# AN ASSESSMENT OF HEALTH EDUCATORS' LIKELIHOOD OF ADOPTING GENETICALLY MODIFIED FOOD COMPETENCIES FOR HEALTH PROMOTION

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

IN THE GRADUATE SCHOOL OF THE

TEXAS WOMAN'S UNIVERSITY

DEPARTMENT OF HEALTH STUDIES

BY

RENEE O'DONNELL, MS

DENTON, TX

MAY 2017

ACKNOWLEDGEMENTS

I would first like to thank my family for being there for me throughout this grueling process and for believing in me. My sister, Terra, is a great example of perseverance and she was always around for physical, emotional, and sometimes financial, support. My parents are also to thank as they instilled in me a work ethic that they would often remind me of when I would need it most; my partner in life, Michael, for being an amazing support system and my biggest fan. My rent-a-family is also to thank, they really have been second parents and siblings to me and lend support constantly. And my soon-to-be family, for even though I met them later in my dissertation process, they've supported me more than I could have hoped for.

I would also like to thank my committee chair, Dr. Golman, for agreeing to help me with this difficult subject matter. My committee is the reason my dissertation is complete, whose edits I could not have done well without. And lastly, I want to thank the researchers who allowed me to adopt their surveys and modify them to fit the needs of my study. It is a tremendous success for everyone when researchers share their work, and I am grateful.

ABSTRACT

AN ASSESSMENT OF HEALTH EDUCATORS' LIKELIHOOD OF ADOPTING GENETICALLY MODIFIED FOOD COMPETENCIES FOR HEALTH PROMOTION

RENEE O'DONNELL

MAY 2017

Genetically modified (GM) food utilizes biotechnology to increase crop yield, decrease pesticide use, modify nutritional content, and other desirable effects to systematically influence how food is produced. The acceptance of GM food technology has been met with opposition as communities campaign for GM food labeling and/or promote the possibility of detrimental effects from foods that are GM. To date, there are no GM Food Competencies that have been standardized across all public health organizations. The purpose of this study was to assess health educators' knowledge and attitude toward GM food, where they received information regarding GM food, and if they participated in GM food education at present. A quantitative data collection was employed in which 98 health educators completed an online survey questionnaire. Descriptive statistics were used to answer the research questions. Pearson correlations were conducted to address the null hypotheses. An analysis of variance was computed to help support investigations. Structural equation models (SEMs) were created to help explain the mediation relationship media and perceived barriers had on other test variables, like self-efficacy in performing GM food education tasks. Findings of this

study indicated that the majority of health educators had no previous experience in GM food education and their knowledge was low regarding what GM food is; however, their perceived barriers in addressing GM food as health educators' responsibility were similar. The results of this study supported the need for establishing GM food competencies across health organizations and disciplines in order to help ensure consumers receive unbiased, scientific information, in order to properly discern whether GM food provides benefits and/or harm to the consumer.

TABLE OF CONTENTS

LIST OF TABLES

Tables Page

LIST OF FIGURES

Figures Page

# CHAPTER I

# INTRODUCTION

A new public health topic is the use of biotechnology, a technology utilizing genetic enhancement to increase animal and plant yields or efficiency, vaccine development, and other technological advancements that are not available organically. Specifically, genetically modified (GM) food is a type of biotechnology that is applied in both plant and animals to increase crop yields, increase nutritional value, decrease growth time, and introduce new characteristics to name a few. The research and support for GM food is controversial and limited, with studies showing a lack of knowledge among the general population (Han and Harrison, 2007). Pew Research Center (2016) found US adults had limited trust in scientists and their knowledge and position on GM foods, with 39 % of Americans believing GM foods are worse for their health. With the divide of the U.S. public and scientific community, a trusted mediator role needs to bring the two communities together; in this case, a health educator would be a perfect advocate for each of the communities.

The World Health Organization (WHO) defines public health as "the science and art of preventing disease, prolonging life and promoting health through the organized efforts and informed choices of society, organizations, public and private, communities and individuals" (WHO, 2011, p. 2). Public health education prepares students to be

effective public health professionals and is comprised by the following core areas of public health knowledge: biostatistics, epidemiology, environmental health sciences, health services administration, and social and behavioral sciences (Council on Education for Public Health [CEPH], 2015).

A public health professional is someone who communicates public health information to nonscientific audiences, such as the general population or mass media (American Public Health Association [APHA], 2014). Public health professionals are advocates for health, recommending the most appropriate course of action based on available scientific knowledge and scientific uncertainty regarding a health topic, weighing the risk to benefit ratio (Regidor et al., 2007). A health educator should be knowledgeable about controversial health topics and GM food is a major controversial health topic (Pew Research Center, 2016). GM food is everywhere and although many consumers are aware of the technology, many are not able to correctly identify GM technology. A health educator needs to have working knowledge of GM food applications and the known risks and benefits associated with the technology in order to properly educate the lay consumer.

## Purpose of the Study

The purpose of this study was to address the knowledge and attitudes of practicing health educators in the US toward GM food, the influence of media exposure, and the confidence level that they would adopt GM food competencies and promote GM food education. Specifically, this study examined four questions: 1) What are practicing

health educators' knowledge of GM food? 2) What are practicing health educators' attitude towards GM food? 3) Where are practicing health educators currently receiving their information, if any, regarding GM food? And 4) What is health educators' confidence level of performing GM food education tasks?

These four questions were examined and answered by utilizing subsets of three existing surveys. The first study measured knowledge and attitude of GM food of teachers and students and was modified to assess practicing health educators. The second study measured dependency on media for information about food safety incidents related to the beef industry and was modified to measure GM food. The third study measured the likelihood of health educators to adopt GM food competencies and was modified to measure confidence level to develop a plan for GM food education. Competencies are "a cluster of related knowledge, skills, and attitudes that affect a major part of one's job (a role or responsibility), that correlates with performance on the job, that can be measured against some accepted standards, and that can be improved via training and development" and are a major foundation in public health (Parry, S., 1996, p. 50).

Practicing health educators are being addressed for this study because previous research shows a lack of GM food knowledge among U.S. consumers, health professionals, and teachers. By assessing the current knowledge of practicing health educators regarding GM food and where they receive their information a plan of action can be introduced for GM food competency adoption and promotion.

## Theoretical Foundation

Media Dependency Theory identifies "specific kinds of cognitive, affective, and behavioral changes in people that are regularly brought about by the mass media because of individual and societal dependence on their information resources" (Ball-Rokeach & DeFleur, 1976, p. 9). Media is an important variable because health issues are addressed in the media and "mass media are often cited as important sources of health information by individuals" (Morton & Duck, 2001, p. 602). In this study, Media Dependency Theory is used to examine where health educators get their information regarding GM food and the effect it has on their knowledge, perceived compatibility towards GM food, perceived barriers in adoption of GM food competencies, and self-efficacy in performing GM food education tasks.

## Research Questions and Hypotheses

- What is practicing health educators' knowledge of GM food?
- What is the perceived compatibility of GM food and health educators' beliefs/values?
- Where are health educators receiving information on GM food?
- Is media a mediator for knowledge and confidence level toward GM food education tasks (self-efficacy) among health educators?
- What are health educators' confidence levels for performing GM food education tasks?

The following null hypotheses were tested at the .05% significance level:

- There is no correlation between compatibility toward GM food and perceived barriers in adopting GM food competencies
- There is no correlation between knowledge of GM food and media exposure
- Exposure to media is not a mediator for GM knowledge and confidence level towards GM food education tasks

## Delimitations

The delimitations for this study were as follows:

- The target population is a purposive convenience sample of health educators from the SOPHE database and HEDIR database.
- The health educators must be in the field working as a health educator or be teaching courses within the concentration of health education, health promotion, health or behavioral sciences.

## Limitations

The limitations for this study were as follows:

- The PsychData data collection, survey through e-mail, presents some limitations.
- Any survey is limited by characteristics of the respondents that may be beyond the control of the researcher: motivation to complete the survey, knowledge of the content area, and honesty in reporting.

- Another limitation is the validity and reliability of the survey from the modification of existing instruments.
- The generalizability of this study's results are limited by the number of respondents.

## Assumptions

The assumptions for this study are as follows:

- Indicators of the concept of GM knowledge and compatibility are measureable.
- Indicators of media dependency are measureable.
- Compatibility, knowledge, awareness, and media influence are interrelated.

## Definition of Terms

Below are the definitions of terms utilized in this study:

Health Educator- A health educator teaches people about healthy behaviors, promotes wellness, collects data and discusses health concerns, and assess the needs of the community (U.S. Department of Labor and Bureau of Labor Statistics [BLS], 2014).

Health Education- "Any combination of learning experiences designed to help individuals and communities improve their health, by increasing their knowledge or influencing their attitudes" (WHO, 2015, para. 1).

Certified Health Education Specialist- A process by which the National Commission for Health Education Credentialing, Inc. (NCHEC) grants recognition to an

individual who has met predetermined qualifications specified by the association (NCHEC, 2015b).

Allerginicity- "is the potential of a substance (e.g., food or food components such as proteins) to cause an allergy" (European Food Safety Authority [EFSA], 2010, p. 10).

Agricultural Biotechnology- "A range of tools, including traditional breeding techniques, that alter living organisms, or parts of organisms, to make or modify products; improve plants or animals; or develop microorganisms for specific agricultural uses. Modern biotechnology today includes the tools of genetic engineering" (USDA, 2013, p.1).

Bacillus thuringiensis (Bt)- "A soil bacterium that produces toxins that are deadly to some pests" (USDA, 2013, p.1).

Bt crops- "Crops that are genetically engineered to carry a gene from the soil bacterium Bacillus thuringiensis (Bt). The bacterium produces proteins that are toxic to some pests but non-toxic to humans and other mammals" (USDA, 2013, p.1).

Competencies in public health- "a cluster of related knowledge, skills, and attitudes that affect a major part of one's job (a role or responsibility), that correlates with performance on the job, that can be measured against some accepted standards, and that can be improved via training and development" (Parry, S., 1996, p. 50).

Genetic engineering- "Manipulation of an organism's genes by introducing, eliminating or rearranging specific genes using the methods of modern molecular

biology, particularly those techniques referred to as recombinant DNA techniques" (USDA, 2013, p.1).

Genetic modification- "The production of heritable improvements in plants or animals for specific uses, via either genetic engineering or other more traditional methods" (USDA, 2013, p.1).

Health Education Directory (HEDIR)- The place for professionals in health education and health promotion to ask, answer, discuss and debate topics in and around the health education profession (HEDIR, 2016).

Herbicide-tolerant crops (*Ht*)- "Crops that have been developed to survive application(s) of particular herbicides by the incorporation of certain gene(s) either through genetic engineering or traditional breeding methods" (USDA, 2013, p.1).

Insecticide resistance- "The development or selection of heritable traits (genes) in an insect population that allow individuals expressing the trait to survive in the presence of levels of an insecticide (biological or chemical control agent) that would otherwise debilitate or kill this species of insect" (USDA, 2013, p.1).

Insect-resistant crops (*Bt*)- "Plants with the ability to withstand, deter or repel insects and thereby prevent them from feeding on the plant" (USDA, 2013, p.1).

Pesticide resistance- "The development or selection of heritable traits (genes) in a pest population that allow individuals expressing the trait to survive in the presence of levels of a pesticide (biological or chemical control agent) that would otherwise debilitate or kill this pest" (USDA, 2013, p.1).

Recombinant DNA (rDNA) technology- “alterations introduced into the DNA of an organism using modern molecular technologies, such as genetic engineering” (FDA, 2017, para. 2).

The Society for Public Health Education (SOPHE)- is a 501(c)(3) professional organization that provides global leadership to the health education profession. SOPHE promotes preventive health education, which “reduces the costs (both financial and human) spent on medical treatment” (2014, para. 5)

Transgenic organism- “An organism resulting from the insertion of genetic material from another organism using recombinant DNA techniques” (USDA, 2013, p.1).

## Importance of Study

Many health educators work in the field of education, nutrition, health coaching, and health promotion. These professionals should be knowledgeable on a variety of new and controversial health topics that people will want information about, including GM food. The review of the literature introduces the importance of proper GM food education in response to the reported gap of information among the majority of the population.

# CHAPTER II

# REVIEW OF LITERATURE

A clear gap in knowledge exists in relation to GM food among many US consumers, which directly influences the acceptance of GM food (Brown & Ping, 2003). Schilling et al. (2003) reported that U.S. consumers know very little about biotechnology, with their perceived knowledge and actual knowledge exhibiting the weakest relationship. A similar relationship was found among registered dieticians (RDs), certified nurse practitioners (NPs), and physicians, including medical doctors (MDs) and doctors of osteopathy (DOs) licensed in the state of Maryland who exhibited less scientific knowledge of GM food than perceived (Schmidt, Vickery, Cotugna, & Snider, 2005). These professionals were surveyed to measure their knowledge, attitudes, beliefs, awareness, label reading, and food purchase decisions. Of the knowledge-related questions, only two of 14 elicited a high percentage of correct answers (Schmidt et al., 2005).

Hallman and Aquino (2003) found little improvement in GM knowledge test scores among participants that read about GM food prior to evaluation. These authors found a positive relationship among respondents who had heard or read about GM food and their self-assessed knowledge of GM food. However, there was a weak relationship between what respondents thought they knew and what they actually knew. According to this study, where U.S. consumers are getting their information regarding GM food is

either not as credible or scientific as perceived, thus showing a need for a better source of GM food education. In addition, Brown and Ping (2003) assessed consumer perception of GM soybean and found that those surveyed knew little about genetic engineering and relied on the Food and Drug Administration (FDA) or retailers for safety information, bringing to the forefront the need for a better GM food education delivery format.

Acceptance of GM food is associated with consumers' risk/benefit beliefs about biotechnology. Han and Harrison (2007) measured perception, specifically whether respondents find health benefits or harm in GM food. They found that consumers were more willing to buy GM food if they perceive benefits and less likely if they perceive no benefits. Han and Harrison (2007) noted that biotechnology education may be a "viable strategy to mitigate their concerns about unknown health risks and adverse environmental effects" (p. 717), with reference to the lower consumer acceptance of GM technology. Negative perception and negative beliefs toward biotechnology had a more significant impact on acceptance than positive beliefs, with the lack of education and credible information listed as barriers in GMO acceptance (Moon & Balasubramanian, 2004). ABC News conducted a randomized national poll on GM food and found that 52% of Americans do not find GM food safe, while 13% reported being unsure about GM food (ABC News, 2016). Consumer Reports indicated that 92% of consumers want GM food labeled, with a reported 57% of Americans believing that eating GM food is unsafe (Consumer Reports, 2016).

## GM Food in the Media

Twitter, Facebook, Instagram, blogs, etc. are all avenues through which individuals and companies can share and exchange information with the public. Media influence is addressed in mass communication research, resulting in communication models that explain the effects the media may have on individuals in society. Previous research suggests that mass media has powerful indirect effects; and as a result, people change their own attitudes or behaviors (Gunther & Storey, 2003). GM food information available from the media has an impact on what consumers learn about GM food and how it influences their opinions on the topic.

### Positive Media Portrayal

GMO Answers is a website that provides health and safety information in support of biotechnology on behalf of the Council for Biotechnology Information funded by the Council for Biotechnology Information, comprised of BASF, Bayer CropScience, Dow AgroSciences, DuPont, Monsanto Company, and Syngenta (Council for Biotechnology Information, 2017). Members of the council answer questions people have regarding GMOs and supply research, and data that evaluate the safety of GM products. A recent article "Five Tasty Reasons to Reconsider GMO Crops" argued for the benefits for California wine grapes, specialty coffees, Florida orange juice, bananas, and chocolate when adopting biotechnology (Savage, 2014). The following are examples of how GM technology can improve how food is grown, posted from a commentary by an agricultural scientist and contributor to *Biology Fortified* (Savage, 2014): California grapes are at

risk of bacteria-like pathogens destroying the crop, and GM grapes could resolve the vector issue. The coffee rust pathogen afflicts specialty coffees grown in the Americas, and GM coffee provides a possible solution to the disease, allowing the beans to become resistant to the pathogen. Florida orange juice has recently been afflicted by a new bacterial disease from an exotic vector, causing a decline in the market; a proposed GMO solution that could offset the disease. Bananas have a new bacterial enemy that is currently destroying crops in Asia, Australia, and Mozambique, thus revealing another possible GM solution. Lastly, cacao farmers lose much of their product from pests that cause diseases like Witch's Broom and Frosty Pod. Genome sequencing, or GM technology, could provide a resolution to the pest problem with insect-resistant technology.

GM food is arguably the answer to disease pathogens plaguing crops and, consequently, farmers' livelihood. The research supporting biotechnology and the conflicts it can resolve with the support of growers and consumers is available on GMO Answers and other media outlets on behalf of biotechnology companies.

**Negative Media Portrayal**

Social media, like Twitter and Facebook, is a type of media that can be used to disseminate news without having to provide evidence. The Pew Research Center (2014) found 30 percent of Facebook users receive their news from the site and 10 percent of Twitter users receive their news from the site. In 2014, Tom Colicchio, a celebrity chef, restaurateur, and board member of Food Policy Action, utilized Twitter to post a petition

on behalf of labeling GM foods. He further added that 93% of Americans support GMO labeling, blaming the lack of transparency on companies like Monsanto and the Koch Brothers (Colicchio, T., 2014). In 2015, Chipotle became the first national restaurant company to cook only with non-GMO ingredients. On the Chipotle website, they explain that they do not allow GMOs in their ingredients because they are "doubtful that the GMO ingredients that used to be in [their] food meet [their] criteria: ingredients raised with care for animals, farmers, and the environment" (Chipotle, 2015, para. 5). Another company offering non-GMO options is General Mills, specifically in their original Cheerios cereal brand. All Cheerios brands are non-GMO when made in Europe because Europe has GMO labeling laws, and the regulatory process in Europe is stricter than the United States. General Mills supports a US policy on GMO labeling, even though their stance on GMO safety is favorable (General Mills, 2014). Currently, labeling foods non-GMO is a voluntary process for companies.

The Non-GMO Project is a third-party product verification organization for a non-GMO label and advocates for anti-GMO foods. All the benefits of GM technology mentioned in the positive media portrayal are retracted in the Non-GMO Project organization, which provides peer-reviewed research uncovering the facts and myths regarding GM food. The Non-GMO Project identified GM food as harmful to the environment and further argued that it can be toxic, is not regulated to ensure safety, does not increase crop yield, and does not decrease harmful pesticide use (Fagan, Antoniou, & Robinson, 2014).

**Media Influence**

Social media influences how people share information and make decisions (Gustafson & Woodworth, 2014), including decisions about health and well-being, and "the public is said to be poorly informed on many important issues" (McCluskey & Swinnen, 2004, p. 1230). According to a report by Pew Internet, "80% of internet-using adults have consulted a website as a primary source of information on healthcare topics" (Gustafson & Woodworth, 2014, p. 3). Bias in the media is one factor in poorly distributed information. McCluskey and Swinnen (2004) reported "bias in media coverage of agrobiotechnology in the United States and United Kingdom" (p. 1235), pointing out the need for proper GM education among trusted channels. Trusted media channels such as public health organizations, health educators, and peer-reviewed databases are all great examples of platforms that can provide accurate and non-biased information regarding GM food safety.

The association between the media and the food industry has become evident as more companies are listening to concerned consumers and changing their position on GM food. For example, Chipotle cited "potential environmental and health risks of GMOs" and banned GM ingredients from its tortillas and oils (Berry, 2016, p. 14). Berry (2016) also listed Cheerios as sourcing new ingredients for their sugar and cornstarch in order to remove GMOs from this General Mills' cereal.

Twitter, Facebook, Instagram, blogs, etc. are all avenues through which individuals and companies can share and exchange information with the public.

According to US News (2011), more than 41% of Americans get their news from the Internet. In 2014, Tom Colicchio, a celebrity chef, restaurateur, and board member of Food Policy Action, utilized Twitter to post a petition on behalf of labeling GM foods. He further added that 93% of Americans support GMO labeling, blaming the lack of transparency on companies like Monsanto and the Koch Brothers (Colicchio, T., 2014). The lack of transparency among some media outlets allows them to "disseminate medical information unimpeded by the expert medical community" and requires the user to differentiate between what is credible and what is not (Gustafson & Woodworth, 2014, p. 7). The problem with Twitter and other social media platforms is the access to information from both credible sources like the American Heart Association (AHA) accounts and less credible sources like personal celebrity accounts, like Tom Calicchio. Consumers need to be aware of information that has been peer-reviewed and information that is opinion-based in order to make an intelligent decision about the information given.

## Media Trustworthiness

The dichotomy of information regarding GM food has made it difficult to discern which information is credible and which is exaggerated. Diels, Cunha, Manaia, Sabugosa-Madeira, and Silva (2010) investigated existing articles from 1980-2009 referring to GM food and transgenic technology and found that of the 120 articles selected where a conflict of interest was identified, there was a "tendency to produce outcomes favorable to the associated commercial interests" (p. 201). Although there were not enough articles citing funding sources to infer a relationship with the author and a

financial conflict of interest, a significant relationship was present between professional conflict of interest and favorable outcome (Diels et al., 2010). Diels et al. (2010) reported another instance of bias in GM research, noting:

> would-be independent researchers of GM plants' potential impacts are even more restricted to carry out their research because of technology agreements that effectively allow a company to prohibit any research on their product without its explicit authorization even after it has been approved and marketed (p. 201).

