produced. (22)	○	○	○	○	○	○	○	○	○	○	○	
I seek out others who also know or care about where their food comes from. (23)	○	○	○	○	○	○	○	○	○	○	○	
I buy foods based on the nutritional	○	○	○	○	○	○	○	○	○	○	○	

composition and health implication. (24)	
I am familiar with safety, quality, and marketing factors of food. (25)	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○

End of Block: Connection to Ag / FFI

Start of Block: Demographic Information

Q3 We would like to know a little more about you. Please answer the following demographic questions to the best of your ability.

Q4 Gender

○ Male (1)

○ Female (2)

○ Non-binary / third gender (3)

○ Prefer not to say (4)

Q5 Please specify your age in years.

____

Q6 Which of the following best describes your ethnicity?

○ Caucasian / White (1)

○ Hispanic / Latino (2)

○ African American / Black (3)

○ Asian / Pacific Islander (4)

○ Native American / American Indian (5)

○ Mixed / Blend of one or more of the above (7)

○ Other (6) ____

Q7 Zip Code (If you live within the United States)

____

Q9 Which best describes the area you grew up in? (Birth to 18 years)

○ Urban (high population density proximate or part of a major city) (1)

○ Suburban (medium population density within commuting distance of a major city but not by foot) (2)

○ Rural (low population density with large commuting radius and a large number of agricultural land uses) (3)

Q11 Which of the following best describes your diet?

○ Omnivorous (consume both animal-based and plant-based foods) (1)

○ Flexitarian (consume only plant-based foods and occasionally animal-based foods) (2)

○ Pescatarian (consume mostly plant-based foods and a select few animal-based foods like eggs, fish and/or dairy) (3)

○ Vegetarian (consume mostly plant-based foods, and some animal-based foods like eggs and/or dairy) (4)

○ Vegan (consume strictly plant-based foods) (5)

○ Other (6) ____

Q12 Please specify your reasoning for your choice in dietary pattern. Select all of the following that contribute to your dietary purchasing habits.

▢ Health or nutrition (1)

▢ Animal welfare (2)

▢ Environmental impact / Sustainability (3)

▢ Upbringing / How you were raised (4)

▢ Dietary restrictions / Allergies (5)

▢ Religion (6)

▢ Price (7)

▢ Culture (8)

▢ Food production method (non-genetically modified, organic, all natural, etc.) (9)

▢ Partner or spouse has influence (10)

▢ Supporting agriculture (12)

☐ Shop locally grown to combat support of factory farming (13)

☐ Other (11) ____

Q7 Highest level of education completed

○ Some high school / No diploma (1)

○ High school diploma / GED / Equivalent (2)

○ Some college / No degree (3)

○ Technical college (10)

○ Associate's degree (4)

○ Professional degree (5)

○ Bachelor's degree (6)

○ Master's degree (7)

○ Doctorate (PhD / MD / DVM) (8)

○ Higher than doctorate education completed (9)

Q180 Are you a student or faculty/staff member?

○ Student (undergraduate) (4)

○ Student (graduate) (5)

○ Faculty or Staff (6)

Q13 What college are you associated with at Auburn?

▼ Agriculture (1) ... Veterinary Medicine (12)

Q185 Please specify which department you primarily take classes in for your degree and/or which department you work for.

____

End of Block: Demographic Information

Start of Block: Faculty/Staff Giftcard

Q188 If you would like to be entered into the giveaway for $25 Amazon gift cards, please enter your email in the text box below. You have a 10% chance out of all faculty/staff responses to receive a gift card.

Reporting your email will not associate your identity with any of your prior survey answers. This ensures you will maintain anonymity in your survey answers.

If you are selected as a giveaway winner, you will be contacted through email by research personnel.

____

End of Block: Faculty/Staff Giftcard

Start of Block: Student Giftcard

Q72 If you would like to be entered into the giveaway for $25 Amazon gift cards, please enter your email in the text box below. You have a 10% chance out of completed student responses to receive a gift card.

Reporting your email will not associate your identity with any of your prior survey answers. This ensures you will maintain anonymity in your survey answers.

If you are selected as a giveaway winner, you will be contacted through email by research personnel.

End of Block: Student Giftcard

Appendix 2. "*The Use of Simulated Discussion Prompts to Assess Sentiment Toward Agriculture in Higher Education Instructors*" Survey Material

Land Grant Instructor Discussion Prompt Survey

Information Letter: You are invited to participate in a research study to gauge the ability of instructors of land grant institutions to improvise discussion prompts that are creative and foster student engagement. The study is being conducted by Katie Corbitt, a graduate research assistant in the Department of Animal Sciences which is housed within the College of Agriculture, advised by faculty associate professor Dr. Don Mulvaney. You are invited to participate because you are a faculty member of at least 18 years of age and teach at a land grant institution.

What will be involved if you participate? Your participation is completely voluntary. If you decide to participate in this research study, you will be asked to complete an electronic survey on demographic information, teaching demographics, and develop a discussion prompt on a provided topic. Your total time commitment will be approximately 20 minutes.

Are there any risks or discomforts? This survey is a completely voluntary, anonymous study which can be exited at any time. There are no anticipated risks or anticipated discomforts associated with taking this survey and the subject matter you as a participant will be questioned on should not cause any strong physical or emotional responses. At any time during the duration of the survey you may choose to stop completing the survey or may choose to skip any questions that you may find uncomfortable to answer.

Are there any costs? If you decide to participate, there are no costs to you other than the estimated 20 minutes required to complete the survey.

Will you receive compensation for participating? Compensation or reward is not guaranteed, but there are potential benefits as described in the paragraph below.

What are the potential benefits for taking this survey? Though you will not directly benefit from taking this survey, generalized benefits include contributing to information that will be shared via publications, presentation, posters, etc. If you choose to do so, there is a chance to win a giveaway for a smartwatch (Apple Watch Series 8 or SAMSUNG Galaxy Watch 5 Pro) at the end of this survey. Entering the giveaway will require you to enter your email in order to be contacted if you are selected as a winner, however, your email will not be associated with any of the answers you provide during the survey.

If you change your mind about participating, you can withdraw at any time by closing your window browser. Once you've submitted anonymous data, it cannot be withdrawn since it will be unidentifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University or the Department of Animal Sciences.

Any data obtained in connection with this study will remain anonymous. We will protect your privacy and the data you provide by maintaining all data on single password-protected computers accessible only by study approved personnel. Information collected through your participation may be used for presentations at academic conferences or for publication in academic journals.

If you have questions about this study, please contact Katie Corbitt, GRA in the Department of Animal Sciences advised by associate professor Dr. Don Mulvaney at kec0139@auburn.edu.

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Research Compliance or the Institutional Review Board by phone (334) 844-5966 or e-mail at IRBadmin@auburn.edu or IRBChair@auburn.edu.

Having read the information above, you must decide if you want to participate in this research project. If you decide to participate, please click on the arrow below. You may create a copy of this letter to keep.

Page Break

Q38 Which best describes your role/rank at your university? (Prefixes/suffixes on next page)

- ◯ Instructor / Lecturer (1)
- ◯ Assistant Professor (2)
- ◯ Associate Professor (3)
- ◯ Professor (4)
- ◯ Professor of Practice (5)
- ◯ Visiting Scholar (6)
- ◯ Dean (7)
- ◯ Other (please describe) (8) ____

---

*

Q41 What is your position appointment percent? Please enter "0" for empty fields.
Research : ________ (1)
Teaching : ________ (2)
Extension : ________ (3)
Administration : ________ (4)
Service : ________ (5)
Other (please describe) : ________ (6)
Total : ________

End of Block: Default Question Block

Start of Block: Demographics

Q3 We would like to know a little about you. Please answer the demographic questions to the best of your ability.

Q4 Gender

○ Male (1)

○ Female (2)

○ Non-binary / third gender (3)

○ Prefer not to say (4)

Q5 Please specify your age in years.

____

Q6 Which of the following best describes your ethnicity?

- ○ Caucasian / White (1)
- ○ Hispanic / Latino (2)
- ○ African American / Black (3)
- ○ Asian / Pacific Islander (4)
- ○ Native American / American Indian (5)
- ○ Mixed / Blend of one or more of the above (7)
- ○ Other (6) ____

Q7 Zip code of your hometown (If you lived within the United States)

____

Q9 Which best describes the area you grew up in? (Birth to 18 years)

- ○ Urban (high population density proximate or part of a major city) (1)
- ○ Suburban (medium population density within commuting distance of a major city but not by foot) (2)
- ○ Rural (low population density with large commuting radius and a large number of agricultural land uses) (3)

Q7 Highest level of education completed

- ◯ Some high school / No diploma (1)
- ◯ High school diploma / GED / Equivalent (2)
- ◯ Some college / No degree (3)
- ◯ Technical college (10)
- ◯ Associate's degree (4)
- ◯ Professional degree (5)
- ◯ Bachelor's degree (6)
- ◯ Master's degree (7)
- ◯ Doctorate (PhD / MD / DVM) (8)
- ◯ Higher than doctorate education completed (9)

Q37
Which region best describes your university's location?

- ◯ West - Pacific (1)
- ◯ West - Mountain (2)
- ◯ Midwest - West North Central (3)
- ◯ Midwest - East North Central (4)
- ◯ South - West South Central (5)
- ◯ South - East South Central (6)
- ◯ South - Atlantic (7)
- ◯ Northeast - Mid-Atlantic (8)
- ◯ Northeast - New England (9)

Q39 Are there any prefixes/suffixes tied to your title? Please select all that apply.

- ▢ Clinical (1)
- ▢ Adjunct (2)
- ▢ "of the Practice" (3)
- ▢ Research (4)
- ▢ Visiting (5)
- ▢ Emeritus (6)
- ▢ Affiliated/Secondary Appointment (7)
- ▢ Senior or Master (8)
- ▢ "University Professor" (9)
- ▢ Head of Dept or Interim Head (10)
- ▢ None of the above (11)

End of Block: Demographics

Start of Block: Discipline Selection

Q2 To evaluate your ability to improvise, be creative, and foster student engagement, we ask you to create a discussion prompt you would likely use in your class. Based on your area of interest as defined by standards of the American College Testing (ACT) organization, a related topic will be presented to you. This topic will help the researchers establish a baseline for creative competency by narrowing the range of discussion posts.

The link provided (below) describes the area of interest by listing majors/occupational choices that fall within that area, if you need assistance navigating which area best describes you.

https://tinyurl.com/yr62w2zu

Q3 Please select which area of interest best describes your fit at your institution.

