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# Socioscientific Issues in School-Based Agricultural Education: Describing and Exploring Factors of Integration

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# SOCIOSCIENTIFIC ISSUES IN SCHOOL-BASED AGRICULTURAL EDUCATION:

# DESCRIBING AND EXPLORING FACTORS OF INTEGRATION

by

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# ABSTRACT

## SOCIOSCIENTIFIC ISSUES IN SCHOOL-BASED AGRICULTURAL EDUCATION: DESCRIBING AND EXPLORING FACTORS OF INTEGRATION

by

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Utah State University, 2021

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The purpose of this quantitative survey research was to explore the knowledge and integration of socioscientific issues (SSI) among school-based agricultural education (SBAE) teachers by describing and explaining the factors that influence integration. This research was guided by the SSI-based instruction framework and the three-component model of agricultural education. The population for this study was all SBAE teachers in the U.S. and U.S. territories during the 2019-2020 school year. Respondents could choose to complete the survey online or a paper and pencil version. A total of 136 SBAE teachers participated in the study.

School-based agricultural education teachers' self-efficacy related to SSI, their perceived need to teach SSI, and barriers to teaching SSI were explored. Survey responses were analyzed using descriptive statistics, ordinary least squares regression, and logistic regression. Research findings suggest SBAE teacher self-efficacy was a significant predictor of overall SSI integration as well as the integration of climate issues, ecosystem and biodiversity, energy, food security, human population, and natural resource issues. Respondents agreed that SSI are needed in agricultural education, but time to develop curriculum and integrate SSI is a barrier. Overall SBAE teachers felt supported by their administration and communities. The most taught SSI by respondents were natural resource, sustainability, and water issues; and the least taught SSI were energy, climate, and ecosystem and biodiversity issues. Although respondents indicated they were teaching SSI in their classes, the research results suggest that many were not using learning experiences aligned with the SSI-based instruction framework.

Recommendations include integration of SSI and the SSI-based instruction framework in both pre-service agricultural teacher preparation programs and in-service teacher professional development. Aligning state and national agricultural education standards to include SSI is also recommended. Further research should be conducted to explore SBAE teachers' knowledge of SSI, how they are integrating SSI in their classes and what resources and teaching strategies they are using.

(214 pages)

# PUBLIC ABSTRACT

## SOCIOSCIENTIFIC ISSUES IN SCHOOL-BASED AGRICULTURAL EDUCATION: DESCRIBING AND EXPLORING FACTORS OF INTEGRATION

Michelle Burrows

Socioscientific issues (SSI) are complex issues which are scientific in nature and have societal impacts. Many SSI have connections to agriculture and as such should be included in agricultural education curriculum. A clear understanding of what school-based agricultural education (SBAE) teachers know about SSI is needed. The purpose of this research was to explore the knowledge and integration of SSI among SBAE teachers by describing and explaining the factors that influence integration. This quantitative survey research was guided by the SSI-based instruction framework and the three-component model of agricultural education. The population for this study was all SBAE teachers in the U.S. and U.S. territories during the 2019-2020 school year. Participants could choose between an online or a paper and pencil version of the survey. A total of 136 SBAE teachers participated in the research.

School-based agricultural education teachers' self-efficacy related to SSI, their perceived need to teach SSI and barriers to teaching SSI were explored. Survey responses were analyzed using descriptive statistics, ordinary least squares regression, and logistic regression. Findings suggest SBAE teacher self-efficacy was a significant predictor of overall SSI integration as well as the integration of climate issues, ecosystem and biodiversity, energy, food security, human population, and natural resource issues. Respondents agreed that SSI are needed in agricultural education but time to develop curriculum and integrate SSI is a barrier. Overall SBAE teachers felt supported by their administration and communities. The most taught SSI by respondents were natural resource, sustainability, and water issues; and the least taught SSI were energy, climate, and ecosystem and biodiversity issues. Although respondents indicated they were teaching SSI in their classes, the research results suggest that many were not using learning experiences aligned with the SSI-based instruction framework.

Recommendations included integration of SSI and the SSI-based instruction framework in both pre-service agricultural teacher preparation programs and in-service teacher professional development. Aligning state and national agricultural education standards to include SSI is also recommended. Further research should be conducted to explore SBAE teachers' knowledge of SSI, how they are integrating SSI in their classes and what resources and teaching strategies they are using.

# DEDICATION

To my family and friends, who without your love and support this work would not have been possible. Thank you especially to my husband, Bob, and my children, Daniel, Samantha, Amberlee, and Isaac for always being my hype squad and cheering me on when I needed it. To my parents, Sherri and Richard Hoff, Ron and Sue Stone and my grandparents, Dale and Linda, and my parents-in law, Josephine and Chuck Eras for reminding me I could do anything I wanted to no matter what. To the rest of my family and friends, who are too numerous to name, but you know who you are, for your continued support of my quest to learn more.

In memory of

My grandmother, Mary Edith Stone

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# CHAPTER 1: INTRODUCTION

## Chapter Overview

The goals of this chapter include discussing the prevalence of global issues that impact society and the establishment of these issues as priority areas by national and global stakeholders. The definition of socioscientific issues (SSI) is introduced, along with how these issues have been integrated within science education. Furthermore, connections are made between science education and school-based agricultural education (SBAE). Although both subjects address SSI within their curriculum, differences between the two disciplines are briefly highlighted when it comes to following the SSI-based instructional framework with fidelity. This poses the question of intentional integration of SSI into agricultural education. Gaps in agricultural education research concerning SSI integration are recognized along with the need for research to fill this gap. This chapter also introduces the SSI-based instruction framework and how it is used as the theoretical lens for this research. This chapter concludes with the limitations and assumptions of this research project.

## Background

### Socioscientific Issues

Socioscientific issues are reminiscent of the science-technology-society movement; however, the use of SSI is guided by theory and scholarship (Ziedler, 2014). Integrating SSI follows a student-centered, progressive learning environment as opposed to traditional, teacher-centered learning (Ziedler, 2014). Early on, Fleming (1986a) discussed use of SSI within curriculum as a pedagogical practice which requires students to address scientific issues not only from the science perspective but also integrating knowledge of the social realm.

Throughout the literature, SSI is referred to as *socio-scientific* issues and *socioscientific* issues, depending upon the preference of author. As Sadler (2011) pointed out, the use or omission of a hyphen may or may not be a relevant distinction of the authors' understanding of the term. However, in this study I have chosen to use the term socioscientific issues, intentionally omitting the hyphen to represent my understanding of the direct connection between the social and scientific elements of SSI. For additional clarification, in this research I refer to socioscientific issues (SSI) in the plural form, recognizing the multiple issues that make up SSI, while the use of SSI-based instruction framework refers to the singular form.

## Complex Global Issues

Recent estimates of global population numbers show projected increases of 10% to 8.5 billion people by 2030 and populations reaching 9.7 billion by 2050 (United Nations, 2019). These increases cause concerns for issues related but not limited to food security, water access, and environmental impacts. The agricultural industry is deeply entrenched in these issues as it provides nutritious food for the growing population and works to preserve natural resources. However, the agriculture industry is also being criticized for its contribution to some of these complex problems (Pant, 2009; Hobbs & Govaerts, 2010).

The pervasiveness of these complex global issues and their impact on agriculture has prompted stakeholders (e.g., government agencies, world organizations, educational organizations) to voice concerns and assert research priorities to address these issues facing society. The National Institute of Food and Agriculture (NIFA) Challenge Areas list several complex global issues including food security, climate concerns, and water issues (NIFA, 2019). The most recent resolution adopted by the United Nations includes 17 goals for sustainable development through 2030. This resolution cited essential topics, including hunger and food security, water, and conservation, as well as environmental impacts and climate change (United Nations, 2015).

According to the current National Research Agenda of the American Association for Agricultural Education (AAAE), agricultural education has a contribution to solving these issues. Research priority seven explicitly describes the need to address these complex problems, giving rise to the number one ranked research question which is to determine the most effective methods used to prepare individuals to solve issues like climate change and food security, as well as sustainability and water conservation (Roberts et al., 2016). In addition to the AAAE research agenda, National Agriculture in the Classroom's National Agriculture Literacy Outcomes (NALO) also includes the need to address complex issues within the context of agriculture and the environment, and healthy food and its availability to all (Spielmaker & Leising, 2013).

## From Complex Global Issues to Socioscientific Issues

The current National Research Agenda for AAAE was released in 2016 and was the first research agenda in AAAE that explicitly addressed these complex issues. In the agenda, research priority seven calls for research from the field of agricultural education to address complex problems facing society as a result of innovation and population growth (Roberts et al., 2016). The number one research priority question in the research agenda appeals to the agricultural education field to focus on research answering, “What methods, models, and programs are effective in preparing people to solve complex, interdisciplinary problems (e.g., Climate change, food security, sustainability, water conservation, etc.)?” (Roberts et al., 2016, p. 59). Throughout the AAAE research agenda, different terms are used in reference to the complex issues, which include “complex adaptive challenges” (p. 58), “complex interdisciplinary problems” (p. 59), “complex interdisciplinary issues” (p. 59), and “emerging complex issues” (p. 59).

According to the AAAE research agenda, these issues affect agriculture, are scientifically driven, and impact society. Specifically, they “threaten human wellbeing and global sustainability” (Roberts et al., 2016, p. 58). Topics or issues which are scientific in nature that impact society are also known as socioscientific issues (SSI) (Sadler, 2004a). These complex global issues referenced in the research agenda are scientific in nature and impact society, aligning them with SSI. Additionally, these issues are often controversial, contain multiple perspectives, and do not have simple solutions (Sadler, 2004b; Zeidler & Nichols, 2009). Some examples of SSI are climate change, genetically modified organisms (GMOs), food security, and natural resource usage. Agriculture educators have a responsibility to prepare the next generation of agricultural scientists by providing their students with the skills and tools necessary to acknowledge the complexity of SSI to develop viable solutions.

**SSI in Education**

Increasing knowledge of SSI and their impact on the planet's sustainability demands that educational institutions be directly involved in teaching students about these issues. Since agriculture is central to many SSI, school-based agricultural education (SBAE) is uniquely positioned as a profession to contribute to building capacity in the next generation of scientists and agriculturists to address these complex issues (Roberts et al., 2016). SBAE teachers work with students every day who will have a direct hand in solving SSI as they transition into adulthood. Whether through career choices or consumer decisions, the students in today's 21st-century classrooms will be the decision makers of how we tackle SSI. As teachers work with their students toward higher educational pursuits, career preparation, and agricultural literacy, SBAE will be an essential component in the pipeline of addressing SSI.

**SSI and Science Literacy, SBAE, and STEM**

In an effort to promote science literacy, SSI are commonly used in science classrooms to guide students in evaluating facts and research while developing argumentation skills (Pouliot, 2008). The National Research Council (NRC) (1988) indicated "all students need an understanding of basic science concepts" (p. 11). They also recognized "there are many opportunities to teach science through agriculture" and "a common way to capture student interest in science is often by reference to examples in the real world" (NRC, 1988, p. 11). The committee also believed "agricultural and scientific literacy are enhanced when closely related in school" (NRC, 1988, p. 15), which led to the development of agriscience (Shelley-Tolbert et al., 2000). Recognizing that agriculture is a science which impacts society illustrates the importance that integrating SSI into agricultural education can have for students. Given that SBAE has a responsibility to prepare its students for careers in the areas that will address emerging global issues (Geiman, 2013), integrating SSI into SBAE will increase student awareness of SSI and has the potential to raise student interest in these careers.

### *SSI-Based Instruction*

In light of their complex and often controversial nature, addressing SSI in a classroom can be challenging for students and teachers. Guidance through a research-based SSI framework would support SBAE teachers and curriculum developers and provide students with a safe and effective learning environment. The SSI-based instruction developed by Presley et al. (2013) provides this guidance through recommended and required learning experiences. SSI-based instruction is comprised of developing instruction around an issue (e.g., climate change, GMO's, food security) and presenting that issue to the class first. This is followed by helping students confront the science and theory related to the issue, through collecting and/or analyzing data, which may also include having debates or discussions (Presley et al., 2013). While SBAE teachers are often familiar with SSI-based instructional teaching methods, they may not use them regularly in their classes (Shoulders, 2012).

Lee et al. (2013) found that students exposed to SSI in an educational setting may develop increased responsibility and ownership of the issues and a felt willingness to act on those issues. Furthermore, Grace (2006) concluded that education should be preparing students who are not only scientifically literate but also prepared to engage with SSI, especially those which are controversial in nature.

### SSI and Science, Technology, Engineering, and Mathematics

Most SSI are also relevant in science, technology, engineering, and mathematics (STEM) education. As the number of students receiving four-year degrees increases, the number receiving STEM degrees are decreasing and the supply of STEM talent struggles to keep up with demand (U.S. Congress, 2012; Castleman et al., 2018). Integrating SSI into SBAE would not only enable students to gain awareness of global SSI, but also those which impact students on a local level, including issues that directly connect to students' lived experiences. Exposure to SSI has the potential to increase student interest in and ownership of these issues, inspiring them to seek out ways to engage in the issues and potentially pursue higher education or a career path related to SSI (Grace, 2006; Lee et al., 2013). These aspirations could include STEM careers. Additionally, as citizens and consumers, students who are more aware of SSI will be able to make more informed decisions and have an active role in solving these issues, whether it be as a professional, consumer, or both.

## Statement of the Problem

Research of SSI-based instruction has shown promise in improving students' science literacy (Pouliot, 2008), constructive discourse and argumentation (Dawson & Venville, 2008; Patronis et al., 1999), active participation (Evren-Yapicioglu, 2018), social awareness (Evren-Yapicioglu, 2018), and scientific reasoning (Sadler et al., 2007). Given this knowledge, and that integration of SSI has shown to positively influence student learning in SBAE (Shoulders & Myers, 2013), it remains to be seen whether

SBAE teachers are intentionally integrating SSI into their curriculum. If SBAE teachers are integrating SSI, how are they utilizing it, and in which courses?

Although there is abundant research in the field of science education related to SSI (Castano, 2008; Christenson & Rundgren, 2015; Ekborg et al., 2013; Sadler et al., 2016; Zeidler & Nichols, 2009), the research in SBAE and the integration of SSI is scarce (Cross & Kahn, 2018). If SBAE programs are going to contribute to the pipeline of students addressing SSI, a clearer understanding of what SBAE teachers know about SSI and their curriculum integration is essential. This knowledge will provide information as to the practice of SSI integration in SBAE. If SBAE teachers are not currently integrating SSI, it is crucial to know the factors influencing or barriers excluding the use of SSI instructional practice. Additionally, the results of this research will be useful to inform the professional development needs of in-service SBAE teachers and pre-service SBAE teachers in terms of SSI integration.

## Theoretical Framework

This research was guided by the SSI-based instructional framework, which emerged through the examination of several empirical studies of SSI-based instruction by Presley et al. (2013). This framework uses themes that developed across the studies to inform the critical elements of successful SSI-based instruction. While the framework covers required and recommended aspects of design, it is also a flexible tool that can be used to inform curriculum development, teaching, and learning. This framework provides three primary components to inform curriculum development: learners' experiences, curricular design elements, and teachers' characteristics. Additionally, the framework addresses classroom atmospheres and outside influences that will guide SSI integration (Presley et al., 2013).

## Purpose of the Study

This study explores the knowledge and integration of SSI among SBAE teachers by explaining the factors that influence integration. This research addresses the AAAE National Research Agenda priority seven, addressing complex interdisciplinary problems such as climate change, food security, natural resource usage and conservation, and sustainability (Roberts et al., 2016). This research priority acknowledges the complex challenges created by our growing global population and innovation and recommends research addressing how agricultural education contributes to the workforce of individuals who will have a direct hand in solving these challenges. This research will also contribute to the dearth of research connecting SSI and SBAE curriculum.

## Research Objectives

The following research objectives will guide this research:

1. Describe the personal and professional characteristics of SBAE teachers.
2. Describe SBAE teachers' self-efficacy beliefs related to socioscientific issues.
3. Describe SBAE teachers' perceived need to teach socioscientific issues.
4. Describe SBAE teachers' perceived barriers to teaching socioscientific issues (i.e., time, knowledge, peripheral influences).
5. Describe which socioscientific issues SBAE teachers use in their curriculum.

6. Describe teaching strategies and resources used by SBAE teachers when incorporating socioscientific issues into their curriculum.
7. Explain the influence of SBAE teacher attributes (i.e., teaching efficacy beliefs, perceived need, personal and professional characteristics) and peripheral influences (i.e., time barriers, knowledge barriers, other peripheral influences) on teaching socioscientific issues.

## Assumptions

The following assumptions were made in order to accomplish the purpose and research objectives of this study.

1. The population frame used for this research represented a random sample of all secondary agriculture teachers in the United States during the 2020-2021 school year.
2. Agriculture teachers' knowledge and integration of SSI into their curriculum can be measured by the instrument adapted for this study.
3. Agriculture teachers in this study had the ability to access and complete the online instrument, knew the answers to the instrument items, and answered them truthfully.

## Limitations

The following are the limitations identified for this research.

1. This research focuses on secondary agriculture teachers during the 2020-2021 school year, and as such, may not be generalizable to teachers in other disciplines, subjects, school years, or grade levels.
2. The data collected for this research used an online instrument and a paper-pencil instrument that requires the participants to self-report the information, which may be a threat to validity.
3. Online instruments and paper-pencil instruments are limited in the data collected from participants and, as such, may not provide opportunities for more in-depth and meaningful information related to their knowledge and integration of SSI.
4. As a former secondary agriculture teacher, I made every attempt to remain objective. However, my own lived experiences and my own values related to curriculum integration may have influenced my decisions associated with the research topic, development of the instrument, variables selected for study, data collection, analysis, conclusions, and implications.

## Delimitations

The following are the delimitations of this research.

1. This research is focused on secondary agriculture teachers’ knowledge and integration of SSI. Research exists which suggests that SSI is a component of science education; however, this research will focus on agricultural education.
2. The data collected in this research is limited to the SSI included in the instrument. To reduce the time needed to engage with the survey, common

SSI were included in the instrument. However, space was provided in the instrument to allow participants the ability to include specific SSI they address in their curriculum but were not included in the survey.

## Definition of Terms

### Socioscientific Issues (SSI)

Issues that are scientific in nature and have a connection with society (e.g., climate change, food security, natural resource use and conservation, sustainability). These issues may include global, national, regional, and local issues and are often controversial in nature.

### School-Based Agricultural Education (SBAE)

Middle or high school agricultural education program taught by a certified agriculture teacher. Courses taught in school-based agricultural education follow the Agriculture, Food and Natural Resources (AFNR) pathways. The AFNR pathways include agribusiness systems, animal systems, biotechnology systems, environmental systems, food products & processing systems, natural resource systems, plant systems, and power, structural and technical systems.

### Agriculture Teacher

Any middle or high school teacher who is certified to teach agricultural education courses which are part of an AFNR pathway.

**Integration of SSI**

The intentional inclusion of socioscientific issues into the SBAE curriculum with fidelity to the SSI framework.

**SSI-based Instruction Framework**

An instructional framework which indicates primary components for consideration when designing SSI curriculum. This framework was developed by Presley et al. (2013) through their research of SSI integration.

# CHAPTER 2: LITERATURE REVIEW

## Chapter Overview

This chapter will introduce the theoretical framework for this research and background on socioscientific issues (SSI). It will also include details about school-based agricultural education (SBAE); agricultural literacy; science literacy; education for sustainable development (ESD); citizenship education; environmental education, science, technology, society, environment (STSE); and SSI. While each of these areas represents different educational arenas, they have a great deal in common. Conducting research for this literature review provided valuable insight into factors that make up each content area and the extensive overlap of all the content areas (see Figure 2.1). For example, agricultural literacy is concerned with individuals understanding the relationship that the production, processing, and distribution of agriculture products has on society, the economy, and the environment. While STSE is also concerned with understanding relationships between science, the environment, and society, and focuses on real-world problems, culture, and values. These factors align with citizenship education as well as ESD and, overall, connect with SSI. Utilizing underlying themes within each content area, this chapter will connect similarities and highlight differences among the content areas, and provide a bridge to SSI, culminating with integrating SSI in the SBAE curriculum. Finally, a conceptual framework will be introduced.

**Figure 2.1**

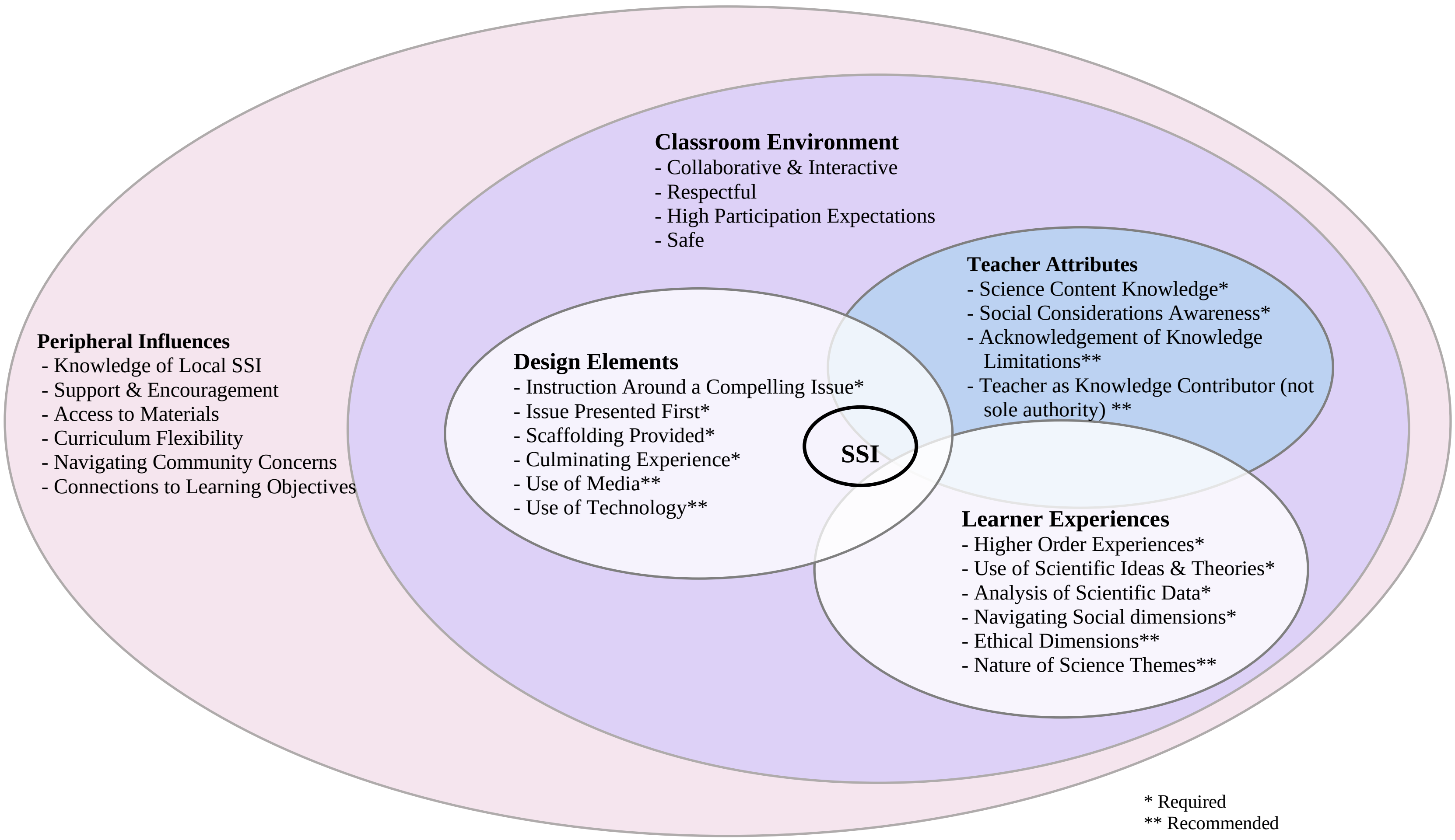
*Connections Between Multiple Educational Content Areas*


## Theoretical Framework

I have situated this research within the SSI-based instructional framework. This instructional framework was developed through the examination of several empirical studies of SSI-based instruction by Presley et al. (2013). It uses themes that developed across the studies to inform the critical elements of successful SSI-based instruction. The SSI-based instructional framework encompasses required and recommended aspects of curriculum design (see Figure 2.2) and is a flexible tool that can be used to also inform teaching and learning. There are three primary components to inform curriculum development including learners' experiences, curricular design elements and teachers' characteristics. Additionally, the framework addresses classroom atmospheres and outside influences that will guide SSI integration (Presley et al., 2013).

**Figure 2.2**

*SSI-based Instruction Framework*



As a teacher integrates SSI, there must be support for SSI integration from the teacher's school and community. They also need access to the material that will enable them to integrate SSI with fidelity to the SSI-based framework. Additionally, teachers will need flexibility within their curriculum to fit the SSI where applicable, and SSI must connect to their current curriculum objectives (Presley et al., 2013).

Addressing the peripheral influences of SSI integration is just one component of the SSI-based instruction framework. Once the peripheral influences are considered, and teachers decide to integrate SSI, special attention then turns to the curriculum design. According to the framework, the design must include certain aspects and experiences by the learner. These required design elements include developing instruction that focuses on an issue that will compel students' attention. This issue is presented first to students before any instruction to consider the problem and what they already know. Instruction then follows that provides scaffolded opportunities for students to engage in higher order thinking and practices while analyzing scientific data about the issue. The lesson would then conclude with an experience that provides students with opportunities to support their learning including, but not limited to, debate or discussion. Using media and technology to connect the issue to students' own lived experiences is recommended. Through this process, learners must use scientific data, apply ideas and theories, and consider the issue's social components. The issue may be a global, regional, or local SSI, and it is recommended that students also consider ethical possibilities and the nature of science connections to the issue (Presley et al., 2013).

In addition to curricular design and learner experiences, the SSI-based framework also accounts for teacher attributes that enhance the SSI experience. Teachers must know about the SSI, including science and social connections. It is also imperative that teachers recognize their knowledge shortcomings and position themselves as facilitators and not the primary expert. The classroom environment must be respectful and safe in that students and teachers are mutually respectful, and students feel safe to engage in the issue. Students should be expected to participate and work collaboratively with their peers (Presley et al., 2013).

Ziedler (2014) indicated that the use of the SSI framework with fidelity would:

- Utilize personally relevant, controversial, and ill-structured problems that require scientific, evidence-based reasoning to inform decisions about such topics.
- Employ the use of scientific topics with social ramifications that require students to engage in dialogue, discussion, debate, and argumentations.
- Integrate implicit and/or explicit ethical components that require some degree of moral reasoning.
- Emphasize the formation of virtue and character as long-range pedagogical goals. (p. 699)

The SSI-based framework can be used to direct curriculum development and pedagogical practices that will expose students to relevant, challenging issues that impact society on a global scale, but also provide experiences they can use to confront those SSI which occur locally. In their research, Cross and Kahn (2018) studied the integration of SBAE curriculum related to soil erosion, informed by the SSI-based instruction framework.

**Socioscientific Issues**

As populations increase worldwide, so does the demand for essentials like food, water, land, and other natural resources. At times, the increased demand for these necessities outpaces the supply, leading to complex, multifaceted societal issues. Often referred to as complex global issues, some of the more recognized issues include but are not limited to, climate change, food security, sustainability, GMOs, and water conservation. These issues occur on a global scale but are also found regionally and locally (Ratcliffe & Grace, 2003).

The idea of societal problems that are elusive or unsolvable has been around since Rittel and Webber (1973) described them in their article addressing public policy issues and referring to them as wicked problems. Rittel and Webber's (1973) definition also aligns with what many refer to as complex global issues. While these issues are complex, merely referring to them as complex global issues fails to recognize the connection these issues have with science and society. Issues or complex problems that have links to science and effect society are known as SSI (Sadler, 2004a). They are even referenced in the literature more than 30 years ago when Fleming (1986a) and Fleming (1986b) explored the interaction of SSI and reasoning in adolescents. Complex global issues, such as climate change, food security, GMOs, water, and other natural resource use and conservation, are SSI directly connected to agriculture. These issues become complex as science interfaces with social values and needs. The solutions require critical thinking and, in some cases, compromise.

While several of the tenets of SSI are reminiscent of the science, technology, and society (STS) movement (see Figure 2.1), distinctions that set them apart originate in the influence of theory and research in fields of philosophy, development, and sociology to inform SSI (Ziedler, 2014). As will be discussed later in this chapter, the science, technology, and society movement has evolved into the science, technology, society, and environment (STSE) movement.

**SSI and Science Integration**

Socioscientific issues are reminiscent of the STS movement; however, SSI is guided by theory and scholarship (Ziedler, 2014). It follows a student-centered, progressive learning environment as opposed to traditional, teacher-centered learning (Ziedler, 2014). Early on, Fleming (1986a) discussed SSI as a pedagogical practice which requires students to address scientific issues not only from the science perspective but also integrating knowledge of the social realm.

Chowdhury (2016) suggested that STS is a context for a curriculum instead of representing an actual curriculum which exhibits a strong focus on the nature of science. Science integration primarily focuses on science concepts being integrated into a curriculum. In contrast, SSI emphasizes not only the development of content knowledge, but it also stresses the essential components of advancing student character, virtue, and moral reasoning (Pedretti & Nazir, 2011; Zeidler & Schafer, 1984; Zeidler & Keefer, 2003). SSI is more about the application of science concepts to real-world problems. Additionally, Reiss (1999) and Osborne and Collins (2000) pointed out the challenge of helping students recognize the relevance that science has to their everyday lives. This is where SSI provides a context for the science content. When integrating SSI, not only do students learn about the science content, but they also consider the social and ethical components and analyze scientific data to form opinions and understandings. Students are able to relate the science content they are learning within the context of SSI. Furthermore, SSI provides those components that STS lacks by way of a theoretical framework to inform program developers of the teaching strategies for implementing SSI and acknowledgement of students' developing standpoints on the issues (Zeidler & Nichols, 2009). Being complicated and often controversial, SSI do not always have clear cut solutions, requiring students to consider the ramifications of an issue that may not be solved in a way that pleases all stakeholders.

**Science and Society**

Individuals must make knowledgeable, informed decisions on a daily basis and many of those decisions have connections to science and technology. To have basic technical or science knowledge is to be science literate but having the ability to critically think and creatively address processes with technical or scientific knowledge is to be scientifically literate (Mainschein, 1998). Laugksch (2000) further described individual scientific literacy as instrumental in contributing to national economies, both as human capitol that meets the demand for scientifically trained workers, but also as supporters of science. Given the technological advancements of the current time as well as the broad issues facing society, it is essential that individuals understand science and its relevance to their daily lives.

**Need for Common Language**

Many educational content areas address SSI in their curriculum; however, most do not utilize the term SSI. For example, education for sustainable development focuses on social, economic, and environmental global threats (McKeown, 2002). Citizenship education is concerned with preparing young people to be active citizens (Kerr, 1999), and environmental education teaches students about the environment and its connection to economics, society, and culture (Ratcliffe & Grace, 2003). SBAE programs prepare students for careers and higher education in content areas such as animal and plant science, environmental and natural resources, and biotechnology. Most SSI have some connection to agriculture and SBAE teachers may include these issues in their curriculum, but do not refer to them as SSI.

Confusion arises due to the lack of continuity in how these issues are identified. Some content areas refer to socio-ecological issues, which are slightly different than SSI but similar, and some may refer to issues as complex global issues or wicked issues. This lack of a common language leads to confusion and, in some cases, duplication of efforts. Collaborative efforts can be realized and enhanced by developing a common language or term used throughout educational arenas. Additionally, and more importantly, those who believe they are addressing SSI may not be integrating the components of the SSI-based instruction framework (Presley et al., 2013) with infusion of a common language.

**SSI in the Classroom**

Integrating SSI in the classroom is a pedagogical approach that introduces students to a way of learning about relevant issues that are front of the mind in their communities. In their study of six different classes of tenth- and eleventh-grade Israeli science and non-science students, Tal and Kedmi (2006) found that students' argumentation skills and value judgment abilities were substantially improved when using an SSI related to fish farming in their local community. Additionally, these students provided a higher number of correct scientific facts within their arguments and counterarguments, suggesting they had learned to apply the scientific evidence discovered to support their claims (Tal & Kedmi, 2006).

In a synthesis of empirical research, Sadler (2004) suggested that students need the practice to demonstrate complex arguments backed by evidence. Still, most importantly, they need relevant examples of issues the students are personally connected to. Additionally, students often set aside scientific evidence to make individual decisions, which impacted informal reasoning. Again, by providing SSI in which students had a closer connection, this allowed the science to have more direct relevance for students and enhanced their reasoning (Sadler, 2004).

Students who experienced SSI in an educational setting showed increased feelings of responsibility and ownership of issues, which promoted further propensity to act (Lee et al., 2013). These behavior changes were evident even through simple exposure to the SSI and the use of discourse (Lee et al., 2013). Furthermore, Bencze et al. (2012) found in their research of high school science students, experience with SSI inside the classroom inspired students to activism about SSI outside the school.

While there is a great deal of research which suggests integrating SSI into classroom curriculum has positive results for student learning in areas of argumentation, critical thinking, activism, content learning, and scientific literacy (e.g., Lee et al., 2013; Sadler, 2004; Sadler et al., 2016; ), there is some research that also suggests that teachers struggle to implement SSI and need the training to ensure proper integration (e.g., Cross, 2019; Shoulders, 2012; Walker & Zeidler, 2007; Wilcox et al., 2014). If teachers are merely mentioning SSI topics in their classes and not providing opportunities for students to delve into the science and social connections of these issues, students are missing out on the intent of the SSI-based framework. This cursory glance at the issues results in students forming a superficial acquaintance with these issues instead of more in-depth knowledge of how SSI impact the world around them. Learning about SSI in their classes is essential for students to learn about the complex issues facing society and the pertinent science of those issues (Kampourakis, 2019).