## Media Dependency Theory

This theory was selected for its relevance to knowledge and awareness with reference to the media; the more dependent an individual is on the media for information, the more important the media will be for that person. Media Dependency Theory identifies "specific kinds of cognitive, affective, and behavioral changes in people that are regularly brought about by the mass media because of individual and societal dependence on their information resources" (Ball-Rokeach & DeFleur, 1976, p. 9). In the present study, Media Dependency Theory is used to examine where health educators get their information regarding GM food and the effect it has on their knowledge and attitude toward GM food. Another aspect of this model is used to assess the influence that media sources have on health educators behavior in relation to designing a GM food education plan. Media is an important part of this study because health issues are addressed in the media and "mass media are often cited as important sources of health information by individuals" (Morton & Duck, 2001, p. 602).

## Biotechnology

Biotechnology is the "application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services" (European Union [EU], 2013, para. 1). The WHO (2015b) reported that biotechnologies are the future in vaccinations and other disease treatment options. It is also thought to "help improve the understanding of disease, disease pathology, epidemiology, and vector control, and so may help limit the effects and spread of infection" (WHO, 2015b, para. 2).

### Types of Biotechnology

Other terms associated with biotechnology are genetically modified organisms (GMOs), genetic engineering (GE), and transgenics. With regard to agriculture, modern biotechnology includes genetic engineering, also referred to as recombinant DNA (rDNA) technology. Unlike conventional plant breeding, GE allows the direct transfer of one or few genes that can improve crop yield in a shorter amount of time. Herbicide-tolerant (*Ht*), insect-resistant (*Bt*), drought resistant (DR), and biofortified crops are at the forefront of modern biotechnology to increase agricultural output, viability, and population health. Agrobiotechnology is meant to improve nutritional value in food and feed, produce vaccines that eradicate animal diseases, and provide diagnostics to detect foodborne illnesses (EU, 2014a).

In the healthcare field, biotechnology is used to create new medicines and vaccines. Biopharmaceuticals, genetically modified pharmaceuticals, are used to treat

“growth diseases, metabolic diseases, MS, rheumatoid arthritis, cancer, and Alzheimer’s” (EU, 2014a, para. 2). Examples of biopharmaceutical approaches are xenotransplantation and transgenics. Xenotransplantation is the “transfer of an organ, tissue, or cells from one species to a different species” (Grey, 2000, para. 1). Xenotransplantation allows for the possibility of a human to receive an organ from another species, such as a pig. Transgenics “involves removing genetic material from one species and adding it to another” and is used in agricultural practices and medical practices (Glenn, 2013, para. 1).

**Global Impact**

The EU’s regulation on GMOs aims to: “Ensure strong protection of human life, health and welfare; Protect the environment; Defend consumer interests; Ensure that the EU's internal market works effectively” (EU, 2014b, para. 2). Member States in the EU are able to restrict or prohibit the cultivation of GMOs, in all or part of their territory (EU, 2014c). Agrobiotechnology is cultivated in the EU, specifically GM maize. GM maize is meant to protect against the European corn borer and has been cultivated since 1998. In 2013, it was cultivated in five other Member States: Spain, Portugal, Czech Republic, Romania, and Slovakia (EU, 2014c). GM maize in the EU represents “0.26% of the 57.4 million hectares of GM maize cultivated worldwide” (EU, 2014c, para. 9).

A second GM crop, namely the GM starch potato, was cultivated in the EU in 2010, but it has no longer been cultivated since 2011 (EU, 2014c). The EU regulations on GM food and animal feed are to:

> Protect human and animal health through stringent safety assessment of GM food and feed before it can be sold; Ensure common procedures for risk assessment and authorization are efficient, transparent and do not take too long; Ensure clear labeling that responds to the concerns of consumers (including farmers buying feed) and enables them to make informed choices (EU, 2014d, para. 1).

Field trials for GMO cultivation in the EU have declined since 2006, with Member States expressing the need to conduct more research on the environmental impact of GMOs (European Policy Evaluation Consortium [EPEC], 2011). Another research issue is the allergenicity of GMOs. The EFSA (2010) reported the main issues in GMO allergenicity are "newly expressed protein(s) that can be present in edible parts of the plants…as an unintended effect of the genetic modification" (p. 12). In other words, precaution is needed when addressing whether GM food may introduce new proteins and thus create new allergies from those proteins.

The Ministry of Agriculture in China approved three varieties of GM soybeans, which was followed by national skepticism of food safety (China Daily, 2013). It is thought that the "Ministry of Agriculture may need to seek other ministries' and departments' help to promote popular science among the public so that it understands what GM food exactly is", following the examination of how uninformed the public is on GM food and their continued distrust (China Daily, 2013, para. 3).

**National Impact**

The United States "is the largest market and leading consumer of biotechnology products in the world, and home to more than 1,300 firms involved in the industry" (SelectUSA, n.d., para. 1). Food products made from GE microbial and plant sources have been in the food supply since the 1990s (FDA, 2015). In 2009, the FDA issued a final guidance for industry on the regulation of GE animals. Using rDNA technology, desirable traits can be introduced into animals. It is used to a) help produce pharmaceuticals, b) decrease environmental impact of a dietary nutrient through excretion in manure, c) serve as a source for cells in xenotransplantation, d) produce antimicrobials that target disease-causing bacteria, and e) provide more efficiently-produced food (FDA, 2014a).

GE animals currently on the market are GE rats and mice used in laboratory research and the GE aquarium fish Zebra danio. Zebra danio is a tropical fish species that is not used for food and was used to create fluorescence in the dark. It was determined to not pose any additional environmental risks compared to conventional species (FDA, 2014b).

In 2012, GE cotton accounted for 94% of all cotton planted, GE soybeans accounted for 93% of all soybeans planted, and GE corn accounted for 8% of all corn planted (FDA, 2015). Most of the GE plants are used in animal feed; however, some plants have been engineered for nutritional traits. There are no mandatory labeling laws

for GE plants and animals, although the FDA does provide resources for voluntary labeling.

**State Impact**

Texas is home to over 3,600 biotechnology manufacturing and R&D firms, making it one of the leading biotech states in the country (Texas Wide Open for Business, 2014). Texas A&M partnered with GlaxoSmithKline to build a $91 million flu vaccine manufacturing plant (Texas Wide Open for Business, 2014). In 2007, Texas Tech University received a research grant for GE cotton that had a higher salt and drought tolerance than conventional cotton (USDA, n.d.). The project began in September 2007 and was completed in August 2011, and now Texas leads the nation in crop production of GE Texas upland cotton (Texas Department of Agriculture [TDA], 2015). Pasapula et al. (2011) reported the outcome of the project and found the GE cotton had more vigorous growth, significantly improved tolerance to both drought and salt stresses in greenhouse conditions, and a 20% increase in fiber yield compared to wild cotton. Texas A&M University conducted a research program involving GE sugarcane to improve crop yield in arid and alkaline conditions from June 2000 to June 2006 (USDA, n.d.b). In 2013, Texas farmers reported 16% and 20% of all corn planted to be GE insect-resistant/herbicide resistant, respectively, and 8% and 17% of all cotton to be GE insect-resistant/herbicide resistant, respectively (USDA, 2013b).

## GM Food Health Concerns

In 2005, the WHO's Food Safety Department released an evidence-based study regarding modern food biotechnology and its influence on human health. In this report, the potential benefits listed were increased agricultural productivity, nutritional value increase, reduced agricultural chemical use, enhanced farm income, improved crop sustainability, and food security (WHO, 2005). The potential risks were listed as monopolization of biotechnology among private firms, lack of biodiversity, allergenicity, traditionalism, and ethics (WHO, 2005).

### Personal Health

The WHO provides a Codex of safety assessment principles for GM foods that should be applied to premarket assessment on a case-by-case basis, including:

a) direct health effects (toxicity);
b) tendency to provoke allergic reactions (allergenicity);
c) specific components thought to have nutritional or toxic properties;
d) stability of the inserted gene;
e) nutritional effects associated with the specific genetic modification; and
f) any unintended effects which could result from the gene insertion (2005, p. 12).

No conclusive research has clarified the likelihood of the aforementioned risks. However, it's the WHO who has advocated for the introduction of internationally agreed procedures for the assessment of genetic engineering (2005). Magaña-Gómez and Calderón de la

Barca (2009) evaluated current assessment practices regarding GMO safety testing and found little to no overlap with the guidelines in safety testing, thus providing no constants among GMO risk assessments.

Controversial research by Spiroux de Vendomois, Roullier, Cellier, and Seralini (2009) studied the impact of three GM maize varieties incorporated in the diet of rat mammalian subjects. Spiroux de Vendomois et al. (2009) found signs of toxicity among the rats fed the GM corn; and the effects were dependent on the sex and dosage of the GM feed, with the toxicity influencing liver and kidney functions. Touyz (2013) quoted article reviews debunking this research, which stated that the rats used in the study were a tumor-prone species, that confounding variables were not properly assessed, and that the research protocol was inadequate. However, Ho, Cummins, and Saunders (2007) reported that GM soybeans caused severely stunted pups in female rats, with more than half dying and suffering damage to the kidney, liver, and pancreas.

Much of the debate regarding the benefits of GE crops concerns nutrition enhancement by incorporating more of a nutrient or introducing a nutrient into the food. An example of the nutrient enhancement approach is the GE golden rice to provide beta-carotene (vitamin A) in order to combat vitamin A deficiency (VAD) (Van der Meer, 2009). Conversely, Nestle (2001) reported issues with the promise of VAD improvement in golden rice, arguing that the bioavailability of the nutrient is low and the ability for the consumer to absorb the nutrient is even lower. Vitamin A is a fat-soluble vitamin and

needs adequate protein and fat stores to properly absorb and transport the nutrient, which the target population lacks and why VAD is prevalent (Nestle, 2001).

Allergenicity is one of the greatest concerns regarding biotechnology in the food and feed system. The number of people suffering from allergies is increasing and so is the number of deaths by anaphylactic food reactions (Gaivoronskaia & Hvinden, 2006). One example of combating allergenicity was demonstrated in a study by Tatham and Shewry (2008). They reviewed the use of GE down-regulation, a process that is meant to reduce allergens in plants by suppressing the protein gene expression responsible for allergens. Another example is research conducted by Dodo, Konan, Chen, Egnin, and Viquez (2008), who experimented with peanut allergies by eliminating the protein responsible for the allergen and used biotechnology to decrease the binding capacity of the protein.

Falkner (2007) reported the major concerns of biotechnology to be allergenicity, toxicity, and antibiotic resistance, with higher levels of toxins in GE plants and antibiotic resistant genes produced in GE crops. Because the long-term effects of biotechnology are unknown and scientists are unsure of the possible mutation in genes causing an unintended consequence, current GE crops that are meant for human consumption do not have genes introduced from known allergens. At present, there are no proven methods for assessing the allergenicity of GE foods, with animal models not validated for human comparison and no universal consensus on proper testing methods.

Antibiotic resistance is an expressed concern among the potential negative influences of biotechnology. Kleter, Peijnenburg, and Aarts (2005) reviewed the health

concerns regarding horizontal gene transfer, or the potential for GE crops to transfer the engineered genes to non-target organisms like humans or animals; potential pathogenicity of select bioengineered genes was analyzed. However, the researchers took a 'weighed evidence' approach and deemed pathogenicity unlikely to raise health concerns (Kleter, Peijnenburg, & Aarts, 2005).

**Environmental Health**

The EFSA published a guideline for environmental risk assessment (ERA) of GM plants in 2010. Addressing the cautionary long-term effects of biotechnology, the EFSA requires a monitoring plan within the application for placing GMOs on the market. First, the insect-resistant and herbicide-resistant crops and their role on environmental impact is discussed. Brookes and Barfoot (2010) reported pesticide and herbicide use "declined substantially with a significant reduction in the Environmental Impact Quotient (EIQ)" (Mannion & Morse, 2012, p. 755). Another benefit of herbicide- and pesticide-resistant crops is the shift to fewer toxic herbicide and pesticide chemicals (Mannion & Morse, 2012). Brookes and Barfoot (2010) also noted the reduction in greenhouse gas emissions when GM crops replace conventional crops, resulting from less pesticide use and different farming methods. In contrast, Benbrook (2012) published a 16-year analysis of pesticide use among GM crops in the United States and found a 527-million-pound increase in herbicide use between 1996 and 2011 among herbicide-resistant crops, with only *Bt* crops reducing insecticide applications by 123 million pounds, thereby leaving an influx of 404 million pounds. Although there seems to be a reduction in insecticide

applications among *Bt* crops, the emergence of corn rootworm (CRW) populations resistant to the GE crop has caused farmers to resume the use of corn soil insecticides, the very insecticides that *Bt* crops were created to eliminate (Benbrook, 2012). Another example of an increase in pesticide use among GM crops is the eight million liter increase from 1995 to 2013 in Argentina (Chopra, 2015).

While the immediate benefits of Ht crops on the environment have been noted in previous research, the long-term effects are unknown; and there is the possibility of insect or herbicide resistance developing in GM crops. An example of resistance was found in the "diamondback moth, a major pest of cruciferous vegetables, to conventional Bt pesticides" (Mannion & Morse, 2012, p. 756). Knowing that there is already pest resistance in conventional crops, resistance in GM crops is also likely to develop. Although there are management techniques that may assuage insect resistance, in 2008 *Bt* cotton had a reported bollworm resistance (Mannion & Morse, 2012). The most notable herbicide resistance is to glyphosate, an herbicide increasingly used with GM crops, and now a reported six new species of weeds have developed resistance to this herbicide (Mannion & Morse, 2012).

Chopra (2105) disputed the positive environmental impact of *Ht* crops by stating "twenty years after [GM crops] were first introduced, we can see that GM crops have not increased crop yields or farmers' incomes, and they have not been better for the environment" (p. 64). Though the initial excitement about GM food production may have shown a positive tide toward production, the Indian Parliamentary Standing Committee

on Agriculture concluded in 2012 that "after the euphoria of a few initial years, [GM] Bt cotton cultivation has only added to the miseries of the small and marginal farmers" (Chopra, 2015, p. 64). Chopra also added to the theory of insecticide resistance among GM crops by addressing the 28 new weed species in the world that are glyphosate-resistant, with 14 documented in the United States and four in Canada (Chopra, 2015).

With the possibility of greater crop yields and less herbicide usage among GE available crops, biodiversity is major concern among environmentalists when addressing biotechnology; the major GE crops are maize, soybean, and cotton. Biodiversity in GM and conventional plants and among species of plants are both of concern. One concern of biodiversity is the preference of farmers to plant GE crops and discontinue planting non-GE crops; this is associated with lack of crop diversity (type of crops) and lack of diversity among the technology of crops (GE or cross-bred). Gene transfer, a process where genes from one organism transfer to an unintended organism, is also of concern in biotechnology. Already gene transfer among GM crops has emerged, posing a problem for crop cultivation and threatening conventional and organic farming. Another example of threats to biodiversity is the incidence of feral species, unintended manifestations of traits in crops that were not engineered, and issues relating to poor management techniques.

The WHO reported on biotechnology efforts in the creation of designer mosquitos that would be unable to carry the malaria parasite or lessen the mosquito population, anti-malarial drugs that have the potential to be effective against multi-drug-resistant

parasites, TB vaccinations, DNA-based AIDS vaccinations in Africa, and meningitis B vaccinations in Cuba (WHO, 2002; PBS, 2016). In 2015, the WHO released a dispatch on the dengue outbreak in Key West, Florida during 2009-2010, where authorities considered using the GM mosquito to prevent reproduction. However, despite outreach and media attention, only half of the community was aware of the proposal and only half of those aware were supportive of the proposal (WHO, 2015c).

An example of how GM food education promotion can bridge the gap for consumers and why it is important among public health is the application of GM technology to the mosquito. Earlier the researcher provided information on GM insects and the risks and benefits associated with the environment with the GM mosquito introducing a promising resolution in malaria control. In August 2016, the FDA approved the GM mosquito for suppressing the spread of the Zika virus (PBS, 2016). Zika virus is spread mostly by the bite of an infected mosquito which can cause certain birth defects when contracted by an expecting mother (CDC, 2016). The target population for the release of the GM mosquito is Tampa Bay, Florida where the residents were reportedly divided on the FDA approved approach (PBS, 2016). In November 2016 Monroe County, Florida residents voted on whether they would accept the GM mosquito to fight the Zika spread, and voted 'yes' (American Council on Science and Health (ACSH), 2016). However, Key Haven, a smaller area of Monroe County, voted 'no', and is the location scientists scheduled to release the GM mosquitoes, leaving the scientists searching for another site for the release (ASCH, 2016). The reported divide among the Florida

residents stems from their lack of knowledge regarding GM technology and their lack of trust in the scientific community and/or their lack of resources from non-biased parties (ASCH, 2016).

This GM mosquito incident is just one example of how a health educator could be a resource person for the community and provide educational resources to give community members credible information. GM technology, specifically GM food, has been approved by the FDA and the scientific community but leaves consumers questioning the safety and ethics of GM food. Whether communities will accept GM food technology or countries will import GM food based off of their fear of the unknown is not so much different than public fear of vaccinations and the rise in vaccine-preventable disease outbreaks.

**Economic Health**

GE crops have shown an increase in crop yield, allowing a greater profit margin for farmers with less crop loss associated with pests. However, issues involved in GE seed are the cost of the seed and sometimes the inability to reuse the seed due to the intellectual property of the technology within it. To date, GE seeds are almost entirely owned by private companies, allowing these companies control over the premium of the seeds, depending on the intellectual property right (IPR) protection laws (Qaim, 2005). For example, in India, GM cotton seeds can cost three to eight times as much as the cost of conventional hybrid seed, and in Canada, GM seeds are more expensive than non-GM seed (Chopra, 2015). The approach of biotechnology to offer enhanced nutrient benefits

did not prove to be less costly than supplementation in the VAD study (Van der Meer, 2009). Chow, Klein, and Laxminarayan (2010) found GM mustard seed to cost five times the amount of vitamin A supplementation.

## GM Food Knowledge and Attitudes

### Awareness, Knowledge, and Attitudes of Consumers toward GM Food

Schilling, Hallman, Hossain, and Adelaja (2003) surveyed US adults using a random proportional sampling technique on their perceptions of food biotechnology. They found that the vast majority indicated they have heard very little about biotechnology. In addition, 41.8% of consumers reported that they "somewhat approve" of GM hybrid plants with 18.9% and 17.7% reporting "somewhat disapprove" and "strongly disapprove," respectively (Schilling et al., 2003). However, when asked about GM hybrid animals, 20.7% responded 'somewhat approve' and 42.8% reported 'strongly disapprove' (Schilling et al., 2003).

Brown and Ping (2003) assessed consumer perceptions of GM soybean and found that consumers knew little about genetic engineering and relied on the FDA or retailers for safety information. Hallman and Aquino (2003) examined consumer perceptions of GMOs using questions similar to the Eurobarometer GMO survey from 1999 and 2003. The target population was comprised of non-institutionalized U.S. adults, with over 40% claiming little knowledge regarding biotechnology. Interestingly, Hallman and Aquino (2003) found a decline in respondents believing that GM technology would improve the quality of their lives, from 59% in 2001 to only 39% in 2003.

In a review of US adults, Laux, Mosher, and Freeman (2010) measured awareness, acceptance, and safety perceptions of GMOs of college students at Iowa State University. The relationships between nationality and acceptance, safety perceptions and acceptance, and field of study and acceptance were evaluated. The strongest relationships were safety perceptions and acceptance, and nationality and acceptance, with p= 0.000 and p= 0.007, respectively (Laux et al., 2010). If students were unsure of the safety of GMOs, they were less accepting of the technology. International students felt more negatively about GM technology.

Qin and Brown (2008) analyzed the differences in gender acceptance of GE salmon, measuring intent to purchase and attitude. The questionnaire included a pre-test, an information piece about GE salmon, and a post-test with awareness and overall attitude toward GE salmon among the questions. Their results showed that men had a slightly positive attitude toward GE salmon, while women had a negative overall attitude, with men being more willing to purchase GE salmon than women. Han and Harrison (n.d.) found that consumers were more willing to buy GM food if they perceive benefits to themselves and less likely if they perceive no benefits. Han and Harrison (2007) noted that biotechnology education may be a "viable strategy to mitigate their concerns about unknown health risks and adverse environmental effects" (p. 717), with reference to lower consumer acceptance of GM technology.

Moon and Balasubramanian (2004) found that negative beliefs toward biotechnology had a more significant impact on acceptance than positive beliefs, listing

the lack of education and credible information as barriers in GMO acceptance. The reviewed literature shows a pattern in the lack of sufficient knowledge regarding biotechnology and the recommendation for more credible education on GM technology. Fritz et al. (2004) found that Europeans' awareness of GM food was declining, while people in the United States and Canada had a high awareness, but poor knowledge of GM food in relation to health.

**Awareness, Knowledge, and Attitudes of Professionals in the Health Field**

Professionals in the health field are considered experts in matters of personal health and as such need to exhibit credible and reliable information on GM foods. Registered dieticians (RDs), certified nurse practitioners (NPs), and physicians, including medical doctors (MDs) and doctors of osteopathy (DOs) licensed in the state of Maryland, were surveyed to measure their knowledge, attitudes, beliefs, awareness, label reading, and food purchase decisions. Of the knowledge-related questions, only two of 14 elicited a high percentage of correct answers: the definition of biotechnology and the applications of plant GE (Schmidt et al., 2005). The majority of the respondents agreed that GE technology makes crops more pest resistant. However, there was also a high lack of confidence noted in their ability to discuss the science of GE with their clients and patients (Schmidt et al., 2005).

Another study assessing the viewpoints of dietetics professionals found that many did not view GM food as ineffective in solving word hunger and also felt that consumers have the right to know if their food has been genetically altered (Roberts, Struble,

McCullum-Gomez, & Wilkins, 2006). This study reported three distinct viewpoints on GM foods: precautionary, cautiously supportive, and promoting. All the viewpoints addressed in this study reflected the respondents' agreement that their role is important in facilitating an open dialogue regarding GM food (Roberts et al., 2006).