▼ Agriculture & Natural Resources Conservation (Ag Econ, Animal Science, Forestry, Wildlife/Wildlands Management, etc.) (1) ... Social Sciences & Law (Law, Criminology, Economics, History, Political Sciences, Psychology, etc.) (18)

Q4 What is the name of the department you work for or do the most work with? Examples include Dept. of Biological Sciences, Urban Studies, Hospitality Majors, etc.

____

End of Block: Discipline Selection

Start of Block: Climate Change

Q5 To evaluate your ability to improvise, be creative, and foster student engagement, we ask you to create a discussion prompt you would likely use in your course design.

An effective discussion prompt includes the identification of a problem that is understood by the responding group, identification of appropriate assumptions, presentation of data related to the problem, description of facts relevant to the problem, and asking questions for student cognitive engagement (Wang, 2019; Weltzer-Ward et al, 2009).

Wang, Y.-M. (2019). Enhancing the Quality of Online Discussion—Assessment Matters. Journal of Educational Technology Systems, 48(1), 112–129. https://doi.org/10.1177/0047239519861416
Weltzer-Ward, L., Baltes, B. and Knight Lynn, L. (2009), "Assessing quality of critical thought in online discussion", Campus-Wide Information Systems, Vol. 26 No. 3, pp. 168-177. https://doi.org/10.1108/10650740910967357

Q6 Design a discussion prompt related to climate change. This should include elements related to human activity, agriculture, and other natural processes like changes in the Earth's atmosphere, temperatures, and others.

____

____

Q44 Optional additional data: If you would like to provide the researchers with more qualitative data, please provide an example response to the prompt you created.

____

____

End of Block: Climate Change

Start of Block: Urban Sprawl/Imminent Domain

Q7 To evaluate your ability to improvise, be creative, and foster student engagement, we ask you to create a discussion prompt you would likely use in your course design.

An effective discussion prompt includes the identification of a problem that is understood by the responding group, identification of appropriate assumptions, presentation of data related to the problem, description of facts relevant to the problem, and asking questions for student cognitive engagement (Wang, 2019; Weltzer-Ward et al, 2009).

Wang, Y.-M. (2019). Enhancing the Quality of Online Discussion—Assessment Matters. Journal of Educational Technology Systems, 48(1), 112–129. https://doi.org/10.1177/0047239519861416
Weltzer-Ward, L., Baltes, B. and Knight Lynn, L. (2009), "Assessing quality of critical thought in online discussion", Campus-Wide Information Systems, Vol. 26 No. 3, pp. 168-177. https://doi.org/10.1108/10650740910967357

Q8 Design a discussion prompt related to urban sprawl and/or imminent domain. This should include elements related to private property (residential and agricultural), public use, undefined edges of urban and rural areas, causes and consequences, population patterns, etc.

____

Q45 Optional additional data: If you would like to provide the researchers with more qualitative data, please provide an example response to the prompt you created.

____

____

End of Block: Urban Sprawl/Imminent Domain

Start of Block: Rural Communities

Q9 To evaluate your ability to improvise, be creative, and foster student engagement, we ask you to create a discussion prompt you would likely use in your course design.

An effective discussion prompt includes the identification of a problem that is understood by the responding group, identification of appropriate assumptions, presentation of data related to the problem, description of facts relevant to the problem, and asking questions for student cognitive engagement (Wang, 2019; Weltzer-Ward et al, 2009).

Wang, Y.-M. (2019). Enhancing the Quality of Online Discussion—Assessment Matters. Journal of Educational Technology Systems, 48(1), 112–129. https://doi.org/10.1177/0047239519861416
Weltzer-Ward, L., Baltes, B. and Knight Lynn, L. (2009), "Assessing quality of critical thought in online discussion", Campus-Wide Information Systems, Vol. 26 No. 3, pp. 168-177. https://doi.org/10.1108/10650740910967357

Q10 Design a discussion prompt related to challenges facing rural communities. This should include elements related to voting challenges, interaction with the public, or challenges in rural education.

____

____

Q46 Optional additional data: If you would like to provide the researchers with more qualitative data, please provide an example response to the prompt you created.

____

____

End of Block: Rural Communities

Start of Block: International Trade

Q13 To evaluate your ability to improvise, be creative, and foster student engagement, we ask you to create a discussion prompt you would likely use in your course design.

An effective discussion prompt includes the identification of a problem that is understood by the responding group, identification of appropriate assumptions, presentation of data related to the problem, description of facts relevant to the problem, and asking questions for student cognitive engagement (Wang, 2019; Weltzer-Ward et al, 2009).

Wang, Y.-M. (2019). Enhancing the Quality of Online Discussion—Assessment Matters. Journal of Educational Technology Systems, 48(1), 112–129. https://doi.org/10.1177/0047239519861416
Weltzer-Ward, L., Baltes, B. and Knight Lynn, L. (2009), "Assessing quality of critical thought in online discussion", Campus-Wide Information Systems, Vol. 26 No. 3, pp. 168-177. https://doi.org/10.1108/10650740910967357

Q14 Design a discussion prompt related to international trade. This should include elements related to major cost components (such as tariffs), market outlooks, negotiations, and others.

____

____

Q47 Optional additional data: If you would like to provide the researchers with more qualitative data, please provide an example response to the prompt you created.

____

____

End of Block: International Trade

Start of Block: Art

Q11 To evaluate your ability to improvise, be creative, and foster student engagement, we ask you to create a discussion prompt you would likely use in your course design.

An effective discussion prompt includes the identification of a problem that is understood by the responding group, identification of appropriate assumptions, presentation of data related to the problem, description of facts relevant to the problem, and asking questions for student cognitive engagement (Wang, 2019; Weltzer-Ward et al, 2009).

Wang, Y.-M. (2019). Enhancing the Quality of Online Discussion—Assessment Matters. Journal of Educational Technology Systems, 48(1), 112–129. https://doi.org/10.1177/0047239519861416
Weltzer-Ward, L., Baltes, B. and Knight Lynn, L. (2009), "Assessing quality of critical thought in online discussion", Campus-Wide Information Systems, Vol. 26 No. 3, pp. 168-177. https://doi.org/10.1108/10650740910967357

Q12 Design a discussion prompt related to incorporation of natural landscapes and environmental elements into the arts. This should include references to use of natural scenery as central or peripheral subject matter, its use for public awareness of or respect for the environment or describing the history of incorporating nature and the environment into the arts.

____

____

Q48 Optional additional data: If you would like to provide the researchers with more qualitative data, please provide an example response to the prompt you created.

____

____

End of Block: Art

Start of Block: Product Marketing

Q15 To evaluate your ability to improvise, be creative, and foster student engagement, we ask you to create a discussion prompt you would likely use in your course design.

An effective discussion prompt includes the identification of a problem that is understood by the responding group, identification of appropriate assumptions, presentation of data related to the problem, description of facts relevant to the problem, and asking questions for student cognitive engagement (Wang, 2019; Weltzer-Ward et al, 2009).

Wang, Y.-M. (2019). Enhancing the Quality of Online Discussion—Assessment Matters. Journal of Educational Technology Systems, 48(1), 112–129. https://doi.org/10.1177/0047239519861416
Weltzer-Ward, L., Baltes, B. and Knight Lynn, L. (2009), "Assessing quality of critical thought in online discussion", Campus-Wide Information Systems, Vol. 26 No. 3, pp. 168-177. https://doi.org/10.1108/10650740910967357

Q16 Design a discussion prompt related to product marketing of food. This could include elements related to branding strategies, influential media, and others.

____

____

Q49 Optional additional data: If you would like to provide the researchers with more qualitative data, please provide an example response to the prompt you created.

____

____

End of Block: Product Marketing

Start of Block: Dietary Choice

Q17 To evaluate your ability to improvise, be creative, and foster student engagement, we ask you to create a discussion prompt you would likely use in your course design.

An effective discussion prompt includes the identification of a problem that is understood by the responding group, identification of appropriate assumptions, presentation of data related to the problem, description of facts relevant to the problem, and asking questions for student cognitive engagement (Wang, 2019; Weltzer-Ward et al, 2009).

Wang, Y.-M. (2019). Enhancing the Quality of Online Discussion—Assessment Matters. Journal of Educational Technology Systems, 48(1), 112–129. https://doi.org/10.1177/0047239519861416

Weltzer-Ward, L., Baltes, B. and Knight Lynn, L. (2009), "Assessing quality of critical thought in online discussion", Campus-Wide Information Systems, Vol. 26 No. 3, pp. 168-177. https://doi.org/10.1108/10650740910967357

Q18 Design a discussion prompt related to dietary choice. This should include elements related to protein source, carbohydrate balance, type of fat, caloric intake, and others.

____

____

Q50 Optional additional data: If you would like to provide the researchers with more qualitative data, please provide an example response to the prompt you created.

____

____

End of Block: Dietary Choice

Start of Block: Ag Census

Q25 To evaluate your ability to improvise, be creative, and foster student engagement, we ask you to create a discussion prompt you would likely use in your course design.

An effective discussion prompt includes the identification of a problem that is understood by the responding group, identification of appropriate assumptions, presentation of data related to the problem, description of facts relevant to the problem, and asking questions for student cognitive engagement (Wang, 2019; Weltzer-Ward et al, 2009).

Wang, Y.-M. (2019). Enhancing the Quality of Online Discussion—Assessment Matters. Journal of Educational Technology Systems, 48(1), 112–129. https://doi.org/10.1177/0047239519861416
Weltzer-Ward, L., Baltes, B. and Knight Lynn, L. (2009), "Assessing quality of critical thought in online discussion", Campus-Wide Information Systems, Vol. 26 No. 3, pp. 168-177. https://doi.org/10.1108/10650740910967357

Q26 Design a discussion prompt related to the agricultural census. This should include elements of inputs for computation, uses of the agricultural census, and others.

____

____

Q51 Optional additional data: If you would like to provide the researchers with more qualitative data, please provide an example response to the prompt you created.

____

____

End of Block: Ag Census

Start of Block: Migrant Workers

Q27 To evaluate your ability to improvise, be creative, and foster student engagement, we ask you to create a discussion prompt you would likely use in your course design.

An effective discussion prompt includes the identification of a problem that is understood by the responding group, identification of appropriate assumptions, presentation of data related to the problem, description of facts relevant to the problem, and asking questions for student cognitive engagement (Wang, 2019; Weltzer-Ward et al, 2009).

Wang, Y.-M. (2019). Enhancing the Quality of Online Discussion—Assessment Matters. Journal of Educational Technology Systems, 48(1), 112–129. https://doi.org/10.1177/0047239519861416
Weltzer-Ward, L., Baltes, B. and Knight Lynn, L. (2009), "Assessing quality of critical thought in online discussion", Campus-Wide Information Systems, Vol. 26 No. 3, pp. 168-177. https://doi.org/10.1108/10650740910967357

Q28 Design a discussion prompt related to migrant workers. This should include elements related to difficulties or consequences considering language barriers, availability of migrant workers, training complexities, and others.