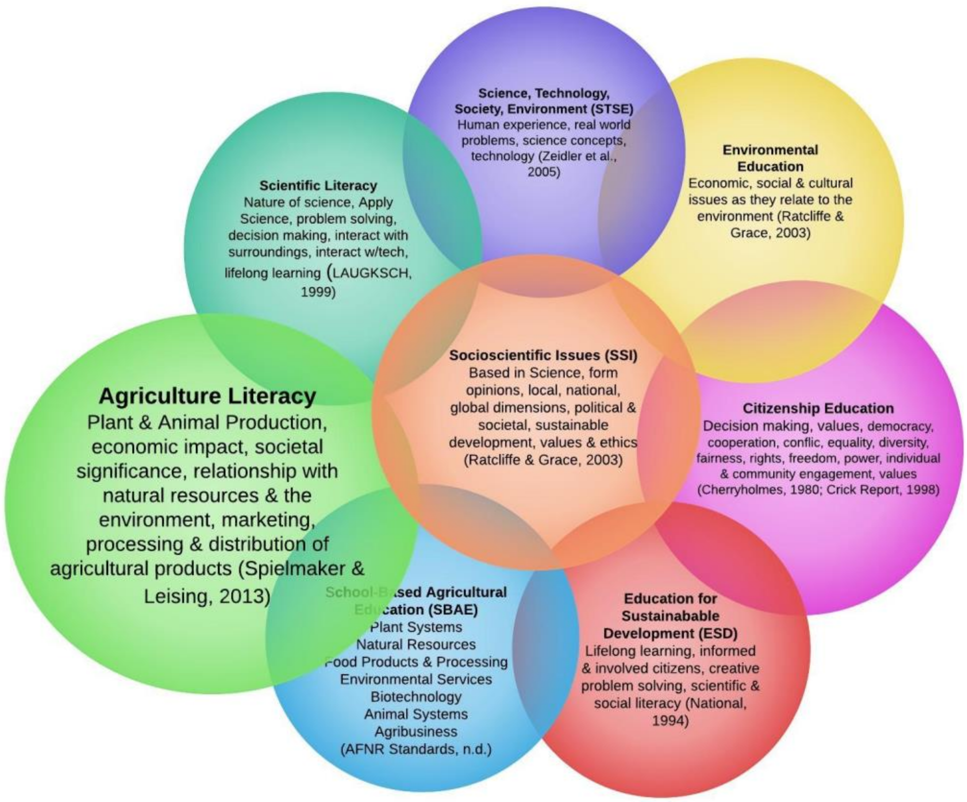
**Agriculture Literacy**

In 1988, the National Research Council (NRC) issued a report detailing the need for an agriculturally literate population (NRC, 1988). Specifically, they determined “an agriculturally literate person's understanding of the food and fiber system would include its history and its current economic, social, and environmental significance to all Americans” (NRC, 1988, p. 8). The council also recommended that all students should receive education about agriculture regardless of whether they were in a rural, suburban, or urban community (NRC, 1988). More recently, in 2013, a National Agriculture Literacy Logic Model was developed along with a supporting definition of an agriculturally literate person/member of society. The logic model (Spielmaker et al., 2014) states that an agriculturally literate individual includes “a person who understands and can communicate the source and value of agriculture as it affects our quality of life” (NAITC, n.d., Agriculture Literacy) (Figure 2.3).

As efforts are made to ensure a more agriculturally and scientifically literate citizenry, as discussed more in the following sections, incorporation of related subjects should occur whenever possible. This integration was also highlighted by the NRC (1988) when they recognized “all students need an understanding of basic science concepts” and “teaching science through agriculture would incorporate more agriculture into curricula, while more effectively teaching science” (NRC, 1988, p. 11). This advice would meet the needs of agricultural literacy and promote science literacy for all students.

**Figure 2.3**

*Agricultural Literacy Connections to Educational Content Areas*




***Agricultural Literacy and SSI***

The literature that connects agricultural literacy and SSI is minimal. However, in their study of SBAE teachers who used school gardens to teach science concepts and increase agricultural literacy, Cross and Kahn (2018) found that while teachers did discuss SSI topics like genetically modified organisms (GMO) with their classes, the SSI instructional framework was not followed. Additionally, the teachers indicated in their interviews that meeting state standards was challenging, but they felt it was important their students experienced applied science in their classes (Cross & Kahn, 2018). These results suggest that teachers believe SSI can help students apply the knowledge they have learned, but they may need support to implement the SSI-based instructional framework.

The National Center for Agricultural Literacy has developed and curated instructional resources for the National Agriculture in the Classroom Organization. The National Agricultural Literacy Curriculum Matrix is a free online database where K-12 educators can find ready-to-use instructional resources aligned to national education standards. All lessons use agricultural content as a context for achieving the standards and increasing agricultural literacy. On the “matrix” (agclassroom.org/matrix) teachers can simply search the topic they want to teach, and the database will return lesson plans and resources available to address the topic and educational standards. An advanced search can be used to specify grade level, type of companion resources, content area standards, agricultural literacy outcomes, and common core. For example, a simple search of “climate change” elicited five lesson plans (grades 6-12) and eight companion resources including five videos, two readings, and a website that could all be used to teach about climate change. Searching “food security” brings up three lessons (grades 6-12) and seven companion resources which include an activity kit, an interactive map, a video, an additional reading, and three websites.

**Agricultural Literacy and Connections to other Content Areas.** When examined closely, the central tenets of agricultural literacy are easily connected with the principles of different content areas discussed in this chapter (e.g., science literacy, citizenship education, SDE, STSE). These educational areas' interconnected relationships provide ample opportunity to integrate them within classroom curricula to meet multiple teaching and learning goals. In their research, Vallera and Bodzin (2016) illustrated the educational connections between ESD, environmental literacy, and science literacy, emphasizing the overlap the three content areas have with agricultural literacy. As will be seen throughout this chapter, these relationships between the realms of science literacy, ESD, environmental education, citizenship education, and STSE give rise to SSI's holistic dynamic and its integration into SBAE.

**Science Literacy**

Science literacy gained traction in the 1950's as America responded to Sputnik's launch by the Soviet Union and became entrenched in the space race (Feinstein, 2011; Laugksch, 2000). After decades of discussions and comparisons, Laugksch (2000) explained that science literacy, as a concept, has different meanings based on the perspectives of those employing it, and it is influenced by several factors, including those found in Figure 2.4. Roberts (2007) separated science literacy into two distinct visions, where Vision I is situated around the *content* of science, and Vision II is situated around the *context* of science. Essentially, this created a distinction between science literacy (Vision I) and scientific literacy (Vision II). Furthermore, Feinstein (2011) argued that science literacy allows individuals to connect science with those things most relevant to them personally. Asserting more specifically,

> that science literate people are competent outsiders with respect to science: people who have learned to recognize the moments when science has some bearing on

their needs and interests and to interact with sources of scientific expertise in ways that help them achieve their own goals (Feinstein, 2011, p. 180).

Science literacy is the ability for individuals to understand how science is connected to their own lives and apply that knowledge to make informed decisions. This idea aligns with agricultural literacy and the importance of making personal connections, and with SSI in the need for individuals (i.e., students) to understand the relevancy of the issues.

**Figure 2.4**

*Science Literacy Connections to Educational Content Areas*

### *Scientific Literacy and SSI*

While there is abundant research related to science literacy and a distinct difference between science and scientific literacy (Roberts, 2007), much of the research uses science literacy and scientific literacy interchangeably. However, for this literature review, I will focus on scientific literacy. The utilization of SSI to promote scientific literacy is well documented in the literature and shows positive effects on students' science literacy (Eastwood et al., 2012; Ritchie et al., 2011; Van Rooy & Moore, 2012). In their use of investigation and story writing about an SSI, Ritchie et al. (2011) found that students' scientific literacy increased, and they expressed enjoyment when learning about something that was occurring nearby, making the SSI relatable. Furthermore, the use of media and a scaffolded approach to news article analysis proved fruitful in developing a curriculum that can be used to help students analyze information to learn about SSI and enhance components of scientific literacy (Van Rooy & Moore, 2012). However, as Eastwood et al. (2012) discovered, while SSI are useful in the classroom, teachers need support to integrate them. Integrating SSI into the existing curriculum can be daunting and overwhelming for teachers who may already be taxed. Supporting teachers in their pursuit of SSI integration is necessary to ensure the SSI-based framework is followed with fidelity.

## Education for Sustainable Development

Although education is a critical element of education for sustainable development (ESD), this initiative was brought forth by political and economic groups outside of the educational realm. In 1992, 172 nations that attended the United Nations Conference on

Environment and Development adopted Agenda 21, which recognized 18 different components of sustainability (Sitarz, 1993). The Agenda declared, “sustainable development education should deal with the dynamics of the physical, biological, social, economic, and spiritual environment. Information regarding all of these aspects should be integrated into all disciplines” (Sitarz 1993, p. 293).

The role of ESD is primarily focused on issues that are threats to the globe, which are social, economic, and environmental in nature (McKeown, 2002). A significant goal of ESD is to develop lifelong learners who will ultimately "have a sustainable livelihood and to live sustainable lives" (McKeown, 2002, p. 20). This goal is accomplished through not only learning about the issues impacting the planet but also discovering the skills, perspectives, and values integral to those issues as they relate to the three main areas of focus: social, economic, and the environment (McKeown, 2002; National, 1994) (Figure 2.5).

**Figure 2.5**

*ESD Connections to Educational Content Areas*


### *ESD and SSI*

Issues that align with ESD are also in line with SSI. Williams and Dollisso (1998) suggested that sustainable agriculture practices should be incorporated into the SBAE program curriculum. Moreover, they recommended seeking out ways to integrate sustainability in agricultural education, which developed connections between teachers and students in their knowledge and understanding of the issues (Williams & Dollisso, 1998). Education for sustainable is likely implemented in SBAE courses; however, those involved (e.g., teachers, teacher educators) may not utilize the same terminology. For example, in their study of agriculture, food, and natural resources (AFNR) teachers, which are also commonly SBAE teachers, McKim et al. (2018) conducted a study exploring the impacts of professional development related to integrating a sustainable water management curriculum. The topic of sustainable water management falls into the ESD realm and it also meets the criteria of being an SSI. This SSI is not only a global issue; it is a regional and local issue. In the study by McKim (2018), the idea of sustainable water management was also a controversial topic, as evidenced by teacher comments related to disagreement and dissent about the issue.

Although it has been suggested in research and the SSI framework, introducing local issues that students can relate to will often elicit more engagement. Simonneaux and Simonneaux's (2009) research suggested that when issues are too close to students, they allow personal feelings to overtake the science learned, impacting reasoning. In their study, the students were introduced to three SSI through the lens of ESD, which are referred to as socially acute questions (SAQ) in France, two of which were local issues, and one was global. They suggested that students used science content to inform their reasoning more fully concerning the global matter, whereas the two local issues elicited more personal feelings (Simonneaux & Simonneaux, 2009). This finding was argued in Sadler's (2009) critique. The author pointed out that when students are entrenched in the SSI context, teachers must take the opportunity to support students in recognizing their deep connection to the issue and apply reasoning (Sadler, 2009). As has been recommended in previously discussed research, teachers need assistance in navigating the learning opportunities that integrating SSI presents. Supporting teachers in their understanding of SSI and its implementation into the curriculum ensures that teachers follow the SSI-based framework.

**Citizenship Education**

Although citizenship education is, in part, included within the premise of ESD, it is included here as a separate section to acknowledge the distinct place citizenship education holds as an educational content area. In a review of the curriculum for 16 different countries, Kerr (1999) found that citizenship education involves many terms including “citizenship, civics, social sciences, social studies, world studies, society, studies of society, life skills, and moral education” (p. 6-7). More broadly, this educational area involves “the preparation of young people for their roles and responsibilities as citizens” (Kerr, 1999, p. 6). The *why* and *how* of citizenship education within these 16 countries was influenced by five relative aspects, "historical tradition, geographical position, socio-political structure, economic system, and global trends," which led to a wide variety of definitions and understandings (Kerr, 1999, p. 8).

In an international Delphi study, which included the countries of Japan, Thailand, Europe, and North America, a working definition of citizenship education was identified as the contribution that education makes to the development of citizen characteristics among students (Cogan, 2000). A review of the literature related to citizenship education produced an array of emphases on which citizenship education concentrates (Figure 2.6) (Cherryholmes, 1980; Advisory Group on Citizenship, 1998).

**Figure 2.6**

*Citizenship Education Connections to Educational Content Areas*


### *Citizenship Education and SSI*

Citizenship education promotes the development of characteristics or values that embody being a citizen. The results of a study conducted by Kim et al. (2020) of Korean middle school students suggested that using community SSI in an educational setting promoted the development of students' sense of place (SOP), or community connection, along with citizenship values and characteristics. They suggested that integrating community SSI allowed the students to connect with the issues and positively influenced students SOP, especially those with beginning low SOP (Kim et al., 2020). Citizenship education has different meanings for different people, which can lead to confusion.

Teachers may vary in their values for citizenship education. When paired with SSI, this may cause tension in curriculum development (Barrue & Albe, 2013).

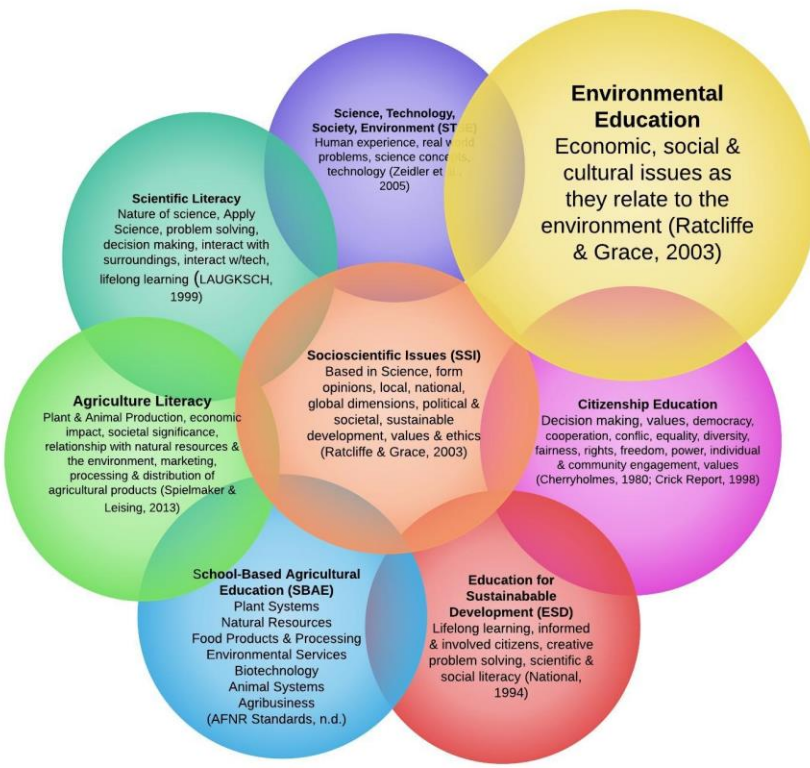
Furthermore, Barrue and Albe (2013) found that teachers were frustrated by the lack of collaboration when designing curriculum and learning activities that involve the complex nature of citizenship education and SSI. As teachers work to integrate SSI, their own values and beliefs will influence their curriculum and teaching choices (Pajares, 1992; Bryan, 2003; Bryan, 2012). Recognizing this is essential for teachers who may need professional development in the integration of SSI. Support is also warranted to help teachers collaborate with other content areas to help students connect the multitude of courses they take in their educational careers.

**Environmental Education**

It is acknowledged that environmental education is a significant part of ESD. However, it is also found as a separate educational subject with its own learning objectives, and as such, is included within this literature review as a separate section. Environmental education originated with the advancement of studying nature and the outdoors and continued through the development of conservation (Stevenson, 2007). Through education, students are introduced to environmental information, which allows them to individually form their own values and beliefs related to the environment. This education may include policy or political information, leading students to act on their decisions, if they so choose (Stevenson, 2007). Some individuals may still link environmental education to focusing primarily on environmental and natural disasters. Yet, scholars and teachers claim that this field should more fully include environmental connections to the economy, society, and cultures (Ratcliffe & Grace, 2003) (Figure 2.7). These environmental education descriptions have considerable overlap with the previously discussed SSI, agricultural literacy, science literacy, ESD, and citizenship education. There are also clear connections between environmental education and science, technology, society, and environment (STSE) (e.g., science, environment, and humans), as highlighted in a subsequent section of this literature review.

**Figure 2.7**

*Environmental Education Connections to Educational Content Areas*



### *Environmental Education and SSI*

Socioscientific issues are a natural fit for integrating into environmental education, given the content which includes environmental impacts from economies and, social and cultural issues. Research conducted by Newton (2016) studied the effects of authentic experiences of controversial environmental issues embedded into an environmental education course through an SSI framework. This study used experiential SSI instruction to determine differences in student engagement from those in traditional classes. The findings suggested students experienced similar changes to informal reasoning as well as ethical and moral development compared to those students who experience SSI in a traditional class setting (Newton, 2016). Furthermore, Newton (2016) found that when the experiential SSI approach was compared to that of an issues investigation and action training, commonly associated with science, technology, society curriculum, students developed reasoning skills to propose solutions to the environmental issues.

Under the premise of enhancing scientific literacy, SSI offers a way to contextualize the science content. There are many SSI which are relevant to the environment including climate change, nuclear power, pollution, and natural resource management (Zeidler & Kahn, 2014). Vision II for scientific literacy, previously discussed in this chapter, envelops environmental literacy. In their use of SSI in a field-based environmental education curriculum, Kinslow et al. (2019) found that high school students significantly improved their socioscientific reasoning and environmental literacy.

Using the SSI-based instruction model, Herman et al. (2018) developed and implemented curriculum for an experiential environmental issues course. They found that using the SSI-based instruction model to inform the curriculum development ensured the educational objectives, instructional priorities, and commitment to theory were aligned (Herman et al., 2018).

**Science, Technology, Society, and Environment (STSE)**

The science, technology, society (STS) movement is a paradigm that represents how “modern science and technology shape modern culture, values, and institutions on one hand, and how modern values shape science and technology, on the other” (Mansour, 2009, p. 1). STS education has looked differently around the world due to the uniqueness of each system of education in society, thus establishing a concrete definition has proven difficult (Solomon, 1993). Over time, STS has evolved to include the environment reflecting their close connections, which has inspired a shift to science, technology, society, and environment (STSE) (Gunstone, 2015).

Gunstone (2015) identified the broad description of STSE, which still includes examining the interactions between science, technology, society, and the environment but "places science squarely within social, technological, cultural, ethical, and political contexts" (p. 932). As can be seen from Figure 2.8, STSE is reminiscent of similar concepts within SSI, but also environmental education, ESD, science literacy, and connects to citizenship education and agricultural literacy.

**Figure 2.8**

*STSE Connections to Educational Content Areas*


***STSE and SSI***

The research is vast related to the transition from science, technology, society (STS) to science, technology, society, environment (STSE) and still there is more when SSI is added to the mix (e.g., Hodson, 2020; Leung et al., 2020; Pedretti & Nazir, 2011; Zeidler et al., 2002). While much of the research points out similarities between STSE and SSI, in fact, Zeidler et al. (2005) point out the differences that STSE centers more around the content of the science wherein SSI is associated with ethics and moral decisions about the issues through communication and discourse.

Leung et al. (2020) identified challenges when the science curriculum transitioned from STS to STSE, but the SSI were actually part of a liberal studies curriculum. In this instance, the SSI were taught through a content-centered approach where students engaged with the SSI to learn the content of the issue and were not prepared to consider the issue outside this context and aside from the science (Leung et al., 2020). This was one example where the overlap of SSI with the liberal studies course provided an avenue for teachers to address the issues in the classes, however they may not have been equipped to address the science of the SSI.

**School-Based Agricultural Education (SBAE)**

Agricultural education reaches more than 1,000,000 students across all 50 states and three U.S. territories (The Council, n.d.). These students are enrolled in SBAE programs in urban, suburban, and rural areas. Students in SBAE programs experience classroom instruction, leadership opportunities through FFA, and experiential learning through supervised agricultural experiences (SAE) (NAAE, n.d.). Students enrolled in SBAE programs experience a wide variety of courses in subjects that range from plant systems to natural resources and biotechnology to power, structural and technical systems (Figure 2.9). Many of these experiences prepare students for their futures, in a career, in education, and in society.

**Figure 2.9**

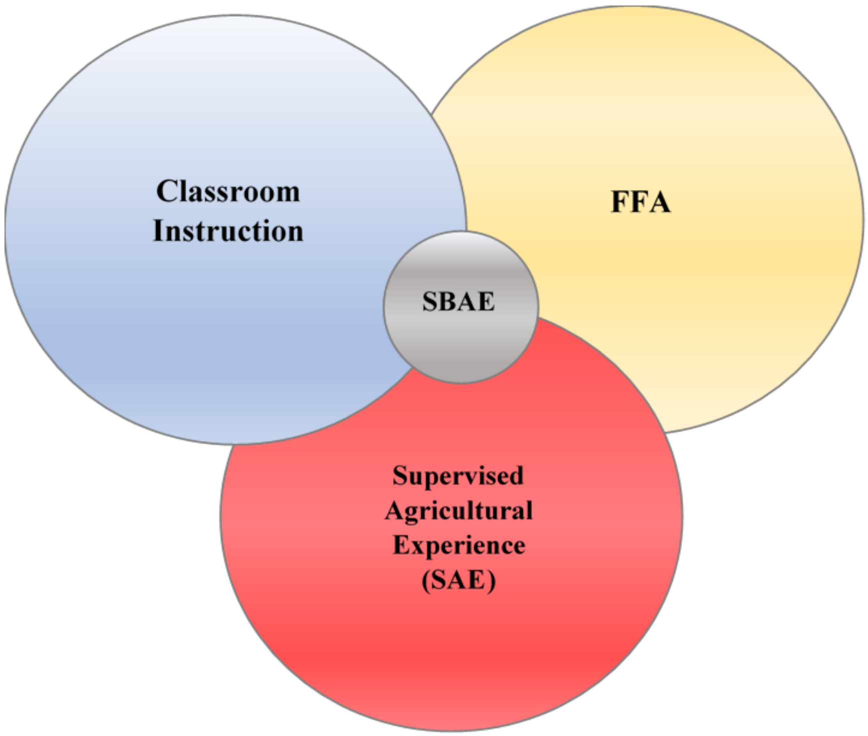
*SBAE Connections to Educational Content Areas*


SBAE teachers employ various teaching methods including experiential learning, problem-solving, inquiry-based learning, and direct instruction. In addition to the wide array of subjects taught, this differentiation of instructional strategies provides flexibility for SBAE teachers to integrate global, regional, and local SSI into their curriculum.

The three-component model is a framework within SBAE which guides teachers in the components that make up a complete SBAE program (FFA, n.d.). The three-component model includes student experiences in the classroom, leadership, and career experiences in FFA, and experiential learning through their supervised agricultural experience (SAE) (see Figure 2.10).

**Figure 2.10**

*SBAE Three-Component Model of Agricultural Education*




***SBAE and SSI***

The SBAE curriculum often includes topics considered SSI. For example, it is not unusual to discuss GMOs in a plant science, food science, or biotechnology class. However, there is little research that unites SSI and SBAE explicitly together. While there is a paucity of research in this area, the first to study SSI within SBAE, Shoulders (2012), found that while teachers were excited to integrate SSI and reported familiarity with teaching methods consistent with SSI (e.g., problem-solving, inquiry-based instruction, experiential learning), teachers might not have been using them regularly in their classes.

Cross (2019) later studied the use of SSI in SBAE and discovered that teachers in the study struggled with the background knowledge to implement SSI discussions about GMOs that encouraged students to employ scientific reasoning. In fact, teachers were inclined to share their own opinions and values with the students (Cross, 2019). Teachers must be cognizant of allowing their own opinions and values to influence students' reasoning. Both of these studies highlight SBAE teachers' difficulty in utilizing the SSI framework to guide instruction thoroughly.

In 1988 the National Research Council issued recommendations that indicated science and agriculture were a good fit for collaboration. They believed that offering science through agriculture courses would be an even more effective way to teach science (National Research Council, 1988). In their research of agriculture and science teachers' perceptions about integrating science into SBAE classes, Thompson and Warnick (2007) found that the teachers differed in their agreement on many issues. While agriculture teachers agreed they had the competence to teach science concepts and students should receive graduation credit for their agriscience classes, science teachers agreed less with those statements (Thompson & Warnick, 2007). Even though science teachers and SBAE teachers do not always agree on science integration in agriculture classes, Chiasson and Burnett, (2001) found students in their study enrolled in agriculture classes, performed better on high school state standardized science exams.

Efforts to unite science and SBAE are evident in curricular programs such as Curriculum for Agricultural Science Education (CASE). This curriculum and the professional development opportunities are developed and designed using recognized teaching pedagogy informed by research (CASE, n.d.a.). CASE curriculum includes content connections between science and agricultural education using problem-based learning activities which align to the Next Generation Science Standards, Common Core Standards for High School Mathematics, Common Core Standards for High School English Language Arts and, depending on the topic, the Common Career and Technical Core Content Standards (i.e. AFNR, Agricultural Power and Technology, Natural Resources and Ecology, Animal and Plant Biotechnology, Food Science and Safety, Mechanical Systems in Agriculture, Environmental Science Issues, Agricultural Research and Development, Agriculture Business Foundations) (CASE, n.d.a.b).

**AFNR Content Standards and SSI**

The AFNR content standards are a national set of standards for each career pathway in SBAE. These standards revised in 2015 are provided as a guide to state and local education leaders for use when developing state and local education standards for SBAE pathways (The National Council, 2015). These standards focus on the following SBAE course pathways: power, structural and technical systems, plant systems, natural resource systems, environmental service systems, biotechnology systems, animal systems, agribusiness systems, AFNR cluster skills, career Ready Practices (The National Council, 2015).

While each state's education standards may differ slightly for SBAE programs, most closely follow the national AFNR standards. As such, the AFNR standards are used in this literature review to determine the ability to meet SBAE standards through the use of SSI. The AFNR cluster skills standards represent what "students should know and be able to do after completing a program of study in any AFNR career pathway" (The National Council, 2015). Of the six Common Career Technical Core (CCTC) Standards in the AFNR cluster skills, integrating SSI into the SBAE curriculum would help meet five of those standards. An examination of the CCTC standards for the individual course pathways revealed that SSI would assist it in meeting standards in all of the courses. In addition to the CCTC, the AFNR standards are crosswalked to the national Common Core English Language Arts standards, National Common Core Mathematics standards, Next Generation Science Standards, Green/Sustainability Knowledge and Skill Statements, and the National Standards for Financial Literacy (The Council, n.d.).

With the knowledge of the research conducted in science, citizenship, and agricultural education, it is clear there is a dearth in the research surrounding the integration of SSI in SBAE. Within this research study, SBAE teachers' knowledge and integration of SSI will be examined. The SSI-based framework will be the lens in which this study is designed, implemented, and analyzed.

### ***SSI in SBAE***

Topics or issues which are scientific in nature while impacting society are also known as SSI (Sadler, 2004a), and several of these issues are connected to agriculture (e.g., climate change, food security, genetic engineering, natural resource use, sustainability) (Roberts et al., 2016). Research has shown that science teachers believe that SSI-based curriculum offers benefits and advantages for student learning (Lee et al., 2006; Evren-Yapicioglu, 2018). Additionally, agricultural education teachers believe that students should learn about global agricultural issues (Hurst et al., 2015), and SBAE teachers in Oregon agreed that science integrated into the agricultural education curriculum could help students achieve educational standards (Warnick et al., 2004). Moreover, Davis and Jayaratne (2015) found that SBAE teachers felt that curricula should help students understand global issues. In light of these findings, there is very little research that marries SSI and SBAE.

In their research related to teachers' reasons for continuing or discontinuing to implement SSI lessons in their curriculum, Wilcox et al. (2014) found that modification was integral to continued use of the lessons. They further found that teachers who did modify or adapt the lesson saw re-engagement of their students, which prompted teachers to continue using the SSI lesson (Wilcox et al., 2014). This idea of modifying the lessons supports implementing SSI into the SBAE curriculum as SBAE teachers enjoy a fair amount of flexibility in their curriculum to adjust and adapt lessons to fit their needs. Additionally, it was discussed that while science is a common component within SBAE, these classes are structured differently than science classes, and SBAE teachers have different responsibilities than science teachers, which may influence the integration of SSI by SBAE teachers (Wilcox et al., 2014).

## Teaching Efficacy Beliefs of SSI

Knowing teacher self-efficacy beliefs as they relate to SSI will be essential to understanding their integration of SSI in their teaching. Bandura (1995, 2009) explains that people are influenced to act or think a certain way and are motivated by their self-efficacy. Individuals' beliefs about something will also be influential in their self-efficacy (Bandura, 1995, 2009). Roath and Hay (2016) found that teachers who had lower self-efficacy were not as committed to teaching the content and did not spent as much time teaching the material. Additionally, they found teachers used more teacher-centered approaches, and attempts to motivate students were fewer (Roath & Hay, 2016).

### Teacher Perceived Need to Integrate SSI

When integrating curriculum, teachers must perceive a need for their students to learn the content before they will integrate it (Li & Linder, 2007). Teachers must have a felt need, regardless if it is real or perceived, to teach SSI (Lee et al., 2006). In their research, Lee et al. (2006) found that although teachers expressed a need to integrate SSI, they did not due to peripheral influences that created barriers to integration.

### Teacher Attributes and Demographics

Teacher attributes are influential in their teaching. According to the SSI-based instruction framework, teacher attributes of content knowledge, awareness of social considerations, knowledge limitations and seeing themselves more as a contributor of knowledge, will help determine the extent to which teachers will integrate SSI. Knowing the attributes of SBAE teachers will contribute to researchers' understanding of their integration of SSI in their teaching and curriculum. Previous research on the influence of demographics and individuals' beliefs and actions has informed the selection of teacher attributes and demographics in this study.

#### *Years of Experience Teaching*

A teacher's level of experience can influence many aspects of their teaching. For example, Wang and Cheng (2009) suggested in their study that those who had more teaching experience were more likely to integrate new curriculum. Furthermore, Scales et al. (2006) found that female teachers had higher mean scores related to science principles and knowledge as did teachers with less than five years of experience compared to their more experienced counterparts.

### *Gender of Teacher*

Gender has been shown to influence individuals' beliefs and actions. Research has suggested that male teachers have higher self-efficacy related to science (Riggs, 1991). However, McCright (2010) found that women express greater concern for environmental issues such as climate change and global warming. Additionally, McCright's (2010) research suggested that women have greater climate knowledge than men, but men perceived they had more accurate knowledge than they actually did. Further research supports the assertion that women are more concerned about the environment, especially when it comes to environmental risks, and these concerns are even higher for women who have children (Davidson & Freudenburg, 1996). It is unclear if gender plays a role in SBAE teachers' integration of SSI.

### *Political Ideology*

Individuals are influenced by their beliefs; this applies to political ideology as well. Fox and Firebaugh (1992) suggested that differences in political attitudes among gender show up most in issues related to the environment and the military. They also proposed that women have less confidence in science and are more concerned for the environment (Fox & Firebaugh, 1992). Furthermore, McCright's (2010) findings indicate that political ideology influences climate change, specifically those who identify as a

Democrat or liberal are more concerned about climate change than those who identify as conservative or Republican. It is unclear whether political ideology plays a role in SBAE teachers' integration of SSI.

### *Teaching Credential, Science Endorsement, and Science Credit*

SBAE teachers often enter the profession through a traditional teacher preparation program or through an alternative licensure program coming from industry. A teachers' credential type can influence their self-efficacy and their propensity to remain in the profession (Robinson & Edwards, 2012). Robinson and Edwards (2012) found in their study that alternatively certified teachers had higher self-efficacy than traditionally certified teachers, but traditionally certified teachers were more apt to remain in the profession. Teachers with alternative licenses who may have come from industry may have prior knowledge of SSI topics before entering teaching, enhancing their ability to integrate SSI due to their experience and knowledge in that area.

It has also been suggested that teachers may have a negative attitude toward science if they lack training in the content preparation, leading some to avoid teaching science (Riggs, 1991). Many SBAE teachers have an additional science certification and some students enrolled in SBAE programs receive science graduation credits from their agriculture classes. Given that SSI originated in the science disciple, science certifications may influence a teacher's integration of SSI. Teachers with science certifications may have learned about SSI in the process of earning their certification or through continuing education professional development opportunities.

## Barriers of Integrating SSI

Research suggests that barriers exist when teachers integrate SSI into their curriculum. While much of this research has taken place in science education, there are studies in SBAE that suggest teachers experience barriers to integrating SSI (Cross, 2019; Shoulders, 2012). Barriers which have been identified in research outside of SBAE relate to: (a) time to develop curriculum and time within the curriculum to teach it (Lee et al., 2006); (b) teacher knowledge of the SSI and the social considerations related to them (Gray & Bryce, 2006; Lee & Witz, 2009; Presley et al., 2013); and (c) outside influences in the form of school administrative and community support (Presley et al., 2013).

### *Time to Integrate SSI*

If teachers are going to integrate new curriculum or implement teaching strategies, they must have time to develop or gain access to the curriculum and have flexibility and time within their curriculum to integrate it. Lee et al. (2006) suggested teachers perceived time as a barrier to integrating SSI. The SSI-based instruction framework also indicates teachers must have access to materials and flexibility within the curriculum to integrate SSI with fidelity to the framework (Presley et al., 2013). The framework also identifies core design elements that must be present when integrating SSI (Presley et al., 2013). If teachers are developing their own curriculum, this may take extra time, especially if they are unfamiliar with the SSI topic and/or the teaching strategies they are using.

### *Teacher Knowledge of SSI*

Teachers must have content knowledge in order to teach it to their students. Even after professional development, some teachers may still lack knowledge and confidence to teach specific content. In their study of teachers who attended a professional development regarding biotechnology, Gray and Bryce (2006) found that even after attending the professional development, teachers gained knowledge in the subject and teaching techniques, but still lacked the confidence to implement them. In order to integrate SSI, teachers must have knowledge relative to the content of the SSI (Lee & Witz, 2009; Presley et al., 2013). Included in this section will be research that discusses that teachers often avoid SSI because they do not feel they have specific knowledge of the particular SSI topics. In general, teachers may avoid teaching content they are less knowledgeable about (Rapoport, 2010).