**Awareness, Knowledge, and Attitudes of Educators**

Morrison (2012) assessed vocational teachers concerning their awareness of biotechnology and the perception of its application in Guyana. Findings showed that the majority of respondents (75.8%) had "some" awareness of biotechnology, with 31.7% indicating that they taught "nothing at all" in relation to biotechnology education. However, 89.6% of the respondents believed the public is not given enough information about GM foods, with only 27.2% of the teachers having a favorable opinion toward the technology (Morrison, 2012).

Wilson, Kirby, and Flowers (2002) investigated the intent of North Carolina agricultural educators to adopt an agricultural biotechnology curriculum, measuring their self-perceived importance and knowledge with a multiple-choice test that followed to assess actual knowledge. The agricultural educators perceived themselves to be somewhat knowledgeable in biotechnology, with 44% of the respondents scoring below 70% on the actual knowledge multiple-choice test (Wilson et al., 2002). Although the actual knowledge of the agricultural educators did not appear to be high, over half intended to adopt a biotechnology curriculum.

Another study assessed the knowledge and attitude of teachers in select cities in India, also measuring perceived risks and benefits regarding GM food. Mohapatra, Priyadarshini, and Biswas (2010) found that many concepts related to GM food were not well understood by the teachers and that many did not think GM food would be healthier to eat than non-GM food. Conversely, many of the teachers viewed GM crops as higher yielding than non-GM crops, and believed that they can help decrease the scarcity of food and are beneficial to farmers (Mohapatra et al., 2010). A unique perspective in this study is the assessment of religious beliefs and how it may influence their opinion regarding a scientific approach to altering animals, specifically the sacredness of cows among Indian religious beliefs. For example, Hindu teachers thought that utilizing GE cattle to make meat more nutritious should be banned along with any GM foods containing human genes (Mohapatra et al., 2010).

Gardner and Jones (2010) examined the risk perception of science educators regarding biotechnology to determine the perceived potential risks and benefits of biotechnology applications. A correlation between years of teaching experience and risk perception was found in that the more teaching experience educators have, the less perceived risk they have toward biotechnology (Gardner & Jones, 2010). Another relationship between content knowledge and biotechnology application benefits was established, demonstrating that a higher level of knowledge regarding GM food enables a greater understanding of the benefits of the application of GE.

In addition, knowledge about biotechnology influences the concerns that teachers have regarding biotechnology education. Borgerding, Sadler, and Koroly (2013) assessed teachers' concerns about biotechnology education. The researchers used the Stages of Concern framework (George, Hall, and Stiegelbauer, 2006) to investigate how science teachers approach biotechnology education and what concerns teachers have about it. This qualitative research design showed that the teachers considered biotechnology instruction very important, but that adding a new curriculum to their existing curricula would be difficult. Another factor contributing to their concern was their working knowledge of biotechnology, with more than half citing that they are poorly prepared to teach biotechnology.

Technology teachers' beliefs about biotechnology and its instruction were found to be a factor in biotechnology education implementation (Kwon & Chang, n.d.). This study examined Korean technology teachers' beliefs related to their intent to implement biotechnology education and measured their perceived beliefs regarding many aspects of biotechnology education. Kwon and Chang (n.d.) determined that 32% of respondents taught biotechnology content at present. Many found value in biotechnology education, but perceived a lack of desire among the target population to learn more about this technology. However, the technology educators found it important to teach biotechnology in their classes; and their confidence in their knowledge influenced the likelihood of adding biotechnology education to their curricula.

Fritz et al. (2004) conducted research to assess awareness and acceptance of GM food among "people who communicate science to the public" prior to a workshop on biotechnology (pre-workshop), post-workshop, and a year after (follow-up). Respondents were significantly more aware of GM food post-workshop and follow-up compared to pre-workshop, but were still identified as aware of GM food pre-workshop. Regardless of the timeframe in the study, participants all responded that they rely on newspapers to educate themselves on GM food (Fritz et al., 2004). Pre-workshop participants were somewhat accepting of GM food (not including animals), with no significant difference post-workshop or follow-up. Obstacles identified in the pre-workshop period consisted of "fear of genes moving unchecked to other plants, insects, or microorganisms," with a significantly higher fear expressed post-workshop. In the follow-up period, fear was reported as a significantly higher obstacle compared to post-workshop (Fritz et al., 2004).

**The National Academic Press**

The National Academic Press (NAP) put together a group of the following: The Committee on GE Crops: Past Experience and Future Prospects, Board on Agriculture and Natural Resources, Food and Nutrition Board, and a Board on Life Sciences. This group was charge with examining the evidence regarding potential negative effects and benefits of current and future GM food technology. The NAP found favorable economic outcomes for producers using GE soybean, cotton, and maize. Insect-resistant crops were found to decrease yield losses and insecticides for small and large farms while creating a higher insect biodiversity and minimizing pests (NAP, 2016). However, resistance-

management is key to using GE crops as it was also found to cause damaging levels of resistance in some target insects and have a relatively equal yield to non-GE crop practices.

Addressing the agronomic problem, of biodiversity or pesticide resistance among weeds or insects, the NAP found evidence of benefits and drawbacks. Surveys of farm-levels did not reveal a lack of biodiversity in crops; however, a heavy reliance on pesticide-resistant GE crops did encourage some weeds to evolve a resistance to pesticide treatment. In areas where adoption of *Bt* maize or *Bt* corn is high, the research group found statistical evidence of a reduction in insect-pest populations, with the European corn borer becoming so uncommon that a *Bt* toxin for that pest is no longer warranted (NAP, 2016). The interesting relationship of insect-pest loss is the benefit for both GE farming and non-GE farming.

The personal health issues presented earlier were also addressed by the committee. The NAP agreed that many previous animal studies were not optimal and performed an independent analysis. Long-term data analysis on livestock health before and after the introduction of GE crops was performed and showed no adverse health effects (NAP, 2016). To assess the effects of GE on human health, epidemiological data was examined for incidence of cancer and other health problems over time and found no substantiated evidence that GE foods were less safe than non-GE crops. Regarding nutrition quality, the testing procedures used in most analyses of GE crops and non-GE crops do not provide enough evidence that the nutritional difference found is due to GE

technology and not naturally occurring variations in conventional crops. Better testing methods for detecting nutritional differences were starting to be applied when this review was written, transcriptomics, proteomics, and metabolomics, and no significant difference were found.

Allergenicity is still an unknown for possible future health concerns. The NAP found it difficult to develop a solution where allergenicity could be tested before or after commercialization of a GE crop, with the logistics uncertain and the individual characteristics of people's digestion systems in relation to allergen breakdown (NAP, 2016). In other words, known allergens are resistant to digestion by gut fluids, yet individuals have different acidic gut fluid levels; therefore, a simulated gut-fluid test may not be efficient (NAP, 2016). Another posed health-risk assumption, horizontal gene transfer, was regarded as highly unlikely with no health risk assumed. Glyphosate was also found to have no connection with cancer risk; and as long as it is used as directed, there appears to be no other associated risk with the endocrine system (NAP, 2016).

Cultural acceptance was addressed in regards to GE technology and the Academy agreed that GE crop governance should be transparent and participatory in order to allow comparison of molecular profiles. In other words, with new technologies and modifications, all new varieties, GE or non-GE, should be subject to safety testing to help prevent unintended consequences. This could provide more common ground among national and global trading if regulatory practices for crops are more synchronized.

Economically, GE seed is more expensive than conventional seeds initially, with the overall cost equaling out if farming practices are properly regulated (NAP, 2016). This means farmers use less pesticides on their crops and overtime the initial cost of the GE seed would balance out the reduced purchase of pesticide. In the case of intellectual property, the NAP (2016) advised that more research should be done on existing intellectual property protection and how patents influences seed price and viability.

In summary, the NAP found no definitive proof that GE technology negatively impacts human or animal health, does not seem to cause more pesticide use as long as it is managed properly, and has not proven to disrupt agrodiversity. GE technology seems to bridge the gap between potential yield and actual yield, but no significant evidence proves GE technology produces a greater yield than conventional crops. Recommendations for avoiding pesticide-resistance in GE crops were given to adopt the high dose/refuge strategy to delay the evolution of resistance. Limitations of the NAP examination were lack of current and reliable research, e.g., in the area of allergenicity safety testing. Another limitation was the cost of GE seed and how the intellectual property is to be addressed, leaving uncertainty among long-term adoption practices for some farmers. The NAP provided a thorough analysis on past examinations, current practices, and regulatory practices within the US and other countries.

## Health Educators and GM Food Education

Health educators offer knowledge, skills, and training that complement those health care providers, policy makers, human resource personnel, and many other

professionals whose work impacts human health (SOPHE, 2017). They are found in community settings, education settings, public health departments, nonprofit organizations, private businesses, and health care facilities. To date, there are no GM food competencies in public health or GM food education plans among health educators/promoters; additionally, there are also no other health professionals that have identified GM food education practices. Health educators/promoters can fill this gap in GM food education and can provide accurate information to remediate the insufficient knowledge about GM food that currently exists among the general public.

**The Health Educator**

The U.S. Department of Labor (2014) defined a health educator as someone who teaches people about behaviors that promote wellness and are typically responsible for developing programs and events to teach people about health topics. SOPHE is a 501(c)(3) professional organization that provides global leadership to the health education profession. SOPHE promotes preventive health education, which "reduces the costs (both financial and human) spent on medical treatment" (SOPHE, 2014, para. 5). According to SOPHE (2014) one of the standard occupational classifications of a health educator is the ability to handle controversial health content.

**Health Educator Certification**

The health education profession recognizes certification as the method of individual credentialing for the profession. The National Commission for Health Education Credentialing, Inc. (NCHEC) is a nonprofit, tax-exempt organization that has

been granted accreditation by the National Commission for Certifying Agencies (NCCA) in compliance with stringent testing and measurement standards among health testing organizations (NCHEC, 2008a). According to NCHEC, a health educator has seven areas of responsibility:

Area I: Assess Needs, Assets and Capacity for Health Education

Area II: Plan Health Education

Area III: Implement Health Education

Area IV: Conduct Evaluation and Research Related to Health Education

Area V: Administer and Manage Health Education

Area VI: Serve as a Health Education Resource Person

Area VII: Communicate and Advocate for Health and Health Education (NCHEC, 2008b, para. 2).

A certified health education specialist must graduate from an accredited or approved health program and receive an acceptable score on a qualifying health education exam. The seven areas of responsibility act as a toolkit for health educators to reference and follow to make sure there are being comprehensive in their approach to health education in their field.

## Core Competencies for Public Health Professionals

The Council on Linkages Between Academia and Public Health Practice (Council on Linkages; 2014) developed the core competencies adopted by the Public Health Foundation (PHF) and the CDC. These are meant to "provide a framework for

workforce development planning and action" and be interpreted and adapted to meet specific organizational needs (p. 2).

I. Analytical/Assessment Skills
II. Policy Development/Program Planning Skills
III. Communication Skills
IV. Cultural Competency Skills
V. Community Dimensions of Practice Skills
VI. Public Health Sciences Skills
VII. Financial Planning and Management Skills
VIII. Leadership and Systems Thinking Skills

Within these eight core competencies, three tiers are recognized for different levels of incorporation: Tier 1: Front Line Staff/Entry Level, Tier 2: Program Management/Supervisory Level, and Tier 3: Senior Management/Executive Level (Public Health Foundation, 2014). The Public Health Foundation (PHF) is a collaboration of 20 organizations that aims to improve public health education and training, practice, and research (Public Health Foundation, 2014). These competencies are important for the field of health education in order to properly evaluate the capacity of the health educator; to make sure health educators can effectively educate within their scope of practice.

**Role of Health Educators**

The practice of using media as a platform for health education is growing and allowing larger audiences to be reached quickly (Barnes, Giles, Neiger, Thomsen, &

Thackeray, 2003). Health educators increasingly rely on the media to disseminate health information and this visibility aids the practitioner, the public, and the profession (Barnes et al., 2003). The role of a health educator and the media is to corroborate news stories and develop a working relationship with news outlets in order to deliver health education to the public. The importance of media and "how youth and young adults use social media to support health decision-making should be of interest to public health researchers, physicians, and other health care providers" (Gustafson & Woodworth, 2014, p. 3).

GM food education is important to address the negative attitudes and lack of knowledge that emerged from the literature discussed above. Borgerding, Sadler, and Koroly (2013) assessed teachers' concerns about biotechnology education. One factor contributing to these concerns was their working knowledge of biotechnology, with more than half citing that they are poorly prepared to teach biotechnology. Much of the problem is related to the apparent lack of consensus among researchers in recommending whose responsibility it is to educate U.S. consumers on GM food. The following occupations were recommended in previous research: dieticians, supermarket retailers, physicians, science teachers, government agencies, science organizations, and legislation. However, no previous researchers mentioned health educators as a population responsible for relaying scientific information to the public and for development of health education programs.

Health educators/promoters were addressed in this study because, to the investigator's knowledge, only one other study has targeted health educators, with the actual target population identifying professionals who communicate science to the public. The study specifically mentioned cooperative extension educators, educators (no specificity), and agricultural property owners or affiliates, but not a specific target population for health educators.

## Summary

The review of the literature has described the importance of proper GM food education in response to the visible gap in knowledge among much of the population. Biotechnology and the impact of GM food specifically were defined. The purpose of health educators as the target population was explained, along with the need to measure their knowledge of and compatibility toward GM food. A health educator should be knowledgeable about controversial health topics, among which is GM food. GM food is everywhere and, although many consumers are aware of the technology, many are not aware of how GM technology plays a role in their everyday lives. A health educator needs to have working knowledge of GM food applications and the known risks and benefits associated with the technology in order to properly educate the lay consumer. GM food competencies were proposed to better serve the health educator/promoter in this innovative field.

# CHAPTER III

# METHODOLOGY

The researcher used a quantitative approach to examine four questions: 1) What effect does the media have, if any, on health educators' knowledge and perceived compatibility toward GM food?; 2) What are practicing health educators' knowledge of and perceived compatibility toward GM food?; 3) Where are practicing health educators currently receiving their information, if any, regarding GM food?; and 4) What is the confidence level of completing tasks for delivery of GM food education among health educators? The researcher also examined the following hypotheses: $H^0$ = there will be no correlation between compatibility toward GM food and perceived barriers in adopting GM food competencies; $H^0$ = there is no relationship between knowledge of GM food and media exposure; and exposure to media is not a mediator for GM knowledge and confidence level towards GM food education tasks.

This study analyzed primary quantitative data from three existing instruments modified to measure knowledge and attitude of GM food, media dependency on health information, and perception of developing a GM food education plan.

## Sample Population

The survey was disseminated among professional members of health organizations such as SOPHE and the Health Education Directory (HEDIR). A priori power analysis was conducted using the R program MedPow (Kenny and Judd, 2014) to

determine the minimum sample size required to find the significance indirect effect in the mediation analysis with a desired level of power set at .80, an α-level at .05, and moderate effect sizes. Based on the analysis, it was determined that a minimum of 105 participants was required to ensure adequate power for the mediation analysis. Preliminary analyses, correlation tests and ANOVAs, needed minimum sample sizes within the 105 according to the power analyses conducted using G*Power version 3. 1. 9 (Cohen, 1988; Erdfelder, Faul, & Buchner, 1996; Faul, Erdfelder, Lang, & Buchner, 2007).

## Protection of Human Participants

The Texas Woman's University Institution Review Boards (IRBs) review research studies that involve human subjects to protect their rights and welfare and thus require approval prior to initiation of research (see Appendix A). The principal investigator ensured participants that their participation was completely voluntary and included an informed consent within the survey recruitment letter (see Appendix B). Participants could complete the survey without leaving any personal information; however, they had the option to leave an e-mail address to enter to win an Amazon gift card. Completion of the survey served as an agreement and understanding of the informed consent for this study as deemed acceptable by the IRB. Furthermore, using the snowball technique for recruitment the principal investigator encouraged participants to forward the PsychData link to other educators (see Appendix C). The principal investigator did not have access to any e-mails. The principal investigator set the options

in PsychData for complete anonymity, and no IP addresses or e-mails were tracked or associated with their submission. Finally, the principal investigator completed both the National Institutes of Health online course and the Responsible Conduct of Research training through the Collaborative Institutional Training Initiative (CITI) as required by the Texas Woman's University (see Appendices D and E). This study was given an IRB-Exempt status.

## Instrumentation

The study assessed practicing health educators in the US using a web-based survey comprised of subsets from three existing surveys and demographic data (e.g., age, ethnicity, and gender) (see Appendix F). The three existing surveys measure GM food knowledge and attitudes of teachers and students; consumers' dependency on media for information about food safety incidents related to the beef industry; and an assessment of health educators' likelihood of adopting genomic competencies for the public health workforce (see Appendix G-I). The surveys were modified to fit the criteria for this study and delivered within PsychData, a commercial web-based survey tool (PsychData, 2017).

A 5-point Likert scale and open-response and closed-response questions were used to collect data. The researcher measured the following variables: knowledge of GM food, attitude towards GM food, confidence level of developing a GM food education plan, types of media used to access health information, media influence, and media dependency. The estimated time to complete the survey was 10 minutes. Questions 1-17

targeted demographic data. Questions 18- 28 were adapted from the *Public Perceptions of Genetically Modified Foods: A National Study of American Knowledge and Opinion Survey* and were designed to answer the research question (Hallman, Hebden, Aquino, Cuite, and Lang, 2003):

- What is practicing health educators' knowledge of GM food?

Questions 29- 66 were adapted from the *Health Promotion and Genetics/Genomics* survey and were designed to answer the research question (Chen, 2007):

- What is health educators' perceived compatibility towards GM food?
- What are health educators' confidence levels for performing tasks for GM food education?

Questions 67- 111 were adapted from *Aggies' Perceptions of and Use of Media about the Beef Industry* survey and were designed to answer the following research questions (Charanza, 2011):

- Where are practicing health educators currently receiving their information, if any, regarding GM food?
- What effect does the media have, if any, on health educators' knowledge and perceived compatibility toward GM food?

The content validity of the instrument was established by administering the questionnaire to three faculty members who currently teach in Health Studies programs and a staff member in the Center for Research Design and Analysis. The content reviews served to determine the understanding of content, the length of time it takes to complete the survey, the clarity of wording, and the effectiveness of fulfilling the purpose of the study. The survey was revised based on the feedback of the review committee and were minor enough to continue with the distribution of the survey.

## Data Collection Procedures

The principal investigator e-mailed the recruitment letter and PsychData link to SOPHE. The SOPHE organization agreed to advertise the PsychData survey in their monthly periodical (see Appendix J). Then, the principal investigator e-mailed the recruitment letter to the HEDIR listerv, which delivered the e-mail to all subscribed members, and encouraged the forwarding of the PsychData survey to other qualified educators (see Appendix K). As a result of using different avenues to recruit participants, the data collection period occurred between September and December 2016. The responses of the surveys were electronically and anonymously collected via PsychData.

## Data Analysis

In addition to descriptive analyses, preliminary analyses, correlation tests and ANOVAs, were conducted to test the relationships among variables using Statistical Package for the Social Sciences (SPSS) and PsychData. At last, structural equation

models (SEMs) were created using SPSS AMOS and PsychData. All testing was conducted at the .05 alpha level.

The observed, endogenous variable used in the SEMs (Figure 2 and Figure 3): constructs of media (TV, Radio, Newspaper, and Internet) and perceived barriers. Observed, exogenous variables were: current, self-efficacy, and compatibility. Unobserved, endogenous variable: media. In the SEM for Figure 4, the observed, endogenous variables were: constructs of perceived barriers (lack of knowledge about how to incorporate GM food education into health promotion, lack of knowledge on GM food, lack of time to add something new, and GM food is not a priority in my current work) and self-efficacy. The observed, exogenous variables were: trust, GM communication channels, compatibility, and difficulty. The unobserved, endogenous variable was perceived barriers.

**Theoretical Model and Framework**

Many people are unaware of what GM food is and if it's safe, understanding the factors associated with incorporating this innovation into the food supply becomes important. Structural Equation Modeling (SEM) is more of a confirmatory analysis than an exploratory analysis, and with the bootstrapping technique, it can maximize a moderate sample size. Bootstrapping allows for a more accurate Type I error rate and power than a single sample method by creating a sampling distribution to create confidence intervals. Therefore, to explore and interpret health educators' likelihood to adopt GM food competencies into health promotion, a SEM model was theorized and

tested. It was assumed that the majority of health educators had not received any formal GM food training and thus relied on different media channels to learn about and formulate opinions regarding GM food. The driving theory for this SEM was The Media Dependency Theory, and was used to show the impact media has on health educators' knowledge and likelihood that they would develop GM food education plans (see Figure 1).

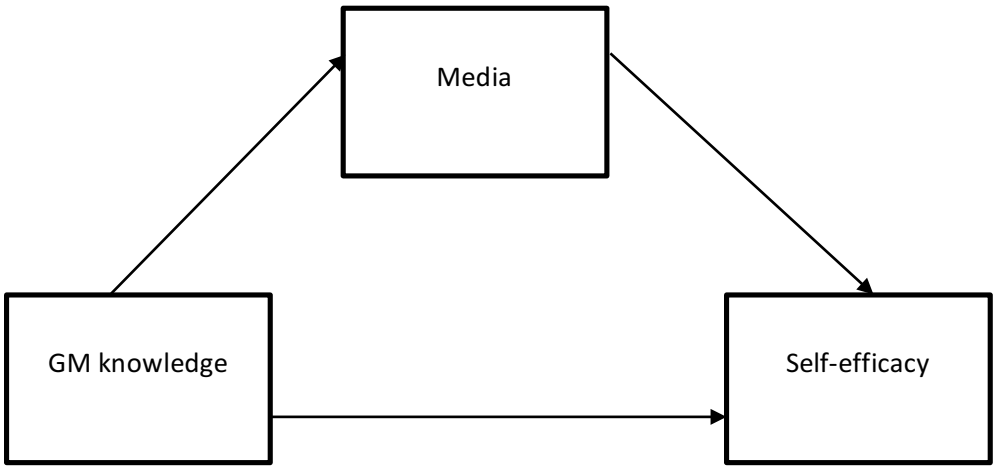


*Figure 1.* Theoretical model of health educators' GM knowledge and confidence level in performing GM education tasks (self-efficacy) as mediated by media.