____

____

Q52 Optional additional data: If you would like to provide the researchers with more qualitative data, please provide an example response to the prompt you created.

____

____

End of Block: Migrant Workers

Start of Block: Ethical Consider. Dietary Choice

Q21 To evaluate your ability to improvise, be creative, and foster student engagement, we ask you to create a discussion prompt you would likely use in your course design.

An effective discussion prompt includes the identification of a problem that is understood by the responding group, identification of appropriate assumptions, presentation of data related to the problem, description of facts relevant to the problem, and asking questions for student cognitive engagement (Wang, 2019; Weltzer-Ward et al, 2009).

Wang, Y.-M. (2019). Enhancing the Quality of Online Discussion—Assessment Matters. Journal of Educational Technology Systems, 48(1), 112–129. https://doi.org/10.1177/0047239519861416
Weltzer-Ward, L., Baltes, B. and Knight Lynn, L. (2009), "Assessing quality of critical thought in online discussion", Campus-Wide Information Systems, Vol. 26 No. 3, pp. 168-177. https://doi.org/10.1108/10650740910967357

Q22 Design a discussion prompt related to ethical or theological reasonings toward dietary choice. These should include benefits, ramifications, traditions, and others.

____

____

Q53 Optional additional data: If you would like to provide the researchers with more qualitative data, please provide an example response to the prompt you created.

____

____

End of Block: Ethical Consider. Dietary Choice

Start of Block: AWA

Q23 To evaluate your ability to improvise, be creative, and foster student engagement, we ask you to create a discussion prompt you would likely use in your course design.

An effective discussion prompt includes the identification of a problem that is understood by the responding group, identification of appropriate assumptions, presentation of data related to the problem, description of facts relevant to the problem, and asking questions for student cognitive engagement (Wang, 2019; Weltzer-Ward et al, 2009).

Wang, Y.-M. (2019). Enhancing the Quality of Online Discussion—Assessment Matters. Journal of Educational Technology Systems, 48(1), 112–129. https://doi.org/10.1177/0047239519861416
Weltzer-Ward, L., Baltes, B. and Knight Lynn, L. (2009), "Assessing quality of critical thought in online discussion", Campus-Wide Information Systems, Vol. 26 No. 3, pp. 168-177. https://doi.org/10.1108/10650740910967357

Q24 Design a discussion prompt related to the political policy ramifications of the Animal Welfare Act. This should include elements related to policy changes, consequences, effects, and others.

____

____

Q54 Optional additional data: If you would like to provide the researchers with more qualitative data, please provide an example response to the prompt you created.

____

____

End of Block: AWA

Start of Block: Genetically Engineered Products

Q19 To evaluate your ability to improvise, be creative, and foster student engagement, we ask you to create a discussion prompt you would likely use in your course design.

An effective discussion prompt includes the identification of a problem that is understood by the responding group, identification of appropriate assumptions, presentation of data related to the problem, description of facts relevant to the problem, and asking questions for student cognitive engagement (Wang, 2019; Weltzer-Ward et al, 2009).

Wang, Y.-M. (2019). Enhancing the Quality of Online Discussion—Assessment Matters. Journal of Educational Technology Systems, 48(1), 112–129. https://doi.org/10.1177/0047239519861416
Weltzer-Ward, L., Baltes, B. and Knight Lynn, L. (2009), "Assessing quality of critical thought in online discussion", Campus-Wide Information Systems, Vol. 26 No. 3, pp. 168-177. https://doi.org/10.1108/10650740910967357

Q20 Design a discussion prompt related to genetically engineered products. Elements should include use in food production, human biomedical implications, and others.

____

____

Q55 Optional additional data: If you would like to provide the researchers with more qualitative data, please provide an example response to the prompt you created.

____

____

End of Block: Genetically Engineered Products

Start of Block: Giveaway

Q42 If you would like to be entered into the giveaway for a smartwatch, please enter your email in the text box below.

Reporting your email will not associate your identity with any of your prior survey answers.

This ensures you will maintain anonymity in your survey answers.   If you are selected as a giveaway winner, you will be contacted through email by research personnel.

____

Q43 If you are selected as a winner, which smartwatch do you have preference for.

- ○ Apple Watch (Series 8) (1)
- ○ SAMSUNG Galaxy Watch (5 Pro) (2)

End of Block: Giveaway

Appendix 3: *"Credibility Judgments in Higher Education"* Survey Material

Graduate Student Scientific Literacy, Science Communication, and Teaching Survey

Information Letter: You are invited to participate in a research study to provide insight into graduate student perceptions, appreciation, and understanding across complex sciences. The study is being conducted by Katie Corbitt, a graduate research assistant in the Department of Animal Sciences which is housed within the College of Agriculture, advised by faculty associate professor Dr. Don Mulvaney. You are invited to participate because you are a graduate student of at least 18 years of age at Auburn University.

What will be involved if you participate? Your participation is completely voluntary. If you decide to participate in this research study, you will be asked to complete an electronic survey on various demographic information, science literacy, science communication, and past, current, and future teaching. Your total time commitment will be approximately 30 minutes.

Are there any risks or discomforts? This is a completely voluntary, anonymous study which can be exited at any time. There are no anticipated risks or anticipated discomforts associated with taking this survey and the subject matter you as a participant will be questioned on should not cause any strong physical or emotional responses. At any time during the duration of the survey you may choose to stop completing the survey or may choose to skip any questions that you may find uncomfortable to answer.

Are there any costs? If you decide to participate, there are no costs to you other than the estimated 30 minutes required to complete the survey.

Will you receive compensation for participating? Compensation or reward is not guaranteed, but there are potential benefits as described in the paragraph below.

What are the potential benefits for taking this survey? If you choose to do so, a giveaway for $50 Amazon gift cards will be available for you to enter at the end of this survey. Entering the giveaway will require you to enter your email in order to be contacted if you are selected as a winner, however, your email will not be associated with any of the answers you provide during the survey. However, there is no guarantee that you will receive any of the benefits described. Your chance of winning a gift card is 1 out of 10, where 10% of completed surveys will receive a gift card. Also, at the end of the survey, information about a professional development workshop will be communicated. To receive more information, your email will need to be provided. Your email will not be associated with any of the answers you provide during the survey.

If you change your mind about participating, you can withdraw at any time by closing your window browser. Once you've submitted anonymous data, it cannot be withdrawn since it will be unidentifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University or the Department of Animal Sciences.

Any data obtained in connection with this study will remain anonymous. We will protect your privacy and the data you provide by maintaining all data on single password-protected computers accessible only by study approved personnel. Information collected through your participation may be used for presentations at academic conferences or for publication in academic journals.

If you have questions about this study, please contact Katie Corbitt, GRA in the Department of Animal Sciences advised by associate professor Dr. Don Mulvaney at kec0139@auburn.edu.

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Research Compliance or the Institutional Review Board by phone (334) 844-5966 or e-mail at IRBadmin@auburn.edu or IRBChair@auburn.edu.

Having read the information above, you must decide if you want to participate in this research project. If you decide to participate, please click on the arrow below. You may create a copy of this letter to keep.

End of Block: Information Letter

Start of Block: Demographic Information

Q3 We would like to know a little about you. Please answer the following demographic questions to the best of your ability.

Q4 Gender

- ○ Male (1)
- ○ Female (2)
- ○ Non-binary / third gender (3)
- ○ Prefer not to say (4)

Q5 Age

- ○ 18-19 (1)
- ○ 20-29 (2)
- ○ 30-39 (3)
- ○ 40-49 (4)
- ○ 50-59 (5)
- ○ 60+ (6)

Q6 Which best describes your ethnicity?

- ○ Caucasian / White (1)
- ○ Hispanic / Latino (2)
- ○ African American / Black (3)
- ○ Asian / Pacific Islander (4)
- ○ Native American / American Indian (5)
- ○ Mixed / Blend of one or more of the above (7)
- ○ Other (6) ____

Q8 What political party are you affiliated with if any at all?

- ◯ Democratic (1)
- ◯ Republican (2)
- ◯ Independent (3)
- ◯ Libertarian (6)
- ◯ Prefer not to say (4)
- ◯ Other (5) ____

Q9 Which best describes the area you grew up in? (Birth to 18 years)

- ◯ Urban (high population density proximate or part of a major city) (1)
- ◯ Suburban (medium population density within commuting distance of a major city but not by foot) (2)
- ◯ Rural (low population density with large commuting radius and a large number of agricultural land uses) (3)

Q11 Which of the following best describes your diet?

- ◯ Omnivorous (consume both animal-based and plant-based foods) (1)
- ◯ Flexitarian (consume only plant-based foods and occasionally animal-based foods) (2)
- ◯ Pescatarian (consume mostly plant-based foods and a select few animal-based foods like eggs, fish and/or dairy) (3)
- ◯ Vegetarian (consume mostly plant-based foods, and some animal-based foods like eggs and/or dairy) (4)
- ◯ Vegan (consume strictly plant-based foods) (5)
- ◯ Other (6) ____

Q12 Please specify your reasoning for your choice in dietary pattern. Select your top 5 reasons (left) and drag them (right) in order of corresponding level of importance.

#1 = Most important
#5 = Least important

Level of Importance
_______ Health or nutritional value (1)
_______ Animal welfare (2)
_______ Environmental impact / Sustainability (3)
_______ Upbringing / How you were raised (4)
_______ Dietary restrictions / Allergies (5)
_______ Religion (6)
_______ Price (7)
_______ Culture (8)
_______ Food production method (non-genetically modified, organic, all natural, etc.) (9)
_______ Partner or spouse has influence (10)
_______ Supporting agriculture (12)
_______ Shop locally grown to combat support of factory farming (13)
_______ Other (11)

Q92 Please specify your past undergraduate program of study. Major only.

____

Q13 What college are you associated with at Auburn?

- ○ Agriculture (1)
- ○ Architecture, Design, Construction (2)
- ○ Business (3)
- ○ Education (4)
- ○ Engineering (5)
- ○ Forestry and Wildlife (6)
- ○ Human Sciences (7)
- ○ Liberal Arts (8)
- ○ Nursing (9)
- ○ Pharmacy (10)
- ○ Sciences and Mathematics (11)
- ○ Veterinary Medicine (12)

Q14 Please specify your graduate program of study. Major only.

____

Q15 Which of the following degree programs best applies to you?

I am working toward a ...

- ◯ Graduate Certification (8)
- ◯ Master of Agriculture (1)
- ◯ Master of Arts (2)
- ◯ Master of Education (10)
- ◯ Master of Science (3)
- ◯ Doctor of Philosophy (4)
- ◯ Doctor of Medicine (5)
- ◯ Doctor of Nursing Practice (12)
- ◯ Doctor of Veterinary Medicine (6)
- ◯ Postdoc (7)
- ◯ Other (9) ____

Q93 Which best describes your role at Auburn University?