### *Peripheral Influences and Integration of SSI*

Research suggests outside influences such as community and administrator support can influence teachers' tendency to integrate SSI into their curriculum (Presley et al., 2013). Additionally, if a particular SSI topic does not align with community or administration beliefs, those topics may be omitted from the curriculum. Teachers also need access to materials to assist in integration of SSI (Presley et al., 2013).

Research suggests that teacher support from administration can come in two forms, specifically in *what* teachers teach and *how* teachers teach (Crookes, 1997). In-service teachers who are teaching content new to them will need professional development or support in learning the new approaches and new content. Support for attending outside professional development is essential for in-service teachers. This idea holds true when teachers are learning teaching strategies new to them. Supovitz et al. (2010) also found that teacher pedagogy is influenced by not only their peers, but also administrative leadership.

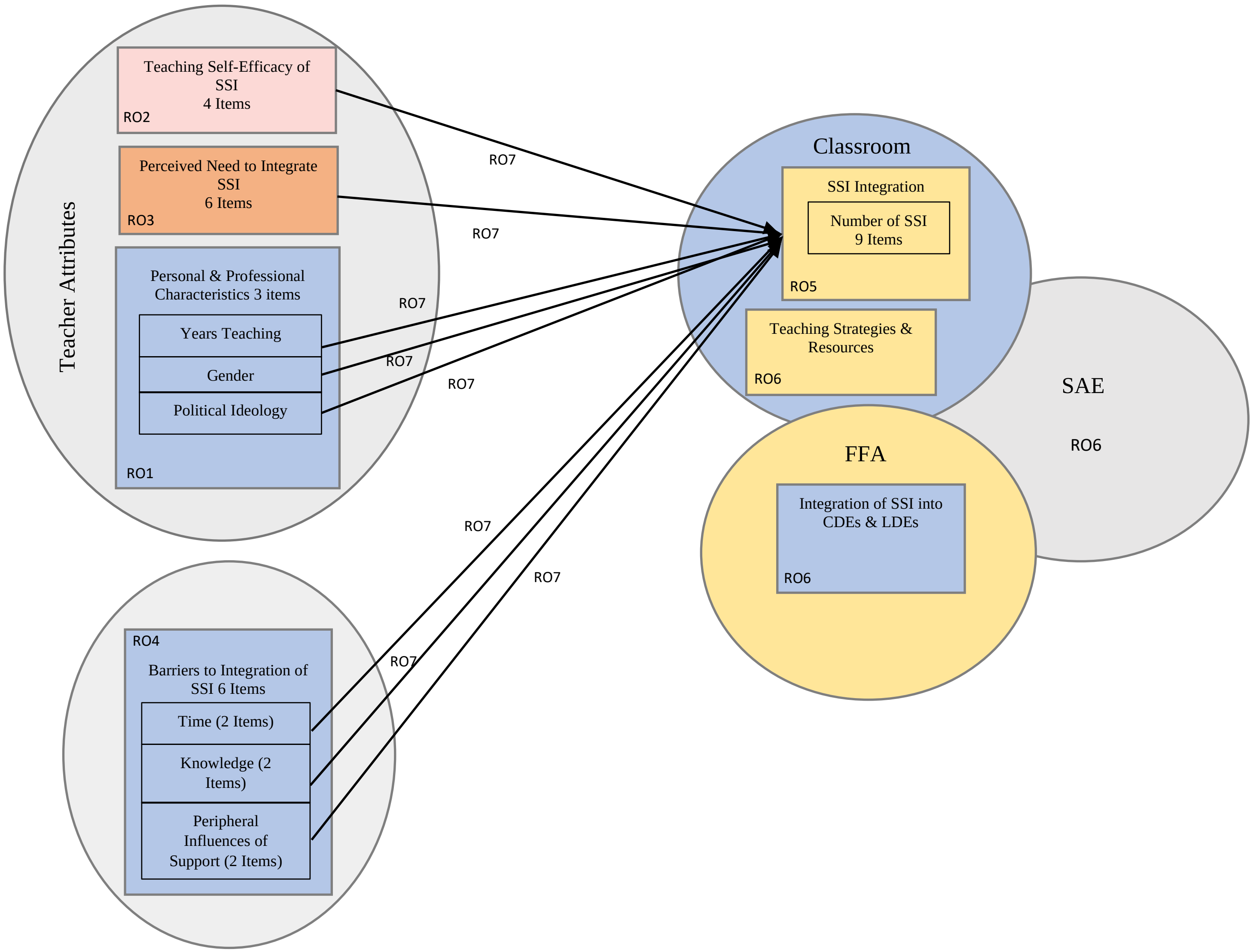
Many SBAE programs also have an advisory committee which is made up of community members and industry partners who collaborate with the SBAE teacher to ensure that students are learning the appropriate skills to meet the needs of industry and higher education. These community members can have an effect on what students are learning in the classroom.

## Conceptual Framework

The conceptual framework for this study has been developed for this research by combining the SBAE three-component model, the SSI-based instruction framework (Presley et al., 2013), and the literature findings. As seen in Figure 2.11, this model illustrates the factors within the SSI-based framework, which will influence SBAE teachers as they integrate SSI into their current curriculum. Along with the teacher's own attributes, their teaching efficacy of SSI and their perceived need to integrate SSI will influence whether they integrate SSI in their classroom curriculum.

**Figure 2.11**

*Conceptual Framework*



## Chapter Summary

This chapter reviewed the SSI-based framework and discussed how it informed this research along with SSI and several educational content areas (e.g., agricultural literacy, scientific literacy, ESD, citizenship education, STSE, environmental education, SBAE). First, a review of SSI and the SSI-based framework was discussed. Second, a review of seminal and recent research related to each content area was covered, and connections were made between these educational realms and SSI. Third, a description of the variables of interest and their relationship to SSI integration and the conceptual frameworks which guided the overall research has been included. Fourth, a discussion for the context of the three-component model within SBAE is also included. Moreover, pertinent research related to the theoretical framework and the development of the conceptual framework has been reviewed here and guides the following chapters. All of the information and research shared within this chapter served as guidance for this study's design, the collecting of data, the analysis, and the discussion of the findings.

# CHAPTER 3: METHODOLOGY

## Chapter Overview

In this chapter, I will provide details of the methodological procedures of this research study. Details include the purpose and research objectives, the research design and population sample, instrument development, and data collection and analysis methods.

### Research Design and Research Objectives

For this research, I employed a descriptive survey methodology to collect data that provided information related to school-based agricultural education (SBAE) teacher attributes (i.e., teaching efficacy beliefs, perceived need to integrate, personal and professional characteristics) and perceived barriers of time, knowledge, and classroom environment on the integration of SSI into the SBAE curriculum and FFA events (i.e., CDEs & LDEs). A web-based survey was chosen because it allows for large sample size, ease of completion by participants, and collection and analysis of a large amount of data (Dillman et al., 2014). However, in light of current conditions in education, due to COVID-19, where teachers have been inundated with online teaching, paper surveys were mailed to teachers with the option of completing the paper version or taking the survey online. The quantitative correlational research methodology was used to evaluate the relationships between SBAE teacher attributes and perceived barriers and SBAE teachers' integration of SSI in their classroom curriculum.

### *Research Objectives*

The following research objectives guided this research:

1. Describe the personal and professional characteristics of SBAE teachers.
2. Describe SBAE teachers' self-efficacy beliefs related to socioscientific issues.
3. Describe SBAE teachers' perceived need to teach socioscientific issues.
4. Describe SBAE teachers' perceived barriers to teaching socioscientific issues (i.e., time, knowledge, peripheral influences).
5. Describe which socioscientific issues SBAE teachers use in their curriculum.
6. Describe teaching strategies and resources used by SBAE teachers when incorporating socioscientific issues into their curriculum.
7. Explain the influence of SBAE teacher attributes (i.e., teaching efficacy beliefs, perceived need, personal and professional characteristics) and peripheral influences (i.e., time barriers, knowledge barriers, other peripheral influences) on teaching socioscientific issues.

## Population and Sample

The target population for this research included all SBAE teachers in the U.S. and U.S. territories during the school year 2020-2021. An SBAE teacher is defined in this research as any middle or high school teacher who is certified to teach agricultural education courses. SBAE teachers are registered with the National FFA Organization as FFA advisors; thus, participant contact information was obtained in a frame from the National FFA Organization, consisting of a random sample of all SBAE teachers during the 2020-2021 school year. A research proposal was submitted to the National FFA

Organization, including a request for a frame of SBAE teacher names, school mailing addresses, and email addresses.

At the time of this study, there were approximately 12,000 SBAE teachers (National Association of Agricultural Educators, 2020.) nationwide. The survey instrument in this study included both continuous and categorical data; thus, the sample size included consideration of both variable types (Krejcie & Morgan, 1970; Cochran, 1977). Using the formula recommended by Krejcie & Morgan (1970), with a population size of 12,000, a population proportion of 0.50, which is a more conservative estimation of variability in larger populations, and a margin of error of ± 5%, the minimum sample size needed for generalizability would be 372. Using Cochran's (1977) formula for continuous variables, with a 95% confidence interval, 0.50 population proportion, and a ± 3% margin of error on a 5-point scale, the minimum sample size would be 267. Likewise, using Cochran's (1977) formula for categorical variables, a population of 12,000, 0.50 population proportion, and a ± 5% margin of error, the sample size to be generalizable to the population would be 384. Using the more conservative sample size, 384 was the target sample size.

Given that web-based surveys typically have a response rate approximately 10% lower than other survey types (Fan & Yan, 2010; Hardin, 2002) and response rates by SBAE teachers can be low, ranging between 20% and 35% (Fraze et al., 2003; McKim, 2016; Sorensen, 2015; Weeks, 2019), the requested frame of participants from the National FFA organization would need to be larger than the 384 sample size recommendation using the Cochran (1977) formula.

When considering oversampling, it is recommended to utilize the original sample size and estimation of response rate, which could come from previous research. Adjusting the original sample size by dividing the sample size by the proportion of likely responders then provides a more accurate number for the total sample (Bartlett et al., 2001; Johnson & Christensen, 2017). In the case of this research, using 384 as the sample size and a potential 35% response rate, the new recommended sample size would be 1,097 for an online only survey. However, in their research of agriscience teachers, Fraze et al. (2003) found that their teachers' response rate was highest in the mail surveys at 60%. In their meta-analysis of 35 comparisons between email and mail surveys, Shih and Fan (2009) discovered that mailed surveys' response rates were 20% higher than email surveys. Furthermore, results from Sax et al. (2003) found that participants who received a paper version of the survey with the option to complete it online responded at a higher rate than respondents of the web only survey. Due to the increased demands of online instruction for teachers during the 2019-2020 school year, using a mailed survey is a relevant option for this research.

Considering the demands on teachers to teach online more than they usually do as a result of COVID-19, it was expected that teachers would be overwhelmed by the amount of time they spent online. Thus, a paper version of the survey was mailed to 100 randomly selected teachers, and they had the option to complete the paper version or take it online. It was anticipated this strategy would result in a higher response rate, requiring a smaller sample request from National FFA. Using a potential response of 60%, requesting contact information for 640 teachers from National FFA would result in the 384 respondents needed for this research. Although, recent requests from National FFA have resulted in smaller frames, as such, I requested a frame from the National FFA consisting of 500 teacher names, school mailing addresses, and emails.

## Description of the Survey Instrument

The survey instrument (see Appendix) was comprised of items that addressed the research objectives and contained items related to SBAE teachers' personal and professional characteristics as well as items to enable determination of the SBAE teachers' integration of SSI in classroom curriculum, FFA events (i.e., CDEs & LDEs), and SAE. The instrument also contained items to assess SBAE teachers' knowledge, teaching self-efficacy, and perceived barriers toward SSI integration. Survey items were guided by previous research (Giliberti, 2018; Kara, 2012; Lee et al., 2006) and the SSI-based framework (Presley et al., 2013). These items addressed SBAE teachers' perceived need to integrate SSI as well as their teaching self-efficacy and barriers related to integrating SSI.

## Development of the Survey Instrument

The literature was used to inform the development of the survey instrument for this research. The use of published instruments that have been tested and found to be valid and reliable were modified to fit the current research study's needs. As can be seen in Table 3.1, different items within the survey instrument were modified from instruments used in Giliberti (2018), Lee et al. (2006), and Evren-Yapicioglu (2018) as well as researcher-developed items.

**Table 3.1**

*Summary of Measures Used to Develop Survey Instrument for This Research*

| Measures | Scale | Items adapted from Giliberti (2018) instrument* | Items adapted from Lee et al. (2006) instrument ** | Items developed by researcher |
|---|---|---|---|---|
| Integration of SSI in classroom curriculum | Frequency, Percent | | | 2 & 3 |
| Integration of SSI in FFA events | Frequency, Percent | | | 7 |
| Teaching strategies and resources used when integrating SSI | Frequency, Percent | | | Groups 4, 5, & 6 |
| Teachers' personal teaching efficacy beliefs regarding SSI | 5-point Likert | | Group 8 | |
| Teachers' perceived need to integrate SSI into their curriculum | 5-point Likert | | Group 8 | |
| Possible barriers to integrating SSI (time & knowledge) | 5-point Likert | Group 9 | | |
| Possible barriers to integrating SSI (peripheral influences) | 5-point Likert | | | Group 9 |

* Adapted from Harder & Linder (2008)
**Also used in Kara (2012)

The survey instrument used in the Giliberti (2018) study was a modified version of the instrument used in Harder and Linder (2008), which was also used by Harder (2007) and Li and Linder (2007). In the research conducted by Giliberti (2018), the researcher studied the integration of school gardens. Those items used from the Giliberti (2018) study were modified to replace school gardens with SSI. The sections of the instrument that were informed by Lee et al. (2006) were also used in research conducted by Kara (2012). In their study, Lee et al. (2006) assessed teacher integration of SSI into the science & technology curriculum while Kara (2012) determined teacher integration of SSI into the biology curriculum. In both studies, the questions were identical save for the content (e.g., science & technology, biology). I used these same questions in the instrument for this research, and the content was changed to agricultural education classes. In developing these items, the 5-point scale was used to maintain continuity throughout the instrument.

A paper version (see Appendix D) of the instrument was developed along with a Qualtrics™ version, allowing participants a choice when participating. The paper survey was mailed to 100 randomly selected participants using their school mailing address through the United States Postal Service. An online random number generator was used to determine which participants would receive the paper survey and the surveys were mailed through the U.S. Postal Service. Upon receipt of the paper survey, participants had the option to complete the paper version and return it in the enclosed self-addressed, stamped envelope, or take the survey online through Qualtrics™.

**Inclusion of SSI**

To determine the SSI to be included in the survey, I started with the AAAE research agenda and recorded each of the SSI included there. I then reviewed the National Agricultural Literacy Outcomes (NALO) and recorded all of the SSI included in those literacy outcomes. After reviewing several websites including National Farm Bureau, Union of Concerned Scientists, Organization for Economic Co-operation and Development (OECD), National Science Teachers Association, several social media groups, and reading multiple articles related to important issues facing the globe and society, I compiled a list of all the SSI that were prominently discussed in each of these venues. I was able to categorize many of the issues and ultimately arrived at nine top SSI which I included on the survey. Those SSI were climate issues, ecosystem & biodiversity issues, energy issues, food security issues, genetic engineering issues, human population issues, sustainability issues, and water issues.

## Measures

### ***Teacher Personal and Professional Characteristics***

The instrument consisted of personal demographic items related to gender and political ideology. Also included were professional characteristic items related to teaching experience, wherein respondents answered with the number of years they have been teaching, and the state they currently teach in. Additional questions related to licensure were asked, specifically whether respondents had a traditional or alternative teaching credential, a science certification, and whether students received science credit for their agricultural education courses. Political ideology was a categorical variable with "1 = *conservative*, 2 = *moderate*, 3 = *liberal*, 4 = *I prefer not to answer*, that was later dummy coded into a dichotomous variable, "1 = *conservative,* 0 = *not conservative*". Teaching credential, science certification, and students receiving science credit were all dichotomous variables. State teaching in was categorical and teaching experience was a continuous variable (Table 3.2).

**Table 3.2**

*Statistical measurements by construct and variable type*

| Research Objective | Construct/Variable | Variable Type | Statistical Measurements | Instrument Number |
|---|---|---|---|---|
| 1 | Demographics, professional Years of Experience | Continuous | Mean, SD | 11 |
| 1 | Demographics, professional State teaching in (grouped by region) | Categorical | Frequency, Percent | 12 |
| 1 | Demographics, personal - Gender | Dichotomous | Frequency, Percent | 13 |
| 1 | Demographics, personal - Political Ideology | Categorical, Dichotomous | Frequency, Percent | 14 |
| 1 | Demographics, professional - Teaching Credential | Categorical | Frequency, Percent | 15 |
| 1 | Demographic, professional – Science Endorsement | Categorical | Frequency, Percent | 16 |
| 1 | Demographic, professional – Students receive science credit | Dichotomous | Frequency, Percent | 17 |
| 2 | Teaching Efficacy Beliefs | Continuous 1-5 Scale | Mean, SD | Group 8 (1-4) |
| 3 | Need to Integrate SSI | Continuous 1-5 Scale | Mean, SD | Group 8 (5-10) |
| 4 | Barriers to SSI Integration (Time & Knowledge) | Continuous 1-5 Scale | Mean, SD | Group 9 (1-4) |
| 4 | Barriers to SSI Integration (Peripheral Influences) | Continuous 1-5 Scale | Mean, SD | Group 9 (5-6) |
| 5 | SSI Integration (SSI Topics) | Categorical | Frequency, Percent, Mean, SD | 3 |
| 6 | Integration in FFA Events (CDEs & LDEs) | Categorical | Frequency, Percent | Group 7 |
| 6 | SSI Integration (Teaching Strategies & Resources) | Categorical | Mean, SD | Groups 4-6 |
| 7 | Demographics/Professional & personal, teaching Efficacy, Need to Integrate, Barriers (Time, Knowledge, Peripheral Influences, X SSI Integration | Continuous X Continuous | β, $R^2$, *p*-values, (Regression) | |

***Self-Efficacy Toward SSI***

The four survey items that comprised the self-efficacy construct measured efficacy related to teaching strategies, teacher knowledge and understanding, and confidence in developing materials for SSI integration. Respondents were asked to rate their level of agreement with each of the items in this construct which were measured on a 5-point Likert scale (1 = *Strongly Disagree*, 2 = *Disagree*, 3 = *Neutral*, 4 = *Agree*, 5= *Strongly Agree*). Items in this construct included: “I am able to use various teaching strategies to address socioscientific issues in agricultural education classes”, “I sufficiently understand what socioscientific issues in agriculture are”, “I have confidence in developing teaching and learning materials about socioscientific issues”, and “I have the knowledge necessary to effectively teach about socioscientific issues to my agricultural education students”. These variables were categorical and the construct of self-efficacy for SSI integration was found to be reliable (4 items; post-hoc Cronbach’s α .83). A higher mean response for the self-efficacy construct indicates higher SBAE teacher self-efficacy toward SSI integration.

***Teachers’ Perceived Need to Integrate SSI***

Teachers’ perceived need to integrate was measured using items related to teachers’ beliefs that SSI are appropriate and needed in agricultural education. Teachers’ perceptions of student background regarding SSI, increasing student interest and concern, and students’ need to establish their own opinions were also be measured. Teachers were asked to rate their agreement with the perceived need to integrate SSI items in this construct which were measured on a 5-point Likert scale (1 = *Strongly Disagree*, 2 = *Disagree*, 3 = *Neutral*, 4 = *Agree*, 5= *Strongly Agree*) and were categorical variables.

Items which comprised this construct included: “teaching about socioscientific issues is NOT appropriate in an agricultural education class”, “introducing socioscientific issues into agricultural education classes is definitely necessary”, “the inadequacy of students’ background regarding socioscientific issues needs to be addressed”, “introducing socioscientific issues into agricultural education classes will increase students’ interest in these issues”, “students need to be concerned with socioscientific issues related to agricultural science”, and “students need to enhance their ability to decide their own positions about socioscientific issues in agricultural education classes”. The construct of teachers’ perceived need to integrate SSI was comprised of six items and was found to be reliable (6 items; post-hoc Cronbach’s α .79). A higher mean response for the perceived need to integrate SSI construct, indicates a higher SBAE teacher perceived need to integrate SSI.

***Teachers’ Perceived Barriers to Integrating SSI***

The survey items included in the instrument measured barriers perceived by teachers to integrating SSI. These items related to time, teacher knowledge, and peripheral influences of support. These items were measured on a 5-point Likert scale (1 = *Strongly Disagree,* 2 = *Disagree*, 3 = *Neutral*, 4 = *Agree*, 5= *Strongly Agree*) and were categorical variables.

**Time.** The items comprising the construct of time barriers related to lack of time within the curriculum to integrate SSI and time to prepare SSI curriculum. The construct of teachers’ perceived barriers of time consisted of two items (2 items; post-hoc Cronbach’s α .67). The items which comprised this construct included the sentence stem of, a barrier to teaching socioscientific issues in my classes is, followed by “lack of time to integrate”, and “lack of time to prepare curriculum”.

**Knowledge.** Knowledge barrier items entailed teachers' knowledge of the science content of SSI and their knowledge of social considerations of SSI. Teachers’ perceived knowledge as a barrier was made up of two items (2 items; post-hoc Cronbach’s α .87) and was found to be reliable. The items in this construct included the sentence stem of, a barrier to teaching socioscientific issues in my classes is, followed by “lack of science content knowledge of socioscientific issues”, and “lack of knowledge about the social considerations in socioscientific issues”.

**Peripheral Influences.** The construct of peripheral influences contained items addressing barriers of support from teachers' administration and community. This construct of barriers of support included two items and was found to be reliable (2 items; post-hoc Cronbach’s α .77). The item which comprised this construct included the sentence stem of, a barrier to teaching socioscientific issues in my classes is, followed by “teaching socioscientific issues is supported by my administration” and “teaching socioscientific issues is supported by the community”.

### *Pilot Test*

I conducted a pilot test on secondary SBAE teachers in Utah and Nevada. Teachers received both a paper and online version of the survey. The instrument was pilot tested using 25 teachers in Utah and five teachers in Nevada; those teachers were not included in the responses for the broader research. Feedback was provided on the amount of time the survey took, readability of the questions, and ease of navigating the survey. Reliability tests were conducted on all constructs from the pilot data and all constructs except time barriers exceeded the alpha of .70 recommended by Nunnally & Bernstein (1994) (Table 3.3).

**Table 3.3**

*Construct Reliability Estimates of the Survey Instrument*

| Instrument Construct | Cronbach's α Pilot | Post-hoc Cronbach's α |
|---|---|---|
| Teaching Self-Efficacy for SSI | .81 | .83 |
| Perceived Need to Integrate SSI | .76 | .79 |
| Time Barriers | .57 | .67 |
| Knowledge Barriers | .95 | .87 |
| Support Barriers | .84 | .77 |

*Note*. *N* = 22

### *Reliability and Validity*

The instrument was reviewed by a panel of experts comprised of doctoral students in education and professors in education, career and technical education, and agricultural education to confirm content and face validity. Additionally, the instrument's constructions were guided by published research (Aviles, 2017; Giliberti, 2018; Kara, 2012; Lee et al. 2006) using similar instruments and constructs which have been reported along with reliability measures. Instrument development was also guided by the theoretical framework, the SSI-based Framework (Presley et al., 2013). Adjustments to the instrument were made based after the pilot to improve reliability and validity. The reliability for the time barriers construct was lower than the level commonly recommended; consequently, I eliminated some of the questions that did not seem to fit in an attempt to improve the reliability of this construct. Due to the low responses in the pilot, I conducted a post-hoc reliability test on the final instrument to confirm the construct reliability of time barriers. The post-hoc reliability results were .67. Some scholars have argued that .70 is an arbitrary cutoff and that results as low as .05 can be considered reliable (Field, 2018; Nunnally, 1978). Given that the reliability estimate of .67 was so close to the arbitrary .70 cutoff, I cautiously kept this variable in the analysis.

Although Cronbach's alpha provides an accurate estimate of reliability for two item constructs, research recommends using the Spearman-Brown coefficient as a more reliable measure (Eisinga et al., 2013). Thus Spearman-Brown coefficient analyses were conducted on the two-item constructs of time barriers ($\rho = .67$), knowledge barriers ($\rho = .87$), and support barriers ($\rho = .77$). These tests resulted in the same reliability estimates as the Cronbach's alpha.

## Data Collection

A national sample frame of SBAE teachers' contact information, specifically teacher names, school mailing addresses, and teacher emails from the National FFA Organization were requested. I followed the tailored design method, whereas the procedures used considered the population of participants, SBAE teachers, and the topic of the survey research (Dillman et al., 2014). Every attempt was made to reduce the errors which can occur in survey research, including those associated with the population frame and those in the sample who complete the survey, leading to potential coverage errors and sampling errors. Additionally, I made every effort to develop a survey instrument and respondent contact letters that reduced potential nonresponse and measurement errors by establishing a positive social exchange between the research and the respondents. This favorable exchange occurs when respondents desire to be a part of the study based on their understanding of the benefits to themselves and the profession, and those benefits outweigh the costs of participation (Dillman et al., 2014). Multiple contact modes with participants and data collection were utilized in this research to encourage participation (Dillman et al., 2014). Due to current conditions related to COVID-19, participants were contacted through the mail and via email. Using a combination for both mail and web-based surveys, participants were invited to take part in the research study through a five-contact process (Dillman, 2007; Dillman et al., 2014).

For the 100 random participants who received the paper survey in the mail, the first contact was made through email (Appendix I) which briefly introduced the study and alerted the teacher to watch for a paper version of the survey in their school mail. This first email also contained a link to an online version of the survey which the participant could opt into instead of the paper version. The teacher received the mailed paper version of the survey, along with a welcome letter and information for the online version, within 7-10 days of receiving the first introductory email. This mail correspondence served as the second contact with participants.

The other 400 participants received their first contact through an email introducing them to the study and inviting them to participate (Appendix E). The email also contained the link to access the survey. A follow-up email was sent approximately seven days after the first email (Appendix F), which, by this time, the teacher should have received the paper survey. This email served as the first reminder and an opportunity for participants to request an additional paper survey if they had not received the initial one in the mail or preferred a paper survey instead of the online version. This was followed by a third email (Appendix G) serving as a second reminder, two days later. The last contact (Appendix H) consisting of the final reminder and thank you, was sent a week later. Overall, the participants were contacted five times - once through the mail, and four times via email, over 3.5 weeks. This process follows the tailored design method and includes a combination of recommendations for contacting participants through the mail and email, as described by Dillman (2007) and Dillman et al. (2014). This recruitment process took place during the first three weeks in December of 2020.

Those who received a paper survey in the mail received a complete mailing package which included an introduction letter, the survey, an agreement letter for their signature, and a return self-addressed, stamped envelope. The paper version of the survey also had instructions for returning the completed survey and signed agreement letter in the envelope provided. While a plain envelope was used to mail the materials, a first-class stamp, personalized return address labels, and university letterhead stationery were also used. These tend to add a personal touch that can increase response rates in mailed surveys (Dillman, 2007).

The electronic version of the survey was designed and administered through Qualtrics™, which allowed participants to complete the survey online and enabled data to be collected and downloaded for analysis. The surveys returned by mail were hand-entered into a Statistical Package for the Social Sciences (SPSS) file, ultimately being combined with data collected from the surveys that were completed online.

The population parameters were all SBAE teachers in the United States and its territories who taught at least one agricultural education class during the 12 months prior to receipt of the survey. This timeframe included the 2019-2020 school year. The survey included two questions for the respondents prior to beginning the survey. The first question was their agreement to participate in the survey. The second question asked, “Within the past 12 months, were you a teacher who taught at least one approved agriculture course?”. If they answered no to either question, the online survey automatically sent them to the *thank you* page at the end of the survey. None of the paper surveys were returned with no answers for this question.

**Human Subjects Approval and Confidentiality**

Prior to collecting this data, an application was submitted to the Institutional Review Board (IRB) at Utah State University. The application included all required data collection details, letters to invited participants accompanying the survey, including all verbiage for emails, as well as both versions of the survey instrument. All IRB regulations were followed to ensure ethical research practices and the confidentiality of participant information and responses. All completed paper surveys were stored in a locked box in my office at Utah State University. All electronic data has been stored in a Box.com file which is password protected.

## Data Analysis

Upon collection, data were loaded into Qualtrics™ and analyzed using Statistical Package for Social Science (SPSS). Data were reviewed for abnormalities and missing entries. Paper surveys received in the mail were entered into SPSS by hand.

### *Data Transformation*

The raw data in SPSS were transformed in a way that allowed for analysis according to the research objectives for this study. I conducted frequency counts for all variables and ensured that missing data was properly coded as to not be utilized in the analysis. I also recoded those variables that required it to properly conduct the analysis for those variables. Additionally, construct variables were created by computing the individual item means and combing those items into the construct (Field, 2018). The new construct equaled the combined means of the individual items that made up each construct. Variables were also transformed through dummy coding to allow for the proper analysis procedures (Field, 2018; Vaske 2008). All transformations were conducted in SPSS and saved in a working file, separate from the raw data.

### *Statistical Assumptions*

Prior to analysis, statistical assumptions were tested for in the data for both parametric data and regression to ensure the data were not biased and met the necessary statistical assumptions. A Kolmogorov-Smirnov test indicated a slightly non-normal distribution, however checking for additional assumptions resulted in no outliers. Further assumptions were tested for including multicollinearity, homoscedasticity, heteroscedasticity, and skewness. Therefore, I concluded that the data met all the assumptions of linearity, homogeneity, and independence (Field, 2018).

As shown in Table 3.3, descriptive statistics were used to describe participants' personal and professional characteristics, as well as Research Objectives 2-6, while linear and logistic regression were used to explain Research Objective 7. The integration of SSI was summated for each of the SSI, and a mean was calculated. An ordinary least squares (OLS) multiple linear regression was conducted to determine relationships between teacher demographics, the constructs in the study (i.e., teaching efficacy, perceived need to integrate SSI, and perceived barriers to integration), and the dependent variable of SSI integration.

Using recommendations by Green (1991), where minimum sample sizes of $50 + 8k$ ($k$ is the number of predictor variables) are needed for testing a model and ensuring stability and statistical power, an estimated minimum sample size to test a model in this study was 114, with eight predictor variables. To test individual predictor variables, the minimum sample size, according to Green (1991), was $104 + k$; thus, the minimum acceptable sample size was 112 responses to test individual variables, given the eight predictor variables. This indicated that a minimum of 114 responses were needed to conduct the regression analyses for SSI integration. Betas, standardized betas, and overall $R^2$ were calculated and reported for the regression analyses conducted. Research recommends sample sizes for logistic regression include 10 participants for every independent variable (Harrell et al., 1984; Harrell, et al., 1996; Peduzzi et al., 1996). Given that this research included eight independent variables, a minimum sample size of 80 participants were needed to test the logistic regression.

Given that individual SSI (i.e., climate issues, ecosystem & biodiversity issues, energy issues, food security issues, genetic engineering issues, human population issues, natural resource issues, sustainability issues, water issues) are dichotomous, meaning teachers either selected they teach these issues or not, a logistic regression was used to identify relationships between the independent variables of interest and the dependent variables. The independent variables of interest were the constructs of self-efficacy, perceived need to integrate SSI, barriers of time, barriers of knowledge, barriers of supports, and the demographics of years of experience, political ideology, and gender. The logistic regression provides the predicted log odds for each independent variable as well as an odds ratio that can be used to determine probability.

### *Analysis of each research objective*

**Research Objective One.** Describe the personal and professional characteristics of SBAE teachers. Descriptive statistics were used to describe the characteristics of SBAE teachers, both personal and professional. I used frequency, percentages, means and standard deviations to describe the findings for the various characteristics.

**Research Objective Two.** Describe SBAE teachers' teaching efficacy beliefs related to socioscientific issues. There were four individual items that made up this construct and each item was measured on a 5-point Likert scale (1 = *Strongly Disagree*, 2 = *Disagree*, 3 = *Neutral*, 4 = *Agree*, 5= *Strongly Agree*). After testing for reliability, I transformed these four items into the self-efficacy construct by calculating and combining the means for each item to create one variable. I also used descriptive statistics to describe the teaching self-efficacy of teachers related to SSI and reported the mean and standard deviation. Correlations were conducted for the items that made up the construct of self-efficacy (Table 3.4). It was also found to be reliable (4 items; post-hoc Cronbach's α .83). Correlations were conducted to ensure that items were correlated and adequately formed the construct of self-efficacy.

**Table 3.4**

*Descriptive Statistics and Correlations for Self-efficacy*

| Variable | *M* | *SD* | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| 1. I am able to use various teaching strategies to address socioscientific issues in agricultural education classes. | 4.09 | 0.67 | - | | | |
| 2. I sufficiently understand what socioscientific issues in agriculture are. | 4.04 | 0.61 | .467** | - | | |
| 3. I have confidence in developing teaching and learning materials about socioscientific issues. | 3.84 | 0.71 | .553** | .551** | - | |
| 4. I have the knowledge necessary to effectively teach about socioscientific issues to my agricultural education students | 3.86 | 0.70 | .616** | .447** | .683** | - |

$N = 109$, $^{**}p < .001$

**Research Objective Three.** Describe SBAE teachers' perceived need to teach socioscientific issues. Six individual items made up the construct of perceived need to teach SSI and each item was measured on a 5-point Likert scale (1 = *Strongly Disagree*, 2 = *Disagree*, 3 = *Neutral*, 4 = *Agree*, 5= *Strongly Agree*). After testing for reliability, I transformed the six items into the need construct by calculating the means for each item and combining them, creating one variable. I then reported descriptive statistics including the mean and standard deviation. I also conducted correlations for all the items that made up the construct of perceived need to integrate SSI to determine how each item correlated (Table 3.5). This construct was found to be reliable (6 items; post-hoc Cronbach's α .79).