**Summary**

This section presented the design of this study which included the following methods: a preliminary analysis, a mediation analysis, and a description of an electronic survey. The convenient sample was described to include all practicing health educators subscribed to the SOPHE and/or HEDIR organizations. Protection of human rights was detailed. The adoption and assessment process of the survey instrument was outlined to

include content modification, reliability, and content validity. Steps of the data collection procedures were described as well as presentation of data analysis with associated computations. Variables were defined.

# CHAPTER IV

# RESULTS

The purpose of this study was to collect data on knowledge and attitudes of health educators toward GM food as well as assess the relationship (if any) media has on health educators' knowledge and attitude as well as their usage of media for continuing education. This study also assessed their confidence level that they would develop a GM food education plan, if not already included.

## Demographics

Among the collected sample of 123 respondents, 98 were considered "complete" in that they were eligible to participate in the survey (identified as a health educator and/or promoter) and completed more than 65% of the survey questions. Of the participants, most identified as white (72.4%) and female (83.7%). Approximately 30.6% identified as Protestant, 23.5% no religious preference, and 17.3% identified as Catholic. The majority of the respondents had a graduate degree with doctoral degree at 43.9% and master's degree at 40.8% of the population.

Participants (n = 98) were asked to identify their current health education field. The majority of participants identified as a health educator (50%), followed by other (24.5%), and public health educator (20.4%). Respondents were asked to clarify which settings they worked in (community, business, higher education, K-12 setting, health

services, federal/state, and other) with the option to choose more than one setting. Most respondents identified a college/university setting (71.4%) and a community setting (43.9%). Participants (n = 98) were asked to note their years worked as a health educator. 28.6% reported over 20 years of experience with a relatively even split between the remaining categories (see Table 1).

Table 1

*Frequencies and Percentages for Categorical Demographic Variables*

| - | *n* | % |
|---|---|---|
| Years Worked | | |
| 5 years or less | 25 | 25.5 |
| >5 - 10 | 22 | 22.4 |
| >10 - 20 | 23 | 23.5 |
| More than 20 years | 28 | 28.6 |
| Gender | | |
| Female | 82 | 83.7 |
| Male | 16 | 16.3 |
| Highest Educational Level | | |
| Bachelor's Degree | 9 | 9.2 |
| Master's Degree | 40 | 40.8 |
| Doctoral Degree | 43 | 43.9 |
| Other | 6 | 6.1 |

*Note. (n = 98)*

**Existing Tasks Related to Core Competency Content**

Participants were asked to identify whether they currently perform 5 tasks related to GM competencies into health promotion, mirroring 5 of the 7 areas of responsibility. These competencies were adapted from the ones created and adapted by Chen (2007). Results indicated that there were a higher percentage of participants who did not

currently perform the tasks (see Table 2). Even though the majority of health educators did not perform the 5 tasks, the task incorporated the most was "Task 3: Conducting a needs assessment for community-based genetically modified (GM) food education programs (10.2%.)"

Table 2

*Inventory of Existing GM Food Core Competency Tasks Content*

| GM Food Core Competency Tasks (N = 98) | Responses | Yes % | No % |
|---|---|---|---|
| Task 1: Translating complex genetically modified (GM) food information for use in community-based health education programs | 98 | 3.1 | 96.9 |
| Task 2: Developing a plan for incorporating genetically modified (GM) food into health education services by working with community organizations, GM food experts, and other stakeholders | 98 | 5.1 | 94.9 |
| Task 3: Conducting a needs assessment for community-based genetically modified (GM) food education programs | 98 | 10.2 | 89.8 |
| Task 4: Advocating for community-based genetically modified (GM) food education programs. | 98 | 5.1 | 94.9 |
| Task 5: Integrating genetically modified (GM) food components into community-based education programs. | 98 | 4.1 | 95.9 |

## Perceived Level of Confidence for GM Food Core Competencies

Five items were created to evaluate health educators' confidence in incorporating the 5 outlined GM food competencies. A 10-point scale was adopted from the Chen

(2007) self-efficacy scale to evaluate respondents' confidence to adopt the competencies. The scale ranged from 1 (0% confident) – 10 (100% confident), with the average response at a low confidence (3-5 range) (see Table 3). The highest confidence mean score of 5.70 out of 10 resulted from "Task 3: Conducting a needs assessment for community-based genetically modified (GM) food education programs."

Table 3

*Perceived Level of Confidence for Completing Competency Tasks*

| GM Food Core Competency | *N* | Mean | SD |
|---|---|---|---|
| Task 1: Translating complex genetically modified (GM) food information for use in community-based health education programs | 98 | 3.72 | 2.754 |
| Task 2: Developing a plan for incorporating genetically modified (GM) food into health education services by working with community organizations, GM food experts, and other stakeholders | 98 | 4.61 | 3.018 |
| Task 3: Conducting a needs assessment for community-based genetically modified (GM) food education programs | 98 | 5.70 | 2.961 |
| Task 4: Advocating for community-based genetically modified (GM) food education programs. | 98 | 5.03 | 2.823 |
| Task 5: Integrating genetically modified (GM) food components into community-based education programs. | 98 | 4.93 | 2.947 |

*Note.* Scale is scored 1-10 (1 = 0% confident and 10 = 100% confident).

**Descriptive Analysis for GM Knowledge, Perceived Compatibility, and Perceived Barriers**

The means and standard deviations of the continuous variables of interest are shown in Table 4. Participants' knowledge scores ranged from -11 to 11, with an average score of 6.46 (M = 6.46, SD = 2.69). Eleven True/False/Don't Know questions were adopted from Hallman et al. (2003) to measure respondents' knowledge of GM food. Each question received a score as don't know = 0, incorrect answer = -1, and correct answer = 1. The higher the score, the more correct answers. Compatibility between health educators' personal/professional beliefs and the adoption of GM food competencies were assessed for consistency. The higher the score, the higher the compatibility toward GM food competencies. A 4-point Likert scale measured eight items addressing perception of consistency among personal and professional beliefs toward GM food competencies. The answer choices range from Strongly Disagree = 1 to Strongly Agree = 4 and the minimum score of compatibility is 8 and the maximum score is 32. The average perceived compatibility was 21 (M = 21.61, SD = 4.67) (see Table 4).

Perceived barriers in adopting GM food competencies were evaluated using a six-item, 4-point Likert scale. The scale ranged from Not a Barrier at All = 1 to A Strong Barrier = 4, with the higher scores indicating more obstacles in GM food competency adoption. The mean score for perceived barriers was 16 (M = 15.81, SD = 3.42) (see Table 4).

Table 4

*Means and Standard Deviations of GM Knowledge, Perceived Compatibility, and Perceived Barriers*

| - | *N* | *M* | *SD* | Min | Max |
|---|---|---|---|---|---|
| GM Knowledge | 98 | 6.46 | 2.69 | -11 | 11 |
| Perceived Compatibility Between Professional/Personal Beliefs and GM Food Competencies | 98 | 21.61 | 4.67 | 8 | 32 |
| Perceived Barriers to Adopting GM Food Competencies | 98 | 15.81 | 3.42 | 6 | 24 |

The percentages and frequencies of perceived barriers to adopting GM food competencies into health education responsibilities are displayed in Table 5. The top barriers identified were lack of knowledge about GM food (82.7%), GM food is not a priority in my current work (81.6%), lack of time to add something new into my work (69.4%), and lack of knowledge about how to incorporate GM food into health promotion (66.4%). The barrier identified as the least challenging was incompatibility between GM food and my religious beliefs (8.2%).

Table 5

*Perceived Barriers to Adopting GM Food Competencies*

| Perceived Barriers | % | *f* |
|---|---|---|
| Incompatibility between GM food and my religious beliefs | 8.2 | 8 |
| Lack of knowledge about GM food | 82.7 | 81 |
| Lack of knowledge about how to incorporate GM food into health promotion | 66.4 | 65 |
| Lack of time to add something new into my work | 69.4 | 68 |
| GM food is not a priority in my current work | 81.6 | 80 |
| Having to deal with the public's mistrust of GM food information or technologies | 49 | 48 |

*Note*. A total of 98 participants responded to this question

**Communication Channels for GM Food**

Communication channels are "the process by which participants create and share information with one another in order to reach a mutual understanding" (Rogers, 1983, p. 17). In this study, communication channels consisted of mass media channels, interpersonal channels, and internet channels were assessed to measure how often (1 = Never to 5 = Very Often) health educators used these sources to learn about GM food. Eight items assessed this variable with a higher score indicating health educators are more likely to acquire GM food information from multiple communication channels (see Table 6). The mean scores for individual communication channels were around the same score (M = 2) with an overall communication score of 19 (M = 18.92, SD = 6.29). The

combined eight item scale ranged from 8 to 40, resulting in health educators not utilizing multiple communication channels to learn about GM food.

Table 6

*Communication Channels for Acquiring Information About GM Food*

| - | *N* | *M* | *SD* | Min | Max |
|---|---|---|---|---|---|
| Heard about GM food on TV? | 98 | 2.77 | .993 | 1 | 5 |
| Heard about GM food on the radio? | 98 | 2.22 | .969 | 1 | 5 |
| Heard about GM food in the newspaper? | 98 | 2.45 | .986 | 1 | 5 |
| Talked about GM food with your colleagues? | 98 | 2.32 | 1.01 | 1 | 5 |
| Discussed GM food at professional conferences? | 98 | 1.81 | 1.01 | 1 | 5 |
| Talked about GM food with those whom you educate (e. g. communities, students, and/or patients)? | 98 | 2.10 | 1.09 | 1 | 5 |
| Talked about GM food with your relatives and/or families? | 98 | 2.40 | 1.21 | 1 | 5 |
| Read about GM food on the internet? | 98 | 2.86 | 1.14 | 1 | 5 |

Note. Scale: 1 = Never, 2 = Not Very Often, 3 = Not Often, 4 = Often, 5 = Very Often

**Findings Related to Consumers' Dependencies on Media During Normal Times**

Respondents were asked to indicate how many hours per week they spent on media for personal, business, and/or entertainment use (see Table 7). The Internet was the medium most health educators used for gathering information at an average of 15 hours per week (M = 14.99, SD = 16.27). Television shows and movies were the second highest

in hours per week (M = 6.20, SD = 5.46). Respondents indicated that RSS feeds (M = 0.21, SD = 0.87) were used least often for gathering information. Trustworthiness of media providing information about any issue was also assessed and scored using a Likert scale from 1 to 5 (1 = "Strongly Disagree" and 5 = "Strongly Agree") (see Table 8). Respondents found newspapers (M = 3.11, SD = 0.92) to be the most trustworthy source for information and television shows and movies to be the least trustworthy (M = 2.31, SD = 0.99).

Table 7

*Hours per Week Spent on Media for Personal, Business, and/or Entertainment Use*

| Medium | *N* | *M* | *SD* | Range |
|---|---|---|---|---|
| Television (shows, movies) | 97 | 6.20 | 5.46 | 25 |
| Television (news channels) | 96 | 3.39 | 4.21 | 30 |
| Radio | 97 | 3.18 | 3.76 | 20 |
| Internet | 97 | 14.99 | 16.27 | 79.8 |
| Facebook | 97 | 4.65 | 7.18 | 50 |
| Twitter | 98 | 0.62 | 1.65 | 10 |
| Blogs | 98 | 0.52 | 1.36 | 8 |
| YouTube | 98 | 1.20 | 2.53 | 16 |
| RSS feeds | 98 | 0.21 | 0.87 | 7 |
| E-mail list subscriptions | 97 | 1.29 | 2.02 | 15 |
| Magazines | 98 | 0.80 | 1.48 | 7 |
| Newspapers | 98 | 1.50 | 2.77 | 15 |
| Other | 95 | 0.36 | 1.43 | 10 |

*Note*. (n = 98)

Table 8

*Trustworthiness of Media in Providing Information About Any Issue*

| Medium | *N* | *M* | *SD* |
|---|---|---|---|
| Television (shows, movies) | 98 | 2.31 | 0.99 |
| Television (news channels) | 98 | 3.00 | 1.04 |
| Radio | 98 | 3.10 | 1.04 |
| Internet | 98 | 3.06 | 1.03 |
| Facebook | 97 | 2.40 | 0.99 |
| Twitter | 97 | 2.51 | 0.98 |
| Blogs | 97 | 2.59 | 0.97 |
| YouTube | 97 | 2.54 | 0.87 |
| RSS feeds | 97 | 2.66 | 0.85 |
| E-mail list subscriptions | 97 | 2.97 | 0.97 |
| Magazines | 97 | 2.86 | 0.89 |
| Newspapers | 97 | 3.11 | 0.92 |
| Other | 97 | 2.76 | 0.73 |

*Note.* (n = 98). Scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

Overall, 54.1% of respondents (n = 96) indicated that media coverage of issues has changed their opinion and attitudes about an issue in a negative way, and 42.9% (n = 96) indicated that media coverage changed their opinion and attitudes about an issue in a positive way.

**Helpful Media Sources for Providing Information about GM Food**

Health educators were asked to identify which media sources they found helpful in providing information regarding GM food. The Internet was the medium most valued for gathering information on GM food (59.2%); with television news channels following at 32.7% (see Table 9). The least helpful media source identified was RSS feeds 4.1%.

Table 9

*Helpful Media Sources for Providing Information About GM Food*

| Medium | *n* | % |
|---|---|---|
| Television (shows, movies) | 96 | 9.2 |
| Television (news channels) | 96 | 32.7 |
| Radio | 96 | 20.4 |
| Internet | 96 | 59.2 |
| Facebook | 96 | 12.2 |
| Twitter | 96 | 7.1 |
| Blogs | 96 | 8.2 |
| YouTube | 96 | 6.1 |
| RSS feeds | 96 | 4.1 |
| E-mail list subscriptions | 96 | 25.5 |
| Magazines | 96 | 14.3 |
| Newspapers | 96 | 25.5 |
| Other | 96 | 20.4 |

*Note*. (n = 98, 2 participants did not answer this question).

**Overall Opinion Concerning GM Food Covered in Survey**

The last question in the survey asked respondents to identify their opinion toward issues concerning GM food that were addressed in the survey and was graded using a 5-item Likert scale (1 = "Don't Know" to 5 = "Extremely Strongly"). The majority of respondents indicated "Not at All Strongly" with 43.9% and "Somewhat Strongly" with 30% (n = 96). The least popular opinion "Extremely Strongly" resulted in 2%. If "Very Strongly" and "Extremely Strongly" are combined, the respondents indicate a 14.2% toward a stronger favorable opinion on GM food issues addressed in this survey.

## Perceived Level of Importance for GM Food

### Pearson Correlation for First Null Hypothesis- Rejected

A Pearson Correlation was computed to address the first null hypothesis: There will be no correlation between compatibility toward GM food and perceived barriers in adopting GM food competencies. Table 10 shows the Pearson correlation coefficients between these two groups. There was a negative correlation $r(98), = -.258, p < .05$ for frequencies of participants who indicated compatibility toward GM food and perceived barriers in adopting GM food competencies. Therefore, the first null hypothesis was rejected due to the relationships between the variables.

Table 10

*Pearson Correlation Coefficients Among Perceived Barriers and Compatibility*

| | | Perceived barriers to adopting GM food competencies |
|---|---|---|
| Compatibility toward GM food | Pearson correlation | -.258* |
| | Sig. (two-tailed) | .010 |
| | N | 98 |

Note. *Correlation significant at the 0.05 level (2-tailed).

### Pearson Correlation for Second Null Hypothesis- Accepted

A Pearson Correlation was computed to address the second null hypothesis: There is no correlation between knowledge of GM food and media exposure. Questions 18-28 asked participants True/False questions about GM food. Questions 59-61 and 66 asked participants how often they heard about GM food through different media sources. GM

knowledge scores were categorized into a grading system (high = 8.8 - 11, medium = 6.6 - 8.7, low = 6.5 <). There was no correlation *r* (98), = -.126, *p* > .05 for frequencies of participants who indicated mass media channels where they have acquired GM food information and knowledge grades. Therefore, the second null hypothesis was accepted. In addition, it is interesting to note that there was a negative correlation between hearing about GM food on TV and GM knowledge *r* (98), = -.241, *p* < .05.

**Analysis of Variance Among GM Knowledge and Self-Efficacy**

A one-way analysis of variance (ANOVA) was conducted to determine if GM knowledge differed on perceived confidence level (self-efficacy) of GM food education tasks. Results revealed an insignificant effect of GM knowledge on self-efficacy, F (97) = .226, *p* > .05. As shown in Table 11, participants who have higher GM knowledge scores do not have a higher self-efficacy in GM food education tasks compared to medium and low knowledge scores.

Table 11

*One-Way Analysis of Variance Among GM Knowledge and Self-Efficacy*

| - | N | M | SD | F | P |
|---|---|---|---|---|---|
| GM Knowledge Score | | | | | |
| High | 23 | 24.49 | 12.11 | .226 | >.05 |
| Medium | 33 | 24.88 | 12.60 | | |
| Low | 42 | 23.05 | 12.24 | | |

**Structural Equation Models for Media as a Mediator**

Table 12 demonstrates the interrelationships among the study variables. Pearson's product moment correlations were conducted to examine the relationships among all

scales. As shown in Table 12, importance in staying current in GM food information was negatively correlated with beliefs in compatibility ($r$ = -.379, $p$ < .01) and positively correlated with media coverage of GM food ($r$ = .303, $p$ < .01). Self-efficacy in GM education tasks was positively correlated with media coverage of GM food ($r$ = .202, $p$ < .05) and negatively correlated with perceived barriers in adopting GM food competencies ($r$ = -.248, $p$ < .05). Beliefs in compatibility was positively correlated with media coverage of GM food ($r$ = .213, $p$ < .05) and negatively correlated with perceived barriers in adopting GM food competencies ($r$ = -.340, $p$ < .01).

No correlation was found between self-efficacy in GM education tasks and importance in staying current in GM food information, beliefs in compatibility and self-efficacy in GM food tasks, perceived barriers in adopting GM food competencies and importance in staying current in GM food information, and lastly among media coverage of GM food and perceived barriers in adopting GM food education competencies.

Table 12

*Pearson's Product–Moment Correlations Between Scales*

| Variable | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1- Importance in staying current in GM food information | - | | | | |
| 2- Self-efficacy in GM education tasks | .124 | - | | | |
| 3- Beliefs in compatibility | -.379** | .039 | - | | |
| 4- Media covering GM food | .303** | .202* | .213* | - | |
| 5- Perceived barriers in adopting GM food competencies | -.165 | -.248* | -.340** | -.170 | - |

*Note. *p < .05, **p < .01.*

The bias-corrected bootstrapping method (5000 bootstrap samples) was used to test the direct and indirect effects of two of the three independent variables on perceived barriers through the mediator (media) in two separate models (See Figures 2 & 3). As shown in Table 13, the direct effect and total effect of media on perceived barriers was significant ($p < .05$). The effect sizes were (-.144, .000, -.155), respectively. It indicated that higher scores on compatibility were negatively associated with higher scores with perceived barriers. The indirect effects of compatibility on perceived barriers were not significant ($p > .05$). The direct and total effects of compatibility were significant ($p < .01$).

Table 13

*Standardized Direct and Indirect Effects of Current, Compatibility, and Media on Perceived Barriers*

| Effects | Direct effects | Indirect effects | Total effects |
|---|---|---|---|
| Compatibility → Media | .447 | | .447 |
| Media → Perceived Barriers | .174 | | .174 |
| Compatibility → Perceived Barriers | -.144** | .000 | -.155** |
| Current → Media | .476* | | .476* |
| Media → Perceived Barriers | .176 | | .176 |
| Current → Perceived Barriers | .227 | .073 | .206 |

*Note*. *$p < .05$, **$p < .01$

**Structural Equation Model for Perceived Barriers as a Mediator**

Pearson's product moment correlations were conducted to examine the relationships among all scales. As shown in Table 14, self-efficacy is positively correlated with GM in media ($r = .204$, $p < .05$). Trust in media sources is positive

correlated with self-efficacy ($r = .236$, $p < .05$). Compatibility is significantly correlated with GM in media ($r = .319$, $p < .01$) and trust ($r = .206$, $p < .01$). Perceived barriers had the largest negative correlations with GM in media ($r = -.344$, $p < .01$), self-efficacy ($r = -.279$, $p < .01$), compatibility ($r = -.205$, $p < .05$), and difficulty ($r = -.348$, $p < .01$). No correlation was found between trust and GM in media, compatibility and self-efficacy, and difficulty and self-efficacy, trust, and compatibility.