- ◯ Graduate Teaching Assistant (GTA) (1)
- ◯ Graduate Research Assistant (GRA) (2)
- ◯ Graduate Extension Assistant (GEA) (3)
- ◯ Graduate Assistant (GA) (4)

End of Block: Demographic Information

Start of Block: Science Literacy Questionnaire

Q81 What do you consider as credible sources of scientific information? (Check all that apply)

- ▢ Any publication (1)
- ▢ Peer-reviewed journals and articles (2)
- ▢ Open-access journals and articles (3)
- ▢ .gov / .edu websites (4)
- ▢ .org websites (5)
- ▢ .com websites (17)
- ▢ Blogs (18)
- ▢ Google (19)
- ▢ Wikipedia (20)
- ▢ Those who work in industry (6)
- ▢ Professionals in industry (7)
- ▢ Government agencies (8)
- ▢ Commodity organizations (9)
- ▢ Professors / higher educational instructors (10)
- ▢ Graduate students (11)
- ▢ Books (12)
- ▢ Social Media (13)
- ▢ Social Media Influencers (SMIs) (21)

☐ A friend (15)

☐ Your boss or other administrators (16)

☐ Other (14) ____

Q117 Please rank some of these sources (3-5 is plenty) regarding the level of credibility they hold.
Drag the source (left) to the box with the corresponding level of credibility that source holds (right).

Above average credibility / Most credible	Average credibility	Below average credibility, but still credible
______ Any publication (1)	______ Any publication (1)	______ Any publication (1)
______ Peer-reviewed journals and articles (2)	______ Peer-reviewed journals and articles (2)	______ Peer-reviewed journals and articles (2)
______ Open-access journals and articles (3)	______ Open-access journals and articles (3)	______ Open-access journals and articles (3)
______ .gov / .edu websites (4)	______ .gov / .edu websites (4)	______ .gov / .edu websites (4)
______ .org websites (5)	______ .org websites (5)	______ .org websites (5)
______ .com websites (17)	______ .com websites (17)	______ .com websites (17)
______ Blogs (18)	______ Blogs (18)	______ Blogs (18)
______ Google (19)	______ Google (19)	______ Google (19)
______ Wikipedia (20)	______ Wikipedia (20)	______ Wikipedia (20)
______ Those who work in industry (6)	______ Those who work in industry (6)	______ Those who work in industry (6)
______ Professionals in industry (7)	______ Professionals in industry (7)	______ Professionals in industry (7)
______ Government agencies (8)	______ Government agencies (8)	______ Government agencies (8)
______ Commodity organizations (9)	______ Commodity organizations (9)	______ Commodity organizations (9)

______ Professors / higher educational instructors (10)	______ Professors / higher educational instructors (10)	______ Professors / higher educational instructors (10)
______ Graduate students (11)	______ Graduate students (11)	______ Graduate students (11)
______ Books (12)	______ Books (12)	______ Books (12)
______ Social Media (13)	______ Social Media (13)	______ Social Media (13)
______ Social Media Influencers (SMIs) (21)	______ Social Media Influencers (SMIs) (21)	______ Social Media Influencers (SMIs) (21)
______ A friend (15)	______ A friend (15)	______ A friend (15)
______ Your boss or other administrators (16)	______ Your boss or other administrators (16)	______ Your boss or other administrators (16)
______ Other (14)	______ Other (14)	______ Other (14)

Q82 Do you think there is value or importance in incorporating science topics into the non-science classroom? (For example, in a basic writing course receiving a prompt to advocate for climate change policy.)

◯ Yes, always. (1)

◯ It is appropriate in some areas, but not in others. (2)

◯ No, there is no need to incorporate science into non-science curricula. (3)

Q83 If you would like to justify your answer to the previous question, please be encouraged to provide your response in the box below.

____

Q36 As a student, have you ever witnessed or sensed misinformation taught outside of your discipline?

	I never sensed misinformation. (1)	I sensed some misinformation, but it didn't bother me. (2)	I sensed some misinformation. (3)	I sensed misinformation in equal amounts to accurate information. (4)	I experienced more misinformation than the average student. (5)
Sensed Misinformation (1)	○	○	○	○	○

Q102 If you would like to justify your answer to the previous question regarding your sensed level of misinformation, please be encouraged to provide your response in the box below.

____

Q94 Similarly, have you ever witnessed or sensed bias of a **science related topic** presented by instructors?

	I never experienced or sensed bias. (1)	I sensed very little bias. (2)	I sensed some bias. (3)	I sensed a high degree of bias. (4)	I experience bias very often in a highly intentional manner. (5)
Level of Bias (1)	○	○	○	○	○

Q103 If you would like to justify your answer to the previous question regarding your sense of bias, please be encouraged to provide your response in the box below.

____

Q107 Similarly, have you ever been in a classroom setting that made you feel challenged because you had different perspectives on a **science** topic?

	I didn't have different opinions than the class majority or instructor. (1)	I never sensed a challenge, even with differing opinions. (2)	I sensed some challenge, but it didn't bother me. (3)	I was challenged more than expected with my differing perspective. (4)	I was always challenged because of my differing perspective. (5)
Sense of Challenge (1)	o	o	o	o	o

Q108 If you would like to justify your answer to the previous question regarding feeling challenged, please be encouraged to provide your response in the box below.

____

Q109 Have you ever been in a classroom or learning environment where either the attitudes or articulated views of classmates or the instructor was enough to intimidate you?

	I didn't have different opinions than the class majority or instructor. (1)	The challenge didn't intimidate me. (2)	I felt challenged and slightly intimidated. (3)	I was challenged and intimidated enough to not participate in the class. (4)	I was challenged and intimidated enough to want to drop the class. (5)	I was challenged and intimidated enough to conform to the majority opinion. (6)
Sense of Challenge (1)	o	o	o	o	o	o

Q110 If you would like to justify your answer to the previous question regarding being intimidated by an instructor or class, please be encouraged to provide your response in the box below.

____

Q105 Have you ever felt as though sharing or voicing your differing opinions in a classroom or learning environment could result in measurable consequences (grade suffering, judgment, etc.)?

	I didn't have different opinions than the class majority or instructor. (1)	Even with differing opinions, I did not feel at risk of consequences. (2)	I sensed some potential consequences. (3)	I felt at risk for consequences because of my differing opinions. (4)
Risk of Consequences (1)	○	○	○	○

Q112 If you would like to justify your answer to the previous question regarding potential consequences, please be encouraged to provide your response in the box below.

____

Q115 Have you ever conformed to an opposite opinion than your own because of potential consequences, intimidation, etc.?

	I didn't have different opinions than the class majority or instructor. (1)	I didn't feel like I needed to conform even with my differing opinions. (2)	I felt some pressure to conform because of my different opinions. (3)	I was heavily pressured to conform because of my differing opinons. (4)
Pressure to Conform (3)	○	○	○	○

Q113 If you would like to justify your answer to the previous question, please be encouraged to provide your response in the box below.

____

End of Block: Science Literacy Questionnaire

Start of Block: Science Communication Questionnaire - Use for workshop data

Q122 Do you believe there is value in communicating science to non-science audiences?

	No value (1)	Low value (2)	Some value (3)	Moderate value (4)	High value (5)
Level of perceived value to me (1)	o	o	o	o	o

Q123 How often do you communicate science to a non-science audience?

	Never (1)	Once every few months (2)	Once a month (4)	Once a week (5)	More than once a week (7)
Frequency of communicating science (1)	o	o	o	o	o

Q124 In what ways do you communicate science to non-science audiences?

- ▢ Formal talks (1)
- ▢ Everyday engagement (one-on-one interactions in daily life) (2)
- ▢ Interviews (3)
- ▢ Outreach events (4)
- ▢ Discussion panels (5)
- ▢ Public forums (6)
- ▢ Online (blog posts, social media interactions, etc.) (7)
- ▢ Writing articles for public use (8)
- ▢ Podcasting or broadcasting (9)
- ▢ Policy deliberation (10)
- ▢ University led consultation (Extension programs) (11)
- ▢ Other (12) ____
- ▢ I do not communicate science to non-science audiences. (13)

Q125 What non-science audiences do you communicate with?

- ▢ Science-interested public (1)
- ▢ Stakeholders of industry (4)
- ▢ Members of industry (12)
- ▢ Journalists (5)
- ▢ Policymakers (2)
- ▢ K-12 students (6)
- ▢ Potential funders (7)
- ▢ Community members (8)
- ▢ Resource managers (9)
- ▢ Business leaders (10)
- ▢ Other (3) ____
- ▢ I do not communicate science to non-science audiences. (11)

Q126 Which of the following methods have you participated in to help build your science communication skills?

- ▢ Attended conferences with a focus on communicating science (1)
- ▢ Taken classes about science communication (4)
- ▢ AU programs regarding science communication (2)
- ▢ Programs outside of AU regarding science communication (3)
- ▢ Webinars for science communication (5)
- ▢ Years of experience communicating science have built up my skillset (8)
- ▢ Other (6) ____
- ▢ I have not had any prior experience with these or other methods. (7)

Q127 How comfortable are you communicating complex science to a non-science audience?

	Uncomfortable (1)	Less comfortable (2)	Average comfort (3)	Moderately comfortable (4)	Very comfortable (5)
Level of comfort (1)	○	○	○	○	○

Q120 How valuable would a credentialing program which focuses on principles of communicating science be to you? (at Auburn University)

	No opinion (1)	Absolutely no value (9)	Low value (2)	Moderate value (10)	High value (4)
Level of perceived value to me (1)	○	○	○	○	○

Q128 Please describe what motivates or inspires you to communicate science to non-science audiences.

____

End of Block: Science Communication Questionnaire - Use for workshop data

Start of Block: Past Teaching Questionnaire

Q84 During your collegiate studies have you had instructors or professors address scientific topics in a non-science classroom? (For example, discussing artificial intelligence or other scientific topics in a public speaking course.)

○ Yes, in many non-science classrooms. (1)

○ Yes, sometimes in non-science classrooms. (2)

○ Yes, maybe once in a non-science classroom. (3)

○ No, I have not experienced this phenomenon previously. (4)

Display This Question:

If During your collegiate studies have you had instructors or professors address scientific topics i... = Yes, in many non-science classrooms.

Or During your collegiate studies have you had instructors or professors address scientific topics i... = Yes, sometimes in non-science classrooms.

Or During your collegiate studies have you had instructors or professors address scientific topics i... = Yes, maybe once in a non-science classroom.