**Table 3.5**

*Descriptive Statistics and Correlations for Construct Perceived Need to Integrate SSI*

| Variable | *M* | *SD* | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| 1. Teaching about socioscientific issues are NON appropriate in an agricultural education class (Recoded) | 4.39 | 0.71 | - | | | | | |
| 2. Introducing socioscientific issues into agricultural education classes is definitely necessary. | 4.25 | 0.61 | .702** | - | | | | |
| 3. The inadequacy of students' background regarding socioscientific issues needs to be addressed. | 3.95 | 0.69 | .214** | .316** | - | | | |
| 4. Introducing socioscientific issues into agricultural education classes will increase students' interest in these issues. | 3.93 | 0.71 | .185 | .295** | .403** | - | | |
| 5. Students need to be concerned with socioscientific issues related to agricultural science. | 4.27 | 0.56 | .333** | .359** | .422** | .443** | - | |
| 6. Students need to enhance their ability to decide their own positions about socioscientific issues in agricultural education classes. | 4.45 | 0.55 | .539** | .379** | .379** | .316** | .616** | - |

$N = 110$, $^{**}p < .001$.

**Research Objective Four.** Describe SBAE teachers' perceived barriers to teaching socioscientific issues (i.e., time, knowledge, peripheral influences). There were six items that measured these barriers on a 5-point Likert scale (1 = *Strongly Disagree*, 2 = *Disagree*, 3 = *Neutral*, 4 = *Agree*, 5= *Strongly Agree*). In order to create the three different constructs that measured teachers' perceived barriers, I calculated the means for those items that measured barriers of time and combined them. I conducted the same operations for barriers of knowledge and peripheral influences and then reported means and standard deviations for all three constructs. Furthermore, I conducted correlations for barriers of time (Table 3.6), barriers of knowledge (Table 3.7), and barriers of support (Table 3.8). The construct of barriers of time was slightly less than the recommended ($\alpha$ = 0.70) (Kline, 1999); however, results as low as .05 can still be considered reliable (Field, 2018, Nunnally, 1978). The constructs of knowledge and support were found to be reliable (Table 3.8).

**Table 3.6**

*Descriptive Statistics and Correlations for Barriers of Time*

| Variable | *M* | *SD* | 1 | 2 |
|---|---|---|---|---|
| 1. Lack of time to integrate | 3.46 | 0.96 | - | |
| 2. Lack of time to prepare curriculum | 3.78 | 0.99 | .506** | - |

*N* = 110, ***p* < .001.

**Table 3.7**

*Descriptive Statistics and Correlations for Barriers of Knowledge*

| Variable | *M* | *SD* | 1 | 2 |
|---|---|---|---|---|
| 1. Lack of science content knowledge of socioscientific issues | 2.90 | 1.04 | - | |
| 2. Lack of knowledge about the social considerations in socioscientific issues | 2.95 | 0.99 | .771** | - |

*N* = 110, ***p* < .001.

**Table 3.8**

*Descriptive Statistics and Correlations for Barriers of Support*

| Variable | *M* | *SD* | 1 | 2 |
|---|---|---|---|---|
| 1. Teaching socioscientific issues is supported by my administration. | 1.8 | 33.6 | - | |
| 2. Teaching socioscientific issues is supported by the community. | 2.7 | 40.9 | .629** | - |

*N* = 110, ***p* < .001.

**Table 3.9**

*Construct Reliability for Barriers of Time, Knowledge & Support*

| Construct | Post-hoc Cronbach's α |
|---|---|
| Time | 0.67 |
| Knowledge | 0.87 |
| Support | 0.77 |

**Research Objective Five.** Describe which socioscientific issues SBAE teachers use in their curriculum. For this objective, I used descriptive statistics to describe the SSI that SBAE teachers indicated they were using in their classes. I reported frequencies and percentages for each SSI and also for gender, political ideology, and years of experience as they related to each SSI.

**Research Objective Six.** Describe teaching strategies and resources used by SBAE teachers when incorporating socioscientific issues into their curriculum. Teaching strategies for this research included debate, group work, lecture/direct instruction, Socratic method, and role play. Resources included in the survey were the internet, media, textbooks, other printed sources besides textbooks, resources outside school such as guest speakers, use of technology, and scientific data analysis. Additionally, FFA career development events (CDE), leadership development events (LDE), and supervised agricultural experience (SAE) were included on the survey and reported as a teaching strategy/resource. I used descriptive statistics to describe the teaching strategies and resources used by SBAE teachers including frequencies and percentages. For the FFA CDEs, LDEs, and SAE, I reported means and standard deviations.

**Research Objective Seven.** Explain the influence of SBAE teacher attributes (i.e., teaching efficacy beliefs, perceived need, personal and professional characteristics) and peripheral influences (i.e., time barriers, knowledge barriers, other peripheral influences) on teaching socioscientific issues. I used logistic and multiple linear regression to explain the influence of SBAE teacher attributes and peripheral influences on teaching SSI in SBAE classes.

In order to construct the SSI integration dependent variable, I calculated the sum of each participant's responses to the SSI they integrate, which provided a level of SSI integration. For example, if a respondent selected three of nine SSI in the survey, that respondent's SSI integration was three. These individual respondent results were used in the regression analysis. I conducted an OLS regression with SSI overall integration as the dependent variable with the constructs of efficacy, perceived need to integrate SSI, barriers of time, knowledge and support, gender, political ideology, and years of experience as the predictor variables. I reported betas, standardized betas, and overall $R^2$ for the regression analysis.

I also performed a logistic regression for each of the individual SSI. The dependent variable was the individual SSI, and the dependent variables were the constructs of efficacy, perceived need to integrate SSI, barriers of time, knowledge and support, years of teaching experience, political ideology, and gender. A total of nine logistic regressions were conducted, one for each SSI, and I reported model fit, odd ratios, and probabilities for each of the regressions.

# CHAPTER 4

# RESEARCH FINDINGS

## Chapter Overview

This chapter provides the findings and analysis of the quantitative data collected in this research study. Details by research objective are included with appropriate tables and figures. The purpose of this study was to explore the knowledge and integration of socioscientific issues (SSI) among school-based agricultural education (SBAE) teachers by explaining the factors that influence the integration of SSI into SBAE curriculum. This research was guided by the following research objectives:

1. Describe the personal and professional characteristics of SBAE teachers.
2. Describe SBAE teachers' self-efficacy beliefs related to socioscientific issues.
3. Describe SBAE teachers' perceived need to teach socioscientific issues.
4. Describe SBAE teachers' perceived barriers to teaching socioscientific issues (i.e., time, knowledge, peripheral influences).
5. Describe which socioscientific issues SBAE teachers use in their curriculum.
6. Describe teaching strategies and resources used by SBAE teachers when incorporating socioscientific issues into their curriculum.
7. Explain the influence of SBAE teacher attributes (i.e., teaching efficacy beliefs, perceived need, personal and professional characteristics) and peripheral influences (i.e., time barriers, knowledge barriers, other peripheral influences) on teaching socioscientific issues.

The population for this research consisted of all school-based agricultural education teachers in the United States and its territories who taught at least one agricultural education course during the 12 months prior to the survey, which included the 2019-2020 school year.

## Response Rate

The total response rate for this study, including paper and online surveys totaled 27.2% (*N* = 136; mail = 6; electronic = 130). Due to some missing data points, the responses range from 109 to 112 for some of the analyses. Responses were tested using the constructs in the survey instrument (i.e., teaching efficacy, perceived need to integrate, perceived barriers to integration) and teacher demographics in an independent samples *t*-test and crosstabs to compare responders and non-responders to determine the presence of nonresponse bias. Teacher demographics used included teaching experience, state currently teaching in, gender, political ideology, teaching credential, science endorsement, and student science credit. It is recommended to contact non-responders by phone to collect non-response data (Linder et al., 2001; Miller & Smith, 1983); however the participant frame only included emails and school mailing address. Thus, Linder et al.'s (2001) recommendation was implemented by using late response data. Their recommendation indicated a minimum of 30 late respondents be used for testing, however the final email only elicited 18 additional responses, so responses from the last two emails were classified as *late* responders and used in the non-response bias testing. For this research, a total of 44 responders were classified as late and 63 were classified as early. Independent samples *t*-test and crosstabs were conducted to check for non-response bias between those who responded after the last two reminder emails (late respondents; *n* = 44) and those who responded prior to the last two emails (early respondents; *n* = 63) using the variables of interest (Linder et al., 2001; Miller & Smith, 1983). The variables of interest included the survey constructs (i.e., teaching efficacy, perceived need, time barriers, knowledge barriers, support barriers), and teacher demographics (i.e., teaching experience, state currently teaching in, gender, political ideology, teaching credential, science endorsement, and student science credit). Because multiple variables were being compared, I used the Bonferonni correction to account for Type I errors. A total of six variables were measured so I used the calculation recommended by Vaske (2008): $\alpha = .05/6 = .008$. At this alpha, no variables were found to be significant and thus I concluded non-response bias was not present in the data. Although the response rate is not large enough to be generalizable across all SBAE teachers, it is representative of the population of SBAE teachers (Lawver et al., 2018).

**Research Objective 1**

Research objective one sought to describe the personal and professional characteristics of SBAE teachers. Characteristics described in this research included teachers' years of experience, gender, political ideology, type of teaching credential, whether the teacher had a science endorsement, and if their students receive science credit for their agriculture classes. The respondents also represented teachers who were teaching in all of the AFNR pathways, with animal and plant systems being the most commonly taught pathways and biotechnology the least taught pathway (Table 4.1).

**Table 4.1**

*AFNR Pathways Taught by Respondents*

| AFNR Pathway | Percent of Respondents |
|---|---|
| Agribusiness Systems | 47.8 |
| Animal Systems | 74.2 |
| Biotechnology Systems | 22.1 |
| Environmental Systems | 30.9 |
| Food Products & Processing Systems | 33.1 |
| Natural Resource Systems | 51.5 |
| Plant Systems | 61.0 |
| Power, Structural and Technical Systems | 55.1 |

*N* = 136

The teachers who participated in this research represented experience levels from first-year teachers to those having 40 years of teaching experience, with the mean of years teaching being 12. The sample of SBAE teachers also represented all four National FFA regions (Table 4.2) and of those who answered, 54% (*n* = 58) identified as male and 46% (*n* = 49) identified as female, while 29 respondents did not answer (Figure 4.2).

**Table 4.2**

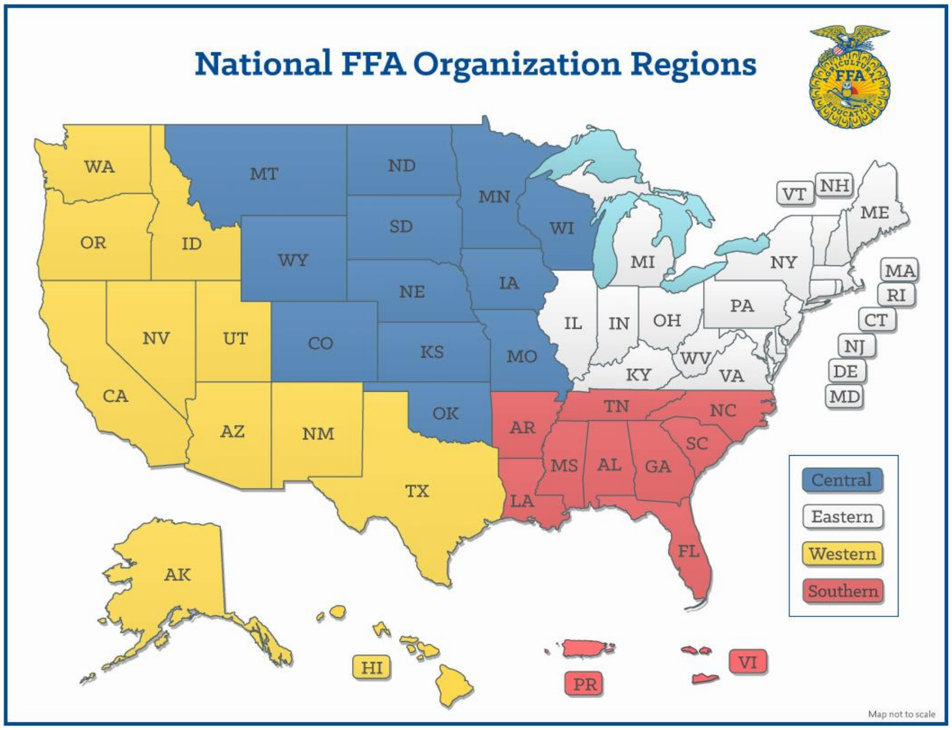
*Respondents by FFA Region*

| FFA Region | Valid Percent of Respondents |
|---|---|
| Western | 20.5 |
| Central | 34.8 |
| Eastern | 22.3 |
| Southern | 22.3 |

*N* = 136

**Figure 4.1**

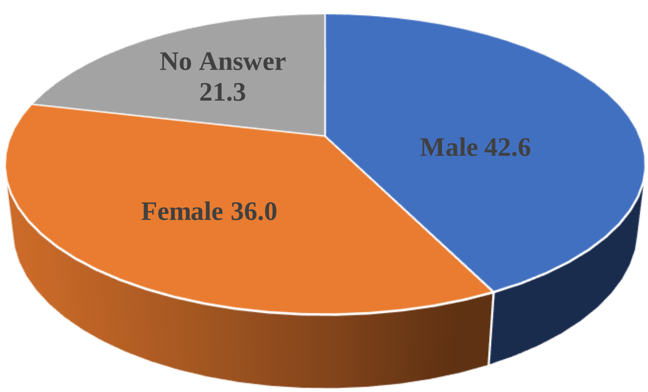
*National FFA Region Map*




*Note.* Map retrieved from ffa.org March 3, 2021.

**Figure 4.2**

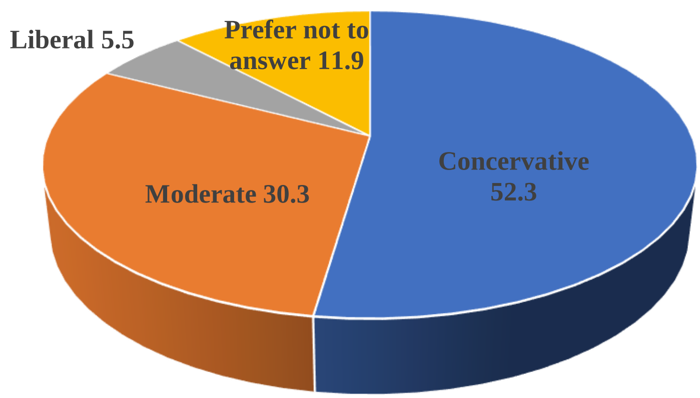
*Gender of Respondents by Percent*



Conservative political ideology represented more than half (52.3%; *n* = 57) of SBAE teachers who participated in the study, 30.3% (*n* = 33) identified as moderate, and 5.5% (*n* = 6) identified as liberal (Figure 4.3). Those who preferred not to identify their political ideology made up 11.9% (*n* = 13) of the respondents.

**Figure 4.3**

*Political Ideology of Respondents by Percent*




The majority of SBAE teachers in the study had a traditional agricultural education teaching certification (*n* = 84.5%) versus an alternative teaching license. While more than half of the teachers who participated in this research (*n* = 53%) did not have a science endorsement, 52.7% (*n* = 58) of all respondents indicated their students did receive science credit for their agriculture classes. When asked about the term socioscientific issues, 44% of SBAE teachers indicated they had not heard of it prior to this survey.

**Research Objective 2**

This research objective sought to describe SBAE teachers' self-efficacy related to SSI. Four items in the survey made up the construct of self-efficacy related to SSI and were measured using a five-point Likert-type scale (from 1 = *strongly disagree* to 5 = *strongly agree*). These items elicited teachers' self-efficacy related to using various teaching strategies to address SSI, understanding what SSI are in agriculture, confidence about developing materials about SSI, and having knowledge to teach about SSI. Higher scores for each item indicated a greater self-efficacy related to SSI. The construct of SBAE self-efficacy for SSI resulted in an overall mean of $M = 3.96$, $SD = 0.55$ (Table 4.3). These results indicate that overall teachers agree they are efficacious when it comes to SSI.

**Table 4.3**

*Descriptive Statistics for Constructs Self-efficacy, Need, & Barriers of Time, Knowledge & Support*

| Construct | *M* | *SD* |
|---|---|---|
| Self-efficacy | 3.96 | 0.55 |
| Need | 4.21 | 0.45 |
| Barriers of Time | 3.62 | 0.84 |
| Barriers of Knowledge | 2.93 | 0.96 |
| Barriers of Support | 3.71 | 0.66 |

*Note*. Mean limits scaling for constructs 1 - 1.49 = *strongly disagree*, 1.50 - 2.49 = *disagree*, 2.50 - 3.49 = *neutral*, 3.50 - 4.49 = *agree*, 4.50 - 5.00 = *strongly agree*.

### Research Objective 3

This research objective sought to describe SBAE teachers' perceived need to teach SSI in their agricultural education courses. The construct measuring teachers' perceived need to teach SSI in agricultural education courses was made up of six items which were measured using a five-point Likert-type scale from 1 = *strongly disagree* to 5 = *strongly agree*. Higher scores for each item indicated a greater perceived need to teach SSI in agricultural education courses. These items elicited teachers' perceptions related to the appropriateness of teaching SSI in an agricultural education class, the necessity of teaching SSI in agriculture classes, the adequacy of students' backgrounds, students' interests, students' concern for SSI, and students' ability to form their own opinions related to SSI.

The construct for SBAE teachers' perceived need to teach SSI in their agricultural education courses contained six items and resulted in an overall mean of *M* = 4.21, *SD* = 0.45 (Table 4.3). These results indicate that teachers overall agreed there is a need for SSI incorporation into agricultural education.

### Research Objective 4

Research Objective 4 sought to describe SBAE teachers' perceived barriers to teaching socioscientific issues, specifically as they relate to teachers' time to prepare curriculum and integrate it, knowledge of science content and social considerations of SSI, as well as peripheral influences in the form of administration and community support. The construct of teachers' perceived barriers of time consisted of two items (*M* = 3.62; *SD* = 0.84), where more than half of respondents agreed or strongly agreed they lack the time to prepare curriculum (71.8%; *n* = 79) and integrate SSI (60.9%; *n* = 67) into their classes. Teachers' perceived knowledge as a barrier was made up of two items (*M* = 2.93; *SD* = 0.96), and 41.9% of respondents either disagreed or strongly disagreed that they lacked the knowledge of science content (*n* = 46) and 40% (n = 44) disagreed or strongly disagreed they lacked knowledge of the social considerations of SSI. However, nearly one-quarter of respondents answered neutral for both of the items related to knowledge. The construct of support was made up of two items (*M* = 3.71; *SD* = 0.66) and had moderate responses. More than half of the respondents felt supported by administration (64.6%; *n* = 71) and their community (56.4%; *n* = 62). Additionally, one-third (33.6%; *n* = 37) of respondents selected neutral regarding administrative support and more than one-third (40.9%; *n* = 45) of respondents chose neutral related to community support.

**Research Objective 5**

This research objective sought to describe which of the SSI presented in the study were being taught by SBAE teachers. Nine SSI were included in the survey along with blank spaces for teachers to write in any additional SSI they integrate into their classes but were not included in the list of options. None of the respondents used the additional space to write in other SSI they integrate into their curriculum. Natural resource issues (66.9%; *n* = 91), water issues (64.7%; *n* = 88), and sustainability issues (66.2%; *n* = 90) were the most selected SSI taught by SBAE teachers (Table 4.4). The least selected SSI that respondents indicated they taught were climate issues (48.5%; *n* = 66), ecosystem and biodiversity issues (49.3%; *n* = 67), and energy issues (47.1%; *n* = 64). Of the three

SSI taught the least by respondents, male SBAE teachers taught climate issues and ecosystem and biodiversity issues at slightly higher rates than their female counterparts, however more female SBAE teachers taught energy issues than male teachers (Table 4.4). For all of the top three SSI taught by SBAE teachers, more male teachers than female teachers indicated they include them in their curriculum (Table 4.4).

**Table 4.4**

*Percent of Socioscientific Issues Taught by SBAE Teachers by Gender*

| SSI | Respondents | Gender | |
|---|---|---|---|
| | | M | F |
| | % | % | % |
| Natural Resource Issues | 66.9 | 56.4 | 43.6 |
| Sustainability Issues | 66.2 | 53.8 | 46.2 |
| Water Issues | 64.7 | 53.2 | 46.8 |
| Food Security Issues | 62.5 | 49.3 | 50.7 |
| Genetic Engineering Issues | 57.4 | 48.5 | 51.5 |
| Human Population Issues | 53.7 | 52.3 | 47.7 |
| Ecosystem & Biodiversity Issues | 49.3 | 55.9 | 44.1 |
| Climate Issues | 48.5 | 50.8 | 49.2 |
| Energy Issues | 47.1 | 47.5 | 52.5 |
| I do not teach any socioscientific issues | 2.9 | 0 | 100 |

*Note.* Gender is the percent of those who selected the given SSI. *N* = 107

Conservative respondents indicated they teach climate and water issues the least and teach ecosystem and biodiversity issues and genetic engineering issues the most (Table 4.5). Additionally, energy and sustainability issues were taught by both conservative respondents and those who did not identify as conservative in equal numbers (Table 4.5).

**Table 4.5**

*Percent of Socioscientific Issues Taught by SBAE Teachers by Political Ideology*

| SSI | Respondents | Political Ideology | |
|---|---|---|---|
| | | Conservative | Not Conservative |
| | % | % | % |
| Natural Resource Issues | 66.9 | 52.5 | 47.5 |
| Sustainability Issues | 66.2 | 50.0 | 50.0 |
| Water Issues | 64.7 | 45.0 | 55.0 |
| Food Security Issues | 62.5 | 52.6 | 47.4 |
| Genetic Engineering Issues | 57.4 | 53.6 | 46.4 |
| Human Population Issues | 53.7 | 50.8 | 49.2 |
| Ecosystem & Biodiversity Issues | 49.3 | 54.2 | 45.8 |
| Climate Issues | 48.5 | 46.7 | 53.3 |
| Energy Issues | 47.1 | 50.0 | 50.0 |
| I do not teach any socioscientific issues | 2.9 | 50.0 | 50.0 |

*Note.* Political ideology is the percent of those who selected the given SSI. *N* = 109

Early career teachers indicated they taught climate and ecosystem and biodiversity issues more than their mid- and late-career counterparts (Table 4.6), and late-career teachers taught all SSI except climate issues less than early- and mid-career teachers (Table 4.6). Furthermore, more early-career teachers than mid- or late-career teachers indicated they teach all of the SSI, except for natural resource issues where it was the same as mid-career teachers (Table 4.6).

**Table 4.6**

*Percent of Socioscientific Issues Taught by SBAE Teachers by Years Teaching*

| SSI | Respondents | Years Teaching | | |
|---|---|---|---|---|
| | | Early (1-5) | Mid (6-15) | Late (16-40) |
| | % | % | % | % |
| Natural Resource Issues | 66.9 | 34.2 | 34.2 | 31.6 |
| Sustainability Issues | 66.2 | 36.2 | 33.8 | 30.0 |
| Water Issues | 64.7 | 39.7 | 33.3 | 27.0 |
| Food Security Issues | 62.5 | 38.6 | 34.7 | 26.7 |
| Genetic Engineering Issues | 57.4 | 35.2 | 32.4 | 32.4 |
| Human Population Issues | 53.7 | 39.7 | 33.3 | 27.0 |
| Ecosystem & Biodiversity Issues | 49.3 | 42.4 | 30.5 | 27.1 |
| Climate Issues | 48.5 | 44.8 | 17.2 | 38.0 |
| Energy Issues | 47.1 | 36.1 | 34.4 | 29.5 |
| I do not teach any socioscientific issues | 2.9 | 25.0 | 25.0 | 50.0 |

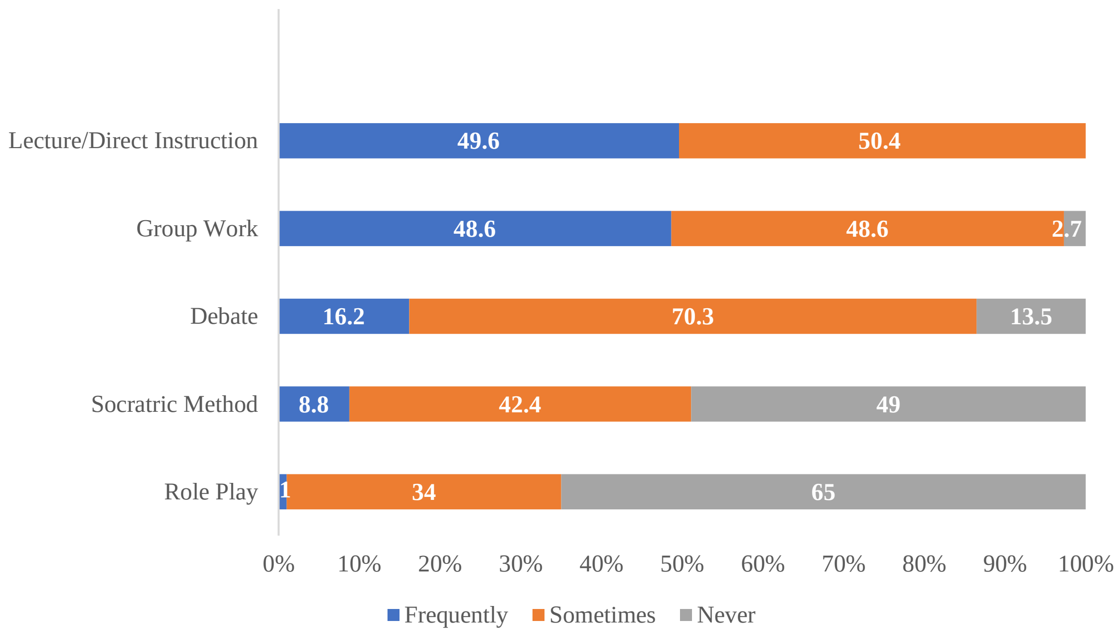
*Note.* Years teaching is the percent of those who selected the given SSI. *N* = 109

**Research Objective 6**

Research Objective 6 sought to describe the teaching strategies and resources used by SBAE teachers when incorporating SSI into their curriculum. Participants were provided a list of teaching strategies and resources used when incorporating SSI into their curriculum and asked to indicate whether they use them frequently, sometimes, or never. While all respondents indicated they frequently (49.6%; *n* = 56) or sometimes (50.4%; *n* = 57) use lecture or direct instruction, 65% (*n* = 67) indicated they never use role play when teaching SSI (see Figure 4.3). The majority of respondents also answered they sometimes use debate (70.3%; *n* = 78), and 49% (*n* = 50) responded they never use the Socratic Method (Figure 4.4).

**Figure 4.4**

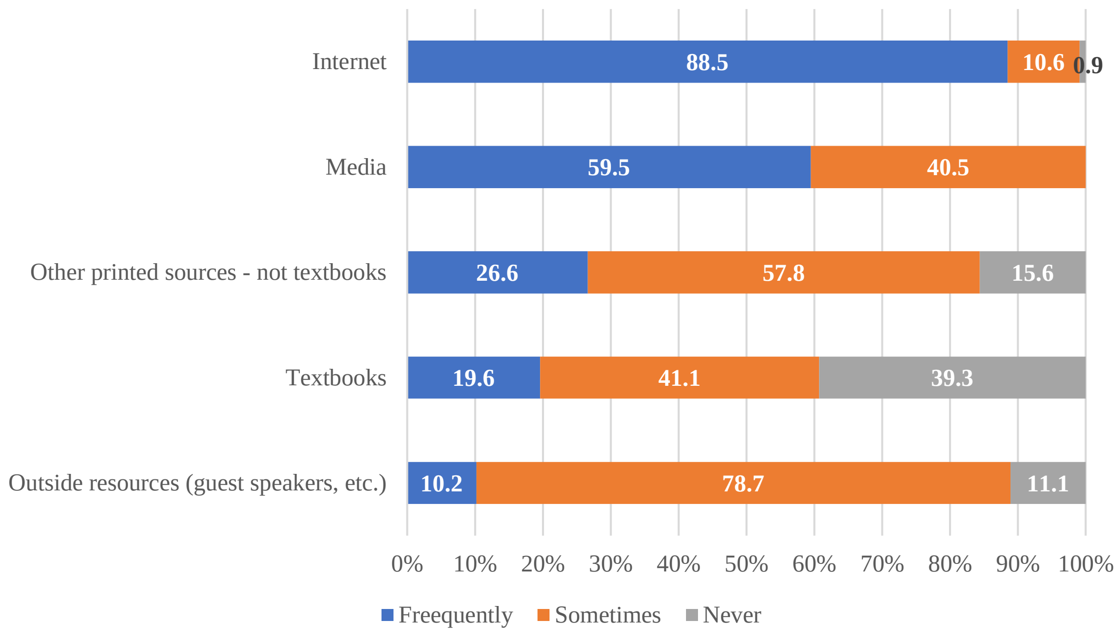
*Teaching Strategies Used by SBAE Teachers When Incorporating SSI by Percent*




When considering resources, SBAE teachers in this study indicated they frequently (19.6%; *n* = 22) or sometimes (41.1%; *n* = 46) use textbooks and 78.7% (*n* = 85) sometimes use outside resources such as guest speakers (see Figure 4.4). The internet was the most frequently used resource by SBAE teachers (88.5%; *n* = 100). All respondents indicated they use media frequently (59.6%; *n* = 66) or sometimes (40.5%; *n* = 45) when teaching SSI (Figure 4.5).

**Figure 4.5**

*Resources used by SBAE Teachers When Incorporating SSI by Percent*




When asked to consider the use of technology and scientific data analysis when incorporating SSI into their curriculum, most respondents agreed (38.4%; *n* = 43) or strongly agreed (52.7%; *n* = 59) they use technology, but fewer agreed (55.4%; *n* = 62) or strongly agreed (9.8%; *n* = 11) their students analyze scientific data (see Table 4.7). In fact, 25% (*n* = 28) of the respondents selected neutral for using scientific data analysis when teaching SSI (Table 4.7).

**Table 4.7**

*SBAE Teachers use of Technology and Data Analysis when Incorporating SSI by Percent*

| | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | *M* | *SD* |
| When learning about socioscientific issues my students | | | | | | | |
| use technology | 52.7 | 38.4 | 3.6 | 1.8 | 3.6 | 4.35 | 0.92 |
| analyze scientific data | 9.8 | 55.4 | 25.0 | 3.6 | 6.3 | 3.59 | 0.95 |

When asked about incorporating SSI into FFA career development events (CDE) and leadership development events (LDE) and SAE, respondents indicated they integrate SSI into LDEs the most followed by CDEs then SAEs (Table 4.8). However, nearly one-third (32.7%; *n* = 37) of respondents chose neutral for CDEs, and 27.4% (*n* = 31) selected neutral for LDEs but respondents chose neutral most for SAE (38.9%; *n* = 44) (Table 4.8).

**Table 4.8**

*SBAE Teachers Incorporation of SSI into FFA and SAE by Percent*

| | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | *M* | *SD* |
| I incorporate SSI into … | | | | | | | |
| FFA CDEs | 10.6 | 44.2 | 32.7 | 7.1 | 5.3 | 3.48 | 0.97 |
| FFA LDEs | 15.0 | 46.9 | 27.4 | 6.2 | 4.4 | 3.62 | 0.97 |
| SAE | 9.7 | 37.2 | 38.9 | 8.8 | 5.3 | 3.37 | 0.97 |

**Research Objective 7**

Research Objective 7 sought to explain the influence of SBAE teacher attributes (i.e., teaching efficacy beliefs, perceived need, personal and professional characteristics) and peripheral influences (i.e., time barriers, knowledge barriers, other peripheral influences) on teaching socioscientific issues. An ordinary least squares (OLS) regression was conducted to determine any influence of the independent variables on the dependent variable. The degree of integration of SSI was the dependent variable with independent variables being teaching efficacy of SSI, teachers' belief of the need for SSI in agricultural education; barriers of time, knowledge and support; years of teaching experience; political ideology; and gender. Political ideology was dummy coded as conservative "1" and not conservative "0", and gender was dummy coded as female "1" and male "0".

I first conducted a correlation of the dependent variable, SSI integration and the independent variables of interest (i.e., teaching efficacy, perceived need to integrate, barriers of time, knowledge and support, years of experience, political ideology, gender) (see Table 4.9) for the regression analysis. I then conducted the OLS regression. The independent variables combined resulted in a statistically significant model ($F$ = 6.21, $p <$ .001) and predicted 34.6% ($R^2$ = .346) of the variance of SSI integration by SBAE teachers. Two of the independent variables, self-efficacy and gender, were found to be significant predictors of teachers' integration of SSI (Table 4.10). Using the standardized coefficients ($\beta$) to determine the strength of the relationship between integration of SSI and the independent variables, I found teaching efficacy of SSI to be the strongest predictor of SSI integration ($\beta$ = .533; $p$-value < .001), followed by gender ($\beta$ = .185; $p$ <

.05). These results indicate that as teaching efficacy increases, teachers are more likely to integrate SSI. These results further show that female teachers are more likely to integrate SSI into their courses.