Table 14

*Pearson's Product–Moment Correlations Between Scales*

| Variable | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1- GM in Media | - | | | | | |
| 2- Self-Efficacy | .204* | - | | | | |
| 3- Trust | .113 | .236* | - | | | |
| 4- Compatibility | .319** | .068 | .206* | - | | |
| 5- Difficulty | .240* | .196 | -.029 | .027 | - | |
| 6- Perceived Barriers | -.344** | -.279** | .012 | -.205* | -.348** | - |

*Note. *p < .05, **p < .01.*

The bias-corrected bootstrapping method (5000 bootstrap samples) was used to test the direct and indirect effects of two of the four independent variables on self-efficacy through the mediator (perceived barriers) (See Figure 4). As shown in Table 15, the direct effect, indirect effect, and total effect of perceived barriers on self-efficacy was significant ($p < .05$). The effect sizes were (.254, .396, .375), respectively. It indicated that the indirect effect of GM communication on self-efficacy was positive ($p < .05$).

Difficulty and self-efficacy also had a positive indirect effect ($p < .05$). The table shows that the variable GM communication directly effects barriers ($p < .01$), barriers directly effects self-efficacy ($p < .05$), and GM communication indirectly effects self-efficacy ($p < .05$). The variable difficulty directly effects barriers and barriers directly effects self-efficacy ($p < .05$), with difficulty indirectly effecting self-efficacy ($p < .05$).

Table 15

*Standardized Direct and Indirect Effects of GM communication, Barriers, and Difficulty on Self-efficacy*

| Effects | Direct effects | Indirect effects | Total effects |
|---|---|---|---|
| GM communication → Barriers | -.100** | | -.100** |
| Barriers → Self-efficacy | -.024* | | -.024* |
| GM communication→ Self-efficacy | .254 | .396* | .375 |
| Difficulty → Barriers | -.106* | | -.106* |
| Barriers → Self-efficacy | -.024* | | -.024* |
| Difficulty → Self-efficacy | .327 | .393* | .396 |

*Note*. *$p < .05$, **$p < .01$

The first SEM (Figure 2) and the second SEM (Figure 3) have the same variables with different observed variables mediated. The third SEM (Figure 4) has new observed and latent variables, with a different mediator, perceived barriers. Confirmatory factor analysis for Figure 2 and Figure 3 established that the recursive models for current, compatibility, self-efficacy, media (consisting of TV, radio, newspaper, and internet), and perceived barriers fit the data perfectly ([$\chi 2$ (98) = 14.727, p < .05; CFI = 1.000 and RMSEA = .000). CFA for Figure 4 established that the recursive model for GM communication, perceived barriers, self-efficacy, trust, compatibility, and difficulty fit the data adequately ([$\chi 2$ (98) = 24.290, p < .05; CFI = .957 and RMSEA = .054).

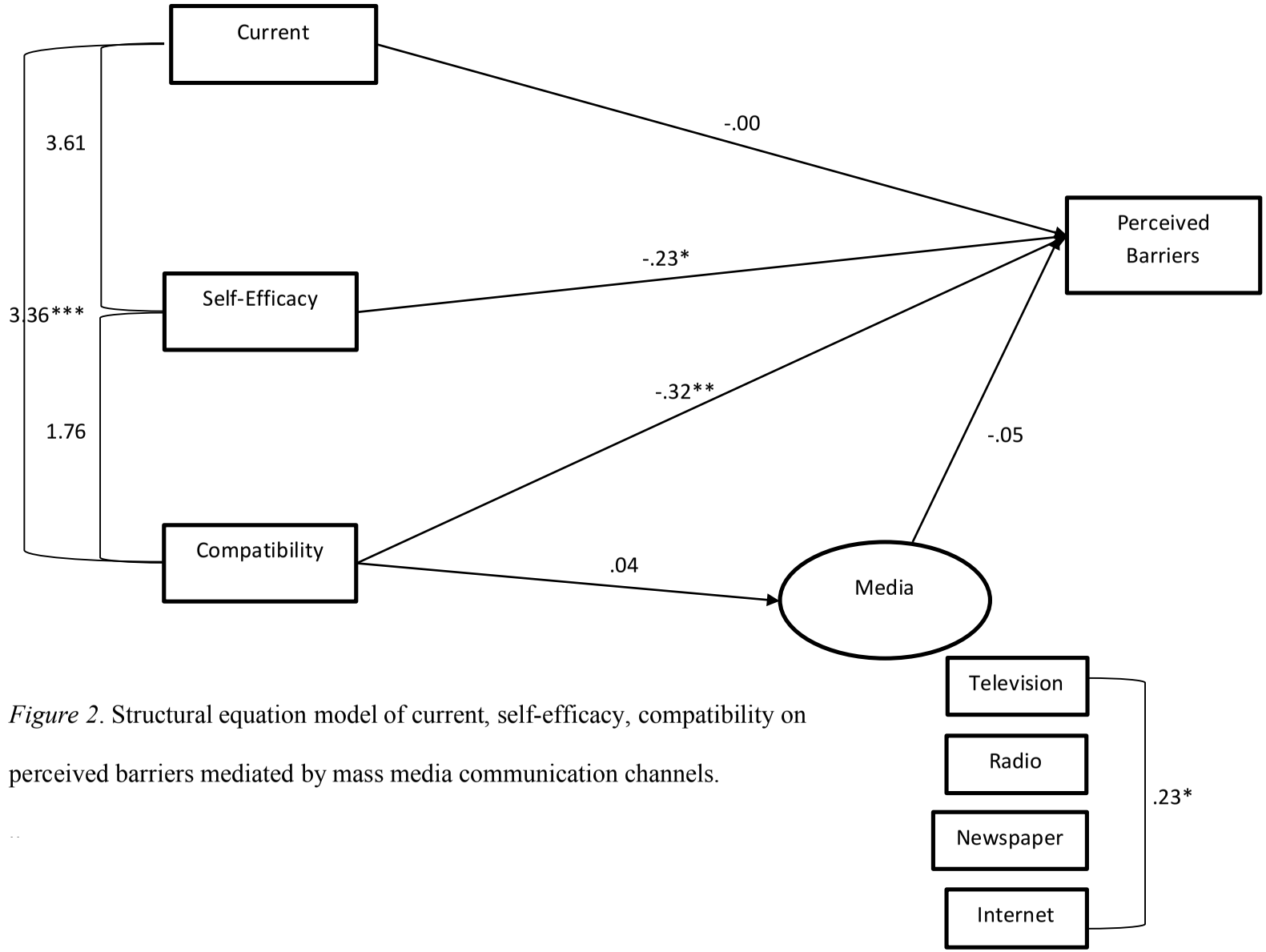


*Figure 2*. Structural equation model of current, self-efficacy, compatibility on perceived barriers mediated by mass media communication channels.

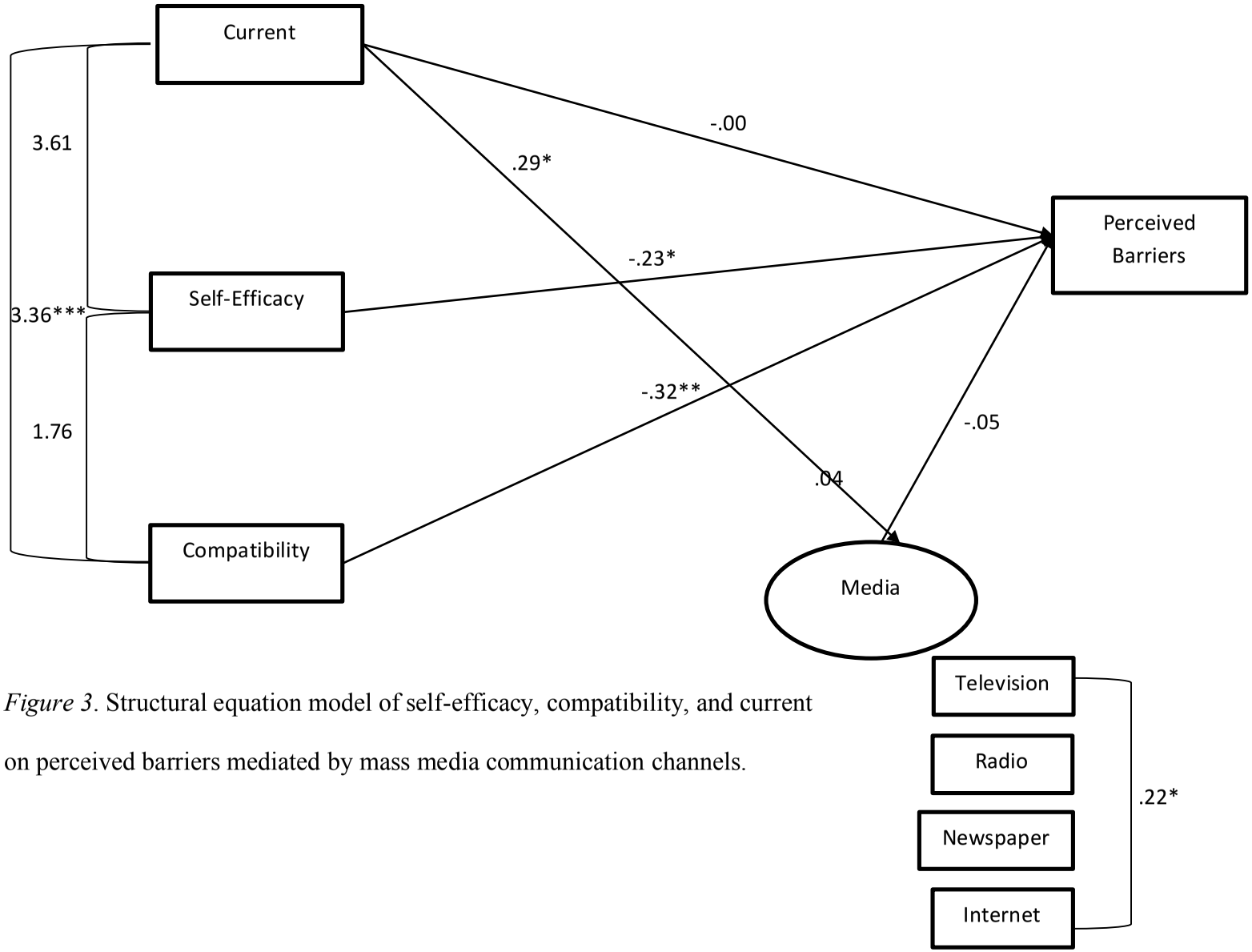


*Figure 3*. Structural equation model of self-efficacy, compatibility, and current on perceived barriers mediated by mass media communication channels.

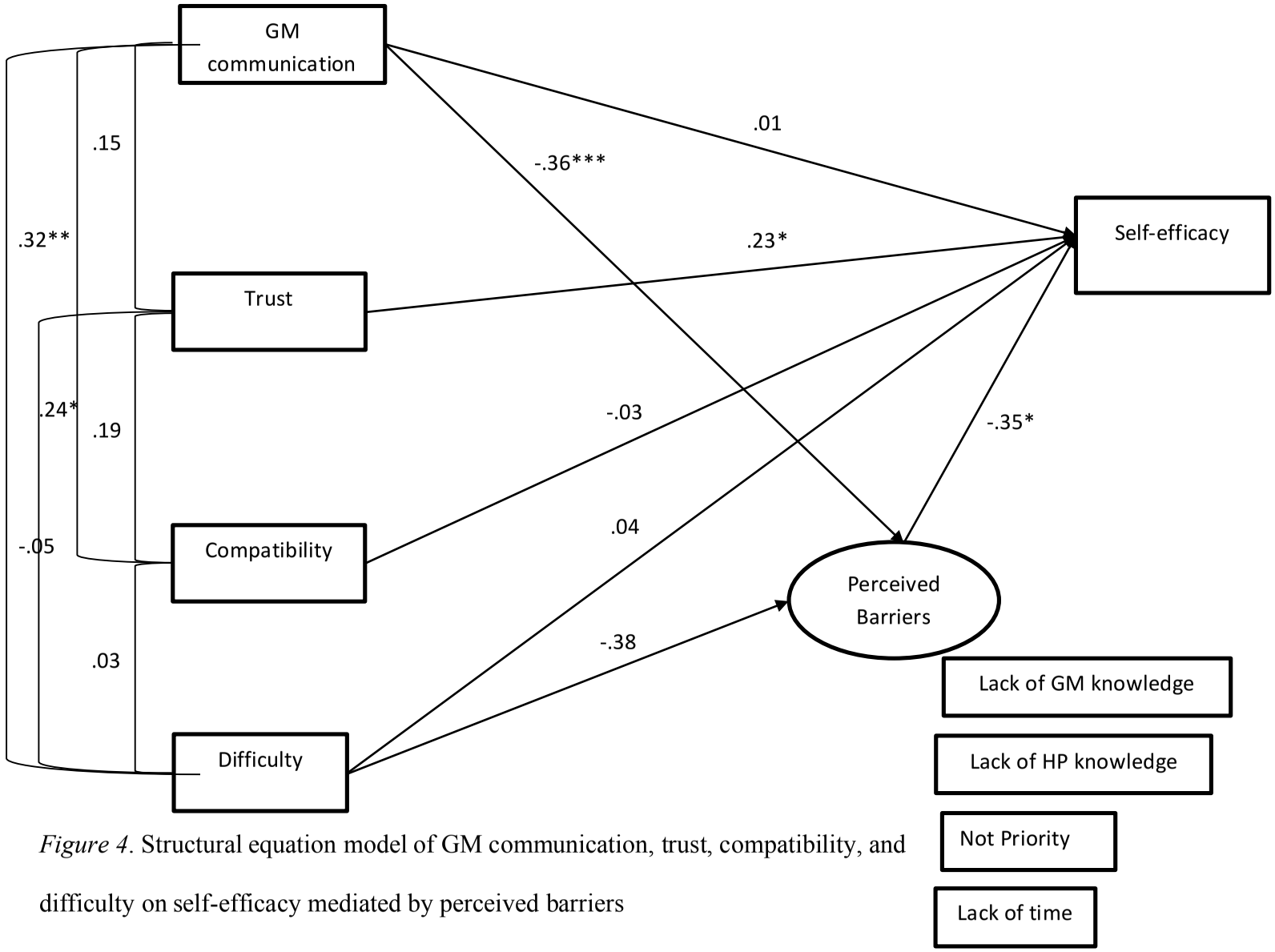


*Figure 4*. Structural equation model of GM communication, trust, compatibility, and difficulty on self-efficacy mediated by perceived barriers

## Summary

A preliminary analysis was conducted to examine health educators' knowledge of GM food and their current incorporation of GM food into health promotion practice. Frequencies and percentages obtained from survey responses were used to provide a description of the sample. Identifying where health educators were receiving their information about GM food was examined. The level of confidence for completing GM food education tasks was presented using percentages and a Likert response scale. The relationship between compatibility toward GM food and perceived barriers in adopting GM food competencies was examined using a Pearson correlation. As a result, the first null hypothesis was rejected. A Pearson correlation was used to examine the correlation between knowledge of GM food and media exposure. No correlation was found; thus, the second null hypothesis was accepted. Percentages and frequencies were used to report perceived barriers of incorporating GM food competencies into health promotion. Descriptive statistics were used to present communication channels health educators used for acquiring information on GM food, hours per week health educators used media sources for personal, business, and/or entertainment purposes, and trustworthiness of media on all issues. Frequencies and percentages were used to describe helpful media sources for providing information on GM food. Two SEMs were used to test the proposed mediator, media, and were found successful using different variables than previously hypothesized by the investigator. A third SEM was used to test a different mediator, perceived barriers, that also fit well. Lastly, an overall opinion Likert scale was

used to assess the overall attitude of health educators toward GM food topics addressed in the survey.

# CHAPTER V

# DISCUSSION, CONCLUSION, AND RECOMMENDATIONS

## Summary

The purpose of this study was to examine the knowledge health educators have regarding GM food and the likelihood that health educators would adopt GM food education. This was accomplished by utilizing three surveys and modifying them to fit the needs of this study and by having health educators respond to the survey. Another purpose of the study was to assess the current perceptions that health educators have toward GM food and to determine from where they receive their information about GM food. Media usage and dependency was the underlying subject for this survey, as health educators responded that they have received no formal education on GM food. Using an online survey design, this study not only assessed health educators' knowledge and compatibility in relation to GM food, but also their confidence level in five core competency tasks on GM food education. Participants were also asked to identify their perceived barriers in adopting GM food competencies. Descriptive statistics and Pearson correlations helped describe the findings and addressed the need for establishing GM food competencies.

## Discussion and Implications

### Demographics

A total of 123 health educators representing different health promotion settings participated in this study, with 98 participants completing the survey and thus qualifying for inclusion in the analysis. The HEDIR and SOPHE organizations were selected for recruitment because of their large health educator subscriber base. Current health promotion settings consisted of university/college, community, health care, government/federal, university health services, K-12, business/industry, and others. There was a relatively even split of years worked as a health educator, with 28 respondents reporting over 20 years. Most participants hold a doctorate degree (43.9%), followed by a master's degree (40.8%). All of the participants live in the Unites States and are subscribers of HEDIR or SOPHE that were conveniently selected for this study.

### Research Questions and Hypotheses

The first research question identified health educators' knowledge of GM food. Participants responded to a series of 11 True/False questions about GM food. Results revealed an overall low knowledge score on GM food for health educators (see Table 4). These findings were consistent with the previous literature concerning GM food knowledge among teachers, medical professionals, and students. The investigator's research revealed that health educators had no previous background or knowledge about GM food and those educators that did have prior knowledge were researching about GM food on their own. Health educators are responsible for relaying quality information to

those they represent and therefore need access to GM food information. The researcher proposes the addition of GM Food Competencies in order to create more resources for health educators and aid in proficiency of the topic. Competencies facilitate development and work as a guide for staff training, reference for professionals, and set a standard for proficiency. PHF (2009) surveyed public health practitioners that work at the Health Resources and Services Administration (HRSA) Public Health Training Centers (PHTCs) to determine how public health practitioners use core competencies. Practitioners cited competencies as "very helpful as a guide to what knowledge, skills and abilities we should have and lend themselves to ready identification of gaps and training needs" (PHF, 2009, p. 1). The New York City Department of Health and Mental Hygiene cited "it would be useful to have a way to more specifically relate competencies to specific job requirements," supporting the development of education-specific competencies (p. 4). With GM Food Competencies health educators will have a reliable resource for creating GM food education plans and references with accurate data regarding risks/benefits associated with GM food.

The second research question addressed health educators' perceptions of compatibility between GM food and their beliefs/values. Findings demonstrated that their perceived compatibility was less than favorable. This lack of compatibility could be explained by the fact that most health professionals had an overall opinion of "not at all strongly" and "somewhat strongly" interest in the GM food issues addressed in the survey, which could result in less compatibility with GM food because they are less

concerned with GM food issues. Another possibility for their moderate compatibility could be their lack of exposure to GM food education in their field and the lack of communication regarding GM food among colleagues. Whether participants are less concerned with GM food effects or a perceived lack of GM Food Competencies in health education/promotion was not observed. However, consumer reports have shown that they are concerned with GM food and as such health educators need to be aware of said concern in order to effectively provide education (Qin & Brown, 2008). Consumers are concerned over GM food and "hold mixed views about scientists connected with GM foods" (PEW Research Center, 2016, para. 18). The Pew Research Center (2016) found 43 percent of respondents trusted scientists "some," yet the NAP (2016) reported an overall consensus of safety among the scientific community. The argument to be made is consumers need a trusted source for information that can relay scientific information thereby providing evidence-based research over GM food safety. Health educators "depend upon being perceived as credible, with the creation and maintenance of images of trustworthiness and expertise occurring more often by intention than accident and dependent upon effective communication," which allows more open dialogue between health educators and consumers (NAP, 2003, p. 73). One example of why consumer concerns should be addressed by health educators is dietary choices. If consumers cannot afford organic foods and their conventional foods have been genetically modified this could disrupt their dietary choices and further escalate the poor Westernized diet. Hamill (2002) attributes the Western diet, high intake of dietary fat and a low intake of dietary

fiber, to colon cancer. Brewer and Rojas (2008) found that a third of their 450 study participants reported they would not purchase GM foods and Wei and Brown (2008) found women participants were less likely to by GM salmon than men with women indicating a lack of trust in GM salmon safety. The International Service for the Acquisition of Agro-Biotech Applications (ISAAA) (2017) released a list of the current foods that are genetically modified: alfalfa, apple, Argentine canola, bean, carnation, chicory, cotton, creeping bentgrass, eggplant, eucalyptus, flax, maize, melon, papaya, petunia, plum, Polish canola, poplar, potato, rice, rose, soybean, squash, sugar beet, sugarcane, sweet pepper, tobacco, tomato, and wheat. Much of the crops listed are essential for dietary nutrients such as fiber, vitamins, and minerals. Consumers have already indicated GM food affects their purchase choices and as GM food applications grow health educators need to be ready to properly educate consumers on GM food.

The third research question focused on where health educators are acquiring their information on GM food. The communication channels presented were: TV, radio, newspaper, Internet, speaking with colleagues, discussions at conferences, speaking with those they educate, speaking with relatives. The channel least used for acquiring information on GM food was professional conferences, suggesting that GM food has not been addressed as a health education competency. The researcher infers that health educators were not communicating about GM food because they reported a low self-efficacy in GM food education tasks. Bandura (2004) reports self-efficacy as the individuals' beliefs determine how obstacles are viewed and thus low self-efficacy

creates an obstacle for GM food communication. The Seven Areas of Responsibility provide a foundation for health educators that acts as a toolkit to help guide health educators in program planning. The Public Health Core Competencies provide a checklist for proficiency among health educators as well as a guideline for their reference in their fieldwork. A proposal to create the same foundation for this new area of public health is for GM Food Competencies to be adopted by health educators to improve self-efficacy in GM food education. To create interest among health educators in GM Food Competencies the topic of GM food needs to be addressed among professional channels and conferences in order to facilitate GM food competency adoption. The Centers for Disease Control and Prevention (CDC) emphasized ongoing professional development and training for teachers to help implement a new curriculum or strategies that require new skills in teaching or assessment as a key characteristic in creating an effective health education curriculum (CDC, 2015a). The NAP (2003) wrote "the role of public health in the daily lives of US citizens has become increasingly prominent at the same time that evidence of gaps in the training of public health professionals has emerged," and this reiterates the importance of GM Food Competencies and the relationship interpersonal channels in communication influences health education adoption (p. 72).