Q85 Because you indicated yes to the previous question, did the instructor provide any credible sources with their scientific claims? (Credible sources include those chosen in the question, *What do you consider as credible sources of scientific information?*)

- ○ Yes, always. (1)
- ○ Yes, sometimes. (2)
- ○ No, never. (3)
- ○ I don't recall or remember if they did. (4)

Display This Question:

If During your collegiate studies have you had instructors or professors address scientific topics i... = Yes, in many non-science classrooms.

Or During your collegiate studies have you had instructors or professors address scientific topics i... = Yes, sometimes in non-science classrooms.

Or During your collegiate studies have you had instructors or professors address scientific topics i... = Yes, maybe once in a non-science classroom.

Q86 Please indicate the amount of trust you had in those scientific claims at that moment.

	Very Low (1)	Somewhat Low (2)	Neither Trust or Distrust (3)	Somewhat High (4)	Very High (5)
Level of trust (1)	○	○	○	○	○

Display This Question:

If During your collegiate studies have you had instructors or professors address scientific topics i... = Yes, in many non-science classrooms.

Or During your collegiate studies have you had instructors or professors address scientific topics i... = Yes, sometimes in non-science classrooms.

Or During your collegiate studies have you had instructors or professors address scientific topics i... = Yes, maybe once in a non-science classroom.

Q100 If you would like to justify your answer to the previous question regarding your perceived level of trust in their claims, please be encouraged to provide your response in the box below.

____

Display This Question:

If During your collegiate studies have you had instructors or professors address scientific topics i... = Yes, in many non-science classrooms.

Or During your collegiate studies have you had instructors or professors address scientific topics i... = Yes, sometimes in non-science classrooms.

Or During your collegiate studies have you had instructors or professors address scientific topics i... = Yes, maybe once in a non-science classroom.

Q87 Were you ever skeptical that the scientific information shared could be misinformation?

	Not Skeptical At All (1)	Low Skepticism (2)	Medium Skepticism (3)	High Skepticism (4)
Level of Skepticism for Misinformation (1)	○	○	○	○

Display This Question:

If During your collegiate studies have you had instructors or professors address scientific topics i... = Yes, in many non-science classrooms.

Or During your collegiate studies have you had instructors or professors address scientific topics i... = Yes, sometimes in non-science classrooms.

Or During your collegiate studies have you had instructors or professors address scientific topics i... = Yes, maybe once in a non-science classroom.

Q101 If you would like to justify your answer to the previous question regarding your level of skepticism, please be encouraged to provide your response in the box below.

____

End of Block: Past Teaching Questionnaire

Start of Block: Current Teaching Questionnaire - use for workshop

Q27 Which best describes your teaching experience?

- ◯ None (1)
- ◯ I will teach very soon (6)
- ◯ Teaching Assistant (2)
- ◯ Led my own course or on behalf of professor (3)
- ◯ Currently employed as an educator (4)
- ◯ Previously employed as an educator (5)

Page Break

Display This Question:

If Which best describes your teaching experience? = Teaching Assistant

Or Which best describes your teaching experience? = Led my own course or on behalf of professor

Or Which best describes your teaching experience? = Currently employed as an educator

Or Which best describes your teaching experience? = Previously employed as an educator

Q28 How long have you been teaching?

- ○ I have not taught previously. (1)
- ○ 1 semester / 1/2 year (2)
- ○ 2 semesters / 1 year (3)
- ○ 3 semesters / >1 year (4)
- ○ 4 or more semesters / 2 years or more (5)

Display This Question:

If Which best describes your teaching experience? = Teaching Assistant

Or Which best describes your teaching experience? = Led my own course or on behalf of professor

Or Which best describes your teaching experience? = Currently employed as an educator

Or Which best describes your teaching experience? = Previously employed as an educator

Q95 Which of the following help convey credibility in your teaching? (Check all that apply)

- ▢ I am an expert in the field. (1)
- ▢ I provide a peer-reviewed source. (2)
- ▢ I provide multiple peer-reviewed sources. (3)
- ▢ Cite or phone a colleague specialized in the area (4)
- ▢ Using content experts present on YouTube, TedTalks, etc. (7)
- ▢ Other (5) ____
- ▢ I do not feel the need to prove myself credible. (6)

Display This Question:

If Which best describes your teaching experience? = Teaching Assistant

Or Which best describes your teaching experience? = Led my own course or on behalf of professor

Or Which best describes your teaching experience? = Currently employed as an educator

Or Which best describes your teaching experience? = Previously employed as an educator

Q30 How comfortable are you with teaching science concepts to students in your discipline?

	Uncomfortable (1)	Less Comfortable (2)	Average Comfort (3)	Moderately Comfortable (4)	Very Comfortable (5)
Perceived Level of Comfort (1)	○	○	○	○	○

Display This Question:

If Which best describes your teaching experience? = Teaching Assistant

Or Which best describes your teaching experience? = Led my own course or on behalf of professor

Or Which best describes your teaching experience? = Currently employed as an educator

Or Which best describes your teaching experience? = Previously employed as an educator

Q29 Do you introduce scientific topics in your teaching sessions?

○ Yes (1)

○ No (2)

Page Break

Display This Question:

If Which best describes your teaching experience? = Teaching Assistant

Or Which best describes your teaching experience? = Led my own course or on behalf of professor

Or Which best describes your teaching experience? = Currently employed as an educator

Or Which best describes your teaching experience? = Previously employed as an educator

And Do you introduce scientific topics in your teaching sessions? = Yes

Q31 Please describe what motivates you to include science topics in courses you **currently** teach.

____

Display This Question:

If Which best describes your teaching experience? = Teaching Assistant

Or Which best describes your teaching experience? = Led my own course or on behalf of professor

Or Which best describes your teaching experience? = Currently employed as an educator

Or Which best describes your teaching experience? = Previously employed as an educator

And Do you introduce scientific topics in your teaching sessions? = Yes

Q119 Because you indicated yes to introducing scientific topics, how frequently is science addressed during your teaching sessions?

◯ Less than 10% / Hardly ever (1)

◯ 11-20% / Occasionally (2)

◯ 21-40% / Regularly but erratically (3)

◯ 41-50% / Consistently (4)

◯ 51% or higher / Highly intentional (5)

Display This Question:

If Which best describes your teaching experience? = Teaching Assistant

Or Which best describes your teaching experience? = Led my own course or on behalf of professor

Or Which best describes your teaching experience? = Currently employed as an educator

Or Which best describes your teaching experience? = Previously employed as an educator

And Do you introduce scientific topics in your teaching sessions? = Yes

Q32 Of the following popular science topics, social sciences, and areas of discussion, which are presented during your teaching sessions? (Check all that apply)

- ☐ Climate change (1)
- ☐ Animal related topics (welfare/rights/treatment) (2)
- ☐ Food production / Food scarcity (3)
- ☐ Solving world hunger (4)
- ☐ Population growth trends (5)
- ☐ Environment and/or sustainability (6)
- ☐ Sources of greenhouse gas emissions (human activity, burning fossil fuels, livestock, etc.) (19)
- ☐ Chemical usage (nuclear waste, pesticides, etc.) (7)
- ☐ Microbial lifecycles / Zoonotic disease (8)
- ☐ Antibiotics (9)
- ☐ Antibiotic resistance in humans (14)
- ☐ Antibiotic resistance in animals and livestock (15)
- ☐ Antibiotic resistance in the environment (17)

- [ ] Genetically modified organisms / Genetic engineering (10)
- [ ] Stem cell research (11)
- [ ] Immunizations / Vaccines (12)
- [ ] Nutritional values of meat (16)
- [ ] Nutritional values of plant-based proteins (18)
- [ ] Other (13) ____

Display This Question:

If Which best describes your teaching experience? = Teaching Assistant

Or Which best describes your teaching experience? = Led my own course or on behalf of professor

Or Which best describes your teaching experience? = Currently employed as an educator

Or Which best describes your teaching experience? = Previously employed as an educator

And Do you introduce scientific topics in your teaching sessions? = Yes

Q33 Do you usually fact check the scientific material you teach?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If Which best describes your teaching experience? = Teaching Assistant

Or Which best describes your teaching experience? = Led my own course or on behalf of professor

Or Which best describes your teaching experience? = Currently employed as an educator

Or Which best describes your teaching experience? = Previously employed as an educator

And Do you introduce scientific topics in your teaching sessions? = Yes

Q34 How do you verify or validate the scientific information that you teach? (Check all that apply)

- ☐ I read science articles / journals / textbooks. (1)
- ☐ I Google it. (2)
- ☐ I talk to professionals. (3)
- ☐ I phone a colleague in the specialized area. (4)
- ☐ I refer to social media posts. (7)
- ☐ Other (5) ____
- ☐ I do not need to validate my science content. (6)

Page Break

Display This Question:

If Which best describes your teaching experience? = Teaching Assistant

Or Which best describes your teaching experience? = Led my own course or on behalf of professor

Or Which best describes your teaching experience? = Currently employed as an educator

Or Which best describes your teaching experience? = Previously employed as an educator

Q35 Did you undergo any training preparing you to teach a classroom?

- ○ Yes (1)
- ○ No (4)

Page Break

Display This Question:

If Which best describes your teaching experience? = Teaching Assistant

Or Which best describes your teaching experience? = Led my own course or on behalf of professor

Or Which best describes your teaching experience? = Currently employed as an educator

Or Which best describes your teaching experience? = Previously employed as an educator

And Did you undergo any training preparing you to teach a classroom? = Yes

Q96 Which of the following training environments have you participated in? (Check all that apply)

- ☐ Workshops (at Auburn Univeristy) (1)
- ☐ Workshops (External to Auburn University) (12)
- ☐ College level courses about teaching (4)
- ☐ BIGGIO Center programs (11)
- ☐ Peer-teacher communities of practice / advice (7)
- ☐ Formal training (8)
- ☐ Personal learning networks (podcasts, Twitter, Wiki, social bookmarking sites, etc.) (9)
- ☐ Webinar (13)
- ☐ Other (10) ____

Display This Question:

If Which best describes your teaching experience? = Teaching Assistant

Or Which best describes your teaching experience? = Led my own course or on behalf of professor

Or Which best describes your teaching experience? = Currently employed as an educator

Or Which best describes your teaching experience? = Previously employed as an educator

And Did you undergo any training preparing you to teach a classroom? = Yes

Q97 Which of the following key areas were addressed during your formal training? (Check all that apply)

- ▢ Planning (goals, instructional design, etc.) (1)
- ▢ Classroom environments (establishing culture, behavior, limits, problem mitigation, etc.) (7)
- ▢ Pedagogy (feedback, techniques, learning styles, etc.) (8)
- ▢ Professional development (9)
- ▢ Technological Support (learning how to use programs/equipment to help teach) (4)
- ▢ Online learning management system tutorials (such as Canvas) (10)
- ▢ Other (11) ____

Display This Question:

If Which best describes your teaching experience? = Teaching Assistant

Or Which best describes your teaching experience? = Led my own course or on behalf of professor

Or Which best describes your teaching experience? = Currently employed as an educator

Or Which best describes your teaching experience? = Previously employed as an educator

Q121 Are you affiliated (membership) with any professional teaching societies or organizations?
For example, NACTA ...