**Table 4.9**

*Correlations of Independent Variables of Interest with SSI Integration*

| Variable | M | SD | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. SSI Integration | .628 | .28 | - | | | | | | | | |
| 2. Efficacy | 3.96 | .55 | .526** | - | | | | | | | |
| 3. Need | 4.21 | .45 | .290** | .410** | - | | | | | | |
| 4. Time Barriers | 3.62 | .84 | -.153 | -.138 | -.035 | - | | | | | |
| 5. Knowledge Barriers | 2.93 | .96 | -.256** | -.508** | -.102 | .364** | - | | | | |
| 6. Support Barriers | 3.71 | .66 | .287** | .377** | -.410** | -.162 | -.202* | - | | | |
| 7. Years Teaching | 12.12 | 9.98 | -.057 | .030 | -.127 | .115 | -.067 | -.115 | - | | |
| 8. Political Ideology | .52 | .50 | -.084 | .039 | -.069 | .499 | -.027 | .225* | .032 | - | |
| 9. Gender | .46 | .50 | .101 | -.138 | -.019 | .095 | -.016 | -.001 | -.268** | -.072 | - |

* *p* < .05; ** *p* < .001

**Table 4.10**

*Predictive Model of Teacher Attributes and Peripheral Influences with SSI Integration*

| | | | | Dependent Variable: Integration of SSI | | |
|---|---|---|---|---|---|---|
| Variable | *B* | *SE* | β | 95% CI | | *p* |
| | | | | LL | UL | |
| Self-Efficacy | .262 | .055 | .533 | .153 | .372 | .001* |
| Need | .032 | .062 | .052 | -.090 | .154 | .604 |
| Time Barriers | -.033 | .031 | -.097 | -.094 | .029 | .293 |
| Knowledge Barriers | .023 | .030 | .078 | -.038 | .083 | .458 |
| Support Barriers | .030 | .041 | .073 | -.052 | .112 | .467 |
| Teaching Experience | .000 | .003 | -.007 | -.005 | .005 | .934 |
| Political Ideology | -.067 | .048 | -.122 | -.162 | .029 | .169 |
| Gender | .101 | .049 | .185 | .004 | .197 | .041* |

*Note*. Political Ideology coded 0 = *Not Conservative*, 1 = *Conservative*; Gender coded 0 = *male*, 1 = *female*.
* $p < .05$

To further address research question seven, a binary logistic regression was conducted with each of the individual SSI to determine the relationship between SBAE teacher attributes (i.e., teaching efficacy beliefs, perceived need, personal and professional characteristics) and peripheral influences (i.e., time barriers, knowledge barriers, other peripheral influences) on integrating each of the individual SSI. In order to include political ideology in the logistic regression as an independent variable, it was recoded into a dichotomous variable. While I acknowledge that political ideology is far more complex, with the majority of respondents identifying with a conservative political ideology, this variable was recoded as (1 = *conservative*, 0 = *not conservative*).

***Climate Issues***

The binary logistic regression was conducted with the integration of climate issues as the dependent variable. The independent variables were the constructs of self-efficacy, perceived need to integrate SSI, barriers of time, barriers of knowledge, barriers of support, teaching experience in years, political ideology, and gender. These variables resulted in a significant model ($p = .003$) which also passed the Hosmer and Lemeshow goodness of fit test ($p = .298$) indicating the model was a good fit. The results for the classification table indicated the model correctly classified 66% overall, suggesting our independent variables had an impact on SBAE teachers' integration of climate issues (Table 4.11).

**Table 4.11**

*Classification Table for Teacher Attributes, Peripheral Influences on Climate Issues Integration*[1]

| Observed | Does not teach climate issues | Teaches climate issues | Percent correct |
|---|---|---|---|
| Does not teach climate issues | 26 | 22 | 54.2 |
| Teaches climate issues | 13 | 42 | 76.4 |
| Overall percentage | | | 66.0 |

[1]Dependent variable: integration of climate issues, where 0 = does not integrate climate issues, 1 = integrates climate issues. Independent variables: efficacy, need, time barriers, knowledge barriers, support barriers, teaching experience, political ideology, and gender.

Efficacy was the only independent variable in this regression found to be significant ($p = .009$) with an odds ratio (Exp(B) = 5.05) indicating as efficacy increases by one increment, the probability that SBAE teachers will integrate climate issues increases 5.05 times (Table 4.12). Explained further, the probability that SBAE teachers will integrate climate issues increases by 83.4% as efficacy increases.

**Table 4.12**

*Logistic Regression Influence of Teacher Attributes, Peripheral Influences on Climate Issues Integration*

| Variable | *B* | *S.E.* | Wald $\chi^2$ | Exp(B) | 95% CI for Exp(B) | | *p* |
|---|---|---|---|---|---|---|---|
| | | | | | LL | UL | |
| Efficacy | 1.616 | .624 | 6.743 | 5.050 | 1.488 | 17.144 | .009* |
| Need | .538 | .612 | .772 | 1.713 | .516 | 5.687 | .380 |
| Time Barriers | .145 | .296 | .240 | 1.156 | .647 | 2.065 | .624 |
| Knowledge Barriers | .454 | .308 | 2.180 | 1.575 | .862 | 2.88 | .140 |
| Support Barriers | .545 | .415 | 1.725 | 1.724 | .765 | 3.887 | .189 |
| Teaching Experience | .038 | .026 | 2.132 | 1.039 | .987 | 1.093 | .144 |
| Political Ideology | -.804 | .481 | 2.793 | .447 | .174 | 1.149 | .095 |
| Gender | .880 | .484 | 3.315 | 2.412 | .935 | 6.222 | .069 |

* $p < .05$; $df = 1$

***Ecosystem & Biodiversity Issues***

This model was significant ($p = .001$) and the Hosmer and Lemeshow model fit test ($p = .714$) indicate it is a good fit. The results for the classification table indicated the model correctly classified 71.8% overall, suggesting our independent variables had an impact on SBAE teachers' integration of ecosystem and biodiversity issues (Table 4.13).

**Table 4.13**

*Classification Table for Teacher Attributes, Peripheral Influences on Ecosystem and Biodiversity Issues Integration*[1]

| Observed | Does not teach ecosystem & biodiversity issues | Teaches ecosystem & biodiversity issues | Percent correct |
|---|---|---|---|
| Does not teach ecosystem & biodiversity issues | 28 | 18 | 60.9 |
| Teaches ecosystem & biodiversity issues | 11 | 46 | 80.7 |
| Overall percentage | | | 71.8 |

[1]Dependent variable: integration of ecosystem & biodiversity issues, where 0 = does not integrate ecosystem & biodiversity issues, 1 = integrates ecosystem & biodiversity issues. Independent variables: efficacy, need, time barriers, knowledge barriers, support barriers, teaching experience, political ideology, and gender.

Efficacy was a significant predictor ($p$ = .001) of the integration of ecosystems and biodiversity issues, with the probability of integrating ecosystems and biodiversity issues increasing 91.5% (Exp(B) = 10.75) as SBAE teaching efficacy increases (Table 4.14). No other predictors were significant in this model.

**Table 4.14**

*Logistic Regression Influence of Teacher Attributes, Peripheral Influences on Ecosystems & Biodiversity Issues Integration*

| Variable | *B* | *S.E.* | Wald $\chi^2$ | Exp(B) | 95% CI for Exp(B) | | *p* |
|---|---|---|---|---|---|---|---|
| | | | | | LL | UL | |
| Efficacy | 2.375 | .717 | 10.975 | 10.747 | 2.637 | 43.794 | .001* |
| Need | .029 | .611 | .002 | 1.030 | .311 | 3.408 | .962 |
| Time Barriers | -.091 | .311 | .085 | .913 | .497 | 1.679 | .770 |
| Knowledge Barriers | .363 | .302 | 1.441 | 1.437 | .795 | 2.600 | .230 |
| Support Barriers | .176 | .403 | .188 | 1.193 | .538 | 2.645 | .665 |
| Teaching Experience | -.030 | .025 | 1.351 | .971 | .924 | 1.020 | .245 |
| Political Ideology | -.200 | .473 | .178 | .819 | .324 | 2.071 | .673 |
| Gender | -.082 | .483 | .029 | .921 | .357 | 2.374 | .865 |

* $p < .05$; *Note. df* = 1

***Energy Issues***

Although this regression resulted in a model that was not significant ($p = .056$) it still indicates a good fit by the Hosmer and Lemeshow model of good fit test ($p = .26$). The results for the classification table indicated the model correctly classified 71.8% overall, suggesting our independent variables had an impact on SBAE teachers' integration of energy issues (Table 4.15).

**Table 4.15**

*Classification Table for Teacher Attributes, Peripheral Influences on Energy Issues Integration*[1]

| Observed | Does not teach energy issues | Teaches energy issues | Percent correct |
|---|---|---|---|
| Does not teach energy issues | 27 | 18 | 60.0 |
| Teaches energy issues | 11 | 47 | 81.0 |
| Overall percentage | | | 71.8 |

[1]Dependent variable: integration of energy issues, where 0 = does not integrate energy issues, 1 = integrates energy issues. Independent variables: efficacy, need, time barriers, knowledge barriers, support barriers, teaching experience, political ideology, and gender.

Efficacy was the only significant predictor ($p$ = .005) indicating that as SBAE teachers' efficacy increase, the likelihood of integrating energy issues into their curriculum increases by 5.85 times (Exp(B) = 5.85) (Table 4.16). The probability of SBAE teachers integrating energy issues increases 84.5% as their teaching efficacy increases.

**Table 4.16**

*Logistic Regression Influence of Teacher Attributes, Peripheral Influences on Energy Issues Integration*

| Variable | *B* | *S.E.* | Wald $\chi^2$ | Exp(B) | 95% CI for Exp(B) | | *p* |
|---|---|---|---|---|---|---|---|
| | | | | | LL | UL | |
| Efficacy | 1.766 | .626 | 7.964 | 5.845 | 1.715 | 19.922 | .005* |
| Need | -.673 | .596 | 1.275 | .510 | .159 | 1.641 | .259 |
| Time Barriers | -.044 | .297 | .022 | .957 | .535 | 1.712 | .882 |
| Knowledge Barriers | .053 | .283 | .035 | 1.054 | .606 | 1.834 | .852 |
| Support Barriers | -.293 | .398 | .540 | .746 | .342 | 1.629 | .463 |
| Teaching Experience | -.005 | .024 | .053 | .995 | .949 | 1.042 | .818 |
| Political Ideology | -.391 | .451 | .753 | .676 | .279 | 1.636 | .386 |
| Gender | .796 | .471 | 2.850 | 2.216 | .880 | 5.580 | .091 |

* $p < .05$; *Note. df* = 1

***Food Security Issues***

The binary logistic regression for food security issues integration by SBAE teachers was significant ($p = .002$) and the model was a good fit according to the Hosmer and Lemeshow test of good fit ($p = .878$). The results for the classification table indicated the model correctly classified 76.7% overall, suggesting our independent variables had an impact on SBAE teachers' integration of food security issues (Table 4.17).

**Table 4.17**

*Classification Table for Teacher Attributes, Peripheral Influences on Food Security Issues Integration*[1]

| Observed | Does not teach food security issues | Teaches food security issues | Percent correct |
|---|---|---|---|
| Does not teach food security issues | 14 | 17 | 45.2 |
| Teaches food security issues | 7 | 65 | 90.3 |
| Overall percentage | | | 76.7 |

[1]Dependent variable: integration of food security issues, where 0 = does not integrate food security issues, 1 = integrates food security issues. Independent variables: efficacy, need, time barriers, knowledge barriers, support barriers, teaching experience, political ideology, and gender.

This model resulted in three significant predictors including efficacy ($p$ = .012), barriers of time ($p$ = .014) and gender ($p$ = .046) (Table 4.18). The odds ratio for efficacy (Exp(B) = 4.908) indicates that as SBAE teacher efficacy increases, the likelihood they would integrate food security increases 4.9 times. This shows that the probability that teachers will integrate food security increases by 83% as their efficacy increases. This model also shows that as the barriers of time for SBAE teachers increase, the probability of them integrating food security decreases by 62% (Exp(B) = .38). Additionally, the probability of integrating food security was 74.6% (Exp(B) = 2.95) higher for female SBAE teachers (Table 4.18).

**Table 4.18**

*Logistic Regression Influence of Teacher Attributes, Peripheral Influences on Food Security Issues Integration*

| Variable | *B* | *S.E.* | Wald $\chi^2$ | Exp(B) | 95% CI for Exp(B) | | *p* |
|---|---|---|---|---|---|---|---|
| | | | | | LL | UL | |
| Efficacy | 1.591 | .632 | 6.334 | 4.908 | 1.422 | 16.945 | .012* |
| Need | -1.001 | .662 | 2.285 | .367 | .100 | 1.346 | .131 |
| Time Barriers | -.979 | .400 | 5.987 | .376 | .172 | .823 | .014* |
| Knowledge Barriers | .000 | .315 | .000 | 1.000 | .539 | 1.856 | .999 |
| Support Barriers | .128 | .447 | .082 | 1.136 | .473 | 2.729 | .775 |
| Teaching Experience | -.022 | .025 | .760 | .978 | .931 | 1.028 | .383 |
| Political Ideology | -.153 | .524 | .085 | .858 | .308 | 2.395 | .770 |
| Gender | 1.080 | .542 | 3.972 | 2.945 | 1.018 | 8.517 | .046* |

* $p < .05$; *Note*. $df = 1$

### ***Genetic Engineering Issues***

The logistic regression model for genetic engineering issues was a good fit (H & L Test = .537) and significant ($p = .005$). The results for the classification table indicated the model correctly classified 76.7% overall, suggesting our independent variables had an impact on SBAE teachers' integration of genetic engineering issues (Table 4.19).

**Table 4.19**

*Classification Table for Teacher Attributes, Peripheral Influences on Genetic Engineering Issues Integration*[1]

| Observed | Does not teach genetic engineering issues | Teaches genetic engineering issues | Percent correct |
|---|---|---|---|
| Does not teach genetic engineering issues | 19 | 19 | 50.0 |
| Teaches genetic engineering issues | 13 | 52 | 80.0 |
| Overall percentage | | | 68.9 |

[1]Dependent variable: integration of genetic engineering issues, where 0 = does not integrate genetic engineering issues, 1 = integrates genetic engineering issues. Independent variables: efficacy, need, time barriers, knowledge barriers, support barriers, teaching experience, political ideology, and gender.

Two of the independent variables were significant, need ($p$ = .014) and gender ($p$ = .043) (Table 4.20). This regression model shows that as SBAE teachers' perceived need to integrate genetic engineering increases, the probability of them integrating it is 84.5% higher (Exp(B) = 5.43) and the probability of integrating genetic engineering into SBAE classes is 73% higher for female SBAE teachers.

**Table 4.20**

*Logistic Regression Influence of Teacher Attributes, Peripheral Influences on Genetic Engineering Issues Integration*

| Variable | *B* | *S.E.* | Wald $\chi^2$ | Exp(B) | 95% CI for Exp(B) | | *p* |
|---|---|---|---|---|---|---|---|
| | | | | | LL | UL | |
| Efficacy | .404 | .537 | .566 | 1.497 | .523 | 4.287 | .452 |
| Need | 1.692 | .691 | 6.001 | 5.432 | 1.403 | 21.039 | .014* |
| Time Barriers | -.083 | .326 | .064 | .921 | .486 | 1.743 | .800 |
| Knowledge Barriers | -.565 | .309 | 3.340 | .568 | .310 | 1.042 | .068 |
| Support Barriers | -.274 | .433 | .401 | .760 | .326 | 1.776 | .526 |
| Teaching Experience | .009 | .025 | .141 | 1.009 | .961 | 1.060 | .707 |
| Political Ideology | .300 | .488 | .376 | 1.349 | .518 | 3.513 | .540 |
| Gender | 1.004 | .497 | 4.082 | 2.728 | 1.030 | 7.222 | .043* |

* $p < .05$; *Note. df* = 1

### ***Human Population Issues***

While this logistic regression model did result in a good fit (H & L $p = .222$), it was not significant ($p = .077$). The results for the classification table indicated the model correctly classified 76.7% overall, suggesting our independent variables had an impact on SBAE teachers' integration of human population issues (Table 4.21).

**Table 4.21**

*Classification Table for Teacher Attributes, Peripheral Influences on Human Population Issues Integration*[1]

| Observed | Does not teach human population issues | Teaches human population issues | Percent correct |
|---|---|---|---|
| Does not teach human population issues | 19 | 23 | 45.2 |
| Teaches human population issues | 8 | 53 | 86.9 |
| Overall percentage | | | 69.9 |

[1]Dependent variable: integration of human population issues, where 0 = does not integrate human population issues, 1 = integrates human population issues. Independent variables: efficacy, need, time barriers, knowledge barriers, support barriers, teaching experience, political ideology, and gender.

Though not an overall significant model, the independent variable of efficacy was significant within the model ($p$ = .015) (Table 4.22). The odds ratio indicates that as SBAE teacher efficacy increases, the probability of human population issues being integrated into the curriculum increases 3.941 times, resulting in a probability of integrating human population issues of 79.8% as efficacy increases.

**Table 4.22**

*Logistic Regression Influence of Teacher Attributes, Peripheral Influences on Human Population Issues Integration*

| Variable | *B* | *S.E.* | Wald $\chi^2$ | Exp(B) | 95% CI for Exp(B) | | *p* |
|---|---|---|---|---|---|---|---|
| | | | | | LL | UL | |
| Efficacy | 1.371 | .561 | 5.972 | 3.941 | 1.312 | 11.838 | .015* |
| Need | .482 | .582 | .686 | 1.619 | .518 | 5.061 | .407 |
| Time Barriers | -.277 | .299 | .858 | .758 | .421 | 1.363 | .354 |
| Knowledge Barriers | .405 | .298 | 1.847 | 1.499 | .836 | 2.687 | .174 |
| Support Barriers | .096 | .388 | .061 | 1.100 | .514 | 2.356 | .805 |
| Teaching Experience | -.005 | .024 | .053 | .995 | .949 | 1.042 | .817 |
| Political Ideology | -.101 | .453 | .050 | .904 | .372 | 2.197 | .823 |
| Gender | .578 | .465 | 1.547 | 1.783 | .717 | 4.436 | .214 |

* $p < .05$; *Note.* $df = 1$

### ***Natural Resource Issues***

The logistic regression model was not significant ($p = .060$); however, it does pass the Hosmer and Lemeshow test of good fit ($p = .093$). The results for the classification table indicated the model correctly classified 76.7% overall, suggesting our independent variables had an impact on SBAE teachers' integration of natural resource issues (Table 4.23).

**Table 4.23**

*Classification Table for Teacher Attributes, Peripheral Influences on Natural Resource Issues Integration*[1]

| Observed | Does not teach natural resource issues | Teaches natural resource issues | Percent correct |
|---|---|---|---|
| Does not teach natural resource issues | 6 | 22 | 21.4 |
| Teaches natural resource issues | 2 | 73 | 97.3 |
| Overall percentage | | | 76.7 |

[1]Dependent variable: integration of natural resource issues, where 0 = does not integrate natural resource issues, 1 = integrates natural resource issues. Independent variables: efficacy, need, time barriers, knowledge barriers, support barriers, teaching experience, political ideology, and gender.

The independent variable of efficacy was significant within the model ($p$ = .006) with an odds ratio of 5.27 (Table 4.24). This indicates that as SBAE teacher efficacy increases they are 5.27 times more likely to integrate human population issues. Thus, the probability of integrating human population issues is 84% higher when SBAE teacher efficacy increases.

**Table 4.24**

*Logistic Regression Influence of Teacher Attributes, Peripheral Influences on Natural Resource Issues Integration*

| Variable | *B* | *S.E.* | Wald $\chi^2$ | Exp(B) | 95% CI for Exp(B) | | *p* |
|---|---|---|---|---|---|---|---|
| | | | | | LL | UL | |
| Efficacy | 1.662 | .599 | 7.698 | 5.269 | 1.629 | 17.042 | .006* |
| Need | .549 | .655 | .703 | 1.732 | .480 | 6.249 | .402 |
| Time Barriers | .012 | .323 | .001 | 1.012 | .538 | 1.906 | .970 |
| Knowledge Barriers | .611 | .346 | 3.127 | 1.842 | .936 | 3.627 | .077 |
| Support Barriers | .137 | .436 | .099 | 1.147 | .488 | 2.693 | .753 |
| Teaching Experience | .017 | .028 | .394 | 1.018 | .964 | 1.075 | .530 |
| Political Ideology | -.148 | .511 | .085 | .862 | .317 | 2.345 | .771 |
| Gender | -.078 | .503 | .024 | .925 | .345 | 2.479 | .877 |

* $p < .05$; *Note.* $df = 1$

### ***Sustainability Issues***

The logistic regression for sustainability issues resulted in a significant model ($p = .014$) and a good fit (H & L $p = .587$). The results for the classification table indicated the model correctly classified 76.7% overall, suggesting our independent variables had an impact on SBAE teachers' integration of sustainability issues (Table 4.25).

**Table 4.25**

*Classification Table for Teacher Attributes, Peripheral Influences on Sustainability Issues Integration*[1]

| Observed | Does not teach sustainability issues | Teaches sustainability issues | Percent correct |
|---|---|---|---|
| Does not teach sustainability issues | 9 | 18 | 33.3 |
| Teaches sustainability issues | 5 | 71 | 93.4 |
| Overall percentage | | | 77.7 |

[1]Dependent variable: integration of sustainability issues, where 0 = does not integrate sustainability issues, 1 = integrates sustainability issues. Independent variables: efficacy, need, time barriers, knowledge barriers, support barriers, teaching experience, political ideology, and gender.

Within this model, the independent variable of support barriers was significance ($p = .048$) (Table 4.26) indicating that as SBAE teachers feel more supported by their administration and community, the probability of them integrating sustainability issues is 72.2% higher (Exp(B) = 2.60).

**Table 4.26**

*Logistic Regression Influence of Teacher Attributes, Peripheral Influences on Sustainability Issues Integration*

| Variable | *B* | *S.E.* | Wald $\chi^2$ | Exp(B) | 95% CI for Exp(B) | | *p* |
|---|---|---|---|---|---|---|---|
| | | | | | LL | UL | |
| Efficacy | .936 | .577 | 2.637 | 2.550 | .824 | 7.895 | .104 |
| Need | -.069 | .664 | .011 | .933 | .254 | 3.431 | .917 |
| Time Barriers | -.412 | .368 | 1.256 | .662 | .322 | 1.361 | .262 |
| Knowledge Barriers | -.227 | .329 | .478 | .797 | .418 | 1.518 | .489 |
| Support Barriers | .955 | .484 | 3.895 | 2.600 | 1.007 | 6.715 | .048* |
| Teaching Experience | .003 | .027 | .014 | 1.003 | .952 | 1.057 | .907 |
| Political Ideology | -.826 | .555 | 2.218 | .438 | .147 | 1.298 | .136 |
| Gender | .415 | .531 | .612 | 1.515 | .535 | 4.290 | .434 |

* $p < .05$; *Note. df* = 1

***Water Issues***

The results of this binary logistic regression did not provide a significant model ($p = .069$) though it is a good fit (H & L $p = .137$). The results for the classification table indicated the model correctly classified 76.7% overall, suggesting our independent variables had an impact on SBAE teachers' integration of water issues (Table 4.27).

**Table 4.27**

*Classification Table for Teacher Attributes, Peripheral Influences on Water Issues Integration*[1]

| Observed | Does not teach water issues | Teaches water issues | Percent correct |
|---|---|---|---|
| Does not teach water issues | 8 | 20 | 28.6 |
| Teaches water issues | 2 | 73 | 97.3 |
| Overall percentage | | | 78.6 |

[1]Dependent variable: integration of water issues, where 0 = does not integrate water issues, 1 = integrates water issues. Independent variables: efficacy, need, time barriers, knowledge barriers, support barriers, teaching experience, political ideology, and gender.

Political ideology was the only significant predictor ($p$ = .019) in the model (Table 4.28). The odds ratio for political ideology indicates the probability of integrating water issues in their curriculum is 21.8% lower for those SBAE teachers who identified a political ideology as conservative.

**Table 4.28**

Logistic Regression Influence of Teacher Attributes, Peripheral Influences on Water Issues Integration

| Variable | *B* | *S.E.* | Wald $\chi^2$ | *p* | Exp(B) | 95% CI for Exp(B) | | *p* |
|---|---|---|---|---|---|---|---|---|
| | | | | | | LL | UL | |
| Efficacy | .909 | .557 | 2.668 | .102 | 2.483 | .834 | 7.392 | .102 |
| Need | .232 | .652 | .126 | .722 | 1.261 | .351 | 4.530 | .722 |
| Time Barriers | -.139 | .334 | .173 | .677 | .870 | .452 | 1.676 | .677 |
| Knowledge Barriers | -.114 | .322 | .125 | .724 | .893 | .475 | 1.677 | .724 |
| Support Barriers | .261 | .444 | .345 | .557 | 1.298 | .543 | 3.102 | .557 |
| Teaching Experience | -.011 | .026 | .184 | .668 | .989 | .939 | 1.041 | .668 |
| Political Ideology | -1.276 | .543 | 5.517 | .019 | .279 | .096 | .810 | .019* |
| Gender | .278 | .507 | .299 | .584 | 1.320 | .488 | 3.569 | .584 |

* $p < .05$; *Note. df* = 1

# CHAPTER 5

## CONCLUSIONS & RECOMMENDATIONS

The purpose of this research was to explore the self-efficacy, knowledge, and integration of SSI among SBAE teachers by explaining the factors that influence integration. This research addresses the AAAE National Research Agenda priority number seven, addressing complex interdisciplinary problems such as climate change, food security, natural resource usage and conservation, and sustainability (Roberts et al., 2016). I used quantitative survey methods to discover SBAE teachers' teaching self-efficacy of SSI as well as their level of agreement that SSI is needed in agricultural education. I further described individual SSI topics and overall SSI integration by SBAE teachers. This chapter will summarize the findings from chapter four, provide conclusions and recommendations for future research and for practice, which are based on the results from the following research objectives:

1. Describe the personal and professional characteristics of SBAE teachers.
2. Describe SBAE teachers' self-efficacy beliefs related to socioscientific issues.
3. Describe SBAE teachers' perceived need to teach socioscientific issues.
4. Describe SBAE teachers' perceived barriers to teaching socioscientific issues (i.e., time, knowledge, peripheral influences).
5. Describe which socioscientific issues SBAE teachers use in their curriculum.
6. Describe teaching strategies and resources used by SBAE teachers when incorporating socioscientific issues into their curriculum.

7. Explain the influence of SBAE teacher attributes (i.e., teaching self-efficacy beliefs, perceived need, personal and professional characteristics) and peripheral influences (i.e., time barriers, knowledge barriers, other peripheral influences) on teaching socioscientific issues.

## Summary of Findings

### Research Objective 1

The population for this exploratory quantitative survey research was all SBAE teachers in the United States and its territories who taught agricultural education classes within the 12 months prior to the study, which included the 2019-2020 school year. Although the response rate was not large enough to be generalizable across all SBAE teachers, it was representative of the population of SBAE teachers (Lawver et al., 2018). The respondents ranged from first-year teachers to those with 40 years of teaching experience. A slight majority of respondents were male and just over half identified as conservative. Most of respondents had a traditional agricultural education teaching credential and fewer than half had a science endorsement. Just over half of the SBAE teachers had heard the term *socioscientific issues* prior to participating in this research.

### Research Objective 2

For this research objective, I sought to describe SBAE teachers’ teaching self-efficacy beliefs related to SSI. The overall mean for the construct of self-efficacy was

3.96, indicating they agreed with being efficacious regarding their ability to teach SSI in their classes. There were no significant differences between gender, years of experience, or political ideology.

**Research Objective 3**

The purpose of Research Objective 3 was to describe SBAE teachers' perceived need to teach SSI in their agriculture classes. The overall mean for the construct of need was 4.21, indicating that SBAE teachers agreed that incorporating SSI into agricultural education is needed. There were no significant differences between gender, years of experience, or political ideology for teachers' perceived need to integrate SSI.

**Research Objective 4**

For this research objective, I sought to describe SBAE teachers' perceived barriers to teaching SSI in their classes. These barriers included time, knowledge, and peripheral influences in the form of support. The mean for the construct of time barriers was 3.62, which suggests teachers agreed that time was a barrier for incorporating SSI. This includes barriers of time to incorporate SSI as well as time to develop curriculum related to SSI. With a mean of 2.93 for barriers of knowledge, SBAE teachers overall were neutral when it came to their own knowledge of SSI. Teachers overall agreed ($M$ = 3.96) their administration and community are supportive when it comes to SSI integration. Interestingly though, 27.2% selected neutral when it came to administration support and 33.1% selected neutral related to community support.

### Research Objective 5

The purpose of this research objective was to describe the SSI topics that SBAE teachers were integrating into their classes. Of the nine SSI that were included in this survey, the two SSI topics taught the most were sustainability issues (66.2%) and water issues (64.7%), while the two least taught SSI topics were energy issues (47.1%) and climate issues (48.5%). Further, nearly all of the respondents indicated they teach at least one SSI topic with only 2.9% of them indicating they do not teach any SSI.

### Research Objective 6

For Research Objective 6, I sought to describe the teaching strategies and resources SBAE teachers use when incorporating SSI into their classes. When asked to indicate which teaching strategies they use either *frequently*, *sometimes*, or *never*, only 16.2% of SBAE teachers indicated they use debate frequently, whereas the majority (70.3%) indicated they use debate sometimes. The teaching strategies used most frequently were group work (48.6%) and lecture or direct instruction (49.6%). Furthermore, 49.0% of respondents indicated they *never* use the Socratic method and 65.0% *never* use role play when teaching SSI.

Other teaching strategies I explored were the incorporation of SSI into FFA career development events, leadership development events and SAE. While just over one third of respondents agreed or strongly agreed they incorporate SSI into CDEs, 27.2% selected neutral. In terms of leadership development events, more than half of respondents agreed or strongly agreed they incorporate SSI, although 22.8% chose neutral. Regarding SAE, less than 40% of SBAE teachers agreed or strongly agreed they incorporate SSI, yet 32.4% indicated neutral on the survey.

The most *frequently* used resource by respondents in this research were the internet (88.5%) and media (59.5%) when teaching SSI, while the resources used *never* by respondents were textbooks (39.3%). More than 80% of respondents agreed or strongly agreed that their students use technology when learning about SSI and more than 60.0% agreed or strongly agreed that their students analyze scientific data when learning about SSI. One quarter of respondents selected neutral when regarding students analyzing data while learning about SSI.

**Research Objective 7**

The purpose of research objective seven was twofold. First, to explain the influences of SBAE teacher attributes (i.e., teaching self-efficacy beliefs, perceived need, personal and professional characteristics) on teaching SSI, and second, to explain peripheral influences (i.e., time barriers, knowledge barriers, peripheral influences of support) on teaching SSI in agricultural education classes. Teacher self-efficacy and gender were found to be significant in predicting overall SSI integration. As teacher self-efficacy of SSI increased, the likelihood of SSI integration increased. Additionally, female teachers were more likely to integrate SSI into their curriculum.

In terms of the individual SSI topics, the results indicated that self-efficacy was a significant predictor in the integration of climate issues, ecosystem and biodiversity issues, energy issues, food security issues, human population issues, and natural resource issues. These results indicate that as teacher self-efficacy increases for these SSI topics, the probability of teachers integrating them into their curriculum increases as well. I also found time barriers to be a significant predictor of food security issues, indicating that as time barriers increase for teachers, the probability of them integrating food security issues into their curriculum decreases. Furthermore, I found gender to be a significant predictor on the integration of food security and genetic engineering, suggesting that female SBAE teachers are more likely to teach those SSI topics.

Teachers' perceived need for SSI integration into SBAE classes was found to be a significant predictor of integrating genetic engineering. As their perceived need increased, the probability of teaching genetic engineering also increased. Additionally, teachers' political ideology was found to be a significant predictor of the integration of water issues, suggesting that teachers who identified as conservative had a lower probability of teaching water issues in their classes.

## Conclusions

Through this research I sought to explore SBAE teachers' self-efficacy, knowledge, and integration of SSI as well as barriers to SSI integration into agricultural education curriculum. In this section I will discuss conclusions of this survey research. I have organized them into themes which include self-efficacy, teachers' perceived need to integrate SSI, SBAE teachers' perceived barriers to integrating SSI, SSI topics currently being integrated by SBAE teachers, and teaching strategies and resources used by SBAE teachers when integrating SSI.

**Teacher Self-Efficacy Predicts Integration of SSI**

As has been suggested in previous research, individuals are motivated to act and think in a particular way by their self-efficacy (Bandura, 1995, 2009). In fact, a person's beliefs will also influence their self-efficacy (Bandura, 1995, 2009). Teachers are not immune to this phenomenon and as Roath and Hay (2016) point out, will spend less time teaching material, and use more teacher-centered strategies when their self-efficacy is lower. They also pointed out that teachers with lower self-efficacy make fewer attempts to motivate students (Roath & Hay, 2016).

As a significant predictor of SSI integration overall, teacher self-efficacy influenced whether teachers in this study integrated SSI. The more efficacious teachers felt about SSI, the more they were likely to include SSI in their classes. Not only was self-efficacy significant in predicting SSI integration overall, but it was also significant in predicting the integration of individual SSI topics, including climate issues, ecosystems & biodiversity issues, energy issues, food security issues, human population issues, and natural resource issues. Given the influence that self-efficacy has on teacher actions and motivations, recognizing the relationship between teacher self-efficacy and SSI integration should guide teacher preparation programs to ensure they are introducing pre-service teachers to SSI topics and integrating the SSI framework into methods courses. Early introduction of SSI to pre-service teachers could enable them to gain proficiency integrating SSI into their curriculum and develop their teaching self-efficacy for SSI while still in their teacher preparation program.

Given that the SSI framework originated in science education, it might be that teachers with a science endorsement would have heard of SSI, however many SBAE teachers in this research do not have science endorsements and many who participated in this research had not heard of SSI prior to this survey. This suggests that SBAE teachers are not being exposed to SSI in their pre-service program or in-service professional development, thus not integrating them into their classes. SBAE teachers cannot be expected to incorporate content which they do not know about or understand.

The first time SBAE teachers will learn about SSI could be in their pre-service program or through professional development they will participate in once they are already in the classroom. Professional development can increase self-efficacy for in-service teachers. Learning about SSI, the SSI-based instruction framework, and teaching strategies to integrate SSI during professional development allows in-service teachers to learn with their peers and implement what they have learned in their classrooms, potentially improving their teaching self-efficacy for SSI as well.