The first null hypothesis that guided this study stated the following: There will be no correlation between compatibility toward GM food and perceived barriers in adopting GM Food Competencies. The response categories were between health educators who perceive compatibility toward GM Food Competencies and perceived barriers to adopting

GM Food Competencies. Findings supported the rejection of the null hypothesis with a negative correlation. In other words, as compatibility increases, perceived barriers decrease and vice versa. As a health educator, part of their responsibility is to address perceived barriers among a population. Perceived barriers are a construct in the Health Belief Model (HBM) that is defined as the individual's own evaluation of the obstacles in the way of him/her adopting a new behavior (Glanz, Rimer, and Viswanath, 2008). Janz and Becker (1984) state perceived barriers as the most significant in determining behavior change. To address the health educators' perceived barriers toward GM Food Competencies, time and priority, competencies must be adopted by health organizations and evidence-based practice must be made available to health educators and offered as continuing education credits (CEUs) for health education certifications. Other popular perceived barriers among respondents was lack of knowledge about GM food and lack of knowledge on how to promote GM food education. The CDC (2015a) notes an effective curriculum "is implemented by teachers who have a personal interest in promoting positive health behaviors, believe in what they are teaching, are knowledgeable about the curriculum content, and are comfortable and skilled in implementing expected instructional strategies" (para. 16). Each of the above perceived barriers can be addressed by creating GM Food Competencies to support GM food knowledge acquisition, both for GM food knowledge and knowledge for implementing GM food education practices. The researcher also suggests that adding GM food education into

CEU credits for certification renewals like CHES can help introduce health educators to the topic and reward their effort in continuing education.

The second null hypothesis used Pearson correlation to indicate the relationship between GM knowledge and media. Specifically, this involved mass media channels where health educators have heard about GM food and their knowledge scores were graded on a scale (high, medium, low). There was no correlation between media and GM knowledge. Findings supported the acceptance of the null hypothesis. Though there was no correlation with the combined mass media channels, separately there was a correlation between TV and GM knowledge. A negative correlation was found to indicate that hearing about GM food on TV resulted in lower GM knowledge scores. In today's TV, there are news stories about falsified data reporting and a growing lack of trust among the public and news channels, with this relationship among TV and low GM knowledge exhibiting the same outcome, it is important for the public and health educators to have trustworthy access to information, one of which includes GM food. Comparing the effect TV had on health educators, one can assume a similar effect on the public, thus creating a gap in knowledge regarding GM food. A health educator is responsible for creating an effective pathway of resources and information for the intended population, in this case those that are wary or lack knowledge of GM food, and needs to participate in evidence-based practice to create an effective communication channel.

Continuing the exploration of health educators' confidence level in completing GM food education tasks, sometimes referred to as self-efficacy, the fourth research

question was “What are health educators’ confidence levels in performing GM food education tasks?” The investigator was interested in how many health educators have incorporated GM food into health promotion and how confident they were in this implementation. Most health educators reported not previously completing any of the five tasks, with a lower self-efficacy, overall. The investigator suggests from the literature that no prior experience in GM food health promotion affects the self-efficacy of GM food education tasks. Lack of knowledge about GM food was thought to be another reason for the low self-efficacy scores among participants. When observing the score of the GM knowledge and self-efficacy, the researcher can conclude that respondents scored low in GM knowledge and reported low self-efficacy, thus identifying a need to increase GM knowledge and assess a possible change in self-efficacy. Another possible way to improve the self-efficacy scores of the health educators is by the adoption of GM Food Competencies among public health organizations, like the CDC. The CDC (2015b), specifically the Chronic Disease Prevention and Health Promotion Center, values a commitment to “base all public health decisions on the highest quality scientific data, openly and objectively derived” and would be a great platform for acknowledgement of GM Food Competencies (para. 3).

The third null hypothesis tested whether media is a mediator for knowledge and confidence level toward GM food among health educators. The proposed mediator model did not work for this study, but three new mediator models (SEMs) were created from the variables to measure the confidence level in adopting GM food education tasks.

The variable GM knowledge was dropped in the new SEMs and the mediator was media for two models and perceived barriers for one model. The media mediator was simplified from mass media channels and interpersonal channels to mass media channels only (TV, radio, newspaper, and Internet). Perceived barriers were also simplified to lack of GM food knowledge, lack of knowledge for GM food health promotion, not a priority, lack of time, while leaving out lack of compatibility with religious beliefs and dealing with the public's mistrust. The barriers chose reflected professional perceived barriers to which every participant responded. Media was a mediator for a) compatibility toward GM food and b) perceived barriers in GM Food Competencies adoption, and perceived importance in staying current on GM food information and perceived barriers in GM Food Competencies adoption.

**Theoretical Exploration**

This study incorporated SEMs to explore the influence of the media dependency theory. The theory has three constructs: cognitive effects, affective effects, and behavioral effects of media (information gathering, processing, and delivery) (Ball-Rokeach & DeFleur, 1976). To examine the first construct, participants were asked 11 True/False questions on GM food to obtain GM food knowledge. Participants were also asked from which media channels they have heard or read about GM food. Most respondents did not spend time seeking information about GM food but have heard about it through TV, radio, newspaper, or Internet. The average score for GM knowledge among participants was ranked medium, with roughly six correct responses out of a total

of 11. These two variables support the media dependency theory's cognitive alteration resulting from insufficient or incorrect information. Though health educators have heard of GM food, they are presumably not receiving sufficient information from sources and scored low on the GM knowledge questions. Another cognitive effect that was examined was values, assessing participants' perceived compatibility with GM food through questions about beliefs and values and examining the influence media has on compatibility. This shows some compatibility, but with a relatively low average score. Examining media effects on feelings, or the affective effect, media trustworthiness was assessed using a Likert scale for individual media channels. On average, health educators found TV, radio, newspapers, and Internet to be the most trustworthy, while social media resources was not indicated as trustworthy. Lastly, behavioral effects of media dependency were assessed measuring participants' perceived barriers in adopting GM Food Competencies. About 50% of health educators identified "Lack of knowledge about GM food," "Lack of knowledge about how to incorporate GM food into health promotion," "Lack of time to add something new into my work," "GM food is not a priority in my current work," and "Having to deal with the public's mistrust of GM food information or technologies." Another behavioral effect was measured in self-efficacy through examining confidence levels in adopting GM food education tasks.

## Future Implications for Health Educators

The researcher observed the following: health educators reported low knowledge about GM food, low self-efficacy, and low knowledge on implementing GM food into

health promotion. This observation suggests the need for organizational support for GM Food Competencies and continuing education within the health education field. Health educators are responsible for integrating evidence-based practice in their health education program planning and implementation and the results of this study confirmed a lack of GM food health education practice and low confidence of health educators in applying GM Food Competencies in the future. There is a need for health educators to create GM food education plans and pave the way for future program adoption and to also provide the missing evidence-based practice. Health educators need expert opinion regarding GM food safety and benefits, access to external scientific evidence of GM food safety and benefits, and perspectives of the target population. The literature review reviewed the contrasting opinion of the general public regarding GM food and the need to provide sound education on GM food. This study investigated where health educators learn about GM food and how they perceive GM food and found that many do not receive education regarding GM food because it is not a part of their job description or research interest. The researcher proposes if GM Food Competencies are adopted and health organizations provide continuing education credits for GM food education, health educators or organizations will add GM food to the job description and/or research interest.

The more a community fears the unknown, the more likely GM technology will not be accepted. Pew Research Center (2016) reported US adults feel GM foods create problems for the environment and lead to health problems for the population as a whole,

creating a great opportunity for health educators to incorporate GM food into their health topics and serve as a resource for the general public.

## Proposed GM Food Competencies for Public Health

There are no current GM Food Competencies in public health, health education, or health promotion. Below, the researcher proposed GM Food Competencies to be incorporated into health education/promotion based off of the interpretation of the data and to help address the need for reliable and accurate information regarding GM food technology and its application within communities.

I. Demonstrate knowledge of GM food technology and its impact on the food system.

II. Develop a GM food education plan to help inform the community about current GM food evidence from research and trusted resources for GM food questions.

III. Communicate evidence-based research on GM food and how it influences personal health and environmental health.

IV. Recognize different cultural precautions toward GM food and prepare evidence-based support.

V. Inform other health professionals and trusted community members about reliable GM food resources and applications, and provide information on GM food.

VI. Describe evidence in the development of a GM food education plan and the limitations.

VII. Provide government agencies with authority to address GM food health needs.

VIII. Recognize ethical, legal, and policy issues related to GM food.

The above proposed GM Food Competencies were forwarded by the researcher to the CDC for feedback, however, the CDC reported no staff with appropriate expertise in the investigated area to provide feedback and referred the researcher to the FDA (personal communication, February 2, 2017). Following the CDC communication, the researcher has since contacted the FDA and WHO and awaits feedback on the proposed competencies.

The GM Food Competencies were designed to follow a similar construct of the Seven Areas of Responsibility (NCHEC, 2015b).

**Area I: Assess Needs, Assets and Capacity for Health Education**

Demonstrate knowledge of GM food technology and its impact on the food system, GM Competency I, correlates with the first area of responsibility and the following subcategories:

- 1.2- Access existing information and data related to health
- 1.2.6- Determine the validity of existing data
- 1.6.4- Assess social, environmental, political, and other factors that may impact health education/promotion.

Communicate evidence-based research on GM food and how it influences personal health and environmental health, GM Competency III, also correlates with the following subcategories in Area I:

- 1.1.1- Define the priority population to be assessed
- 1.2.3- Review related literature
- 1.4.2- Identify and analyze factors that impact health
- 1.6.5- Analyze the capacity for providing necessary health education/promotion
- 1.7.1- Synthesize findings
- 1.7.4- Develop recommendations for health education/promotion based on assessment findings
- 1.7.5- Report findings

**Area II: Plan Health Education**

Develop a GM food education plan to help inform the community about current GM food evidence from research and trusted resources for GM food questions, GM Competency II, compliments the second area of responsibility, Area II:

- 2.3.3- Apply principles of evidence-based practice in selecting and/or designing strategies/interventions
- 2.4- Develop a plan for the delivery of health education/promotion
- 2.5.2- Develop plans and processes to overcome potential barriers to implementation

**Area III: Implement Health Education**

Recognize different cultural precautions toward GM food and prepare evidence-based support, GM Competency IV, relates to the following subcategories in Area III:

- 3.2.4- Develop training using best practices
- 3.3.4- Apply principles of diversity and cultural competence in implementing health education/promotion plan

**Area IV: Conduct Evaluation and Research Related to Health Education**

Describe evidence in the development of a GM food education plan and the limitations, GM Competency VI, comprises of the following Area IV subcompetencies:

- 4.1- Develop evaluation plan for health education/promotion
- 4.2- Develop a research plan for health education/promotion
- 4.2.3- Conduct search for related literature
- 4.6.5- Identify limitations of findings
- 4.6.8- Develop recommendations based on findings
- 4.7.4- Incorporate findings into program improvement and refinement

**Area V: Administer and Manage Health Education**

Inform other health professionals and trusted community members about reliable GM food resources and applications, and provide information on GM food, GM Competency V, addresses subcompetencies in Area V.

- 5.2- Manage technology resources
- 5.3.5- Elicit feedback from partners and other stakeholders
- 5.4.3- Create a rationale to gain or maintain program support
- 5.5.2- Analyze an organization's culture to determine the extent to which it supports health education/promotion
- 5.6.5- Recruit staff members and volunteers for programs

**Area VI: Serve as a Health Education Resource Person**

Provide government agencies with authority to address GM food health needs, GM Competency VII, compliments Area VI with the following subcompetencies:

- 6.1.2.- Identify valid information resources
- 6.1.4- Adapt information for consumer
- 6.3.2- Establish advisory/consultative relationships
- 6.3.4- Evaluate the effectiveness of the expert assistance provided
- 6.3.5- Apply ethical principles in consultative relationships

**Area VII: Communicate and Advocate for Health and Health Education**

Recognize ethical, legal, and policy issues related to GM food, GM Competency VIII, reflects the last Area of Responsibility, Area VII, with these subcompetencies:

- 7.2.1- Identify current and emerging issues requiring advocacy
- 7.2.9- Lead advocacy initiatives related to health

- 7.3- Influence policy and/or systems change to promote health and health education
- 7.4.10- Develop materials that contribute to the professional literature

## Diffusion of GM Food Competency Adoption

### Organization

As proposed earlier, the CDC would be a great early adopter of GM Food Competencies. Rogers (1983) states "diffusion occurs within a social system, because the social structure of the system affects the innovation's diffusion in several ways" (p. 24). The social system can "facilitate or impede the diffusion of innovations in the system," which makes it important that the CDC first adopts the GM Food Competencies in order for health educators to later adopt them (p. 25). The CDC is comprised of many divisions that impact public health; the following are examples of a few: Division of Community Health, Adolescent and School Health, Healthy Schools, Workplace Health Promotion, and Public Health Genomics. The CDC could incorporate the GM Food Competencies into one of their existing public health programs and provide a baseline for health educators to access credible information, evidence-based and peer-reviewed research, and toolkits for guidelines on how to teach communities about GM food safety.

### Community

At the community level, change agents need to be identified in order for the GM Food Competencies to be adopted by other health educator organizations and programs. Change agents "target the most elite and innovative opinion leaders and the innovation

will trickle-down to non-elites" (Rogers, 1983). One possibility for other public health organizations to adopt GM Food Competencies is to create GM Food Competency courses and education programs on GM food for health organizations, like SOPHE, to adopt and offer continuing education opportunities. For example, SOPHE provides training courses partnered with the CDC where health educators can access educational resources and receive CEUs. CDC Public Health Literacy Training is a program available in SOPHE (2017) resources that direct users to the CDC course and provides a link for continuing education (CE) credit request/reporting and can be directed towards current certifications held within public health, like the CHES. A similar course program for GM food needs to be created.

**Health Educator**

Health educators are "essential to the health and well-being of individuals and communities to increase access to health services and avoid rising health care costs." (APHA, 2015, para. 2). In other words, health educators help bridge the gap between the public and available resources. Health educators are seen as opinion leaders in the diffusion of GM Food Competencies. Rogers (1983) defines opinion leadership as "the degree to which an individual is able to influence other individuals' attitudes or overt behavior informally in a desired way with relative frequency" (p. 27). GM food creates uncertainty among the consumer population and leaves them seeking for information. This information seeking provides an opportunity for health educators to reduce uncertainty by helping consumers process the information. Specifically, opinion

leadership is “earned and maintained by the individual's technical competence, social accessibility, and conformity to the system's norms” thereby supporting the need for hierarchical support that trickles down to the more accessible scientific group, health educators (Rogers, 1983, p. 27). Health educators are expected to exhibit technical competence, be socially accessible to communities, and be able to comply with socially accepted standards- especially cultural acceptance. The health educator is the last link in the chain of command in GM Food Competency adoption and will help deliver evidence-based information to consumers.

## Conclusion

The literature review and findings of this study support a need to provide accurate information on GM food and to incorporate GM Food Competencies into Public Health. This study also contributed to filling a gap in information concerning health educators’ knowledge of GM food and their perceptions of GM food, both personally and professionally as related to their current field. Most importantly, the study identified where health educators are receiving their information on GM food and which sources they trust for information regarding any issue. Another important outcome of this study was an understanding of the media’s influence on their perceived barriers in adopting GM Food Competencies and how those perceptions influenced their self-efficacy. Health educators perceived high levels of barriers, which could indicate a need for GM Food Competencies in health education. The ultimate goal of this study was to find a way to address the public mistrust of GM food through health promotion and to create an

opportunity for implementing GM Food Competencies in order to properly educate the lay population on the advantages and disadvantages of GM food. The results demonstrated a low self-efficacy for performing GM food education tasks among health educators, but also low levels of knowledge about GM food; more accurate GM food education could provide a greater self-efficacy among health educators in GM food health promotion. Lastly, this study demonstrated the likelihood of GM Food Competencies being used in the development of a GM food education plan among health educators/promoters.

## Limitations and Recommendations for Future Studies

A number of limitations were identified in this study. A small convenience sample was used. Therefore, the power analysis was set at .80, with the intended minimum sample size of 105 participants. After data clean-up, the number of qualifying participants decreased from 123 to 98. To strengthen the power of the mediation analysis, the bootstrapping method was used to calculate a sample size of 5000. A larger sample size is recommended for a better representation of the population and for better external validity.

The data collection method limited the number of potential participants to those that completed the online survey. According to SurveyGizmo, the average response rate for online surveys is 10-15% (SurveyGizmo, 2017). The investigator did not have access to participant e-mails and was dependent on the HEDIR and SOPHE organizations to distribute the survey link. The recruitment e-mail was not sent directly to SOPHE

members, but advertised in a bulletin, and may have been overlooked by potential respondents. Furthermore, spam filters could have prevented the recruitment e-mail from entering the potential participants' e-mail account. The investigator recommends that future researchers seek IRB approval for obtaining the participants' e-mail addresses in future studies so that there is more control over the release and collection of data.

An additional recommendation for future studies is to investigate health educators' desire to learn about GM food and their openness to develop and/or participate in GM food education. Findings from this research indicate that the GM food issues addressed in this study were not very important to respondents (n = 96), with 43.9% indicating "not at all strongly" and 30% indicating "somewhat strongly". These results were interesting in light of an ABC News (ABC News, 2016) poll of a random national sample of 1,024 adults, which found that 52% of respondents believe GM food is unsafe and an additional 13% are unsure. These results serve to further demonstrate the gap that exists between health promotion and GM Food Competencies.

REFERENCES

ABC News. (2016). *Poll: Skepticism of genetically modified foods*. Retrieved from http://abcnews.go.com/Technology/story?id=97567&page=1

American Council on Science and Health. (2016). Florida votes "yes" for science. Retrieved from http://www.acsh.org/news/2016/11/22/florida-votes-yes-science-10431

American Public Health Association (APHA). (2014). *What is public health?* Retrieved from http://apha.org/what-is-public-health

APHA. (2015). *The role of health education specialist in a post-health reform environment.* Retrieved from https://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2016/01/27/13/58/role-of-health-education-specialists

Ball-Rokeach, S., & DeFleur, M. (1976). A dependency model of mass-media effects. *Communication research*, 3(1), 3- 21.

Bandura, A. (2004). Health promotion by social cognitive means. *Health Education & Behavior*, 31(2), 143-164. DOI: 10.1177/1090198104263660.

Barnes, M., Giles, M., Neiger, B., Thomsen, S., & Thackeray, R. (2003). Media relations for health educators: The inside story about the news media. *American Journal of Health Education*, *34*(2), 72-77.

Benbrook, C. (2012). Impacts of genetically engineered crops on pesticide use in the U. S. - The first sixteen years. *Environmental Sciences Europe,* 24(24), 1- 13.

Berry, E. (2016, February). Big changes in big food. *Eating Well.*

Borgerding, L., Sadler, T., & Koroly, M. (2013). Teachers' concerns about biotechnology education. *Journal of Science Education And Technology*, 22(2), 133-147.

Brewer, M., & Rojas, M. (2008). Consumer attitudes toward issues in food safety. *Journal Of Food Safety*, *28*(1), 1-22. doi:10.1111/j.1745-4565.2007.00091.x

Brookes, G. & Barfoot, P. (2010). Global impact of biotech crops: Environmental effects , 1996- 2008. *AgBioForum*, 13(1), 76- 94.

Brown, J., & Ping, Y. (2003). Consumer perception of risk associated with eating genetically engineered soybeans is less in the presence of a perceived consumer benefit. *American Dietetic Association*, 103(2), 208- 214. Doi: 10.1053/jada.2003.50029.

Centers for Disease Control and Prevention (CDC). (2015a). *Characteristics of an effective health education curriculum*. Retrieved from https://www.cdc.gov/healthyschools/sher/characteristics/

CDC. (2015b). *About the center*. Retrieved from https://www.cdc.gov/chronicdisease/about/index.htm

CDC. (2016). *Zika virus*. Retrieved from https://www.cdc.gov/zika/about/index.html

Charanza, A. (2011). *Consumers' dependency on media for information about food safety incidents related to the beef industry*. Retrieved from ProQuest Digital Dissertations.

Chen, L. (2007). *An assessment of health educators' likelihood of adopting genomic competencies for the public health workforce*. Retrieved from ProQuest Digital Thesis. (UMI 3270321).

China Daily. (2013). *Imported GM soybeans flood Chinese market*. Retrieved from http://www.chinadaily.com.cn/food/2013-10/29/content_17066007.htm

Chipotle. (2015). *Food with integrity: G-m-over it*. Retrieved from http://chipotle. com/gmo

Chopra, T. (2015). Broken promises. *Alive: Canada's Natural Health & Wellness Magazine*, (391), 63-67.