____

End of Block: Current Teaching Questionnaire - use for workshop

---

Start of Block: Future Teaching Questionnaire - use for workshop

Q26 Does your preferred future job involve teaching?

◯ Yes (1)

◯ Possibly yes (2)

◯ No (3)

Display This Question:

If Does your preferred future job involve teaching? = Yes

Or Does your preferred future job involve teaching? = Possibly yes

Q89 Do you plan on introducing science topics in your classroom?

◯ Yes, I plan to teach a specific area of science so science topics will be introduced. (1)

◯ Yes, I plan to teach some science even in classrooms centered around non-science topics. (2)

◯ I might teach some science, but I'm sure yet. (3)

◯ No, I do not plan on teaching science topics at all. (4)

Display This Question:

If Does your preferred future job involve teaching? = Yes

Or Does your preferred future job involve teaching? = Possibly yes

Q114 If you would like to expand on the previous question about currently teaching science, please be encouraged to provide your response in the box below.

____

Display This Question:

If Does your preferred future job involve teaching? = Yes

Or Does your preferred future job involve teaching? = Possibly yes

Q88 If you plan on teaching or communicating science in the future, please specify by indicating the ratio of science (0-100) of both science and non-science you would plan on teaching.

	0 10 20 30 40 50 60 70 80 90 100
Science ()	

Display This Question:

If Does your preferred future job involve teaching? = Yes

Or Does your preferred future job involve teaching? = Possibly yes

Q90 Please describe what motivates you to include science topics in courses you **will** teach.

____

____

____

____

____

End of Block: Future Teaching Questionnaire - use for workshop

Start of Block: Reward and Invitation

Q72 If you would like to be entered into the giveaway for $50 Amazon gift cards, please enter your email in the text box below.

Reporting your email will not associate your identity with any of your prior survey answers. This ensures you will maintain anonymity in your survey answers.

If you are selected as a giveaway winner, you will be contacted through email by research personnel.

____

Q73 If you are interested in participating in a one-day credentialing professional development workshop addressing pedagogies for science communication, or a "Science Communication Master Class", please enter your email in the text box below.

Reporting your email will not associate your identity with any of your prior survey answers. This ensures you will maintain anonymity in your survey answers.

The workshop is anticipated to take place early Fall 2022 on Auburn's campus. Your interest in attending is acknowledged by submitting your email. Submission of your email will enter you in an applicant pool, through which you will be contacted by research personnel later on with additional information.

____

End of Block: Reward and Invitation

Appendix 4: ***"Multidisciplinary Workshop to Improve Science & Agricultural Literacy While Reducing Misinformation: A Case Study"*** **Survey Materials**

Appendix 4.1 – Pre-Workshop Survey

AgSTEM 360 **- Enhancing Science Communication in Higher Education Organizations - Pre-Workshop Documentation of Consent**

You are invited to participate in a research study to measure the effectiveness of a science communication workshop for future educators. This survey is the first of two electronic surveys you will take for the research study. The study is being conducted by Katie Corbitt, a graduate research assistant in the Department of Animal Sciences which is housed within the College of Agriculture, advised by faculty associate professor Dr. Don Mulvaney. You are invited to participate because you are a graduate student of at least 18 years of age at Auburn University, and you participated in the first study, **Graduate Student Scientific Literacy, Science Communication, and Teaching Survey**.

What will be involved if you participate? Your participation is completely voluntary. If you decide to participate in this research study, you will be asked to complete an electronic survey on various demographic information, perceptions, and knowledge. Your total time commitment will be approximately 15 minutes.

Are there any risks or discomforts? For this study participants will be in the same room as the PI, a faculty member, as well as other participants, so exposure to COVID-19 is possible. Participants and faculty are welcome to wear face coverings available. In addition, tables will be sanitized and hand sanitizer will be available for use. Precautions will be implemented using the COVID-19 2022 Precautions Matrix to determine appropriate precautions at the time of data collection(s) for a Category C study and will follow Auburn's COVID-19 Guidance protocol. Your identity is unlikely to be known, your identity should be protected. There are no anticipated discomforts associated with taking this survey and the subject matter you as a participant will be questioned on should not cause any strong physical or emotional responses. At any time during the duration of the survey you may choose to stop completing the survey or may choose to skip any questions that you may find uncomfortable to answer.

Are there any costs? If you decide to participate, there are no costs to you other than the estimated 15 minutes required to complete the survey.

Will you receive compensation for participating? Compensation or reward is not guaranteed, but there are potential benefits as described in the paragraph below.

What are the potential benefits for taking this survey? If you choose to do so, there are certification and credentialing at the end of this study. Offered through Auburn University's Credly Program, "AgSTEM 360 Workshop" is offered digitally (badge, certificate). We will provide food and drinks during the workshop hours, you will have the chance to network, and develop a community of science communicators with participation. This research study has a foundation of improving and developing you as a future instructor, therefore the content of the workshop is valuable to your professional experience.

If you change your mind about participating, you can withdraw at any time by closing your window browser. Once you've submitted anonymous data, it cannot be withdrawn since it will be unidentifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University or the Department of Animal Sciences.

Any data obtained in connection with this study will remain anonymous. We will protect your privacy and the data you provide by maintaining all data on single password-protected computers accessible only by study approved personnel. Information collected through your participation may be used for presentations at academic conferences or for publication in academic journals.

If you have questions about this study, please contact Katie Corbitt, GRA in the Department of Animal Sciences advised by associate professor Dr. Don Mulvaney at kec0139@auburn.edu.

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Research Compliance or the Institutional Review Board by phone (334) 844-5966 or e-mail at IRBadmin@auburn.edu or IRBChair@auburn.edu.

______________________________ ______________________________

Investigator's Signature Faculty Investigator's Signature
Date: 2/7/23 Date: 2/7/23

Having read the information above, you must decide if you want to participate in this research project. If you decide to participate, please click on the arrow below. You may create a copy of this letter to keep.

End of Block: Information Letter

Start of Block: KSAO

Q218 The first portion of the survey asks about your knowledge, skills, and abilities pertaining to science communication, worldviews, and sources of agricultural information/statistics.

Q213 Please rank your knowledge regarding the following items:

	None (1)	Low (2)	Average (5)	Above Average (3)	Exceptional (4)
Knowledge of science communication principles (1)	○	○	○	○	○
Knowledge of science communication resources (7)	○	○	○	○	○
Knowledge of world views (9)	○	○	○	○	○
Knowledge of agricultural literacy (15)	○	○	○	○	○
Knowledge of agricultural resources (16)	○	○	○	○	○
Knowledge of pedagogical approaches for communicating science (10)	○	○	○	○	○

Q214 Please rank your skills regarding the following items:

	None (1)	Weak (2)	Good (5)	Excellent (3)	Outstanding (4)
Skills to communicate science (1)	○	○	○	○	○
Skills in finding and navigating science communication resources (10)	○	○	○	○	○
Skills in controlling instincts or biases (15)	○	○	○	○	○
Skills in finding and navigating agricultural resources (13)	○	○	○	○	○
Skills to promote agricultural literacy (16)	○	○	○	○	○
Skills in pedagogical approaches to communicate science (14)	○	○	○	○	○

Q216 Please rank your abilities regarding the following items:

	None (1)	Low (2)	Average (5)	Above Average (3)	Exceptional (4)
Confidence in communicating science topics (7)	○	○	○	○	○
Ability to present science content (9)	○	○	○	○	○
Ability to locate and share science communication resources (13)	○	○	○	○	○
Ability to control instincts or biases (17)	○	○	○	○	○
Ability to locate and share agricultural resources (14)	○	○	○	○	○
Ability to promote agricultural literacy (18)	○	○	○	○	○
Ability to deliver pedagogical approaches (16)	○	○	○	○	○

End of Block: KSAO

Start of Block: Ag Intersection

Q220 The next portion of the survey gauges your perception of the relevance of agriculture to/within your discipline.

Q217 Please indicate your level of agreement or disagreement to the following items:

	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)
I believe agriculture is a relevant topic for everyone to understand. (1)	○	○	○	○	○
I believe that agriculture is relevant to my own discipline. (2)	○	○	○	○	○
I believe agriculture should be presented and taught within context of my discipline. (9)	○	○	○	○	○
I believe providing agricultural context within my discipline can provide/develop students with an additive dimension of understanding. (8)	○	○	○	○	○

End of Block: Ag Intersection

Start of Block: Perception and Knowledge Gauge: Agriculture

Q119 The next portion of the survey gauges your current understanding, perception, and appreciation of agriscience topics.

Q60 To the best of your ability, rank your level of agreement with each statement.

	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)
I believe animals used for food live in humane conditions. (1)	○	○	○	○	○
I believe antibiotics are used appropriately in livestock production. (3)	○	○	○	○	○
I believe non-animal food products (fruits, vegetables, nuts, etc.) are a better source of nutrition than animal products. (34)	○	○	○	○	○

I believe animal products do not contain excess hormones or toxins. (35)	○	○	○	○	○
I believe food labels are more confusing than informative (including all natural, organic, hormone-free, antibiotic-free, cage-free, etc.). (36)	○	○	○	○	○
I believe people should consume animal products. (37)	○	○	○	○	○
I believe the use of genetic technologies enhances grain production (drought-resistance, pest-resistance, etc.). (38)	○	○	○	○	○
I believe the use of genetic technologies improves animal food production (hypoallergenic eggs and milk, vaccine development, etc.). (39)	○	○	○	○	○

I believe that we will not have enough food to feed the growing population in the next 50 years. (40)	○	○	○	○	○
I believe farmers are environmental stewards and use land, water, and other resources respectfully. (41)	○	○	○	○	○

End of Block: Perception and Knowledge Gauge: Agriculture

Start of Block: Demographics

Q3 Lastly, we would like to know a little about you and your expectations of the workshop. Please answer the demographic questions to the best of your ability.

Q4 Gender

○ Male (1)

○ Female (2)

○ Non-binary / third gender (3)

○ Prefer not to say (4)

Q5 Please specify your age in years.

____

Q6 Which of the following best describes your ethnicity?