The SSI-based instruction framework specifically identifies curriculum flexibility, knowledge of science content, and awareness of social considerations as key components to integrating SSI. Results of this research suggest teachers believe they have flexibility and can use various teaching strategies in their classes. They also are confident in their own knowledge of what SSI are and ability to effectively teach SSI. This begs the question then, why are there not more of the teachers who participated in this study teaching SSI? Self-efficacy was not significant for three of the SSI in this research: genetic engineering issues, sustainability issues, and water issues. It could be argued that these topics are already part of their agricultural education curriculum and included in their state standards. If this is the case, they would be teaching these topics; however, given that teachers in this study used lecture and direct instruction most frequently, it is possible they are not teaching these topics in alignment with the SSI-based instruction framework.

**Teacher's Believe They Need to Integrate SSI into SBAE Curriculum**

Although I did not find teachers' perceived need to integrate SSI to be a significant predictor of overall SSI integration, it was a significant predictor of the integration of genetic engineering issues. This suggests the more SBAE teachers perceive that students need to learn about genetic engineering issues, the more likely they are to integrate these issues into their course curriculum. Perhaps genetic engineering has connections to topics SBAE teachers are already teaching in their classes, such as genetically modified organisms (GMO) and as such there is a felt need to integrate that particular SSI. Of all the SSI in the survey, this might have been the only one that teachers had a perceived need to integrate because it is already part of their state education standards (The National Council, 2015).

Teachers in this study overwhelmingly agreed there is a need to integrate SSI into agricultural education curriculum, however the data from this research does not suggest many SBAE teachers are actually doing it. Even though they agree SSI are needed in SBAE, teachers may not be integrating them if they do not see the alignment to their standards. The SSI-based instruction framework advises an essential element of successful SSI integration is the connection to state and national education standards (Presley et al., 2013). Although Shoulders and Myers (2013) reinforced the understanding that SSI-based instruction is useful in improving students' science content knowledge, explicitly making connections between SSI and SBAE education standards will ensure

SBAE teachers have a perceived need to integrate more than genetic engineering issues. Otherwise, teachers will not integrate what they do not need.

Bearing in mind the mean for teachers' perceived need to integrate SSI was higher than the mean for self-efficacy, teachers appear to know SSI is important, but they lack self-efficacy for teaching it. This is evidenced in the low numbers of SSI integration.

**SBAE Teachers Face Barriers to Integrating SSI**

Although the findings suggest barriers of time, knowledge, and support were not significant predictors to the overall integration of SSI, they did prove to be predictors of the integration of specific SSI topics. When barriers of time increase, the probability of teachers integrating food security into their curriculum decreases by 62%. Considering all that teachers have to contend with, this finding is not surprising. It is interesting though, that barriers of time were not a significant predictor on the integration of other SSI. It could be that food security is something that SBAE teachers integrate but is not seen as necessary, thus as demands on teachers' time intensifies, adjusting where they place their efforts does not include food security at this point. Another consideration is that when time is limited, SBAE teachers may not delve deep into food security issues but rather address them at a surface level.

When considering barriers of support, teachers who feel more supported by their administration and community will be 72.2% more likely to integrate sustainability issues. Teachers can be apprehensive when it comes to integrating unfamiliar content or new teaching strategies. Thus, the SSI-based framework asserts that teachers need support and encouragement when implementing SSI into their curriculum (Presley et al., 2013). This support may be in the form of professional development to learn about the SSI content, curriculum design, or teaching strategies. Administrators and community members should also be supportive when teachers integrate often-controversial SSI, so teachers are not concerned about potential repercussions or criticism when tackling these difficult topics.

I found a negative relationship between teachers' barriers of knowledge and genetic engineering, though not statistically significant ($p = .068$), indicating that as teachers' knowledge barriers increased, they were less likely to integrate genetic engineering issues. Perhaps the complexity of genetic engineering issues requires additional training for teachers to confidently integrate them. If teachers are not receiving training in their pre-service program or during in-service professional development, they may avoid teaching these complex issues. A core aspect of the SSI-based instruction framework is not only teachers' knowledge about the scientific content and social considerations of the SSI, but also their willingness to position themselves as a facilitator or contributor of knowledge instead of the expert (Presley et al., 2013). Even though instructors and coaches tell teachers they don't need to always be the *sage on the stage* but more like the *guide on the side*, this idea is sometimes difficult for teachers to adapt to, which is evidenced in their selection of lecture/direct instruction as a frequently used strategy.

Worth noting is the fact that for both scientific knowledge and understanding of social considerations among teachers, nearly one quarter of respondents selected neutral. Research suggests that when respondents select the neutral option, it may be an indication they do not know, or they are choosing the option they believe to be the social norm

(Chyung et al., 2017). Further concerns could be that respondents are using the neutral as an easy out for items they are unfamiliar with or socially uncomfortable (Chyung et al. (2017). The SSI-based framework iterates that teachers must have the science content knowledge and understanding of the social considerations in order to adequately integrate SSI into their curriculum (Presley et al., 2013) so knowing more fully what a neutral selection related to SSI means to an SBAE teacher is crucial to further understanding SSI integration in SBAE.

**SBAE Teachers Integrate Some SSI**

The survey in this research included nine choices of SSI topics that SBAE teachers were asked to select from, indicating which topics they teach. In addition to those choices provided, two blank spaces were supplied for teachers to write in SSI topics they teach in their classes that were not on the list. This allowed teachers to provide SSI topics that were regional or local that they integrated. It is worth noting that none of the respondents wrote in additional SSI topics. An initial thought might be they simply do not teach other SSI in their programs. Perhaps the teachers in this study were unfamiliar with SSI. If this is the case, they may not have felt comfortable using that space to write in an answer they were unsure of. It is also quite possible the SBAE teachers in this study do teach other SSI, some of which may be local or regional, but do not realize it. This emphasizes the need for common terminology among educational content areas, including SBAE.

Natural resource issues (66.9%), sustainability issues (66.2%), and water issues (64.7%) were the top three SSI taught by respondents, with energy issues (47.1%), climate issues (48.5%), and ecosystem and biodiversity issues (49.3%) being the bottom three SSI taught by respondents. Considering recent events in the news related to widespread wildfires in the west and issues related to national parks and wildlife, it is not surprising that natural resource issues are at the top of the list of SSI. There are two AFNR pathways that encompass natural resource issues, which include environmental systems and natural resource systems. In fact, more than half of SBAE teachers in this study indicated they teach classes in the natural resource pathway and nearly one third teach classes in the environmental pathway. Many CTE programs also promote career exploration and readiness for students and given the job opportunities in the natural resource fields, natural resource SSI would be a natural fit in SBAE.

In light of their natural connection to aspects in agriculture, including production agriculture, it is not surprising that sustainability and water issues are near the top of the list. Nearly 75% of SBAE teachers in this study indicated they teach classes in the AFNR animal systems pathway and more than 60% teach classes in the plant systems pathway. Considering the high number of SBAE teachers teaching in these content areas, it is surprising that not more teachers are integrating the SSI that naturally fit within this content. For example, local SSI could include topics of water runoff pollution from a feedlot operation, which would fit into a class in the animal systems pathway. Another example is a GMO SSI, discussing modified agricultural crops which would fit into a class within the plant systems pathway. This lack of SSI integration could be due to multiple reasons. Anxiety and discomfort can arise for both teachers and students when controversial issues are covered in course material, especially if either party lacks knowledge or maturity to engage in constructive discourse (Borgerding & Dagistan, 2018). Some SSI that fit within an animal or plant course could not only be controversial, but they may also connect to other SSI topics teachers are unfamiliar with or would prefer to avoid. Participants in this research may also be integrating these issues in their classes, but do not realize which of the SSI categories in the survey they would align with.

Energy, ecosystem and biodiversity, and climate issues were the three least taught SSI by SBAE teachers in this study. Although these SSI were taught by fewer than half of the teachers, they were taught by early career teacher more than mid- or late-career teachers. This may be an indication these SSI are more contemporary issues that are recognized by younger individuals.

Only 2.9% of SBAE teachers who participated in the research indicated they do not teach any SSI topics in their classes. While it is encouraging that all of the SSI topics are being taught in SBAE programs, at the same time it is discouraging that the percentages of the respondents who chose each topic are relatively low.

**Teachers Use a Limited Variety of Strategies and Resources to Teach SSI**

Agricultural education teachers use a variety of methods to teach content in their classes. However, when asked about specific strategies used when teaching SSI, 65% of respondents in this study indicated they *never* use role play and 49% *never* use the Socratic method. Debate was the strategy most selected as being used *sometimes* (70.3%), followed by direct instruction *sometimes* being used (50.4%). The teaching strategies most respondents said they used *frequently* were lecture or direct instruction (49.6%) and group work (48.6%). These results suggest while SBAE teachers are integrating SSI, they do not seem to be integrating them using the learning experiences outlined in the SSI-based instruction framework, in which higher order experiences are a required component (Presley, et al., 2013).

As has been previously discussed in this research, SSI are often controversial and teaching these issues in the classroom can lead to what some might consider disruptions in classroom management and students feeling uncomfortable. By using lecture or direction instruction, teachers maintain a degree of control over the classroom environment and the content learned. Teachers may also be using teaching methods they learned by, thus teaching the way they were taught (Lortie, 1975/2002). Agriculture teacher preparation programs may be so focused on ensuring their students know *what* to teach, they are overlooking *how* to teach. In-service are focused on meeting state and national education standards, which dictate *what* to teach and do not guide teachers on *how* to teach.

Research previously conducted found that SBAE teachers are familiar with some of the teaching methods described in the SSI-based instruction framework but may not use them routinely (Shoulders, 2012). Results of this research support findings from Shoulders (2012) that SBAE teachers are not regularly infusing SSI teaching strategies into their curriculum. Cross (2019) later found that SBAE teachers lacked the background knowledge needed to implement SSI. One third of teachers in this study agreed they lacked the science content knowledge and lacked knowledge of the social considerations to teach SSI, and nearly one quarter of teachers responded neutral to these items.

The SSI-based instruction framework clearly identifies required and recommended learner experiences when engaging in SSI in the classroom. Required learner experiences include higher order thinking and addressing scientific theories and ideas, and considering social components related to the SSI (Presley et al., 2013). Recommended learner experiences include ethic and nature of science considerations associated with the SSI (Presley et al., 2013). These learner experiences do not often occur in conjunction with lecture or direct instruction but are often associated with role play and the Socratic method, which most SBAE teachers in this study indicated they never use.

On the other hand, in line with the SSI-based framework, SBAE teachers in this study indicated they were using media *frequently* (59.5%) or *sometimes* (40.5%) and the majority of teachers agreed their students use technology and analyze scientific data when learning about SSI. However, nearly 40% of the SBAE teachers in this study indicated they never use a textbook and 25% selected neutral when it came to their students analyzing scientific data. Previous research suggests that a neutral selection could be indicative of either the respondent not knowing the answer or selecting the answer they believe to be the social norm for this response (Chyung et al., 2017). It is important to consider several queries that arise from these results. What is the rationale behind SBAE teachers never using textbooks? Perhaps they are outdated, or they are expensive, creating additional barriers to integrating SSI. There are many online resources available to teachers, such as the National Agricultural Literacy Curriculum Matrix and teachers may be using these more current resources instead of textbooks. Knowing the resources that teachers are using in their classes to address SSI would add to the understanding of what teachers are using to integrate SSI. While teachers are using media and technology to integrate SSI, knowing what kinds of media and technology and how they are being used would add to the research related to SBAE and SSI. Additionally, knowing the types of scientific data students are analyzing and what SSI they represent would assist in our understanding of SSI in SBAE courses.

## Research Implications

Emerging issues that are based in science which are impacting society have lasting consequences and need solutions. These SSI are global, regional, and local, having impacts on demands for food, water, and natural resources. Many of these complex issues have direct connections to agriculture. It will take creative ideas from individuals who are agriculturally and scientifically literate to solve these SSI. The SSI-based instruction framework provides a roadmap of sorts to guide educators in the integration of SSI into classroom curriculum. The connections between agriculture and science offer perfect opportunities to incorporate SSI into SBAE curriculum.

This study contributes to the limited number of studies related to SSI and SBAE in many ways. While the previous research exploring SSI and SBAE focused primarily on curriculum and instruction of SSI topics (Cross, 2019; Shoulders 2012), the field of agricultural education must know where SBAE teachers are in terms of their own knowledge and self-efficacy of teaching SSI before teachers can be expected to teach SSI in their classes. Understanding SBAE teachers' knowledge of SSI and their use of instructional strategies and resources to teach these important topics in their classes is essential to furthering the integration of SSI into SBAE curriculum. This research provides a glimpse into what SBAE teachers know about SSI and which SSI topics they are teaching.

This study contributes to the research began by Shoulders (2012) and Cross (2019) into the connections between SSI and SBAE and informs the field of agricultural education as to SBAE teachers' self-efficacy, knowledge, perceived barriers, and teaching strategies and resources used to integrate SSI. More specifically, this research provides a look into the SSI that SBAE teachers are integrating and the methods they are using. This research also contributes to the understanding of SBAE teachers' perceived need to integrate SSI and possible barriers they experience related to SSI integration.

## Limitations

Limitations are present in all research. The limitations for this research were discussed in chapter one but are revisited here.

1. This research focused on SBAE teachers during the 2020-2021 school year and may not be generalizable to teachers in other disciplines, subjects, school years, or grade levels.
2. Although the response rate offers a large enough sample to conduct reliable statistical analysis, it is not large enough to be generalizable to the SBAE teacher population. This research provides important information related to SBAE teachers' self-efficacy, knowledge of, and integration of SSI; however, generalizations across all SBAE teachers and programs is cautioned.
3. While statistical checks were conducted to ensure reliability and validity of the instrument and the data collected, threats to internal validity may appear due to the self-report nature of the survey.

4. The data collected for this research was obtained from an online and paper-pencil survey instrument which may not provide more in-depth information related to teachers' self-efficacy, knowledge, and integration of SSI.
5. This survey research was also conducted during the Covid-19 pandemic which may account for some of the responses as well as the limited participation in the research.
6. An additional limitation of this research stems from the negligible amount of research previously conducted in this area. With limited research connecting SSI and SBAE, much of the literature used to inform this research originated in education content areas outside of SBAE.

## Recommendations

In this section, I will provide recommendations for practice and recommendations for future research for the agricultural education profession. Knowledge from this research can be used to inform pre-service teacher preparation programs as well as in-service professional development.

### Recommendations for Practice

1. Agriculture teacher educators should include the SSI-based instruction framework in pre-service agricultural education courses.
    a. Future agriculture teachers will gain a better understanding of these issues and their impacts on society, agricultural education, and the agriculture

industry. Introducing pre-service agriculture teachers to the SSI topics that are plaguing society, especially those that have connections to agriculture, will enable them to help their future students learn about these issues and how they, as future agriculturists, can have an impact on the solutions to these issues.

   b. Future agriculture teachers will learn the best teaching methodologies to incorporate SSI into their agricultural education classes.
   c. Future agriculture teachers will gain experience developing lessons that integrate global, regional, and local SSI. As pre-service teachers gain more experience with global SSI, they will be able to recognize and integrate local and regional SSI which their students will be able to connect with as well.

2. In-service professional development should be offered to SBAE teachers to inform them of SSI and the SSI-based instructional framework. Learning about SSI will help SBAE teachers provide contextual experiences for their students, enabling students to form their own opinions about these issues and increasing student interest in activism toward SSI.
3. Establishing a common language between educational content areas, including SBAE, would benefit teachers and students.
4. National and state SBAE content standards should be updated to include SSI.
5. Establish materials that are adaptable as agriculture, science, and society change so that teachers have access to the most current resources available.

**Recommendations for Research**

This study explored the knowledge and integration of SSI among SBAE teachers by explaining some of the factors that influence integration of SSI. This research explained teacher self-efficacy as it relates to SSI, SBAE teachers' perceived need to integrate SSI, and barriers to integration of SSI. While there are limitations within this research, it contributes to the limited, but necessary, body of research that currently exists connecting SSI and SBAE. As such, I have the following recommendations for further research:

1. I recommend that future research go beyond this study and explore more deeply the teaching strategies and resources SBAE teachers are using when teaching SSI. More precisely, research should focus on the design elements of the curriculum and the experiences of the learners as they relate to the SSI-based instruction framework. This research would benefit from an observational, qualitative approach to not only identify those strategies and resources being used, but also observe how they are being used in SBAE classrooms.
2. Determining the impacts of including SSI and the SSI-based framework in pre-service agriculture teacher preparation programs as well as in-service professional development.
3. Exploring impacts on the self-efficacy of SBAE teachers related to SSI and their integration into agricultural education curriculum is important to furthering the connection between SSI and SBAE.
4. Given the number of respondents who selected neutral, additional research should be conducted to explore SBAE teachers' confidence and knowledge as it relates to

SSI. If teachers are in fact neutral related to confidence and knowledge, more research should be conducted to explore why teachers would have a neutral opinion in this area.

5. Additional exploration of the barriers experienced by SBAE teachers related to time, knowledge, and other peripheral influences.
6. Research exploring barriers related to SSI, experienced by teachers at different stages in their careers as well as possible barriers influenced by location of the SBAE program. This research would be beneficial to inform teacher preparation programs and professional development opportunities in the areas most needed.
7. Models in this research only explained 34.6% of the of SSI integration. It is unclear what may be accounting for the remainder of the variances. Research exploring additional predictors on SBAE teachers' integration of SSI would benefit agricultural education students and the profession.
8. I also recommend research determining how SBAE teachers are learning about SSI and gain a clearer understanding of what SBAE teachers know about SSI.
9. Research should also be conducted to discover the self-efficacy and knowledge of pre-service agriculture teacher educators related to SSI and the SSI-based instruction framework. Ensuring that teacher educators are positioned to integrate SSI and the SSI-based instruction framework into pre-service agricultural teacher education programs is essential.

This research has explored the connections between SSI and SBAE - more specifically the integration of SSI into SABE curriculum along with SBAE teachers' self-efficacy, knowledge, and perceived barriers. These complex SSI facing society are a priority for many stakeholders in education and in agriculture. Future students, both as SBAE teachers and in other careers, will be instrumental in ensuring that agriculture and education have a seat at the table when it comes to solving these complex issues. Advancing our understanding of SSI and ensuring students are agriculturally and scientifically literate will establish agricultural education's seat at the table when it comes to impacting solutions of important and complex SSI.

**References**

Advisory Group on Citizenship. (1998). *Advisory Group on Citizenship final report: Education for Citizenship and the Teaching of Democracy in Schools*. Qualifications and Curriculum Authority. https://dera.ioe.ac.uk/4385/1/crickreport1998.pdf

Aviles, H. H. (2017). *An examination of Oklahoma agricultural educators' innovativeness and perceptions regarding the mandated adoption and use of the agricultural experience tracker* [Master's thesis, Oklahoma State University]. Oklahoma State University Digital Commons. https://shareok.org/bitstream/handle/11244/54478/Aviles_okstate_0664M_15226.pdf?sequence=1

Bandura, A. (2009). *Self-efficacy in changing societies* (A. Bandura, Ed). Cambridge University Press. (Original work published 1995)

Barrue, C. & Albe, V. (2013). Citizenship education and socioscientific issues: Implicit concept of citizenship in the curriculum, views of French middle school teachers. *Science & Education*, *22*, 1089-1114. https://doi.org/10.1007/s11191-012-9571-4

Bartlett, II, J. E., Kotrlik, J. W., & Higgins, C. C. (2001). Organizational research: Determining appropriate sample size in survey research. *Information Technology, Learning, and Performance Journal*, *19*(1), 43-50. https://www.opalco.com/wp-content/uploads/2014/10/Reading-Sample-Size1.pdf

Bencze, L., Sperling, E., & Carter, L. (2012). Students' research-informed socio-scientific activism: Re/visions for a sustainable future. *Research in Science Education*, *42*, 129-148. http://doi.org/10.1007/s11165-011-9260-3

Borgerding, L. A., & Dagistan, M. (2018). Preservice science teachers' concerns and approaches for teaching socioscientific and controversial issues. Journal of Science Teacher Education, *29*(4), 283-306. https://doi.org/10.1080/1046560X.2018.1440860

Bryan, L. A. (2003). Nestedness of beliefs: Examining a prospective elementary teacher's belief system about science teaching and learning. *Journal of Research in Science Teaching*, *40*(9), 835-868. https://doi.org/10.1002/tea.10113

Bryan, L. A. (2012). Research on science teacher beliefs. In B. J. Fraser et al. (Eds.), *Second International Handbook of Science Education* (pp. 477-495). Springer Science + Business Media. https://doi.org/10.1007/978-1-4020-9041-7_33

CASE Curriculum for Agricultural Science Education. (n.d.a.a). About CASE. CASE Curriculum for Agricultural Science Education. Retrieved March 3, 2021 https://case4learning.org/about-case/curriculum-philosophy/

CASE Curriculum for Agricultural Science Education. (n.d.a.b). About CASE. CASE Curriculum for Agricultural Science Education. Retrieved March 3, 2021 https://www.case4learning.org/curriculum/curriculum-standards-alignment/

Castano, C. (2008). Socio-scientific discussions as a way to improve the comprehension of science and the understanding of the interrelation between species and the environment. *Research in Science Education*, *38*, 565-587. http://doi:10.1007/s11165-007-9064-7

Castleman, B. L., Long, B. T., & Mabel, Z. (2018). Can financial aid help to address the growing need for STEM education? The effects of need-based grants on the completion of science, technology, engineering, and math courses and degrees.

*Journal of Policy Analysis and Management*, *37*(1), 136-166. https://doi.org/10.1002/pam.22039

Cherryholmes, C. H. (1980). Social knowledge and citizenship education: Two views of truth and criticism. *Curriculum Inquiry, 10*(2), 115-141. https://www.jstor.org/stable/1179776

Chiasson, T. C., & Burnett, M. F. (2001). The influence of enrollment in agriscience courses on the science achievement of high school students. *Journal of Agricultural Education*, *42*(1), 61-71. https://doi.org/10.1.1.598.8431

Christenson, N., & Rundgren, S. C. (2015). A framework for teachers assessment of socio-scientific argumentation: An example using the GMO issue. *Journal of Biological Education, 49*(2), 204-212. http://doi:10.1080/00219266.2014.923486

Chowdhury, M. A. (2016). The integration of science-technology-society/science-technology-society-environment and socio-scientific-issues for effective science education and science teaching. *Electronic Journal of Science Education*, *20*(5), 19-38. https://files.eric.ed.gov/fulltext/EJ1188220.pdf

Chyung, S. Y., Roberts, K., Swanson, I., & Hankinson, A. (2017). Evidence-based survey design: The use of a midpoint on the Likert scale. International Society for Performance Improvement, *56*(10), 15-23. https://doi.org/10.1002/pfi.21727

Cochran, W. G. (1977). *Sampling techniques* ($3^{rd}$ ed.). John Wiley & Sons.

Cogan, J. J. (2000). Citizenship education for the $21^{st}$ century: Setting the context. In J. J. Cogan & R. Derricott (Eds.), *Citizenship for the 21$^{st}$ Century an International Perspective on Education* (pp. 1-20). Routledge.

Crookes, G. (1997). What influences what and how second and foreign language teachers teach? *The Modern Language Journal*, *81*, 67-79. https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1540-4781.1997.tb01627.x?casa_token=X9zEx_xJRIIAAAAA:wvuBQKlLTc3LEMlEvbt_d9dk3p38a8GOrKBgbis3NT2uZBUhEw5jHCu2nRdTWFt6FxZx9wcBFD0g1M0

Cross, S. M. (2019). *Exploring the use of socioscientific issues-based curriculum to promote scientific and agricultural literacy* [Doctoral dissertation, The Patton College of Education of Ohio University]. Ohio Digital Commons. https://etd.ohiolink.edu/apexprod/rws_etd/send_file/send?accession=ohiou1562691245953197&disposition=inline

Cross, S. M. & Kahn, S. (2018). Science in the garden: A qualitative analysis of school-based agricultural educators' strategies. *Journal of Agricultural Education, 59*(4), 88-104. http://doi.org/10.5032/jae.2018.04088

Davidson, D. J., & Freudenburg, W. R. (1996). Gender and environmental risk concerns a review and analysis of available research. *Environment and Behavior*, *28*(3), 302-339. https://doi.org/10.1177/0013916596283003

Davis, R. J., & Jayaratne, K. S. U. (2015). In-service training needs of agriculture teachers for preparing them to be effective in the 21st century. *Journal of Agricultural Education, 56*(4), 47-58. http://doi.org.10.5032/jae.2015.04047

Dawson, V. M., & Venville, G. (2008). Teaching strategies for developing students' argumentation skills about socioscientific issues in high school genetics. *Research in Science Education, 40*, 133-148. http://doi.org/10.1007/s11165-008-9104-y

Dillman, D. A. (2007). *Mail and internet surveys the tailored design method* (2nd ed.). John Wiley & Sons, Inc,

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2014). *Internet, phone, mail, and mixed-mode surveys the tailored design method*. John Wiley & Sons, Inc..

Eastwood, J. L., Sadler, T. D., Zeidler, D. L., Lewis, A., Amiri, L., & Applebaum, S. (2012). Contextualizing nature of science instruction in socioscientific issues. *International Journal of Science Education, 34*(15), 2289-2315. https//.doi.org/10.1080/09500693.2012.667582

Eisinga, R., Grotenhuis, M., & Pelzer, B. (2013). The reliability of a two-item scale: Pearson, Cronbach, or Spearman-Brown? *International Journal of Public Health 58*, 637-642. http://doi.org/10.1007//s00038-012-0416-3

Ekborg, M., Ottander, C., Silfver, E., & Simon, S. (2013). Teachers' experience of working with socio-scientific issues: A large scale and in depth study. *Research in Science Education, 43,* 599-617. http://doi.10.1007/s11165-011-9279-5

Evren-Yapıcıoğlu, A. (2018). Advantages and disadvantages of socioscientific issue-based instruction in science classrooms. *International Online Journal of Education and Teaching*, *5*(2), 361-374. http://iojet.org/index.php/IOJET/article/view/327/240

Fan, W., & Yan, Z. (2010). Factors affecting response rates of the web survey: A systematic review. *Computers in Human Behavior*, *26*, 132-139. https://doi.org/10.1016/j.chb.2009.10.015

Feinstein, N. (2011). Salvaging science literacy. *Science Education*, *95*(1), 168-185. https://doi.org/10.1002/sce.20414

Field, A. (2018). *Discovering statistics using IBM SPSS statistics* (North American ed.). Sage Publications.

Fox, M. F., & Firebaugh, G. (1992). Confidence in science: The gender gap*. *Social Science Quarterly, 73*(1), 101-113.

Fleming, R. (1986a). Adolescent reasoning in socio-scientific issues. Part I: Social cognition. *Journal of Research in Science Teaching*, *23*, 677-687. https://onlinelibrary.wiley.com/doi/abs/10.1002/tea.3660230803

Fleming, R. (1986b). Adolescent reasoning in socio-scientific issues. Part II: Nonsocial cognition. *Journal of Research in Science Teaching, 23*, 689-698. https://psycnet.apa.org/doi/10.1002/tea.3660230804

Fraze, S. D., Hardin, K. K., Brashears, M. T., Haygood, J. L., & Smith, J. H. (2003). The effects of delivery mode upon survey response rate and perceived attitudes of Texas agri-science teachers. *Journal of Agricultural Education*, *44*(2), 27-37. https://doi.org/10.5032/JAE.2003.02027

Geiman, A. (2013, March/April). Transitioning to STEM in agriscience. *The Agricultural Education Magazine*, *85*(5), 20-23. https://www.naae.org/profdevelopment/magazine/archive_issues/Volume85/2013_03-04.pdf

Giliberti, M. (2018). *Examining characteristics and barriers on the adoption of school gardens among agricultural education teachers* [Doctoral dissertation, Auburn University]. Auburn University Digital Commons https://etd.auburn.edu/bitstream/handle/10415/6753/ELECTRONIC%20DISSERTATION%20PUBLICATION_(MARCO%20GILIBERTI).pdf?sequence=2

Grace, M. (2006), Teaching citizenship through science: socio-scientific issues as an important component of citizenship. *Prospero*, *12*(3), 42–53. https://eprints.soton.ac.uk/63214/

Gray, S. D., & Bryce, T. (2006). Socio-scientific issues in science education: implications for the professional development of teachers. *Cambridge Journal of Education, 36*(2), 171–192. https://doi.org/10.1080/03057640600718489

Green, S. B. (1991). How many subjects does it take to do a regression analysis? *Multivariate Behavioral Research*, *26*, 499-510. https://doi.org/10.1207/s15327906mbr2603_7

Gunstone, R. (Ed.). (2015). *Encyclopedia of science education*. Springer, Dordrecht.

Harder, A. M. (2007). *Characters and barriers impacting the diffusion of e-extension among Texas cooperative extension county extension agents* [Doctoral dissertation, Texas A & M University]. Texas A & M Digital Commons. https://core.ac.uk/reader/147133100

Harder, A., & Lindner, J. R. (2008). An assessment of county extension agents' adoption of extension. *Journal of Extension, 46*(3). https://archives.joe.org/joe/2008june/rb1.php

Hardin, K. K. (2002). *The effects of delivery mode upon survey response rate and perceived attitudes of Texas agriscience teachers* [Master's thesis, Texas Tech University]. Texas Tech Digital Commons. https://ttu-ir.tdl.org/bitstream/handle/2346/17606/31295017083600.pdf?sequence=1

Harrell, F. E. Jr., Lee, K. L., Califf, R. M., Pryor, D. B., & Rosati, R. A. (1984). Regression modelling strategies for improved prognostic prediction. *Stat Med*. *3*(2), 143–52. https://doi.org/10.1002/sim.4780030207.

Harrell, F. E. Jr., Lee, K. L., & Mark, D. B. (1996). Multivariable prognostic models: issues in developing models, evaluating assumptions and adequacy, and measuring and reducing errors. *Stat Med. 15*(4), 361–87. https://doi.org/10.1002/(sici)1097-0258(19960229)15:4<361::aid-sim168>3.0.co;2-4.

Herman, B. C., Sadler, T. D., Zeidler, D. L., & Newton, M. H. (2018). A socioscientific issues approach to environmental education. In M. P. Mueller & D. J. Tippins (Eds.), *International Perspectives on the Theory and Practice of Environmental Education: A Reader* (Vol. 3, pp. 145-161). Springer.

Hobbs, P. R., & Govaerts, B. (2010). How conservation agriculture can contribute to buffering climate change. In M. P. Reynolds (Ed.), Climate change and crop production (Vol. 13, pp. 177-199). CAB International.

Hodson, D. (2020). Going beyond STS education: Building a curriculum for sociopolitical activism. *Canadian Journal of Mathematics and Technology Education*, *20*, 592-622. https://doi.org/10.1007/s42330-020-00114-6

Hurst, S. D., Roberts, G. T., & Harder, A. (2015). Beliefs and attitudes of secondary agriculture teachers about global agriculture issues. *Journal of Agricultural Education*, *56*(1), 188-202. http://doi.org.10.5032/jae.2015.01188

Johnson, R. B., & Christensen, L. (2017). *Educational Research Quantitative, Qualitative, and Mixed Approaches* (6th ed.). Sage Publications.

Kampourakis, K. (2019). Science, society, and scientific literacy. *Science & Education*, *28*, 603-604. https://doi.org/10.1007/s11191-019-00066-w

Kara, Y. (2012). Pre-service biology teachers' perceptions on the instruction of socio-scientific issues in the curriculum. *European Journal of Teacher Education, 35*(1), 111-129. https://doi.org/10.1080/02619768.2011.633999

Kerr, D. (1999), 'Citizenship education in the curriculum: An international review', *The School Field*, *X* (3/4), 5–32. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.585.2377&rep=rep1&type=pdf

Kim, G., Ko, Y., & Lee, H. (2020). The effects of community-based socioscientific issues program (SSI-COMM) on promoting students' sense of place and character as citizens. *International Journal of Science and Mathematics Education, 18,* 399-418. https://doi.org/10.1007/s10763-019-09976-1

Kinslow, A. T., Sadler, T. D., & Nguyen, H. T. (2019). Socio-scientific reasoning and environmental literacy in a field-based ecology class. Environmental Education Research, *25*(3), 388-410. https://doi.org/10.1080/13504622.2018.1442418

Kline, P. (1999). *The handbook of psychological testing* (2nd ed.). Routledge.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement, 30*, 607-610. https://doi.org/10.1177%2F001316447003000308

Laugksch, R. C. (2000). Scientific literacy: A conceptual overview. *Science Education, 84*(1), 71-94. https://doi.org/10.1002/(SICI)1098-237X(200001)84:1<71::AID-SCE6>3.0.CO;2-c

Lawver, R. G., Foster, D. D., & Smith, A. R. (2018). *Status of the U.S. Supply and Demand for Teachers of Agricultural Education, 2014-2016*. http://aaaeonline.org/Teacher-Supply-and-Demand

Lee, H., Abd-El-Khalick, F., & Choi, K. (2006). Korean science teachers' perceptions of the introduction of socio-scientific issues into the science curriculum. *Canadian Journal of Science Mathematics and Technology Education, 6*(2), 97-117. https://doi.org/10.1080/14926150609556691

Lee, H. & Witz, K. G. (2009). Science teachers' inspiration for teaching socio-scientific issues: Disconnections with reform efforts. *International Journal of Science Education, 31*(7), 931-960. https://doi.org/10.1080/09500690801898903

Lee, H., Yoo, J., Choi, K., Kim, S., Krajcik, J., Herman, B. C., & Zeidler, D. L. (2013). Socioscientific issues as a vehicle for promoting character and values for global citizens. *International Journal of Science Education, 35*(12), 2079-2113. http://doi.org/10.1080/09500693.2012.749546

Leung, J. S. C., Wong, K. L., & Chan, K. K., H. (2020). Pre-service secondary science teachers' beliefs about teaching socio-scientific issues. In M. Evagorou, J. A. Nielsen, & J. Dillon (Eds.), *Science Teacher Education for Responsible Citizenship, Contemporary Trends and Issues in Science Education* (52, pp. 21-39). Springer International. https://doi.org/10.1007978-3-030-40229-7_3.