Chow, J., Klein, E., Laxminarayan, R. (2010). Cost-effectiveness of ''golden mustard'' for treating vitamin A deficiency in India. *PLoS ONE*, 5(8), e12046. doi:10.1371/journal. pone.0012046.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd Ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Colicchio, T. (2014). Sign my petition. Retrieved from https://twitter.com/tomcolicchio/status/535863230745174016

Consumer Reports. (2016). *Labels on genetically modified food coming soon: Vermont GMO labeling law prompts change in the industry*. Retrieved from http://www. consumerreports.org/gmos/labels-on-genetically-engineered-food-coming-soon/

Council for Biotechnology Information. (2017). *GMO answers*. Retrieved from https://gmoanswers.com

Council on Education for Public Health (CEPH). (2015). *About*. Retrieved from http://ceph. org/about/#

Council on Linkages Between Academia and Public Health Practice (Council on Linkages). (2014). *Core competencies for public health professionals*. Retrieved from http://www.phf.org/resourcestools/Documents/Core_Competencies_for_Public_Health_Professionals_2014June.pdf

Diels, J., Cunha, M., Manaia, C., Sabugosa-Madeira, B., & Silva, M. (2010). Association of financial or professional conflict of interest to research outcomes on health risks or nutritional assessment studies of genetically modified products. *Food Policy,* 36(2011), 197-203. Doi: 10.1016/j.foodpol. 2010.11.016.

Dodo, H., Konan, K., Chen, F., Egnin, M., & Viquez, O. (2008). Alleviating peanut allergy using genetic engineering: The silencing of the immunodominant allergen Ara h 2 leads to its significant reduction and a decrease in peanut allergenicity. *Plant Biotechnology Journal*, *6*(2), 135-145. doi:10.1111/j.1467-7652.2007.00292. x.

Erdfelder, E., Faul, F., & Buchner, A. (1996). G*POWER: A general power analysis program. *Behavior Research Methods, Instruments, & Computers*, 28(1-11), 175-191.

European Union (EU). (2013). *A definition of biotechnology*. Retrieved from http://ec.europa. eu/enterprise/sectors/biotechnology/what-is-biotechnology/definition/index_en.htm

EU. (2014a). *The contribution of biotechnology to Europe's industry sectors*. Retrieved from http://ec.europa.eu/enterprise/sectors/biotechnology/what-is-biotechnology/contribution/index_en.htm

EU. (2014b). *Legislation on GMO cultivation*. Retrieved from http://ec.europa.eu/food/plant/gmo/legislation/index_en.htm

EU. (2014c). *New EU approach*. Retrieved from http://ec.europa.eu/food/plant/gmo/legislation/future_rules_en.htm

EU. (2014d). *Existing rules on GM food & animal feed*. Retrieved from http://ec.europa.eu/food/plant/gmo/legislation/gm_food_animal_feed_en.htm

European Food Safety Authority (EFSA). (2010). Scientific opinion on the assessment of allergenicity of GM plants and microorganisms and derived food and feed. *EFSA Journal*, 8(7), 1700.

European Policy Evaluation Consortium (EPEC). (2011). *Evaluation of the EU legislative framework in the field of cultivation of GMOs under directive*

*2001/18/EC and regulation (EC) NO 1829/2003, and the placing on the market of GMOs as or in products under directive 2001/18/EC*. Final Report.

Fagan, J., Antoniou, M., & Robinson, C. (2014). *GMO myths and truths*. Great Britain: Earth Open Source.

Falkner, R. (2007). The global biotech food fight: Why the United States got it so wrong. *Brown Journal of World Affairs,* 14(1), 99- 110.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*POWER 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39*(2)*, 175-191.

Food and Drug Administration (FDA). (2014a). *Fact sheet: Genetically engineered animals*. Retrieved from http://www. Fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/GeneticEngineering/GeneticallyEngineeredAnimals/ucm113597.htm

FDA. (2014b). *Consumer Q & A*. Retrieved from http://www.fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/GeneticEngineering/GeneticallyEngineeredAnimals/ucm113672.htm

FDA. (2015). *FDA's role in regulating safety of GE foods*. Retrieved from http://www.fda.gov/forconsumers/consumerupdates/ucm352067.htm

FDA. (2017). *Q&A on FDA regulation of intentionally altered genomic DNA in animals*. Retrieved from

https://www.fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/GeneticEngineering/GeneticallyEngineeredAnimals/ucm113605.htm

Fritz, S., Ward, S., Byrne, P., Namuth, D., & Egger, V. (2004). Short and long-term impacts of biotechnology education on professionals who communicate science to the public. *Journal of Natural Resources and Life Sciences Education,* 33, 111-116.

Gaivoronskaia, G., & Hvinden, B. (2006). Consumers with allergic reactions to food: Perception of and response to food risk in general and genetically modified food in particular. *Science, Technology, & Human Values,* 31(6), 702-730. Doi: 10.1177/0162243906291867.

Gardner, G., & Jones, M. (2010). Science instructors' perceptions of the risks of biotechnology: Implications for science education. *Research in Science Education,* 41, 711-738. Doi: 10.1007/s11165-010-9187-0.

George, A., Hall, G., and Stiegelbauer, S. (2006). *Measuring implementation in schools: The stages of concern questionnaire*. Retrieved from http://www.sedl.org/pubs/catalog/items/cbam17.html

General Mills. (2014). *On GMOs*. Retrieved from https://www.generalmills.com/News/Issues/on-biotechnology

Glanz, K., Rimer, B., & Viswanath, K. (Eds.). (2008). *Health behavior and health education: Theory, research, and practice*. (4th ed.). San Francisco, CA: Jossey-Bass.

Glenn, L. (2013). Ethical issues in genetic engineering and transgenics. *American Institute of Biological Sciences*. Retrieved from http://www.actionbioscience.org/biotechnology/glenn.html#primer

Grey, S. (2000). Xenotransplantation for the treatment of type 1 diabetes. *American Institute of Biological Sciences*. Retrieved from http://www.actionbioscience.org/biotechnology/grey.html

Gunther, A. & Storey, J. (2003). The influence of presumed influence. *Journal of Communication,* 53(2), 199- 215. doi**:** 10.1111/j.1460-2466.2003.tb02586.x.

Gustafson, D., & Woodworth, C. (2014). Methodological and ethical issues in research using social media: A metamethod of Human Papillomavirus vaccine studies. *BMC Medical Research Methodology*, 14(1), 1-18. doi:10.1186/1471-2288-14-127.

Hallman, W., & Aquino, H. (2003). Consumer perceptions of genetically modified food [PDF document]. *Food Policy Institute.* Retrieved from http://ageconsearch.umn.edu/bitstream/22058/1/sp03ha05.pdf

Hallman, W. K., Hebden, W. C., Aquino, H.L., Cuite, C.L. and Lang, J.T. (2003). Public perceptions of genetically modified foods: A national study of American knowledge and opinion [PDF document]. *Food Policy Institute*. Retrieved from http://foodpolicy.rutgers.edu/docs/pubs/2003_public_perceptions_of_genetically_modified_foods.pdf

Hamill, F. A. (2002). Colon cancer and the western diet. *Integrative Cancer Therapies, 1*(4), 420-424.

Han, J., & Harrison, W. (2007). Factors influencing urban consumers' acceptance of genetically modified foods. *Review of Agricultural Economics*, 29(4), 700-719. doi: 10.1111/j.1467-9353.2007.00382.x.

Health Education Directory (HEDIR). (2016). *HEDIR*. Retrieved from http://www.hedir.org/

Ho, M., Cummins, J., & Saunders, P. (2007). GM food nightmare unfolding in the regulatory sham. *Microbial Ecology in Health and Disease*, 19, 66- 77.

International Service for the Acquisition of Agro-Biotech Applications (ISAAA). (2017). *GM crops list.* Retrieved from http://www.isaaa.org/gmapprovaldatabase/cropslist/

Janz, N. & Becker, M. (1984). The health belief model: A decade later. *Health Edu Q*, 11(1), 1- 47. doi:10.1177/109019818401100101.

Kenny, D. & Judd, C. (2014). Power Anomalies in Testing Mediation. *Psychological Science*, 25(*2*), 334-339.

Kleter, G., Peijnenburg, A., & Aarts, H. (2005). Health considerations regarding horizontal transfer of microbial transgenes present in genetically modified crops. *Journal of Biomedicine and Biotechnology,* 2005(4), 326-352. doi: 10.1155/JBB.2005.326.

Kwon, H. & Chang, M. (n.d.). Technology teachers' beliefs about biotechnology and instruction in South Korea. *The Journal of Technology Studies*, 67- 75.

Laux, C., Mosher, G., & Freeman, S. (2010). Factors affecting college students' knowledge and opinions of genetically modified foods. *The Journal of Technology Studies,* 36(2), 2-9.

Magana-Gomez, J. & Carlderon de la Barca, A. (2009). Risk assessment of genetically modified crops for nutrition and health. *Nutrition Reviews* 67(1), 1-16. doi: 10.1111/j.1753-4887. 2008.00130.x.

Mannion, A. & Morse, S. (2012). Biotechnology in agriculture: Agronomic and environmental considerations and reflections based on 15 years of GM crops. *Progress in Physical Geography,* 36(6), 747-763. doi: 10.1177/0309133312457109.

Misra, A., Kumar, S., Verma, A., Chanana, N., …Dwivedi, P. (2012). Safety evaluation of genetically modified mustard (V4) seeds in terms of allergenicity: Comparison with native crop. *GM Crops & Food*, *3*(4), 273-282. doi:10.4161/gmcr.20191.

Mohapatra, A., Priyadarshini, D., & Biswas, A. (2010). Genetically modified food: Knowledge and attitude of teachers and students. *Journal of Science Education Technology*, 19, 489-497. doi: 10. 1007/s10956-010-9215-x.

Moon, W., & Balasubramanian, S. (2004). Public attitudes toward agrobiotechnology: The mediating role of risk perceptions on the impact of trust, awareness, and

outrage. *Review Of Agricultural Economics*, *26*(2), 186-208. doi:10.1111/j.1467-9353.2004.00170.x.

Morrison, D. (2012). Awareness and perception of genetic modification among science and technical vocational teachers in Guyana: Focusing on genetically modified foods. *Journal of Agricultural Science and Technology,* 789-797.

Morton, T. & Duck, J. (2001). Communication and health benefits: Mass and interpersonal influences on perceptions of risk to self and others. *Communication Research*, 28(5), 571- 601.

McCluskey, J. & Swinnen, J. (2004). Political economy of the media and consumer perceptions of biotechnology. *American Journal of Agricultural Economics*, 86(5), 1230-1237.

National Academic Press (NAP). (2003). Who will keep the public healthy? Educating public health professionals for the 21st century. *The National Academic Press*, 1-304.

NAP. (2016). Genetically engineered crops: Experiences and prospects. *The National Academic Press*, 1- 606. doi: 10.17226/23395.

National Commission for Health Education Credentialing, Inc. (NCHEC). (2015). *History of NCHEC*. Retrieved from http://www.nchec.org/aboutnchec/history/

NCHEC. (2015b). *Responsibilities and competencies for health education specialists*. Retrieved from http://www.nchec.org/credentialing/responsibilities/

Nestle, M. (2001). Genetically engineered "golden" rice unlikely to overcome vitamin A deficiency. *Journal of the American Dietetic Association,* 101(3), 289-290. doi: 10.1016/S0002-8223(01)00073-6.

Parry, S. (1996). The quest for competence. *Training Magazine*, 33, 48- 56.

Pasapula, V., Shen, G., Kuppu, S., Paez-Valencia, J., …Payton,P. (2011). Expression of an Arabidopsis vacuolar H+-pyrophosphatase gene (AVP1) in cotton improves drought- and salt tolerance and increases fibre yield in the field conditions. *Plant Biotechnology,* 9(1), 88- 99. doi: 10.1111/j.1467-7652.2010.00535.x.

PBS. (2016). *Feds approve controversial plan to release genetically modified mosquitoes to fight Zika*. Retrieved from http://www.pbs.org/newshour/rundown/feds-approve-controversial-plan-release-mutant-mosquitoes-fight-zika/

Pew Research Center. (2014). *How social media is reshaping news*. Retrieved from http://www.pewresearch.org/fact-tank/2014/09/24/how-social-media-is-reshaping-news/

Pew Research Center. (2016). *The new food fights: U.S. public divides over food science*. Retrieved from http://www.pewinternet.org/2016/12/01/the-new-food-fights/

PsychData. (2017). *About us*. Retrieved from https://www.psychdata.com/content/aboutus.asp

Public Health Foundation (PHF). (2014). *Core competencies for public health professionals*. Retrieved from

http://www.phf.org/resourcestools/Documents/Core_Competencies_for_Public_Health_Professionals_2014June. pdf

PHF. (2009). *Core public health competencies use at the public health training centers*. Retrieved from file:///E:/Dissertation/competency_survey_results_PHTCs.pdf.

Qaim, M. (2005). Agriculture biotechnology adoption in developing countries. *American Journal of Agricultural Economics,* 87(5), 1317-1324.

Qin, W., & Brown, L. (2008). Factors explaining male/female differences in attitudes and purchase intention toward genetically engineered salmon. *Journal of Consumer Behavior*, 7, 127-145. doi: 10.1002/cb.242.

Regidor, E., de la Fuente, L., Gutierrez, J., de Mateo, S., Pascual, C…Ronda, E. (2007). The role of the public health official in communicating public health information. *American Journal of Public Health*, 97(1), S93-S97. doi: 10.2105/AJPH.2006.094623.

Roberts, K., Struble, M., McCullum-Gomez, C., & Wilkins, J. (2006). Use of a risk communication model to evaluate dietetics professionals' viewpoints on genetically engineered foods and crops. *Journal of the American Dietetic Association*, 106, 719-727. doi: 10.1016/j.jada.2006.02.008.

Rogers, E. (1983). *Diffusion of innovations*. (3rd ed. ). New York, NY: The Free Press.

Savage, S. (2014). *Five tasty reasons to reconsider GMO crops*. Retrieved from https://www.biofortified.org/2014/06/five-tasty-reasons-to-reconsider-gmo-crops/

Schilling, B., Hallman, W., Hossain, F., & Adelaja, A. (2003). Consumer perceptions of food biotechnology: Evidence from a survey of U. S. consumers. *Journal of Food Distribution Research*, 34(1), 30- 35.

Schmidt, J., Vickery, C., Cotugna, N., & Snider, O. (2005). Health professionals hold positive attitudes toward biotechnology and genetically engineered foods. *Journal Of Environmental Health*, *67*(10), 44-49.

SelectUSA. (n.d.). *The biotechnology industry in the United States*. Retrieved from http://selectusa.commerce.gov/industry-snapshots/biotechnology-industry-united-states

Society for Public Health Education (SOPHE). (2014). *What is a health education specialist?* Retrieved from http://www.sophe.org/Health-Ed-Specialist-Feb2014.pdf

SOPHE. (2017). *Resources*. Retrieved from http://www.sophe.org/resources/cdc-public-health-literacy-training-course/

Spiroux de Vendomois, J., Roullier, F., Cellier, D., & Seralini, G. (2009). A comparison of the effects of three GM corn varieties on mammalian health. *International Journal of Biological Sciences,* 5(7), 706-726.

SurveyGizmo. (2017). *Survey response rates*. Retrieved from https://www.surveygizmo.com/survey-blog/survey-response-rates/

Tatham, A., & Shewry, P. (2008). Allergens to wheat and related cereals. *Clinical & Experimental Allergy*, *38*(11), 1712-1726. doi:10.1111/j.1365-2222.2008.03101.x.

Texas Department of Agriculture (TDA). (2015). *Texas ag stats*. Retrieved from http://www.texasagriculture.gov/About/TexasAgStats.aspx

Texas Wide Open for Business. (2014). *The Texas biotechnology industry* [PDF document]. Retrieved from http://gov.texas.gov/files/ecodev/Biotech_Report.pdf

Touyz, L. (2013). Genetically modified foods, cancer, and diet: Myths and reality. *Current Oncology,* 20(2), 59-61. doi: org/10.3747/co.20.1283.

U. S. Department of Labor and Bureau of Labor Statistics (BLS). (2014). *Health educators and community health workers*. Retrieved from http://www.bls.gov/ooh/community-and-social-service/health-educators.htm#tab-2

U. S. News. (2011). *More Americans get their news from the Internet*. Retrieved from http://www.usnews.com/opinion/articles/2011/01/11/more-americans-get-their-news-from-the-internet

USDA. (2013). *Glossary of agricultural biotechnology terms*. Retrieved from http://www.usda.gov/wps/portal/usda/usdahome?navid=BIOTECH_GLOSS&navtype=RT&parentnav=BIOTECH

USDA. (2013b). Acreage. *National Agricultural Statistics Service (NASS).* ISSN: 1949-1522.

USDA. (n.d.a). *Engineering cotton for higher salt- and drought- tolerance*. Retrieved from http://www.reeis.usda.gov/web/crisprojectpages/0210659-engineering-cotton-for-higher-salt-and-drought-toelerance.html

USDA. (n.d.b). *Sugarcane improvement for arid, alkaline environments*. Retrieved from http://www.reeis.usda.gov/web/crisprojectpages/0185488-sugercane-improvement-for-arid-alkaline-environments.html

Van der Meer, P. (2009). Plant & environmental biotechnology. *New Biotechnology,* 25S.

Wei, Q., & Brown, J. (2008). Factors explaining male/female differences in attitudes and purchase intention toward genetically engineered salmon. *Journal Of Consumer Behaviour*, *7*(2), 127-145. doi:10.1002/cb.242.

World Health Organization (WHO). (2002). *Genome research can save millions in developing world*. Retrieved from http://www.who.int/mediacentre/news/releases/release34/en/

WHO. (2005). Modern food biotechnology, human health and development: An evidence-based study. *WHO Press.* ISBN: 92 4 159305 9.

WHO. (2011). *Grand challenges in genomics for public health in developing countries: Top 10 policy and research priorities to harness genomics for the greatest health problems*. Retrieved from http://www.who.int/rpc/grand_challenges.pdf?ua=1

WHO. (2015). *Health education*. Retrieved from http://www.who.int/topics/health_education/en/

WHO. (2015b). *Biotechnology/innovation*. Retrieved from http://www.who.int/tdr/diseases-topics/biotechnology-innovation/en/

WHO. (2015c). *Awareness and support of release of genetically modified "sterile" mosquitoes, Key West, Florida, USA.* Retrieved from https://wwwnc.cdc.gov/eid/article/21/2/14-1035_article

Whole Foods Market. (2015). *Faqs in GMOs*. Retrieved from http://www.wholefoodsmarket. com/faqs-gmos

Wilson, E., Kirby, B., & Flowers, J. (2002). Factors influencing the intent of North Carolina agricultural educators to adopt agricultural biotechnology curriculum. *Journal of Agricultural Education*, 43(1), 69-81. doi: 10.5032/jae.2002.01069.

# APPENDIX A

# TWU IRB APPROVAL

**Institutional Review Board**
Office of Research and Sponsored Programs
P.O. Box 425619, Denton, TX 76204-5619
940-898-3378
email: IRB@twu.edu
http://www.twu.edu/irb.html

DATE: July 28, 2016

TO: Ms. Renee Odonnell
Health Studies

FROM: Institutional Review Board (IRB) - Denton

*Re: Exemption for A Mediator Model to Predict Media Influence on Health Educators' Knowledge and Attitudes Toward Genetically Modified (GM) Food and Their Intention to Develop a GM Food Education (Protocol #: 19120)*

The above referenced study has been reviewed by the TWU IRB (operating under FWA00000178) and was determined to be exempt from further review.

If applicable, agency approval letters must be submitted to the IRB upon receipt PRIOR to any data collection at that agency. Because a signed consent form is not required for exempt studies, the filing of signatures of participants with the TWU IRB is not necessary.

Although your protocol has been exempted from further IRB review and your protocol file has been closed, any modifications to this study must be submitted for review to the IRB using the Modification Request Form. Additionally, the IRB must be notified immediately of any adverse events or unanticipated problems. All forms are located on the IRB website. If you have any questions, please contact the TWU IRB.

cc. Dr. Roger Shipley, Health Studies
Dr. Mandy Golman, Health Studies
Graduate School

# APPENDIX B

# INFORMED CONSENT IN SURVEY INSTRUCTIONS

| Health Education and Genetically Modified (GM) Food |
| --- |
| The return of your completed questionnaire constitutes your informed consent to act as a participant in this research.<br><br>Participation in this survey is voluntary and may be discontinued at anytime. 2. This survey will take approximately 30 minutes to complete. If 30 minutes is too much time to complete this survey, you have to option to create a userID and password to complete the survey in increments. Because this survey is administered via internet, there is a potential loss of confidentiality in all email, downloading, and internet transactions; however, every precaution will be taken by the principal investigator, Renee O'Donnell, to protect your identity to the extent that is allowed by law. I have set the options in PsychData for complete anonymity. 1. You may also experience fatigue while participating in this survey; however, you have the option to enter a userID and password to return to the survey at a later time. Your email IP address will not be tracked nor associated with your responses. If you have any questions I may be contacted at rodonnell@twu. edu. Thank you for taking time to complete the following questions. |

# APPENDIX C

# EMAIL SCRIPT SENT TO PARTICIPANTS

Hello Health Educators,

I am a graduate student at Texas Woman's University conducting a research study for the purpose of investigating the influence media has on knowledge and attitude of health educators toward genetically modified (GM) food and their intention on whether they would develop a GM food education plan.

The responses of the surveys will be electronically and anonymously collected via PsychData. Participation is voluntary and information gathered is anonymous and will be kept confidential. However, there is a potential risk of loss of confidentiality in all email, downloading, and internet transactions.

Participants will complete a survey that includes questions about demographic information, as well as questions about their knowledge, attitude, and intention to develop GM food education plans. **The anticipated time to complete the survey is 10 minutes.**

The following link will take you directly to the PsychData survey.

https://www. psychdata. com/s. asp?SID=170632

Thank you for participating. If you choose to enter a drawing to win 1 of 2 $25 Amazon gift cards, provide your preferred email at the end of the survey as instructed.