- ○ Caucasian / White (1)
- ○ Hispanic / Latino (2)
- ○ African American / Black (3)
- ○ Asian / Pacific Islander (4)
- ○ Native American / American Indian (5)
- ○ Mixed / Blend of one or more of the above (7)
- ○ Other (6) ____

Q7 Highest level of education completed

- Some high school / No diploma (1)
- High school diploma / GED / Equivalent (2)
- Some college / No degree (3)
- Technical college (10)
- Associate's degree (4)
- Professional degree (5)
- Bachelor's degree (6)
- Master's degree (7)
- Doctorate (PhD / MD / DVM) (8)
- Higher than doctorate education completed (9)

Q11 Which of the following best describes your diet?

- Omnivorous (consume both animal-based and plant-based foods) (1)
- Flexitarian (consume only plant-based foods and occasionally animal-based foods) (2)
- Pescatarian (consume mostly plant-based foods and a select few animal-based foods like eggs, fish and/or dairy) (3)
- Vegetarian (consume mostly plant-based foods, and some animal-based foods like eggs and/or dairy) (4)
- Vegan (consume strictly plant-based foods) (5)
- Other (6) ____

Q9 What is your hometown zip code (if you live within the United States)?

____

Q224 Which best describes the area you grew up in? (Birth to 18 years)

○ Urban (high population density proximate or part of a major city) (1)

○ Suburban (medium population density within commuting distance of a major city but not by foot) (2)

○ Rural (low population density with large commuting radius and a large number of agricultural land uses) (3)

Q92 Select which of the following describe your connection to agriculture. (Select all that apply)

▢ I have no relation to agriculture other than buying and consuming food at the grocery store. (1)

▢ I personally raise crops and/or animals for protein sources. (3)

▢ My family raises crops and/or animals for protein sources. (2)

▢ I know my grandparents or earlier generations farmed. (10)

▢ I was exposed to agriculture in K-12 classrooms at least once. (4)

▢ I was exposed to agriculture in college classrooms at least once. (5)

▢ I work in an agricultural-related field. (9)

Q94 Where do you get your information about agriculture?

- ☐ I read / learn about agriculture across social media. (6)
- ☐ I read / learn about agriculture in the news. (7)
- ☐ I actively seek out articles regarding agriculture. (8)
- ☐ I actively seek out information about agriculture through "googling." (4)
- ☐ I read food labels. (9)
- ☐ I ask my parents / guardians / family. (5)
- ☐ I hear about it in classroom settings. (10)
- ☐ I ask farmers or other people who work in the industry. (2)
- ☐ I read signs / billboards / other public landmarks. (11)
- ☐ Other (12) ____

Q126 Using the table provided below and your current knowledge of food production, please indicate your level of trust for the following areas of **production animal agriculture**.

	I definitely do not trust farmers' actions in this area. (1)	I somewhat do not trust farmers' actions in this area. (4)	I have no opinion of trust of farmers' actions in this area. (2)	I somewhat trust farmers' actions in this area. (5)	I highly trust farmers' actions in this area. (3)
Animal Wellness & Welfare (1)	○	○	○	○	○
Environmental Stewardship of Animal Agriculture (2)	○	○	○	○	○
Use of Animals for Food (3)	○	○	○	○	○

Q225 What are your expectations of this workshop?

____

____

Q219 Finally, please create your own alias code to use in subsequent surveys. The structure for your alias code should be:

The first 3 letters of your mother's maiden name and the first 3 numbers of your Auburn mailing address.
Example: Mother's maiden name is Adams; Auburn mailing address is 1234 Applewood Lane
Alias code would be: ada123

The creation of an alias for surveys preserves anonymity and in a longitudinal study it removes repetitive questions (i.e. demographics) to reduce survey fatigue.

Please remember your alias code because it is crucial for the researchers to conduct statistical analyses after the study has closed.

____

____

End of Block: Demographics

Start of Block: Food Allergies

Q223 A lunch is offered during the workshop, do you have any specific food allergies we should be aware of? Your answer will not identify you specifically.

____

End of Block: Food Allergies

Appendix 4.2 – Post-Workshop Survey

Post-Workshop Survey for *AgSTEM 360* - Information Letter

You are invited to participate in a research study to measure the effectiveness of a science communication workshop for future educators. This survey is the first of two electronic surveys you will take for the research study. The study is being conducted by Katie Corbitt, a graduate research assistant in the Department of Animal Sciences which is housed within the College of Agriculture, advised by faculty associate professor Dr. Don Mulvaney. You are invited to participate because you are a graduate student of at least 18 years of age at Auburn University, and you participated in the first study, **Graduate Student Scientific Literacy, Science Communication, and Teaching Survey** and you completed the pre-workshop survey.

What will be involved if you participate? Your participation is completely voluntary. If you decide to participate in this research study, you will be asked to complete an electronic survey on various demographic information, perceptions, and knowledge. Your total time commitment will be approximately 15 minutes.

Are there any risks or discomforts? This survey is a completely voluntary, anonymous study which can be exited at any time. There are no anticipated risks or anticipated discomforts associated with taking this survey and the subject matter you as a participant will be questioned on should not cause any strong physical or emotional responses. At any time during the duration of the survey you may choose to stop completing the survey or may choose to skip any questions that you may find uncomfortable to answer.

Are there any costs? If you decide to participate, there are no costs to you other than the estimated 15 minutes required to complete the survey.

Will you receive compensation for participating? Compensation or reward is not guaranteed, but there are potential benefits as described in the paragraph below.

What are the potential benefits for taking this survey? If you choose to do so, there are certification and credentialing at the end of this study. Offered through Auburn University's Credly Program, "AgSTEM Workshop" is offered digitally (badge, certificate). Receiving certifications will require you to enter your email and name in order to be contacted, however, your name and email will not be associated with any of the answers you provide during the survey.

If you change your mind about participating, you can withdraw at any time by closing your window browser. Once you've submitted anonymous data, it cannot be withdrawn since it will be unidentifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University or the Department of Animal Sciences.

Any data obtained in connection with this study will remain anonymous. We will protect your privacy and the data you provide by maintaining all data on single password-protected computers accessible only by study approved personnel. Information collected through your participation may be used for presentations at academic conferences or for publication in academic journals.

If you have questions about this study, please contact Katie Corbitt, GRA in the Department of Animal Sciences advised by associate professor Dr. Don Mulvaney at kec0139@auburn.edu.

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Research Compliance or the Institutional Review Board by phone (334) 844-5966 or e-mail at IRBadmin@auburn.edu or IRBChair@auburn.edu.

____________________________ ____________________________

Investigator's Signature Faculty Investigator's Signature
Date: Date:

Having read the information above, you must decide if you want to participate in this research project. If you decide to participate, please click on the arrow below. You may create a copy of this letter to keep.

Page Break

Q219 Please provide your alias code you created in the pre-survey. The structure for your alias code should be:

The first 3 letters of your mothers's maiden name and the first 3 numbers of your Auburn mailing address.
Example: Mother's name is Adams; Auburn mailing address is 1234 Applewood Lane
Alias code would be: ada123

The creation of an alias for surveys preserves anonymity and in a longitudinal study it removes repetitive questions (i.e. demographics) to reduce survey fatigue. Please remember your alias code because it is crucial for the researchers to conduct statistical analyses after the study has closed.

____

End of Block: Information Letter

Start of Block: KSAO

Q218 The first portion of the survey asks about your knowledge, skills, and abilities pertaining to science communication, worldviews, and sources of agricultural information/statistics AFTER the workshop.

Q213 Please rank your knowledge regarding the following items:

	None (1)	Low (2)	Average (5)	Above Average (3)	Exceptional (4)
Knowledge of science communication principles (1)	o	o	o	o	o
Knowledge of science communication resources (7)	o	o	o	o	o
Knowledge of world views (9)	o	o	o	o	o
Knowledge of agricultural literacy (17)	o	o	o	o	o
Knowledge of agricultural resources (16)	o	o	o	o	o
Knowledge of pedagogical approaches for communicating science (10)	o	o	o	o	o

Q214 Please rank your skills regarding the following items:

	None (1)	Weak (2)	Good (5)	Excellent (3)	Outstanding (4)
Skills to communicate science (1)	○	○	○	○	○
Skills in finding and navigating science communication resources (10)	○	○	○	○	○
Skills in controlling instincts or biases (15)	○	○	○	○	○
Skills in finding and navigating agricultural resources (13)	○	○	○	○	○
Skills to promote agricultural literacy (16)	○	○	○	○	○
Skills in pedagogical approaches to communicate science (14)	○	○	○	○	○

Q216 Please rank your abilities regarding the following items:

	None (1)	Low (2)	Average (5)	Above Average (3)	Exceptional (4)
Confidence in communicating science topics (7)	○	○	○	○	○
Ability to present science content (9)	○	○	○	○	○
Ability to locate and share science communication resources (13)	○	○	○	○	○
Ability to control instincts or biases (17)	○	○	○	○	○
Ability to locate and share agricultural resources (14)	○	○	○	○	○
Ability to promote agricultural literacy (18)	○	○	○	○	○
Ability to deliver pedagogical approaches (16)	○	○	○	○	○

End of Block: KSAO

Start of Block: Ag Intersection

Q220 The next portion of the survey gauges your perception of the relevance of agriculture to/within your discipline AFTER the workshop.

Q217 Please indicate your level of agreement or disagreement to the following items:

	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)
I believe agriculture is a relevant topic for everyone to understand. (1)	○	○	○	○	○
I believe that agriculture is relevant to my own discipline. (2)	○	○	○	○	○
I believe agriculture should be presented and taught within context of my discipline. (9)	○	○	○	○	○
I believe providing agricultural context within my discipline can provide/develop students with an additive dimension of understanding. (8)	○	○	○	○	○

End of Block: Ag Intersection

Start of Block: Perception and Knowledge Gauge: Agriculture

Q119 The next portion of the survey gauges your current understanding, perception, and appreciation of agriscience topics AFTER the workshop.

Q60 To the best of your ability, rank your level of agreement with each statement.

	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)
I believe animals used for food live in humane conditions. (1)	○	○	○	○	○
I believe antibiotics are used appropriately in livestock production. (3)	○	○	○	○	○
I believe non-animal food products (fruits, vegetables, nuts, etc.) are a better source of nutrition than animal products. (34)	○	○	○	○	○
I believe animal products do not contain excess hormones or toxins. (35)	○	○	○	○	○
I believe food labels are more confusing than informative (including all natural, organic, hormone-free, antibiotic-free, cage-free, etc.). (36)	○	○	○	○	○

I believe people should consume animal products. (37)	○	○	○	○	○
I believe the use of genetic technologies enhances grain production (drought-resistance, pest-resistance, etc.). (38)	○	○	○	○	○
I believe the use of genetic technologies improves animal food production (hypoallergenic eggs and milk, vaccine development, etc.). (39)	○	○	○	○	○
I believe that we will not have enough food to feed the growing population in the next 50 years. (40)	○	○	○	○	○
I believe farmers are environmental stewards and use land, water, and other resources respectfully. (41)	○	○	○	○	○

End of Block: Perception and Knowledge Gauge: Agriculture

Start of Block: Demographics

Q3 Lastly, we would like to know a little about you for credentialing purposes and your experience attending the workshop. Please answer the questions to the best of your ability.