Li, Y., & Lindner, J. R. (2007). Barriers to diffusion of web-based distance education at China Agricultural University. *Journal of International Agricultural and Extension Education, 14*(1), 45-57. https://doi.org/10.5191/jiaee.2007.14104

Lindner, J. R., Murphy, T. H., & Briers, G. E. (2001). Handling nonresponse in social science research. *Journal of Agricultural Education, 42*(4), 43-53. https://doi.org/10.5032/jae.2001.04043

Lortie, D. C. (2002). *Schoolteacher a sociological study* (2nd ed.). The University of Chicago Press. (Original work published 1975).

Maienschein, J. (1998). Scientific Literacy. *Science*, *281*(5379), 917. https://search.proquest.com/docview/213564006/fulltextPDF/DDA33A188A2146E4PQ/1?accountid=14761

Mansour, N. (2009). Science-technology-society (STS) a new paradigm in science education. *Bulletin of Science Technology & Society*, *29*(4), 287-297. https://doi.org/10.1177/0270467609336307

McCright, A. M. (2010). The effects of gender on climate change knowledge and concern in the American public. *Population and Environment*, 32, 66-87. https://doi.org/10.1007/s11111-010-0113-1

McKeown, R. (2002). *Education for sustainable development toolkit*. http://www.esdtoolkit.org/esd_toolkit_v2.pdf

McKim, A. J. (2016). *Leadership, mathematics, and science integration by secondary agricultural education* [Doctoral dissertation, Oregon State University]. Oregon State Digital Commons. https://ir.library.oregonstate.edu/downloads/ft848t28h

McKim, A. J., Forbush, M. & McKendree, R. B. (2018). Sustainable water management within agriculture, food, and natural resources education. *Journal of Agricultural Education*, *59*(2), 166-178. https://doi.org/10.5032/jae.2018.02166

Miller, L. E., & Smith, K. L. (1983). Handling non-response issues. *Journal of Extension, 21*(5), 45-50.

National Association of Agricultural Educators. (n.d.) *What is Agricultural Education? Agricultural Education in the United States*. Retrieved June 23, 2020, from https://www.naae.org/whatisaged/

National Agriculture in the Classroom. (n.d.). *Agricultural Literacy. What is agricultural literacy*. http://www.agclassroom.org/get/literacy/

National FFA Organization. (n.d.). *FFA Statistics*. National FFA. Retrieved July 8, 2020, from https://www.ffa.org/statistics/

National Forum on Partnerships Supporting Education about the Environment. (1994). Education for sustainability an agenda for action. U.S. Government Printing Office. https://nepis.epa.gov/Exe/ZyPDF.cgi/40000R8Z.PDF?Dockey=40000R8Z.PDF

National Institute of Food and Agriculture. (2019). *Challenge areas*. https://nifa.usda.gov/challenge-areas

National Research Council. (1988). *Understanding Agriculture: New Directions for Education*. Washington, DC

Newton, M. H. (2016). *A longitudinal examination of a SSI-embedded experiential environmental education course and environmental behaviors* [Doctoral dissertation, University of South Florida]. University of South Florida Scholar Commons. https://scholarcommons.usf.edu/etd

Nunnally, J. C. (1978). *Psychometric theory*. McGraw-Hill.

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). McGraw-Hill.

Osborne, J. & Collins, S. (2000). Pupils' and parents' views of the school science curriculum. *School Science Review*, *82*(298), 23-31. https://www.kcl.ac.uk/archive/website-resources/education/web-files2/news-files/ppt.pdf

Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. Review of Educational Research, *62*(3), 307-322. https://doi.org/10.3102.00346543062003307

Pant, K. P. (2009). Effects of agriculture on climate change: A cross country study of the factors affecting carbon emissions. The Journal of Agriculture and Environment, 10, 72-88. https://doi.org/10.3126/aej.v10i0.2134

Patronis, T., Potari, D., & Spiliotopoulou, V. (1999). Students' argumentation in decision-making on a socio-scientific issue: Implications for teaching. *International Journal of Science Education*, *21*(7), 745-754. http://doi.org/10.1080/095006999290408

Pedretti, E., & Nazir, J. (2011). Currents in STSE education: Mapping a complex field, 40 years on. *Science Education*, *95*(4), 601-626. https://doi.org/10.1002/sce.20435

Peduzzi, P., Concato, J., Kemper, E., Holford, T. R., & Feinstein, A. R. (1996). A simulation study of the number of events per variable in logistic regression analysis. *Journal of Clinical Epidemiology*. *49*(12), 1373–1379. https://doi.org/10.1016/s0895-4356(96)00236-3

Pouliot, C. (2008). Students' inventory of social actors concerned by the controversy surrounding cellular telephones: A case study. *Science Education*, *92*, 543-559. http://doi.org/10.1002/sce.20274

Presley, M. L., Sickel, A. J., Muslu, N., Merle-Johnson, D., Witzig, S. B., Izci, K., & Sadler, T.D. (2013). A framework for socio-scientific issues based education. *Science Educator*, *22*(1), 26.32. https://files.eric.ed.gov/fulltext/EJ1062183.pdf

Rapoport, A. (2010). We cannot teach what we don't know: Indiana teachers talk about global citizenship education. *Education, Citizenship and Social Justice*, *5*(3), 179-190. http://doi.org.10.1177/1746197910382256

Ratcliffe, M., & Grace, M. (2003). *Science education for citizenship. Teaching socio-scientific issues*. Maidenhead: Open University Press.

Reiss, M. J. (1999). Teaching ethics in science. Studies in Science Education, 34(1)115-140. https://doi.org/10.1080/03057269908560151

Riggs, I. M. (1991, April 3). *Gender differences in elementary science teacher self-efficacy* [Paper presentation]. Annual Meeting of the American Education Research Association, Chicago, Illinois. https://files.eric.ed.gov/fulltext/ED340705.pdf

Ritchie, S. M., Tomas, L., & Tones, M. (2011). Writing stories to enhance scientific literacy. *International Journal of Science Education*, *33*(5), 685-707. https://doi.org/10.1080/09500691003728039

Rittle, H. W. J., & Webber, M. M. (1973). Dilemmas in a General Theory of Planning. *Policy Sciences*, *4*(2), 155-169. https://www.jstor.org/stable/4531523

Roath, S., & Hay, A. (2016). Self-efficacy: A South African case study on teachers' commitment to integrate climate change resilience into their teaching practices. Cogent Education, *3*, 1-13. https://dx.doi.org/10.1080/2331186X.2016.1264698

Roberts, D. A. (2007). *Scientific literacy/science literacy*. In S. K. Abell & N. G. Lederman (Eds.), Handbook of research in science education (pp. 729 – 779). Routledge.

Roberts, T. G., Harder, A., & Brashears, M. T. (Eds). (2016). *American Association for Agricultural Education National Research Agenda: 2016-2020*. Gainesville, FL: Department of Agricultural Education and Communication. http://aaaeonline.org/resources/Documents/AAAE_National_Research_Agenda_2016-2020.pdf

Robinson, J. S., & Edwards, M. C. (2012). Assessing the teacher self-efficacy of agriculture instructors and their early career employment status: A comparison of certification types. *Journal of Agricultural Education*, *53*(1), 150-161. https://doi.org/10.2053/jae.2012.01150

Sadler, T. D. (2004a). Informal reasoning regarding socioscientific issues: A critical review of research. *Journal of Research in Science Teaching*, *41*(5), 513-536. http://doi.org/10.1002/tea.20009

Sadler, T. D. (2004b). Moral sensitivity and its contribution to the resolution of socio-scientific issues. *Journal of Moral Education*, *33*(3), 339-358. http://doi.org/10.1080/0305724042000733091

Sadler, T. D. (2009). Socioscientific issues in science education: Labels, reasoning, and transfer. *Cultural Studies of Science Education*, *4*, 697-703. http://doi.org/10.1007/s11422-008-9133-x

Sadler, T. D. (Ed.). (2011). *Socio-scientific issues in the classroom teaching, learning and research*. Springer.

Sadler, T. D., Barab, S. A., & Scott, B. (2007). What do students gain by engaging in socioscientific inquiry? *Research in Science Education, 37*, 371-391. http://doi.org/10.1007s11165-006-9030-9

Sadler, T. D., Foulk, J. A., & Friedrichsen, P. J. (2016). Evolution of a model for socio-scientific issue teaching and learning. *International Journal of Education in Mathematics, Science and Technology*, *5*(2), 75-87. https://doi:10.18404/ijemst.55999

Sax, L. J., Gilmartin, S. K., & Bryant, A. N. (2003). Assessing response rates and nonresponse bias in web and paper surveys. *Research in Higher Education*, *44*(4), 409-432. https://link.springer.com/content/pdf/10.1023/A:1024232915870.pdf

Scales, J., Terry, Jr., R., & Torres, R. M. (2006). Are teachers ready to integrate science concepts into secondary agriculture programs? *Journal of Agricultural Education*, *47*(4), 102-113. https://files.eric.ed.gov/fulltext/EJ871933.pdf

Shelly-Tolbert, C. A., Conroy, C. A., & Dailey, A. L. (2000). The move to agriscience and its impact on teacher education in agriculture. *Journal of Agricultural Education*, *41*(4), 51-61. https://doi.org/10.5032/jae.2000.04051

Shih, T. & Fan, X. (2009). Comparing response rates in e-mail and paper surveys: A meta-analysis. *Educational Research Review* 4, 26-40. https://doi.org/10.1016/j.edurev.2008.01.003

Shoulders, C. W. (2012). *The effects of a socioscientific issues instructional model in secondary agricultural education on students' content knowledge, scientific reasoning ability, argumentation skills, and views of the nature of science*

[Doctoral dissertation, University of Florida]. ProQuest. https://https://search.proquest.com/docview/1369845995?pq-origsite=gscholar

Shoulders, C. W., & Myers, B. E. (2013). Socioscientific issues-based instruction: An investigation of agriscience students' content knowledge based on student variables. *Journal of Agricultural Education*, *54*(3), 140-156. http://doi.org/10.5032/jae.2013.03140

Simonneaux, L. & Simonneaux, J. (2009). Students' socio-scientific reasoning on controversies from the viewpoint of education for sustainable development. *Cultural Studies of Science Education*, *4*, 657-687. https://doi.org/10.1007/s11422-008-9141-x

Sitarz, D. (1993). *Agenda 21: The Earth summit strategy to save our planet*. United States. Library of Congress Catalog Card Number 92-074303. https://www.osti.gov/biblio/6289330

Solomon, J. (1993). *Teaching science, technology and society*. Buckingham, UK: Open University Press.

Sorensen, T. J. (2015). *Agriculture teachers' work and family domain characteristics, work-family conflict, and turnover intentions: A National Study [*Doctoral dissertation, Oregon State University]. Oregon State Digital Commons. https://ir.library.oregonstate.edu/downloads/mc87pt79r

Spielmaker, D. M., & Leising, J. G. (2013). *National agricultural literacy outcomes*. Logan, UT: Utah State University, School of Applied Sciences & Technology. http://agclassroom.org/teacher/matrix

Spielmaker, D. M., Pastor, M., & Stewardson, D. M. (2014, May 5-8). A logic model for agricultural literacy programming [Poster Presentation]. Proceedings of the 41st Annual Meeting of the American Association for Agricultural Education, Snowbird, UT. http://www.aaaeonline.org/uploads/allconferences/5-8-2014_148_AAAE_Poster_Proceedings.pdf.

Stevenson, R. B. (2007). Schooling and environmental education: Contradictions in purpose and practice. *Environmental Education Research*, *13*(2), 139-153. https://doi.org/10.1080/13504620701295726

Supovitz, J., Sirinides, P., & May, H. (2010). How principals and peers influence teaching and learning. *Educational Administration Quarterly*, *46*(1), 31-56. https://doi.org/10.1177/1094670509353043

Tal, T. & Kedmi, Y. (2006). Teaching socioscientific issues: Classroom culture and students' performances. Cultural Studies of Science Education, *1*, 615-644. https://doi.org/10.1007/s11422-006-9026-9

The Council A National Partnership for Excellence in Agriculture and Education. (n.d.a.). *Agricultural Education*. Retrieved June 23, 2020, from https://thecouncil.ffa.org/ageducation/

The National Council for Agricultural Education. *Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards*. (2015). https://ffa.app.box.com/s/n6jfkamfof0spttqjvhddzolyevpo3qn/file/294160068843

Thompson, G. W., & Warnick, B. K. (2007). Integrating science into the agricultural education curriculum: Do science and agriculture teachers agree? *Journal of Agricultural Education*, *48*(3), 1-12. https://doi.org/10.5032/jae.2007.03001

United Nations, General Assembly (2015). Resolution adopted by the general assembly on 25 September 2015. *Transforming our world: the 2030 agenda for sustainable development*. https://www.unfpa.org/sites/default/files/resource-pdf/Resolution_A_RES_70_1_EN.pdf

United Nations, Department of Economic and Social Affairs. Population Division (2019). *World Population Prospects 2019: Highlights*. https://population.un.org/wpp/Publications/Files/WPP2019_10KeyFindings.pdf

U.S. Congress Joint Economic Committee. (2012). *STEM education: Preparing for the jobs of the future*. https://www.jec.senate.gov/public/index.cfm/democrats/2012/4/stem-education-preparing-jobs-of-the-future

Vallera, F. L. & Bodzin, A. M. (2016). Knowledge, skills, or attitudes/beliefs: The contexts of agricultural literacy in upper-elementary science curricula. *Journal of Agricultural Education, 57*(4), 101-117. https://doi.org/10.5032/jae.2016.04101

Van Rooy, W. & Moore, L. (2012). Using media in the classroom: Learning and teaching about the 2011 Japanese earthquake, tsunami and nuclear events from a socio-scientific and science literacy perspective. *Teaching Science: The Journal of the Australian Science Teachers Association, 58*(3), 46-52.

Vaske, J. J. (2008). *Survey research and analysis: Applications in parks, recreation, and human dimensions.* Venture Publishing, Inc.

Walker, K. A., & Zeidler, D. L. (2007). Promoting discourse about socioscientific issues through scaffolded inquiry. *International Journal of Science Education, 29*(11), 1387-1410. https://doi.org/10.1080/09500690601068095

Wang, H., & Cheng, L. (2009). Factors affecting teachers' curriculum implementation. *The Linguistics Journal*. *4*(2), 135-166.

Warnick, B. K., Thompson, G. W., & Gummer, E. S. (2004). Perceptions of science teachers regarding the integration of science into the agricultural education curriculum. *Journal of Agricultural Education, 45*(1), 62-73. http://doi.org/10.5032/jae.2004.01062

Weeks, K. J. (2019). *Twenty-first century skills: A needs assessment of school-based agricultural education teachers* [Master's thesis, Utah State University]. Utah State University Digital Commons. https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=8652&context=etd

Wilcox, A. K., Shoulders, C. W., & Myers, B. E. (2014). Encouraging teacher change within the realities of school-based agricultural education: Lessons from teachers' initial use of socioscientific issues-based instruction. *Journal of Agricultural Education*, 55(5), 16-29. https://doi.org/10.5032/jae.2014.05016

Williams, D. L., & Dollisso, A. D. (1998). Rationale for research on including sustainable agriculture in the high school agricultural education curriculum. Journal of Agricultural Education, 39(3), 51-56. https://doi.org/10.5032/jae.1998.03051

Zeidler, D. L. (2014). Socioscientific issues as a curriculum emphasis: Theory, research and practice. S. K. Abell, & N. G. Lederman (Eds.), *Handbook of research on Science Education* (pp. 697–726). Routledge.

Zeidler, D. L., & Kahn, S. (2014). *It's debatable! Using socioscientific issues to develop scientific literacy K-12*. National Science Teachers Association Press.

Zeidler, D. L., & Keefer, M. (2003). The role of moral reasoning and the status of socioscientific issues in science education: Philosophical, psychological and pedagogical considerations. In D. L. Zeidler (Ed.) *The role of moral reasoning on socioscientific issues and discourse in science education*. (pp. 7-38). The Netherlands: Kluwer Academic Publishers.

Zeidler, D. L., Walker, K. A., Ackett, W. A., & Simmons, M. L. (2002). Tangled up in views: Beliefs in the nature of science and responses to socioscientific dilemmas. Science Education, *86*(3), 343-367. https://doi.org/10.1002/sce.10025

Zeidler, D. L., & Nichols, B. H. (2009). Socioscientific issues: Theory and practice. *Journal of Elementary Science Education*, *21*(2), 49-58. https://link.springer.com/content/pdf/10.1007/BF03173684.pdf

Zeidler, D. L., Sadler, T., Simmons, M., & Howes, E. (2005). Beyond STS. A research based framework for socio-scientific issues education. *Science Education*, *89*(3), 357–377. https://doi.org/ 10.1002/sce.20048

Zeidler, D. L., & Schafer, L. E. (1984). Identifying mediating factors of moral reasoning in science education. *Journal of Research in Science Teaching*, *21*(1), 1-15. https://doi.org/10.1002/tea.3660210102

# APPENDICES

**Appendix A**

Institutional Review Board

Exemption #2
**Certificate of Exemption**

From: Melanie Domenech Rodriguez, IRB Chair

Nicole Vouvalis, IRB Director

To: ***Tyson Sorensen***

Date: ***October 26, 2020***

Protocol #: ***11483***

Title: **Socioscientific Issues in Agricultural Education**

The Institutional Review Board has determined that the above-referenced study is exempt from review under federal guidelines 45 CFR Part 46.104(d) category #2:

> *Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met: (i) The information obtained is recorded in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subject; (ii) Any disclosure of the responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation, or (iii) the information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and the IRB conducts a limited IRB review to make required determinations.*

This study is subject to ongoing COVID-19 related restrictions. As of March 15, 2020, the IRB has temporarily paused all in person research activities, including but not limited to recruitment, informed consent, data collection and data analysis that involves personal interaction (such as member checking and meaning-making). If research cannot be paused, please file an amendment to your protocol modifying procedures that are conducted in person. The IRB will notify you when in person research activities are once again permitted.

This exemption is valid for five years from the date of this correspondence, after which the study will be closed. If the research will extend beyond five years, it is your responsibility as the Principal Investigator to notify the IRB **before** the study's expiration date and submit a new application to continue the research. Research activities that continue beyond the expiration date without new certification of exempt status will be in violation of those federal guidelines which permit the exempt status.

If this project involves Non-USU personnel, they may not begin work on it (regardless of the approval status at USU) until a Reliance Agreement, External Research Agreement, or separate protocol review has been completed with the appropriate external entity. Many schools will not engage in a Reliance Agreement for Exempt protocols, so the research team must determine what the appropriate approval mechanism is for their Non-USU colleagues. As part of the IRB's quality assurance procedures, this research may be randomly selected for audit during the five-year period of exemption. If so, you will receive a request for completion of an Audit Report form during the month of the anniversary date of this certification.

In all cases, it is your responsibility to notify the IRB **prior** to making any changes to the study by submitting an Amendment request. This will document whether or not the study still meets the requirements for exempt status under federal regulations.

Upon receipt of this memo, you may begin your research. If you have questions, please call the IRB office at (435) 797-1821 or email to irb@usu.edu.

The IRB wishes you success with your research.

435.797.1821 | 1450 Old Main Hill | Logan, UT 84322 | MAIN 155 | irb@usu.edu | FWA#00003308

## Appendix B

Letter of Information and Informed Consent

**Socioscientific Issues in Agricultural Education**

You are invited to participate in a research study by Dr. Tyson J. Sorensen, an Assistant Professor and Michelle Burrows, a Graduate Student in Applied Sciences, Technology & Education, at Utah State University.

The purpose of this research is to explore how agricultural education teachers use socioscientific issues in their curriculum. Specifically, we are interested in learning about why, how and which issues are utilized in agriculture classes. You are being asked to participate in this research because as an agricultural education teacher, you can provide valuable insight into how students are trained to address some of today's complex challenges in agriculture.

Your participation in this study is voluntary and you may withdraw your participation at any time for any reason.

If you take part in this study, you will be asked to complete one survey that will take approximately 10 minutes. There is no cost to you except your time. You may answer some or none of the questions.

This is a minimal risk research study. That means that the risks of participating are no more likely or serious than those you encounter in everyday activities. The foreseeable risks include the potential for the loss of confidentiality. However, confidentiality will be kept to the extent permitted by the technology being used. Although every precaution will be taken to ensure confidentiality, the security of information collected from you online cannot be guaranteed. Information collected online can be intercepted, corrupted, lost, destroyed, arrive late or incomplete, or contain viruses. In order to minimize those risks and discomforts, the researchers will securely store data collected in a restricted-access folder on Box.com.

**We will make every effort to ensure that the information you provide remains confidential**. We will not reveal your identity in any publications, presentations, or reports resulting from this research study.

**We will collect your information through** the survey. Online activities always carry a risk of a data breach, but we will use systems and processes that minimize breach opportunities. This survey data will be securely stored in a restricted-access folder on Box.com. Identifiable information, such as name, email and school address will only be retained to ensure reminders are only sent to those who have not completed the survey. All identifiers will be destroyed as soon as all data has been compiled in the electronic analysis program and quality confirmation is complete. It is anticipated that this process will take less than one year. As part of this survey, you will be asked if you are interested in being a part of potential follow up research. If you indicate you are interested, your contact information will be retained for future contact to take part in that research.

**While you will not be compensated for your participation in this research study, your responses will greatly contribute** to the field of agricultural education and our understanding of teaching and learning through the use of socioscientific issues. This research is important to teachers and students in agricultural education and their contribution to solving today's complex and challenging problems.

You can decline to participate in any part of this study for any reason and can end your participation at any time.

If you have any questions about this study, you can contact Michelle Burrows at ***michelle.burrows@aggiemail.usu.edu***. Thank you again for your time and consideration. If you have any concerns about this study, please contact Utah State University's Human Research Protection Office at (435) 797-0567 or ***irb@usu.edu*** and reference IRB Protocol #11483.

**By signing below and continuing to the survey, you agree that you are 18 years of age or older and wish to participate.** You agree that you understand the risks and benefits of participation, and that you know what you are being asked to do. You also agree that if you have contacted the research team with any questions about your participation and are clear on how to stop your participation in this study if you choose to do so. Please be sure to retain a copy of this form for your records.

## Appendix C

Letter of Information and Informed Consent

**Socioscientific Issues in Agricultural Education**

You are invited to participate in a research study by Dr. Tyson J. Sorensen, an Assistant Professor and Michelle Burrows, a Graduate Student in Applied Sciences, Technology & Education, at Utah State University.

The purpose of this research is to explore how agricultural education teachers use socioscientific issues in their curriculum. Specifically, we are interested in learning about why, how and which issues are utilized in agriculture classes. You are being asked to participate in this research because as an agricultural education teacher, you can provide valuable insight into how students are trained to address some of today's complex challenges in agriculture.

Your participation in this study is voluntary and you may withdraw your participation at any time for any reason.

If you take part in this study, you will be asked to complete one survey that will take approximately 10 minutes. There is no cost to you except your time. You may answer some or none of the questions.

This is a minimal risk research study. That means that the risks of participating are no more likely or serious than those you encounter in everyday activities. The foreseeable risks include the potential for the loss of confidentiality. However, confidentiality will be kept to the extent permitted by the technology being used. In order to minimize those risks and discomforts, the researchers will securely store data collected in a restricted-access folder on Box.com.

**We will make every effort to ensure that the information you provide remains confidential**. We will not reveal your identity in any publications, presentations, or reports resulting from this research study.

**We will collect your information through** the survey. Identifiable information, such as name, email and school address will only be retained to ensure reminders are only sent to those who have not completed the survey. This survey data will be securely stored in a restricted-access folder on Box.com and completed paper surveys will be stored in a locked cabinet in the researcher's office during data entry. All identifiers will be destroyed as soon as all data has been compiled in the electronic analysis program and quality confirmation is complete. As part of this survey, you will be asked if you are interested in being a part of potential follow up research. If you indicate you are interested, your contact information will be retained for future contact to take part in that research.

**While you will not be compensated for your participation in this research study, your responses will greatly contribute** to the field of agricultural education and our understanding of teaching and learning through the use of socioscientific issues. This research is important to teachers and students in agricultural education and their contribution to solving today's complex and challenging problems.

You can decline to participate in any part of this study for any reason and can end your participation at any time.

If you have any questions about this study, you can contact Michelle Burrows at ***michelle.burrows@aggiemail.usu.edu***. Thank you again for your time and consideration. If you have any concerns about this study, please contact Utah State University's Human Research Protection Office at (435) 797-0567 or ***irb@usu.edu and reference IRB Protocol #11483***.

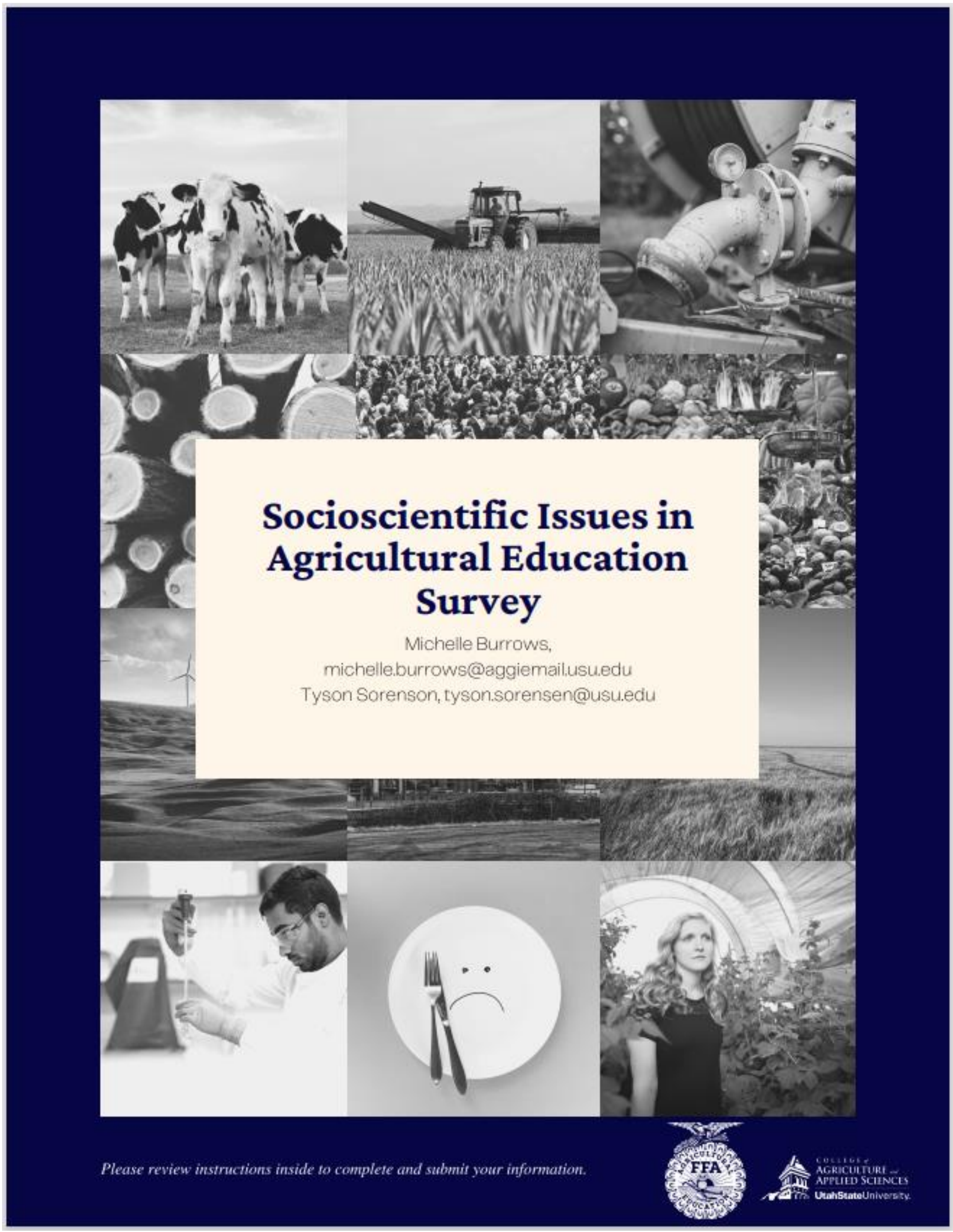
**By signing below and completing the survey, you agree that you are 18 years of age or older and wish to participate.** You agree that you understand the risks and benefits of participation, and that you know what you will be asked to do. You also agree that you have asked any questions you might have and are clear on how to stop your participation in the study if you choose to do so. Please be sure to retain a copy of this form for your records and return this original consent form in the self-addressed stamped envelope along with your completed survey.

Signature: ___________________________________

Print Name: __________________________________________

Date: ____________________________

**Appendix D**


Socioscientific Issues in Agricultural Education Survey
Michelle Burrows,
michelle.burrows@aggiemail.usu.edu
Tyson Sorenson, tyson.sorensen@usu.edu
Please review instructions inside to complete and submit your information.
FFA
AGRICULTURE
APPLIED SCIENCES
UtahStateUniversity

# Socioscientific Issues in Agricultural Education Survey

**Overview**

- Included with this survey is the letter of information that includes detailed information about this research study.
- Also included in this mailing is a self-addressed stamped envelope. When you complete the survey, please return it using the envelope provided. You only need to return the survey (pages 2-7).
- Your responses are extremely valuable to your profession and your fellow agriculture teachers across the nation. Please complete each question as accurately as possible.

**Thank you for taking the time to complete this survey.**

**Overview**

This survey will explore inclusion of socioscientific issues in the agriculture education curriculum you teach. Here is a definition:

> **Socioscientific issues** – any global, regional, or local issues that are based in science and also impact society (e.g. food security, water access and use, climate change, and natural resource use).

***Note:*** below are some examples that may help you when thinking about your curriculum and the issues you teach.

- **Climate issues** may relate to global warming, climate change, greenhouse gasses, etc.
- **Energy issues** may relate to alternative & traditional energy such as coal, natural gas, hydroelectric, solar, fracking, wind, etc.
- **Food security issues** may relate to food insecurity, starvation, food distribution, local food movements, etc.
- **Genetic engineering issues** may relate to GMOs, food labeling, CRISPR, other biotechnology issues, etc.
- **Human population issues** may relate to population growth and impacts.
- **Natural resource issues** may relate to management, multiple-use, public grazing, etc.

- **Sustainability issues** may relate to sustainable agriculture, food production, and natural resource practices.
- **Water issues** may relate to clean water access, pollution, conservation, use, etc.

## SECTION I: Teaching Information

1. Within the past 12 months, were you a teacher who taught at least one approved agriculture course?

   - ❑ Yes
   - ❑ No

2. Indicate which of the following Agriculture, Food, and Natural Resource (AFNR) career pathway areas you have taught courses in, within the past 12 months. (Please select all that apply)

   - ❑ Agribusiness Systems
   - ❑ Animal Systems
   - ❑ Biotechnology Systems
   - ❑ Environmental Service Systems
   - ❑ Food Products & Processing Systems
   - ❑ Natural Resource Systems
   - ❑ Plant Systems
   - ❑ Power, Structural and Technical Systems
   - ❑ I don’t know (list classes below)

## SECTION II: Socioscientific Issues in the Classroom

3. When reflecting on the agriculture classes you teach, please identify the socioscientific issues you teach. (Select all that apply)

   - ❑ Climate Issues
   - ❑ Ecosystem & Biodiversity Issues
   - ❑ Energy Issues
   - ❑ Food Security Issues
   - ❑ Genetic Engineering Issues
   - ❑ Human Population Issues
   - ❑ Natural Resource Issues
   - ❑ Sustainability Issues
   - ❑ Water Issues
   - ❑ I do not teach any socioscientific issues

4. Please select the frequency in which you use specific teaching strategies to teach socioscientific issues in your classes.

5. *When teaching socioscientific issues in my classes, I use the following teaching strategies...*

| | Frequently | Sometimes | Never |
|---|---|---|---|
| **Debate** | F | S | N |
| **Discussion** | F | S | N |
| **Group Work** | F | S | N |
| **Individual Work** | F | S | N |
| **Lecture/Direct Instruction** | F | S | N |
| **Socratic Method** | F | S | N |
| **Role Play** | F | S | N |

Please specify the other teaching strategies you use and write F for those strategies you use frequently and S for those strategies you use sometimes next to the strategy.

6. Please select the frequency in which you use specific sources when teaching socioscientific issues in your classes.

   *When teaching socioscientific issues in my classes, I use the following sources...*

| | Frequently | Sometimes | Never |
|---|---|---|---|
| Internet | F | S | N |
| Media | F | S | N |
| Textbooks | F | S | N |
| Other printed sources besides textbooks | F | S | N |

| | | | |
|---|---|---|---|
| Resources outside school (guest speakers, etc.) | F | S | N |

Please specify the other sources you use and write F for those strategies you use frequently and S for those strategies you use sometimes next to the source.

7. Please indicate your level of agreement with the following statements.

   *When learning about socioscientific issues, my students...*

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| use technology | 1 | 2 | 3 | 4 | 5 |
| analyze scientific data | 1 | 2 | 3 | 4 | 5 |

**1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree**

8. Please indicate your level of agreement with the following statements.

   *I incorporate socioscientific issues into...*

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| FFA Career Development Events | 1 | 2 | 3 | 4 | 5 |
| FFA Leadership Development Events | 1 | 2 | 3 | 4 | 5 |
| Supervised Agriculture Experiences | 1 | 2 | 3 | 4 | 5 |

**1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree**

9. The following statements relate to your **understanding of socioscientific issues**, your **ability to teach** them, and the **need for socioscientific issues** in agricultural education.

   Please indicate your level of agreement with the following statements.