For more information, questions or concerns, please contact me, Renee O'Donnell, at rodonnell@twu. edu.

# APPENDIX F

# SURVEY INSTRUMENT

# Health Education and Genetically Modified (GM) Food

The return of your completed questionnaire constitutes your informed consent to act as a participant in this research.

Participation in this survey is voluntary and may be discontinued at anytime. 2. This survey will take approximately 30 minutes to complete. If 30 minutes is too much time to complete this survey, you have to option to create a userID and password to complete the survey in increments. Because this survey is administered via internet, there is a potential loss of confidentiality in all email, downloading, and internet transactions; however, every precaution will be taken by the principal investigator, Renee O'Donnell, to protect your identity to the extent that is allowed by law. I have set the options in PsychData for complete anonymity. 1. You may also experience fatigue while participating in this survey; however, you have the option to enter a userID and password to return to the survey at a later time. Your email IP address will not be tracked nor associated with your responses. If you have any questions I may be contacted at rodonnell@twu.edu. Thank you for taking time to complete the following questions.

Thank you for participating in my dissertation research! For the purpose of this study...

Genetic modification (GM) is "the production of heritable improvements in plants or animals for specific uses, via either genetic engineering or other more traditional methods."

GM food are "foods derived from organisms whose genetic material (DNA) has been modified in a way that does not occur naturally, e.g. through the introduction of a gene from a different organism."

*1) Do you identify yourself as a health educator or health promoter?

A health educator/promotor is someone that promotes, maintains, and improves individual and community health by assisting individuals and communities to adopt healthy behaviors OR teaches in the health discipline in a school/university setting

- Yes
- No

Continue ONLY when finished. You will be unable to return or change your answers. (Need help?)

Continue » Save and Exit

20% complete

powered by www.psychdata.com

# Health Education and Genetically Modified (GM) Food

2) Which field of health education/promotion most closely describes where you currently work (or most recently worked)?

--Select--

Other:

*3) How many years have you worked as a health educator or health promoter?
(If less than 1 year, please mark "0")

4) In which setting(s)? (Please mark all that apply)

- ☐ Community Setting
- ☐ School (K12) Setting
- ☐ Health Care Setting
- ☐ Business/Industry Setting
- ☐ College/University Setting
- ☐ University Health Services Setting
- ☐ State/Federal Government Setting
- ☐ Other (please specify)

*5) Currently, in which state of the U.S.?

--Select--

*6) What is your age (in years)?

*7) What is your gender?

- ○ Female
- ○ Male

8) How do you describe yourself? (Please mark all that apply)

- ☐ White
- ☐ Black/African American
- ☐ Asian/Pacific Islander
- ☐ Alaskan Native/American (Native) Indian
- ☐ Hispanic/Latino
- ☐ Other (please specify)

*9) What is your religious preference? Is it Protestant, Catholic, Jewish, some other religion, or no religion?

- Protestant
- Catholic
- Jewish
- None
- Buddhism
- Hinduism
- Mormon
- Muslim/Islam
- Orthodox-Christian
- Native American
- Other (please specify)

*10) To what extent do you consider yourself a religious person?

- Not Religious At All
- Slightly Religious
- Moderately Religious
- Very Religious

*11) Are you CHES eligible*?
*A bachelor's, master's or doctoral degree from an accredited institution of higher education; and one of the following:
1. An official transcript (including course titles) that clearly shows a major in health education, including Health Education, Community Health Education, Public Health Education, School Health Education.
2. An official transcript that reflects at least 25 semester hours or 37 quarterly hours of coursework with specific preparation addressing the Area of Responsibility for Health Educator.

- Yes
- No
- I don't know what CHES is

*12) What is the highest level of education you have completed?

- High school degree or below
- Bachelor's degree
- Master's degree
- Doctoral degree
- Other (please specify)

Which of your degree(s) is in Health Education*?

*Health Education, Community Health Education, Public Health Education, School Health Education, Health Promotion, Health Education & Promotion, Health Behavior, Health Education & Behavior

| | Yes | No | N/A |
|---|---|---|---|
| *13) Bachelor's Degree | | | |
| *14) Master's Degree | | | |
| *15) Doctoral Degree | | | |
| *16) Other Degree(s) | | | |

17) From where have you received training in genetically modified (GM) food? (Please mark all that apply)

- I have never had any training in GM food
- Coursework
- Continuing Education Units (CEU)
- Job training
- Other (please specify)

This section is going to ask you some questions about your knowledge of GM food. Please select the correct answer that applies (to the best of your knowledge).

Genetic modification (GM) is "the production of heritable improvements in plants or animals for specific uses, via either genetic engineering or other more traditional methods."

GM food are "foods derived from organisms whose genetic material (DNA) has been modified in a way that does not occur naturally, e.g. through the introduction of a gene from a different organism."

The following knowledge questions are adapted from the *Public Perceptions of Genetically Modified Foods: A National Study of American Knowledge and Opinion* survey (Hallman, Hebden, Aquino, Cuite, & Lang, 2003).

| | Don't Know | True | False |
|---|---|---|---|
| *18) There are some bacteria which live on wastewater. | ○ | ○ | ○ |
| *19) Ordinary tomatoes do not contain genes, while genetically modified tomatoes do. | ○ | ○ | ○ |
| *20) By eating a genetically modified fruit, a person's genes could also become modified. | ○ | ○ | ○ |
| *21) The mother's genes determine whether the child is a girl. | ○ | ○ | ○ |
| *22) The yeast used to make beer contains living organisms. | ○ | ○ | ○ |
| *23) Genetically modified animals are always larger than ordinary animals. | ○ | ○ | ○ |
| *24) It is impossible to transfer animal genes into plants. | ○ | ○ | ○ |
| *25) The cloning of living things produces genetically identical copies. | ○ | ○ | ○ |
| *26) More than half the human genes are identical to those of chimpanzees. | ○ | ○ | ○ |
| *27) Tomatoes genetically modified with genes from catfish would probably taste "fishy." | ○ | ○ | ○ |
| *28) Genetically modified foods are created using radiation to create genetic mutations. | ○ | ○ | ○ |

This section is going to ask you some questions about you attitude towards GM food education. There are no right or wrong answers. Please select the correct answer that applies.

Genetic modification (GM) is "the production of heritable improvements in plants or animals for specific uses, via either genetic engineering or other more traditional methods."

GM food are "foods derived from organisms whose genetic material (DNA) has been modified in a way that does not occur naturally, e.g. through the introduction of a gene from a different organism."

The following set of questions are adapted and modified from the *Health Promotion and Genetics/Genomics* survey (Chen, 2007).

The questions below are designed to assess your attitudes towards different tasks for health educators/promoters:

Task 1: Translating complex gentically modified (GM) food information for use in community-based health education programs

***29)** Have you ever done this task (Translating complex GM food information...)?

- ○ Yes
- ○ No

***30)** How confident do you feel that you can do this task?

- ○ 1 (0% Confident)
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10 (100% Confident)

Task 2: Developing a plan for incorporating genetically modified (GM) food into health education services by working with community organizations, GM food experts, and other stakeholders

***31)** Have you ever done this task (Developing a plan...)?

- ○ Yes
- ○ No

***32)** How confident do you feel that you can do this task?

- ○ 1 (0% Confident)
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10 (100% Confident)

Task 3: Conducting a needs assessment for community-based genetically modified (GM) food education programs

*33) Have you ever done this task (Conducting a needs assessment...)?

- Yes
- No

*34) How confident do you feel that you can do this task?

- 1 (0% Confident)
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 (100% Confident)

Task 4: Advocating for community-based gentically modified (GM) food education programs.

*35) Have you ever done this task?

- Yes
- No

*36) How confident do you feel that you can do this task?

- 1 (0% Confident)
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 (100% Confident)

Task 5: Integrating genetically modified (GM) food components into community-based education programs.

*37) Have you ever done this task (Integrating GM food components...)?

- Yes
- No

*38) How confident do you feel that you can do this task?

- 1 (0% Confident)
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 (100% Confident)

Which of the following items are potential barriers/obstacles for you to adopt genetically modified (GM) food education into your practice?

| | Not A Barrier At All | Not A Barrier | Somewhat A Barrier | A Strong Barrier |
|---|---|---|---|---|
| *39) Incompatibility between GM food and my religious beliefs | ○ | ○ | ○ | ○ |
| *40) Lack of knowledge about GM food | ○ | ○ | ○ | ○ |
| *41) Lack of knowledge about how to incorporate GM food into health promotion | ○ | ○ | ○ | ○ |

Continue ONLY when finished. You will be unable to return or change your answers. (Need help?)

Continue » Save and Exit

40% complete

powered by www.psychdata.com

# Health Education and Genetically Modified (GM) Food

| | Not A Barrier At All | Not A Barrier | Somewhat A Barrier | A Strong Barrier |
|---|---|---|---|---|
| *42) Lack of time to add something new into my work | ○ | ○ | ○ | ○ |
| *43) GM food is not a priority in my current work | ○ | ○ | ○ | ○ |
| *44) Having to deal with the public's mistrust of GM food information or technologies | ○ | ○ | ○ | ○ |

Please indicate your agreement with each statement...

| | Strongly Disagree | Disagree | Agree | Strongly Agree |
|---|---|---|---|---|
| *45) Adopting GM food into health education is consistent with my professional beliefs/values | ○ | ○ | ○ | ○ |
| *46) Analyzing current and future community GM food education needs is consistent with my professional beliefs/values | ○ | ○ | ○ | ○ |
| *47) Advocating for GM food education programs is consistent with my professional beliefs/values | ○ | ○ | ○ | ○ |
| *48) Adopting GM food education into health education is consistent with my personal beliefs/values | ○ | ○ | ○ | ○ |
| *49) Analyzing current and future community GM food education needs is consistent with my personal beliefs/values | ○ | ○ | ○ | ○ |
| *50) Advocating for GM food education programs is consistent with my personal beliefs/values | ○ | ○ | ○ | ○ |

How important is it for you...

| | Not Important At All | Not Important | Somewhat Important | Extremely Important |
|---|---|---|---|---|
| *51) GM food education is consistent with your professional beliefs/values? | ○ | ○ | ○ | ○ |
| *52) GM food education is consistent with your personal beliefs/values? | ○ | ○ | ○ | ○ |

How easy or difficult is it for you to...

| | Not Easy At All | Not Easy | Somewhat Easy | Extremely Easy |
|---|---|---|---|---|
| *53) Stay updated on GM food education-related knowledge? | ○ | ○ | ○ | ○ |
| *54) Stay updated on basic GM food knowledge? | ○ | ○ | ○ | ○ |
| *55) Apply GM food information or technologies to health promotion? | ○ | ○ | ○ | ○ |

How important is it for you...

| | Not Important At All | Not Important | Somewhat Important | Extremely Important |
|---|---|---|---|---|
| *56) Stay updated on GM food education-related knowledge? | ○ | ○ | ○ | ○ |
| *57) Stay updated on basic GM food knowledge? | ○ | ○ | ○ | ○ |
| *58) Apply GM food information or technologies to health promotion? | ○ | ○ | ○ | ○ |

How often have you...

| | Never | Not Very Often | Not Often | Often | Very Often |
|---|---|---|---|---|---|
| *59) Heard about GM food on TV? | ○ | ○ | ○ | ○ | ○ |
| *60) Heard about GM food on the radio? | ○ | ○ | ○ | ○ | ○ |
| *61) Heard about GM food in the newspaper? | ○ | ○ | ○ | ○ | ○ |
| *62) Talked about GM food with your colleagues? | ○ | ○ | ○ | ○ | ○ |
| *63) Discussed GM food at professional conferences? | ○ | ○ | ○ | ○ | ○ |
| *64) Talked about GM food with those whom you educate (e.g. communities, students, and/or patients)? | ○ | ○ | ○ | ○ | ○ |
| *65) Talked about GM food with your relatives and/or families? | ○ | ○ | ○ | ○ | ○ |
| *66) Read about GM food on the internet? | ○ | ○ | ○ | ○ | ○ |

This section is going to ask you some questions about your use of media resources regarding GM food and your trust of media sources regarding GM food.

Genetic modification (GM) is "the production of heritable improvements in plants or animals for specific uses, via either genetic engineering or other more traditional methods."

GM food are "foods derived from organisms whose genetic material (DNA) has been modified in a way that does not occur naturally, e.g. through the introduction of a gene from a different organism."

The following questions have been adapted and modified from the *Aggies' Perceptions of and Use Of Media about the Beef Industry* survey (Charanza, 2011).

During normal times, about how many hours per week do you spend using the following media to gether information for personal, business, and/or entertainment use?

| | Hours/Week |
|---|---|
| *67) Television (shows, movies) | |
| *68) Television (news channels) | |
| *69) Radio | |
| *70) Internet | |
| *71) Facebook | |
| *72) Twitter | |
| *73) Blogs | |
| *74) YouTube | |
| *75) RSS feeds | |
| *76) E-mail list subscriptions | |
| *77) Magazines | |
| *78) Newspapers | |
| *79) Other | |

I consider the following media to be trustworthy in providing accurate and helpful information about any issue.

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| *80) Television (shows, movies) | | | | | |
| *81) Television (news channels) | | | | | |
| *82) Radio | | | | | |
| *83) Internet | | | | | |

# Health Education and Genetically Modified (GM) Food

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| *84) Facebook | ○ | ○ | ○ | ○ | ○ |
| *85) Twitter | ○ | ○ | ○ | ○ | ○ |
| *86) Blogs | ○ | ○ | ○ | ○ | ○ |
| *87) YouTube | ○ | ○ | ○ | ○ | ○ |
| *88) RSS feeds | ○ | ○ | ○ | ○ | ○ |
| *89) E-mail list subscriptions | ○ | ○ | ○ | ○ | ○ |
| *90) Magazines | ○ | ○ | ○ | ○ | ○ |
| *91) Newspapers | ○ | ○ | ○ | ○ | ○ |
| *92) Other | ○ | ○ | ○ | ○ | ○ |

*93) Do you publish your views or opinions on the Internet using social media such as blogs, Facebook, or Twitter?

○ Yes
○ No

Continue ONLY when finished. You will be unable to return or change your answers. (Need help?)

Continue » Save and Exit

80% complete

powered by www.psychdata.com

# Health Education and Genetically Modified (GM) Food

*94) About how many times per week do you publish your views or opinions on social media such as blogs, Facebook, or Twitter?

95) In general, media coverage of issues has changed my opinion and attitudes about an issue in a:

- Negative Way
- Positive Way

About how many hours per week do you use the following media to get information concerning genetically modified (GM) food?

| | Hours/Week |
|---|---|
| *96) Television (shows, movies) | |
| *97) Television (news channels) | |
| *98) Radio | |
| *99) Internet | |
| *100) Facebook | |
| *101) Twitter | |
| *102) Blogs | |
| *103) YouTube | |
| *104) RSS feeds | |
| *105) E-mail list subscriptions | |
| *106) Magazines | |
| *107) Newspapers | |
| *108) Other | |

**109)** The following media are helpful in providing information about genetically modified (GM) food.

- ☐ Television (shows, movies)
- ☐ Television (news channels)
- ☐ Radio
- ☐ Internet
- ☐ Facebook
- ☐ Twitter
- ☐ Blogs
- ☐ YouTube
- ☐ RSS feeds
- ☐ E-mail list subscriptions
- ☐ Magazines
- ☐ Newspapers
- ☐ Other (please specify)

**110)** Media coverage of risks/benefits related to genetically modified (GM) food has changed my opinions and/or attitudes about GM food in a:

- ☐ Negative Way
- ☐ Positive Way

| | Don't Know | Not At All Strongly | Somewhat Strongly | Very Strongly | Extremely Strongly |
|---|---|---|---|---|---|
| ***111)** Overall how strongly would you say you feel about issues concerning genetically modified (GM) food that have been addressed in this survey? | ○ | ○ | ○ | ○ | ○ |

**112)** Thank you for participating in this survey. If you are interested in entering a drawing to win 1 of 2 $25 Amazon gift cards, please type in your preferred e-mail address to enter a random selection drawing (the e-mail entered will receive the virtual $25 Amazon gift card if randomly selected). Your e-mail will only be used in this drawing and will not be saved or forwarded.

Continue ONLY when finished. You will be unable to return or change your answers. (Need help?)

Continue » Save and Exit

100% complete

powered by www.psychdata.com

# APPENDIX G

# PERMISSION TO ADOPT SURVEY

From: Renee O'Donnell <rodonnell@twu.edu>
Subject: Permission to conduct research using SOPHE members for my dissertation
Date: July 5, 2016 at 1:30:51 PM CDT
To: info@sophe.org

Dear SOPHE office,

I am writing to request permission to conduct a research study using members of SOPHE. I am currently enrolled in the Health Studies program at Texas Woman's University and am in the process of writing my dissertation. It is entitled "A mediator model to predict media influence on health educators' knowledge and attitudes towards genetically modified (GM) food and their intention to develop a GM food education".

I hope that the SOPHE organization will allow me to recruit active SOPHE members from the school to anonymously complete a questionnaire (A copy is attached to this email). Interested members, who volunteer to participate, will be given a consent form prior to starting the survey.

If approval is granted, participants will complete the survey at their discretion. The survey process should take no longer than 30 minutes. The survey results will be pooled for the dissertation and all subjects will remain anonymous as no identifying information will be collected.

Your approval to conduct this study will be greatly appreciated. I would be happy to answer any questions or concerns that you may have. You may contact me at my email address: rodonnell@twu.edu.

If you agree, kindly sign below and return the signed form in the enclosed self-addressed envelope. Alternatively, kindly submit

# RE: Questionnaire for genomic competencies

Lei-Shih Chen [lace@hlkn.tamu.edu]
**Sent:** Tuesday, October 20, 2015 1:53 PM
**To:** Odonnell, Renee
**Cc:** chenhpglab@gmail.com

Sure. Let me know if you have any further questions.

Thanks!

Lace

Lei-Shih (Lace) Chen, PhD., PT., CHES
Associate Professor
Director, Health Promotion and Genomics Lab
Editor-In-Chief, Houston Taiwanese American Journal
Department of Health and Kinesiology
Texas A&M University
4243 TAMU
College Station, Texas, 77843-4243
Phone number: 979-862-2912
Fax number: 979-847-8987
E-mail: lace@hlkn.tamu.edu

**From:** Odonnell, Renee [mailto:rodonnell@mail.twu.edu]
**Sent:** Friday, October 16, 2015 4:24 PM
**To:** Lei-Shih Chen <lace@hlkn.tamu.edu>
**Subject:** Questionnaire for genomic competencies

Good afternoon Dr. Chen,

I am a doctoral student studying at Texas Woman's University and my dissertation is over GM food in relation to health educators' knowledge and attitude towards biotechnology and the likelihood of them developing a plan for delivery of GM food education. I ran across your dissertation and would like to know if I could use some of your survey and modify it to meet the needs of my study? I would of course reference your survey and all modifications I made to the original.

I appreciate your time in reading this e-mail and look forward to your response.

Thank you,

Renee O'Donnell, PhD(c), MS, CSCS
Texas Woman's University
Denton, TX
rodonnell@twu.edu

## RE: Public Perceptions of Genetically Modied Foods: A National Study of American Knowledge and Opinion

William K. Hallman [hallman@rci.rutgers.edu]
**Sent:**Tuesday, May 31, 2016 1:35 PM
**To:** Odonnell, Renee
**Cc:** hallman@AESOP.Rutgers.edu

Thanks for your email. Of course, I would be pleased to have you use whatever you think is valuable from my work. Good luck with your dissertation. Let me know if I can be helpful in any way as you move forward.

Bill Hallman

William K. Hallman, PhD.
Professor/Chair
Department of Human Ecology
Rutgers University
55 Dudley Road
New Brunswick, NJ 08901-8520
Office: 848 932 9227

**From:** Odonnell, Renee [mailto:rodonnell@mail.twu.edu]
**Sent:** Tuesday, May 31, 2016 2:16 PM
**To:** hallman@aesop.rutgers.edu
**Subject:** Public Perceptions of Genetically Modied Foods: A National Study of American Knowledge and Opinion

Hello Dr. Hallman,

I am a doctoral student studying at Texas Woman's University and I wanted to use a portion of your survey entitled "Public Perceptions of Genetically Modied Foods: A National Study of American Knowledge and Opinion". Specifically, Table 2: Knowledge of Science and Genetic Modification. I would properly cite your research and the borrowed table in my dissertation. My dissertation is entitled: 'A mediator model to predict media influence on health educators' knowledge and attitudes towards genetically modified (GM) food and their intention to develop a GM food education plan'.

I look forward to your response and cooperation. Thank you for you time.

Best wishes,
Renee O'Donnell, PhD(c), MS, CSCS
Grad Assistant--Health Studies
Texas Woman's University
rodonnell@twu.edu

"The task of the modern educator is not to cut down jungles, but to irrigate deserts." C. S. Lewis

# APPENDIX H

# AGENCY APPROVAL LETTER

SOCIETY FOR PUBLIC HEALTH EDUCATION

Renee O'Donnell, PhD(c), MS, CHES, CSCS
Grad Assistant--Health Studies
Texas Woman's University

Dear Renee O'Donnell:

We have reviewed your research proposal, and I am pleased to inform you that you, hereby, have SOPHE's permission to survey its members. SOPHE will disseminate the email that directs participants to the survey. SOPHE must receive all survey data from this study and you must notify us if an article based on the data is published.

Consent signature: _____ Date: 7/27/16

Sincerely,

Ramona D. Jackson, MPH
Senior Director, Membership & Marketing
Society for Public Health Education
10 G Street, NE, Suite 605
Washington, DC 20002
Tel: 202.408.9804
**Email: rjackson@sophe.org**
**www.sophe.org**