Q126 Using the table provided below and your current knowledge of food production, please indicate your level of trust for the following areas of **production animal agriculture**.

	I definitely do not trust farmers' actions in this area. (1)	I have no opinion of trust of farmers' actions in this area. (2)	I highly trust farmers' actions in this area. (3)	I somewhat do not trust farmers' actions in this area. (4)	I somewhat trust farmers' actions in this area. (5)
Animal Wellness & Welfare (1)	○	○	○	○	○
Environmental Stewardship of Animal Agriculture (2)	○	○	○	○	○
Use of Animals for Food (3)	○	○	○	○	○

Page Break

Q151 Satisfaction & Overall Evaluation

Q149 Use the table below to indicate your satisfaction with the elements of the workshop.

How satisfied are you with ....

	Completely unsatisfied (1)	(2)	Did not impact me (3)	(4)	Exceeds Satisfaction (5)
The relevance of the information to your needs (1)	○	○	○	○	○
Presentation quality of the instructor(s) (2)	○	○	○	○	○
Subject matter knowledge of the instructor(s) (3)	○	○	○	○	○
Training facility (4)	○	○	○	○	○
The overall quality of the training workshop (5)	○	○	○	○	○

Q177 Did the workshop meet your expectations?

	Fell below my expectations (1)	Did not meet my expectations (2)	Neutral (3)	Met my expectations (4)	Exceeded my expectations (5)
Expectation (1)	○	○	○	○	○

Q178 What would you recommend to improve the workshop next time?

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____

Q179 What did you like most about this workshop experience?

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Q180 What did you like least about this workshop experience?

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Q181 Did the credentialing aspect motivate you to participate in the workshop?

○ Yes (7)

○ No (8)

Q231 Thank you for completing the post-workshop survey!

Clicking the orange arrow will redirect you to another survey. This survey will ask for your name and email for certification documents, but will not correlate with any of your previous answers throughout this study.

If you wish to proceed, please click the arrow at the bottom of the screen. If you do not wish to provide your name and email, and not receive certification documents you can close the window you are redirected to.

End of Block: Demographics

Appendix 4.3 – Badge and Certificate Distribution Survey:

Thank you for attending the AgSTEM 360 Workshop!

This Qualtrics survey asks for your preferred name and email address to receive your digital badge and certificate.

If you would like to receive the "AgSTEM 360 Professional Development" certification materials, please press the orange arrow below to continue with the survey. If you wish to not receive certification documentation, please close this window.

Page Break

Q1 Please provide the name you wish to appear on the your certificate. Your answer will not correspond to any of the answers you provided in this study.

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Q3 Please provide the email you wish to deliver on the your digital badge to. Your answer will not correspond to any of the answers you provided in this study.

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End of Block: Certificate Info

Appendix 4.4 – Post-Post-Workshop Survey

Post-Post-Workshop Survey for *AgSTEM 360* - Information Letter

You are invited to participate in a research study to measure the effectiveness of a science communication workshop for future educators. This survey is the first of two electronic surveys you will take for the research study. The study is being conducted by Katie Corbitt, a graduate research assistant in the Department of Animal Sciences which is housed within the College of Agriculture, advised by faculty associate professor Dr. Don Mulvaney. You are invited to participate because you are a graduate student of at least 18 years of age at Auburn University, and you participated in the workshop, **AgSTEM 360: Enhancing Science Communication in Higher Education Organizations**.

What will be involved if you participate? Your participation is completely voluntary. If you decide to participate in this research study, you will be asked to complete an electronic survey on various demographic information, perceptions, and knowledge. Your total time commitment will be approximately 15 minutes.

Are there any risks or discomforts? This survey is a completely voluntary, anonymous study which can be exited at any time. There are no anticipated risks or anticipated discomforts associated with taking this survey and the subject matter you as a participant will be questioned on should not cause any strong physical or emotional responses. At any time during the duration of the survey you may choose to stop completing the survey or may choose to skip any questions that you may find uncomfortable to answer.

Are there any costs? If you decide to participate, there are no costs to you other than the estimated 15 minutes required to complete the survey.

Will you receive compensation for participating? Compensation or reward is not guaranteed, but your responses are greatly appreciated considering the quality of the workshop presented.

If you change your mind about participating, you can withdraw at any time by closing your window browser. Once you've submitted anonymous data, it cannot be withdrawn since it will be unidentifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University or the Department of Animal Sciences.

Any data obtained in connection with this study will remain anonymous. We will protect your privacy and the data you provide by maintaining all data on single password-protected computers accessible only by study approved personnel. Information collected through your participation may be used for presentations at academic conferences or for publication in academic journals.

If you have questions about this study, please contact Katie Corbitt, GRA in the Department of Animal Sciences advised by associate professor Dr. Don Mulvaney at kec0139@auburn.edu.

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Research Compliance or the Institutional Review Board by phone (334) 844-5966 or e-mail at IRBadmin@auburn.edu or IRBChair@auburn.edu.

______________________________ ______________________________

Investigator's Signature
Date: 4-14-23

Faculty Investigator's Signature
Date: 4-14-23

Having read the information above, you must decide if you want to participate in this research project. If you decide to participate, please click on the arrow below. You may create a copy of this letter to keep.

Page Break

Q219 Please provide your alias code you created in the pre-survey. The structure for your alias code should be:

The first 3 letters of your mother's maiden name and the first 3 numbers of your Auburn mailing address.
Example: Mother's name is Adams; Auburn mailing address is 1234 Applewood Lane
Alias code would be: ada123

The creation of an alias for surveys preserves anonymity and in a longitudinal study it removes repetitive questions (i.e. demographics) to reduce survey fatigue. Please remember your alias code because it is crucial for the researchers to conduct statistical analyses after the study has closed.

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End of Block: Information Letter

Start of Block: KSAO

Q218 The first portion of the survey asks about your knowledge, skills, and abilities pertaining to science communication, worldviews, and sources of agricultural information/statistics AFTER the workshop.

Q213 Please rank your knowledge regarding the following items:

	None (1)	Low (2)	Average (5)	Above Average (3)	Exceptional (4)
Knowledge of science communication principles (1)	○	○	○	○	○
Knowledge of science communication resources (7)	○	○	○	○	○
Knowledge of world views (9)	○	○	○	○	○
Knowledge of agricultural literacy (16)	○	○	○	○	○
Knowledge of agricultural resources (15)	○	○	○	○	○
Knowledge of pedagogical approaches for communicating science (10)	○	○	○	○	○

Q214 Please rank your skills regarding the following items:

	None (1)	Weak (2)	Good (5)	Excellent (3)	Outstanding (4)
Skills to communicate science (1)	○	○	○	○	○
Skills in finding and navigating science communication resources (10)	○	○	○	○	○
Skills in controlling instincts or biases (15)	○	○	○	○	○
Skills in finding and navigating agricultural resources (13)	○	○	○	○	○
Skills to promote agricultural literacy (16)	○	○	○	○	○
Skills in pedagogical approaches to communicate science (14)	○	○	○	○	○

Q216 Please rank your abilities regarding the following items:

	None (1)	Low (2)	Average (5)	Above Average (3)	Exceptional (4)
Confidence in communicating science topics (7)	○	○	○	○	○
Ability to present science content (9)	○	○	○	○	○
Ability to locate and share science communication resources (13)	○	○	○	○	○
Ability to control instincts or biases (17)	○	○	○	○	○
Ability to locate and share agricultural resources (14)	○	○	○	○	○
Ability to promote agricultural literacy (18)	○	○	○	○	○
Ability to deliver pedagogical approaches (16)	○	○	○	○	○

End of Block: KSAO

Start of Block: Ag Intersection

Q220 The next portion of the survey gauges your perception of the relevance of agriculture to/within your discipline AFTER the workshop.

Q217 Please indicate your level of agreement or disagreement to the following items:

	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)
I believe agriculture is a relevant topic for everyone to understand. (1)	○	○	○	○	○
I believe that agriculture is relevant to my own discipline. (2)	○	○	○	○	○
I believe agriculture should be presented and taught within context of my discipline. (9)	○	○	○	○	○
I believe providing agricultural context within my discipline can provide/develop students with an additive dimension of understanding. (8)	○	○	○	○	○

End of Block: Ag Intersection

Start of Block: Perception and Knowledge Gauge: Agriculture

Q119 The next portion of the survey gauges your current understanding, perception, and appreciation of agriscience topics AFTER the workshop.

Q60 To the best of your ability, rank your level of agreement with each statement.

	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)
I believe animals used for food live in humane conditions. (1)	○	○	○	○	○
I believe antibiotics are used appropriately in livestock production. (3)	○	○	○	○	○
I believe non-animal food products (fruits, vegetables, nuts, etc.) are a better source of nutrition than animal products. (34)	○	○	○	○	○
I believe animal products do not contain excess hormones or toxins. (35)	○	○	○	○	○
I believe food labels are more confusing than informative (including all natural, organic, hormone-free, antibiotic-free, cage-free, etc.). (36)	○	○	○	○	○

I believe people should consume animal products. (37)					
I believe the use of genetic technologies enhances grain production (drought-resistance, pest-resistance, etc.). (38)					
I believe the use of genetic technologies improves animal food production (hypoallergenic eggs and milk, vaccine development, etc.). (39)					
I believe that we will not have enough food to feed the growing population in the next 50 years. (40)					
I believe farmers are environmental stewards and use land, water, and other resources respectfully. (41)					

End of Block: Perception and Knowledge Gauge: Agriculture

Start of Block: Demographics

Q3 Lastly, we would like to know a little about you. Please answer the questions to the best of your ability.

Q126 Using the table provided below and your current knowledge of food production, please indicate your level of trust for the following areas of **production animal agriculture**.

	I definitely do not trust farmers' actions in this area. (1)	I have no opinion of trust of farmers' actions in this area. (2)	I highly trust farmers' actions in this area. (3)	I somewhat do not trust farmers' actions in this area. (4)	I somewhat trust farmers' actions in this area. (5)
Animal Wellness & Welfare (1)	○	○	○	○	○
Environmental Stewardship of Animal Agriculture (2)	○	○	○	○	○
Use of Animals for Food (3)	○	○	○	○	○

Q222 Have you used principles of science communication or ag literacy since attending the workshop? Or plan to?

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End of Block: Demographics