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| I am able to use various teaching strategies to address socioscientific issues in agricultural education classes. | 1 | 2 | 3 | 4 | 5 |
| I sufficiently understand what socioscientific issues in agriculture are. | 1 | 2 | 3 | 4 | 5 |
| I have confidence in developing teaching and learning materials about socioscientific issues. | 1 | 2 | 3 | 4 | 5 |
| I have the knowledge necessary to effectively teach about socioscientific issues to my agricultural education students. | 1 | 2 | 3 | 4 | 5 |
| I think it is more appropriate to teach socioscientific issues in classes other than those in agriculture. | 1 | 2 | 3 | 4 | 5 |
| Introducing socioscientific issues into agricultural education classes is definitely necessary. | 1 | 2 | 3 | 4 | 5 |
| The inadequacy of students' background regarding socioscientific issues needs to be addressed. | 1 | 2 | 3 | 4 | 5 |
| Introducing socioscientific issues into agricultural education classes will increase students' interest in these issues. | 1 | 2 | 3 | 4 | 5 |
| Students need to be concerned with socioscientific issues related to agricultural science. | 1 | 2 | 3 | 4 | 5 |
| Students need to enhance their ability to decide their own positions about socioscientific issues in agricultural education classes. | 1 | 2 | 3 | 4 | 5 |

**1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree**

10. The following statements address **barriers to teaching socioscientific issues** in agriculture science classes.
    Please indicate your level of agreement with the following statements.

    *A **barrier to teaching** socioscientific issues in my classes is...*

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Lack of time to integrate | 1 | 2 | 3 | 4 | 5 |
| Lack of time to prepare curriculum | 1 | 2 | 3 | 4 | 5 |
| Lack of science content knowledge of socioscientific issues | 1 | 2 | 3 | 4 | 5 |
| Lack of knowledge about the social considerations in socioscientific issues | 1 | 2 | 3 | 4 | 5 |
| Teaching about socioscientific issues are NOT appropriate in an agricultural education class. | 1 | 2 | 3 | 4 | 5 |
| Teaching socioscientific issues is supported by my administration. | 1 | 2 | 3 | 4 | 5 |
| Teaching socioscientific issues is supported by the community. | 1 | 2 | 3 | 4 | 5 |

**1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree**

11. Before this survey, I had heard the term socioscientific issues

    - ❑ Yes
    - ❑ No

## SECTION III: Demographic Information

12. Including this year, please indicate the number of years you have been teaching agricultural education classes.

    __________ years

13. Please indicate the state you currently teach in. ________________________

14. Please indicate the gender you identify with. ___________________________

15. Please identify the political ideology you most closely identify with.

- ❑ Conservative
- ❑ Moderate
- ❑ Liberal
- ❑ I prefer not to answer

16. Please indicate the type of teaching credential you have.

- ❑ Traditional
- ❑ Alternative

17. Do you currently have a science endorsement or certification?

- ❑ Yes
- ❑ No

18. Do your students receive science credit for any of their agricultural education courses?

- ❑ Yes
- ❑ No

19. We know that agricultural education teachers are very busy, and we appreciate your time in taking this survey. Please tell us what led you to participate in this survey.

20. Would you be interested in participating in potential follow up research? If so, please include your preferred contact information here.

# Thank you!!

Please use the self-addressed stamped envelope to return the signed informed consent page and the completed survey (pages 2-7).

**Appendix E**

Email Notice to Participants

Subject: We need your help! Agricultural Education Survey

Dear {Name},

The field of agriculture needs your help! Agriculture is facing some complex challenges and your students will be instrumental in addressing some of these important issues in agriculture and society. With the support of the National FFA Organization, who provided your contact information to us, you have been selected among agriculture teachers across the United States. You are invited to participate in a very important survey about why and how agriculture teachers are using complex issues in their agriculture classes. You can also provide important information as to which socioscientific issues are being addressed in agriculture classes. We need your help to gather this information. By participating, you will help us understand more about how these issues fit into agricultural education and the contribution its students will make in solving many of today's complex problems.

**Below you will find a link to the Socioscientific Issues in Agricultural Education Survey.**
Link here…

The 10-minute survey asks about the socioscientific issues you address in your classes and how you use them. The results of this survey will be extremely useful for stakeholders in agricultural education, including teachers and teacher educators, and can help guide improvements in teacher preparation programs and professional development programs.

In light of the current conditions in education due to COVID-19, we understand that you may be inundated with online teaching and may prefer a different method to complete the survey. If you would prefer a paper version of the survey, please email me (Michelle Burrows) with your physical address and I will send you a paper survey with a self-addressed stamped envelope to return the completed survey.

If you have any questions about the survey or the research, please feel free to contact Michelle Burrows (michelle.burrows@aggiemail.usu.edu) and reference USU IRB Protocol #11483. Thank you in advance for your willingness to help impact teaching and learning in agricultural education.

Sincerely,

**Michelle Burrows**
Graduate Student
Utah State University

**Tyson J. Sorensen, PhD**
Assistant Professor
Utah State University

**Appendix F**

1st Follow-up Email (Second Contact)

Subject: Reminder, Complete the Agricultural Education Survey

Dear {Name},

I am reaching out to enlist your help. A week ago I sent you an email with a link to a very important survey about the use of socioscientific issues in agricultural education. Your responses will be instrumental in our understanding of these issues and how they fit into agricultural education.

As an agriculture teacher myself, I understand that you are very busy and if you haven't had a chance to complete the survey, there is still time. If you've already started it, you can still complete it. The average completion time for those who have responded is 7-8 minutes. (addition to paper version recipients - If you've completed the paper survey and it's in the mail, thank you, and please disregard this reminder.) Remember if you'd prefer to complete a paper version of the survey you may request one by emailing me your physical address and I will send you one with a self-addressed stamped envelope.

Just follow the link below and complete the survey. For your convenience, here is the link to access the survey:  Link here…

Your answers are instrumental in helping us understand how teachers are preparing today's agriculture students to solve the big problems facing agriculture and society. If you have any questions about the survey or the research, please reach out to me at michelle.burrows@aggiemail.usu.edu and reference USU IRB Protocol #11483.

I appreciate your time and your honest responses.

Sincerely,

**Michelle Burrows**
Graduate Student
Utah State University

**Tyson J. Sorensen, PhD**
Assistant Professor
Utah State University

**Appendix G**

2nd email reminder (last contact)

Subject: Last chance to provide your input!

Dear {Name},

I am reaching out to you one last time to encourage you to complete the Socioscientific Issues Survey. If you haven't had a chance to take the survey, there is still time. Please take 7-8 minutes and follow the link below to complete the survey online. Your answers are very important to our understanding of how agriculture teachers are using these complex issues in their classes.

For your convenience, here is the link to access the survey:  Link here…

If you would prefer to take the survey using a paper version, just email me at michelle.burrows@aggiemail.usu.edu, with your physical address and I will send you one with a self-addressed stamped envelope. I greatly appreciate your time and look forward to learning more about how agricultural education is preparing students to solve important issues.

Sincerely,

**Michelle Burrows**
Graduate Student
Utah State University

**Tyson J. Sorensen, PhD**
Assistant Professor
Utah State University

**Appendix H**

Final email reminder and thank you –

Dear ${m://FirstName},

I am reaching out to you one last time to encourage you to complete the Socioscientific Issues Survey. If you haven't had a chance to take the survey, there is still time. Please take 7-8 minutes and follow the link below to complete the survey online. Your answers are very important to our understanding of how agriculture teachers are using these complex issues in their classes.

For your convenience, here is the link to access the survey:

**Follow this link to the Survey:**
${l://SurveyLink?d=Take the Survey}

Or copy and paste the URL below into your internet browser:
${l://SurveyURL}

If you would prefer to take the survey using a paper version, just email me at michelle.burrows@aggiemail.usu.edu, with your physical address and I will send you one with a self-addressed stamped envelope. I greatly appreciate your time and look forward to learning more about how agricultural education is preparing students to solve important issues. Have a wonderful holiday and break.

Sincerely,

**Michelle Burrows**
Graduate Student
Utah State University

**Tyson J. Sorensen, PhD**
Assistant Professor
Utah State University

**Appendix I**

1st email to paper survey recipients –

Subject: We need your help! Agricultural Education Survey

Dear {Name},

The field of agriculture needs your help! Agriculture is facing some complex challenges and your students will be instrumental in addressing some of these important issues in agriculture and society. **In the coming days, you will be receiving a 10-minute paper survey in your school mail.** With the support of the National FFA Organization, you have been selected to participate in this important research about why and how agriculture teachers are using complex issues in their agriculture classes.

Your responses will help us understand more about how these issues fit into agricultural education and the contribution its students will make in solving many of today's complex problems.

Please look for the survey and more information in your school mail. In the meantime, if you have any questions about the upcoming survey or the research, please contact Michelle Burrows at michelle.burrows@aggiemail.usu.edu and reference USU IRB Protocol #11483.

We thank you in advance for your time and look forward to learning more about how agriculture teachers are preparing students to solve important issues.

Sincerely,

**Michelle Burrows**
Graduate Student
Utah State University

**Tyson J. Sorensen, PhD**
Assistant Professor
Utah State University

.

**Appendix J**

Letter included with paper survey. Paper survey participants will receive email reminders with everyone else.

Dear {Name},

The field of agriculture needs your help! Agriculture is facing some complex challenges and your students will be instrumental in addressing some of these important issues in agriculture and society. With the support of the National FFA Organization, who provided your contact information to us, you have been selected among agriculture teachers across the United States. You are invited to participate in a very important survey about why and how agriculture teachers are using complex issues in their agriculture classes. You can also provide important information as to which socioscientific issues are being addressed in agriculture classes. We need your help to gather this information. By participating, you will help us understand more about how these issues fit into agricultural education and the contribution its students will make in solving many of today's complex problems.

Enclosed you will find a paper version of this survey that will take about 10 minutes of your time and will ask about the socioscientific issues you address in your classes and how you use them. Simply complete the survey and return it to me in the self-addressed stamped envelope included with the survey.

The results of this survey will be extremely useful for stakeholders in agricultural education, including teachers and teacher educators, and can help guide improvements in teacher preparation programs and professional development programs.

If you would prefer to take this survey online, you can request a link to the survey by emailing Michelle Burrows (michelle.burrows@aggiemail.usu.edu).

If you have any questions about the survey or the research, please feel free to contact Michelle Burrows (michelle.burrows@aggiemail.usu.edu) and reference USU IRB Protocol #11483. Thank you in advance for your willingness to help impact teaching and learning in agricultural education.

Sincerely,

**Michelle Burrows**
Graduate Student
Utah State University

**Tyson J. Sorensen, PhD**
Assistant Professor
Utah State University

**Curriculum Vitae**

**Michelle Burrows**
College of Agriculture and Applied Sciences
Applied Sciences, Technology & Education
Utah State University
2300 Old Main Hill
Logan, UT 84322
(775) 772-4467 – Cell
burrowsm79@gmail.com

## EDUCATION

**Doctor of Philosophy (ABD)** (Expected Completion May 2021) Utah State University

- Career and Technical Education with Emphasis in Agricultural Education and Curriculum & Instruction
- Dissertation: Socioscientific Issues in Agricultural Education: How School Based Agricultural Education is Addressing the Complex Global Challenges of Today and Tomorrow
- Advisor: Dr. Tyson J. Sorensen

**Master of Science** (2010) University of Nevada, Reno

- Animal Science with Emphasis on agriculture literacy and education
- Thesis title: Assessing the Interest and Feasibility of Incorporating Agriculture into Washoe County Elementary Curriculum
- Advisor: Dr. Dale Holcombe

**Bachelor of Science** (2007) University of Nevada, Reno

- Animal Science/Rangeland Livestock Production

## PROFESSIONAL EXPERIENCE

**Graduate Research Teaching Assistant | Utah State University, Logan, Utah,** June 2018 – Present

- Presidential Doctoral Research Fellow
- Instructor of record
    - Integrated Life Science (USU 1350-LB1, USU 1350-001, USU 1350-002)
    - Managing FFA & SAE (ASTE 3620-001)
- Co-Instructor
    - Student Teaching Seminar (ASTE 5500)
    - Teaching Methods (ASTE 4150/TEE 4400)
- Teaching assistant:
    - Managing FFA & SAE (ASTE 3620-001)
    - Teaching Methods (ASTE 4150/TEE4400)

- Orientation to Agricultural Education (ASTE 2710)

**Agriculture, Natural Resources & Animal Science Teacher and FFA Advisor | Academy of Arts, Careers & Technology, Reno, Nevada,** August 2011- June 2018

Duties:

Maintain and expand existing agriculture program and FFA Chapter, help prepare students for FFA leadership experiences and contests related to curriculum content areas and student interests, assist students with Supervised Agriculture Experiences along with maintaining records in The AET.

- Teach classes which include the following content areas:
  - Horticulture and greenhouse management
  - Animal Science/Veterinary Science
  - Natural Resources & Wildlife Management
  - Floriculture
  - Agriculture Leadership, Communication & Policy
  - Agriculture Science I & II

- Washoe County School District Principle's Leadership Committee
- Nevada Agriculture Teachers Association President
- National FFA Teacher Ambassador
- Co-Advisor – Academy of Arts, Careers & Technology chapter of National Technical Honor Society
- President Elect of Nevada Agriculture Teachers Association
- DuPont Agriscience Teacher Ambassador
- Member of the Nevada State Standards writing team for Veterinary Science, Natural Resources & Wildlife Management, Floriculture, Agriculture Leadership, Communication & Policy
- Member of Nevada Association of Career & Technical Education
- Member of National Association of Agriculture Educators
- FFA Chapter accomplishments
  - 4 FFA American Degree recipients, more than 20 FFA State Degree recipients, 3 Nevada FFA State Officers, 2016 National NRCS Earth Team Partnership Award
  - National FFA Convention CDE teams:
    - Agriscience Fair (silver)
    - Environmental & Natural Resources (silver)
    - Veterinary Science (gold)
    - Agriculture Sales (silver)
    - Prepared Public Speaking (silver)
    - National FFA Scholarship recipient
    - National FFA SAE Grant Award (x2)
    - Western National Rangeland CDE (top 10)
  - Nevada State CDE teams:
    - Agrisicence Fair (gold, silver)
    - Environmental & Natural Resources (gold, silver x 2)

- Veterinary Science (gold, silver)
- Floriculture (silver, bronze)
- Agriculture Sales (gold, silver)
- Agriculture Issues (silver x 2)
- Proficiency – Poultry (gold)
- Nursery & Landscape (silver x 2, bronze)
- Horse Judging (silver x 2, bronze)
- Meat Science Technology (top 5)
- Nevada State FFA Scholarship (x2)
- Rangeland Management CDE (gold, silver, bronze, top five x2)
- Livestock Judging
- Extemporaneous Speaking
- Parliamentary Procedures
- Conduct of Chapter Meeting (bronze)
- Milk Quality & Products
- Poultry

- National FFA Food for All Grant
- Establishment of Academy of Arts Careers & Technology Urban Farm

**Agriculture Literacy Internship Coordinator/Research Assistant | University of Nevada, Reno Department of Animal Biotechnology,** May 2010 – December 2011

Duties:

Prepare and facilitate Agriculture Literacy Internship which includes, preparation of curriculum, contact and schedule participating elementary schools, contact and schedule guest lecturers and experts, teach internship course, collect, compile and analyze research data, assist, train and mentor graduate student

Assist with care for an approximate 50 head flock of sheep that are used for breeding and teaching purposes.

Provide direct animal care such as: feeding, animal care and treatment of minor injuries, maintain an effective breeding program, care during lambing, administration of prescribed medications and vaccinations when needed, maintain all animal records

**Graduate Assistant | University of Nevada, Reno Department of Animal Biotechnology** September 2007 – May 2010

Duties:

Maintain class student records and grades, grade assignments, quizzes and exams, provide additional assistance or tutoring for students as needed, lecture and/or fill in for professor in their absence, assist in the development of lessons, assignments and/or projects, supervise hired undergraduate teaching assistants.

Maintain and provide care for an approximate 50 head flock of sheep used for breeding and teaching purposes.

Provide direct animal care such as: feeding, trimming feet, treatment of minor injuries, maintain an effective breeding program, care during lambing, administration of prescribed medications and vaccinations when needed, maintain all animal records.

Teaching Assistant:

- Animal Science 100 (ANSC 100)
- Physiology of Reproduction (ANSC 309)
- Sheep Management (ANSC 410)
- Veterinary Physiology and Applied Anatomy (VM 328)

**Adjunct Instructor | Truckee Meadows Community College, Department of Science & Nutrition, Reno, Nevada** 2008 – 2010

Duties:

Collaborated with human nutrition course instructors, planned and instructed human nutrition laboratory courses.

**Committee Chair – Farm City Festival | Washoe County Ag in the Classroom, Reno, Nevada** 2008 – 2009

Duties:

Planned, scheduled & organized facility, volunteers/guest speakers and schools

Students and teachers who attend this event were introduced to and educated about Nevada agriculture and its importance to society, in a manner that while meeting state education standards, facilitated awareness and understanding of the connection between agriculture, the environment and themselves.

**Animal Handler/Ranch Hand – Sheep Unit | University of Nevada, Reno Agriculture Experiment Station** 2004 – 2007

Duties:

Assisted with care of production flock as well as research flock of Merino and Merino cross sheep totaling approximately 1000 animals. Direct animal care such as feeding, trimming feet, treatment of minor injuries, prepared sheep for surgery and recovery for biotechnology research, adherence to strict standard operating procedures, cleaned pens, operated equipment including loader, skid loader, dump truck, tractor, feed mill, feed truck and other farming equipment.

**Graduate Student Assistant | University of Nevada, Reno**
**Department of Animal Biotechnology** May – August 2003

Duties:

Assisted graduate student with different aspects of sage grouse study, tracked and captured sage grouse using radio telemetry, collected data including blood & fecal samples and weights, conducted plant transects and identification of plant species.

**Substitute Teacher | Washoe County School District, Reno, Nevada**
2001 – 2003

Duties:

Substitute teaching in grades Kindergarten through 12th grade, in all subject areas

## TEACHING, ADVISING & OTHER ASSIGNMENTS

Courses taught at Utah State University

- Instructor of record
  - Integrated Life Science (USU 1350-LB1, USU 1350-001, USU 1350-002)
  - Managing FFA & SAE (ASTE 3620-001)
- Co-Instructor
  - Student Teaching Seminar (ASTE 5500)
  - Teaching Methods (ASTE 4150/TEE 4400)
- Teaching assistant:
  - Managing FFA & SAE (ASTE 3620-001)
  - Teaching Methods (ASTE 4150/TEE 4400)
  - Orientation to Agricultural Education (ASTE 2710)

Courses taught at Truckee Meadows Community College

- Human Nutrition Laboratory

Courses Taught at University of Nevada Reno

Instructor of Record

- Agriculture Literacy Internship

Teaching Assistant:

- Animal Science 100 (ANSC 100)
- Physiology of Reproduction (ANSC 309)
- Sheep Management (ANSC 410)
- Veterinary Physiology and Applied Anatomy (VM 328)

Courses taught at Academy of Arts, Careers & Technology

- Horticulture and greenhouse management
- Animal Science/Veterinary Science
- Natural Resources & Wildlife Management
- Floriculture
- Food Science
- Agriculture Leadership, Communication & Policy
- Agriculture Science I & II

Student Teaching Supervision

Utah State University - Direct student teaching seminar course through online Canvas platform and coordinate, visit and evaluate agriculture education student teachers

Academy of Arts, Careers & Technology – lead cooperating teacher for student teachers enrolled in agriculture education program at University of Nevada Reno

Academy of Arts, Careers & Technology – lead cooperating teacher for practicum students enrolled in agriculture education program at University of Nevada Reno

Invited Presentations, Workshops & Non-Credit Instruction

- Nevada FFA Convention – The Culture of FFA (2019)
- ASTE 4150 – Guest Lecture, Cooperative Learning (2019)
- ASTE 2710 – Guest Lecture, FFA & SAE (2019)
- ASTE 2710 – Guest Lecture, FFA Membership & Awards (2019)
- ASTE 3240 – Guest Lecture, Experiential Learning & Project Based Learning (2017, 2018)
- Nevada Northern Greenhand Conference – National FFA Curriculum & Resources teacher workshop (2016, 2017)
- Nevada Southern Greenhand Conference – National FFA Curriculum & Resources teacher workshop (2016, 2017)
- Utah Agriculture Education Summer Conference – FFA Curriculum & Resources Workshop (2016)
- Nevada Agriculture Teachers Association Summer Conference – Dupont Agriscience Ambassador Teacher Workshop (2013)
- National FFA Convention – Dupont Agriscience Ambassador Teacher Workshop (2013)
- ANSC 410 – Sheep Management – Guest Lecture, Animal (sheep) nutrition and care during breeding and lambing (2009, 2010)
- ANSC 410 – Sheep Management – Guest Lecture, Agribusiness – record keeping including profit/loss statements, income/expenses, breakeven analysis (2009, 2010)

Co-Curricular Advising

- Utah State Agriculture Education Club (2019 – Present)
- Utah State Collegiate FFA Chapter (2018, 2019)

## SCHOLARSHIP

McKim, A. J., Sorensen, T. J., & **Burrows, M.** (*in review*). The COVID-19 pandemic and agricultural education: An exploration of challenges faced by agriculture teachers. *Journal of Agricultural Education*

**Burrows, M**., Sorensen, T. & Spielmaker, D. (2020). Assessing the acceptance of incorporating agriculture into elementary school curriculum. *Journal of Agricultural Education*, 61(2), 358-370. https://doi.org/10.5032/jae.2020.02358

Smith, C., Sorensen, T. J., **Burrows, M**., and Lawver, R. G. (2020). Pioneering spirit: Examining the motives and experiences of non-SBAE students majoring in agricultural education. *Journal of Agricultural Education, 61*(3), 164-181. https://doi.org/10.5032/jae.2020.03164

Hopkins, N., Sorensen, T. J., **Burrows, M**., and Lawver, R. G. (2020). Happy spouse, happy *green*house: Perceptions of the SBAE teacher's spouse regarding agricultural education as a career. *Journal of Agricultural Education, 61*(3), 194-213. https://doi.org/10.5032/jae.2020.03194

Perryman, B. L., Shultz, B. W., **Burrows, M.**, Shenkoru, T. & Wilker, J. (2020). Fall grazing and grazingexclusion effects on cheatgrass (*Bromus tectorum* L.) seedbank assays in Nevada, USA. *Journal of Rangeland Management*.

**Burrows, M.**, & Sorensen, T. (2020). Unlimited quizzes: Enhance learning in college agriculture science courses. North American Colleges and Teachers of Agriculture, Annual Conference, Virtual Conference. **Poster Presentation**.

**Burrows, M**., Henderson, C., & Sorensen, T. (2020). Utah new teachers: Need for professional development. American Association of Agricultural Education National Conference, Virtual Conference. **Poster Presentation.**

Henderson, C., **Burrows, M**., & Sorensen, T. (2020). Mentoring: Assisting new agriculture teachers in Utah. American Association of Agricultural Education National Conference, Virtual Conference. **Poster Presentation**.

**Burrows, M**. & Sorensen, T. (2019). Changes in Attitude Towards Science when AFNR and Medicine are Used as the Context in a General Life Science Course. American Association of Agricultural Education Western Region Conference, Anchorage, Alaska. **Oral Presentation.**

**Burrows, M**., Sorensen, T., Warnick, B., & Lawver, R. G. (2019). Where are they now: A longitudinal analysis of SBAE teachers in Utah. American Association of Agricultural Education Western Region Conference, Anchorage, Alaska. **Poster Presentation**.

Hile, O., **Burrows, M**., Sorensen, J., & Lawver, R. G. (2019). Preservice agriculture teacher attitudes toward the education of the gifted. American Association of Agricultural Education, Western Region Conference, Anchorage, Alaska. **Poster Presentation.**

**Burrows, M.** & Sorensen, T. (2019). Changes in Attitude Towards Science Among College Students in a General Education Life Science Course. Student Research Symposium, Utah State University, Logan, Utah. **Oral Presentation.**

**Burrows, M.** & Sorensen, T. (2019). Assessing the Acceptance of Incorporating Agriculture into Elementary School Curriculum. American Association of Agricultural Education National Conference, Des Moines, Iowa. **Oral Presentation.**

Cromer, A., Weeks, K., Horning, O., **Burrows, M**., Perry, O. G. (2018). Examining Agriculture TeacherPerceptions of Utilizing Volunteers. American Association of Agricultural Educators Western Region Conference, Boise, ID. **Poster Presentation**.

**Burrows, M**. (2012). Enhancing Undergraduate Education While Meeting a Community Need Through Service Learning. North American Colleges and Teachers of Agriculture Annual Conference, University of Wisconsin River Falls, River Falls, Wisconsin. **Oral Presentation**.

**Burrows, M.** (2011). Incorporating Agriculture into Elementary School Curriculum While Enhancing Undergraduate Education. North American Colleges and Teachers of Agriculture, Annual Conference, University of Alberta, Edmonton, Alberta, Canada. **Poster Presentation**

**Burrows, M.** (2010). Where is Agriculture in Washoe County Elementary School Curriculum? Nevada Cattlemen's Update, Reno, Nevada (P7)

**Burrows, M**. (2009). Assessing the Potential Interest and Feasibility of Incorporating AgricultureEducation that Meets Current Required Standards, into Washoe County Elementary School Curriculum. Nevada Cattlemen's Update, Reno, Nevada (P22)

**Burrows, M.** (2009). Where is Agriculture in Washoe County Elementary School Curriculum? University of Nevada Reno, Main Station Field Day, Reno, Nevada. **Poster Presentation**

**Burrows, M.** (2008). Assessing the Potential Interest and Feasibility of Incorporating Agriculture Education that Meets Current Required Standards, into Washoe County Elementary School Curriculum. University of Nevada Reno, Main Station Field Day, Reno, Nevada. **Poster Presentation.**

**Burrows, M**. (2008). Assessing the Potential Interest and Feasibility of Incorporating Agriculture Education that Meets Current Required Standards, into Washoe County Elementary School Curriculum. **Oral Presentation**, University of Nevada Reno, Gund Ranch Experiment Station Field Day, Austin, Nevada

**Burrows, M.** (2008). Assessing the Potential Interest and Feasibility of Incorporating AgricultureEducation that Meets Current Required Standards, into Washoe County Elementary School Curriculum. **Poster Presentation**, University of Nevada Reno, Gund Ranch Experiment Station Field Day, Austin, Nevada

## PROFESSIONAL MEETINGS, SYMPOSIUMS & CONFERENCES

Utah State University, ETE Learning Circle – Culturally Responsive Teaching and the Brain (2021)
Utah State University, ETE Learning Circle – Evidence Based Teaching, Understanding by Design Meets Neuroscience (2020)
Utah State University, ETE Sparkshop – Supporting Underprepared Students (2020)
American Association of Agricultural Education, Alliance for Gender Affirmation, Community Group Seminar Series (2020)
Utah State University, Annual ETE Conference, Virtual (2020)
Lecture Breakers Virtual Conference (2020)
American Association of Agricultural Education, Supports of Beginning Teachers, Virtual Conference (2020)
Utah State University: eLearnX – Experiential Training for Digital-Age Teaching (2020)
Utah State University, ETE – Atomic Assessment Workshop (2020)
Utah State University, ETE – Dan Holland, Learning Twice, Webinar (2020)
Advancements in Agriculture Development Research, Webinar (2020)
American Association of Agricultural Education, Inclusive Pedagogy Webinar Series (2020)
North American Colleges and Teachers of Agriculture, Annual Conference, Virtual Conference (2020)
American Association of Agricultural Education, Western Region Conference, Virtual Conference (2020)
American Association of Agricultural Education, National Conference, Virtual Conference (2020)
American Association of Agricultural Education, Western Region Conference, Anchorage, Alaska (2019)
American Association of Agricultural Education, National Conference, Des Moines, Iowa (2019)
American Association of Agricultural Education, Western Region Conference, Boise, Idaho (2018)
National Association of Agricultural Educators, Region I Conference, Sheridan, Wyoming 2017)
National FFA Teacher Ambassador Training (2016, 2017)
National Association of Agricultural Educators, National Convention, Las Vegas, Nevada (2016)
Association of Career & Technical Education, National Conference, Las Vegas, Nevada (2016)
Association of Career & Technical Education, National Conference, New Orleans, Louisiana (2015)
National Association of Agricultural Educators, National Convention, New Orleans, Louisiana (2015)

National Association of Agricultural Educators, National Convention, Las Vegas, Nevada (2013)
Association of Career & Technical Education, National Conference, Las Vegas, Nevada (2013)
Nevada Agriculture Teachers Association, Summer Conference (2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017)
Nevada Agriculture Teachers Association, Mid-Winter Conference (2011, 2012, 2013, 2014, 2015, 2016, 2017)
National FFA Convention (2012, 2013, 2015, 2016)
National Dupont Agriscience Teacher Academy (2013)
National Association of Agricultural Educators, Region I Conference, Pendleton, Oregon (2013)
North American Colleges and Teachers of Agriculture, Annual Conference, University of Wisconsin River Falls, River Falls, Wisconsin (2012)
North American Colleges and Teachers of Agriculture, Annual Conference, University of Alberta, Edmonton, Alberta, Canada (2011)
Agriculture in the Classroom, National Conference, St. Louis, Missouri (2011)
National Association of Agricultural Educators, National Convention, St. Louis, Missouri (2011)
Association of Career & Technical Education, National Conference, St. Louis, Missouri (2011)
Agriculture in the Classroom, National Conference, Orange County, California (2010)

## GRANTS & CONTRACTS

- National Institute of Food & Agriculture – Higher Education Challenge Grant: Incorporating Agriculture into Elementary School Curriculum While Enhancing Undergraduate Education in Agriculture - $149,993
- FFA Food for All Grant - $2,485
- 2010 Research and Development Grant - Nevada Rangeland Resource Commission - $3,000
- 2010 Research and Development Grant - Nevada Agriculture Foundation - $1,500
- 2009 Research and Development Grant - Nevada Rangeland Resource Commission - $2,400
- 2008 Research and Development Grant - Nevada Agriculture Foundation - $2,000

## AWARDS & HONORS

- North American Colleges & Teachers of Agriculture Graduate Student Teaching Award (2021)
- Presidential Doctoral Research Fellowship, Utah State University $10,000/year plus tuition (2018-present)
- Utah State University Graduate Student Travel Award $200 (2019)
- Utah State University Graduate Student Travel Award $200 (2018)

- Nevada Agriculture Foundation Agriculture Education Teacher of the Year $1,000 (2016/2017)
- Natural Resource Conservation Service National Earth Team Partnership Award (2016)
- Outstanding Graduate Student – Department of Animal Biotechnology (2010)
- Dean's List - College of Education (2003)
- Dean's List - College of Agriculture, Biotechnology, and Natural Resources (2004) (2005)
- Recipient of the following educational scholarships and grants:
    - UNR Graduate Student Scholarship - $1,000 (2009)
    - Graduate Student Access Grant - $750 (2007) - $2,000 (2008)
    - Garvey Rhodes Scholarship - $2,000 (2006)
    - Sulahria Scholarship - $750 (2006)
    - State Educational Grant - $2,500 (2006)
    - Finlay J. MacDonald Agriculture Scholarship - $300 (2004) - $500 (2006)
    - James H. MacMillan Scholarship - $2,000 (2005) (2006)
    - Robertson-Flemming Scholarship - $1,250 (2004)
    - Ted S. and Ruth Ede Memorial Scholarship - $400 (2004)

## PROFESSIONAL AFFILIATIONS & ACTIVITIES

- Co-Advisor – Utah State University Agricultural Education Club (2018 – present)
- Member AAAE Alliance for Gender Affirmation and Equity (2020 – present)
- Member North American Colleges and Teachers of Agriculture (2011 – 2012, 2018 – present)
- Member American Association of Agricultural Education (2018 – present)
- President Nevada Agriculture Teachers Association (2016 – 2017)
- National FFA Teacher Ambassador (2016 – 2018)
- Co-Advisor – Academy of Arts, Careers & Technology chapter of National Technical Honor Society
- President Elect of Nevada Agriculture Teachers Association (2014 – 2015)
- DuPont Agriscience Teacher Ambassador (2013)
- Member of the Nevada State Standards writing team for Veterinary Science, Natural Resources & Wildlife Management, Floriculture, Agriculture Leadership, Communication & Policy (2012 – 2014)
- Member of Nevada Association of Career & Technical Education (2011 – 2018)
- Member of National Association of Agriculture Educators (2011 – 2018)
- Tau Sigma Honor Society
- Society for Range Management (2005 – 2009)
- Second Vice President - UNR Student Chapter of the Society for Range Management (2007)
- Member - Plant Identification team and Undergraduate Range Management team for competition at the Society for Range Management National Meeting (2006) (2007)
- Member - UNR Student Chapter of the Society for Range Management (2005) (2006)

## S E R V I C E

Utah State University Fall Research Symposium Presentation and Poster Judge (2020)
The Family Place Utah, Circle of Friends Member (2019 – Present)
Utah State University Undergraduate Research and Creative Opportunities Grant Reviewer (2018, 2019, 2020)
Utah State University Student Research Symposium Poster Reviewer (2019, 2020)
Utah State University Student Research Symposium Presentation and Poster Judge (2019, 2020)
AAAE National Conference Poster Reviewer (2019, 2020)
Utah State University Student Research Symposium Presentation Reviewer (2019)
Co-Advisor Utah State University Agriculture Education Club (2019 – Present)
Co-Advisor Utah State University Collegiate FFA Chapter (2018, 2019)
AAAE Western Region Conference Poster reviewer (2019)
AAAE National Conference Poster reviewer (2018)
President Nevada Agriculture Teachers Association (2016-2017)
President Elect Nevada Agriculture Teachers Association (2015-2016)
Nevada Agriculture Foundation Board Trustee (2016 – Present)
Co-Leader and volunteer for Girl Scout Troops 448, 538 & 294
Board Member of PTO and Parent Involvement
Cheerleading Coach for Sierra Youth Football League
Service on many planning committees for elementary & secondary school and extracurricular events