Journal of Agricultural Education, 59(4), 88-104
https://doi.org/10.5032/jae.2018.04088

Science in the Garden: A Qualitative Analysis of School-based Agricultural Educators' Strategies

Sarah M. Cross[1] & Sami Kahn[2]

Abstract

Scholars in science education have reported an in increase in scientific literacy due to socioscientific issues (SSI)-based instruction. While several SSI are related to agriculture, such as climate change, whether to eat organic food, land use issues, and the use of genetically modified organisms (GMOs), literature that connects agricultural education to the theoretical framework is scant. This collective case study investigates how National Future Farmers of America (FFA) Organization teachers utilize school gardens to teach science, including whether and how SSI are utilized as an educational framework. Qualitative data was collected by conducting semi-structured interviews with two Ohio school-based agricultural educators, and data was analyzed using the constant comparative method. Findings indicated both teachers utilized applied science teaching methods and expressed frustrations regarding the difficulty of meeting mandated science learning standards. While the teachers often integrated controversial topics in classroom discussions, fidelity to the SSI framework did not appear to be utilized.

Keywords: Socioscientific issues; agricultural education; qualitative

Introduction

There is a scientific literacy crisis in the United States. Recent Program for International Student Assessment (PISA) scores indicate that U.S. students' scientific literacy ranks have lowered in recent years (Organisation for Economic Co-operation and Development [OECD], 2016). Scientific literacy is "the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity" (National Research Council, 1996, p. 22). In fact, in 2012, PISA results showed that 22 countries scored higher on scienctific literacy than the U.S (National Center for Educational Statistices [NCES], 2015). Scientific literacy is lacking in United States compared to other developed countries (Morgan, Farkas, Hillemeier, & Maczuga, 2016; Morrone, 2001; Trilling & Fadel, 2009; NCES, 2015). Some argue that students are losing interest in science, especially during secondary school years (Braund & Reiss, 2006). As gaps in scientific knowledge have been found during early stages of development, as early as kindergarten (Morgan et al., 2016), scholars have investigated how science is taught to counteract this lack of scientific understanding. While teachers are certainly stretched for time due to mandated standards (Sadler, Amirshokoohi, Kazempour, & Allspaw, 2006), science in the laboratory does not fully represent contemporary science (Braund & Reiss, 2006). Many science educators and researchers seek to engage more students in science by altering instructional methods, such as facilitating productive learning experiences that are relevant to students' everyday lives.

[1] Sarah Cross is a doctoral student of Science Education in the Department of Teacher Education at Ohio University, 103 McCracken Hall, Athens, OH 45701, sc337015@ohio.edu.
[2] Sami Kahn is an Assistant Professor of Science Education in the Department of Teacher Education at Ohio University, 309 McCracken Hall, Athens, OH 45701, kahns@ohio.edu.

Teachers have facilitated pertinent science learning experiences for students through the use of school gardens since around 1900 (Greene, 1910), and today there are over seven thousand documented school gardens that exist across the country (USDA, 2015). Research tends to conclude that school gardens can increase students' test scores (Blair, 2009; Joshi, Azuma, & Feenstra, 2008; Smith & Motsenbocker, 2005), and some studies have shown an increase in students' science achievement (Klemmer, Waliczek, & Zajicek, 2005; Smith & Motsenbocker, 2005). However, although teachers tend to think gardens promote academic instruction (Blair, 2009), they often lack necessary content knowledge in this area (Blair, 2009; Dobbs, Reif, & McDaniel, 1998; Graham, Beall, Lussier, McLaughlin, & Zidenberg-Cherr, 2005; Graham & Zidenberg-Cherr, 2005). Thus, many instructors would like to see school gardening curriculum that relates to mandated learning standards (Graham et. al, 2005; Graham & Zidenberg-Cheer, 2005). Promoting scientific literacy through gardening education curriculum seems like a natural fit, as the teaching of scientific concepts, such as soil science and biology, are already being implemented by many teachers. How can teachers promote scientific literacy through relevant gardening education? Perhaps socioscientific issues (SSI), an educational framework that uses complex societal issues to engage students in meaningful inquiry can provide an ideal context for promoting scientific literacy.

Although school gardens have not been explored as a context for SSI, some scholars have utilized gardens to help students investigate societal problems, such as climate change (Sellmann & Bogner, 2013). Students may be able to more readily grasp scientific concepts when real problems are discussed in the classroom, including the consequences of decisions (Castano, 2008). One such real problem that readily relates to agricultural education is the challenge of food insecurity, a global situation that leaves nine out of ten people in the world undernourished (United Nations, n.d.).

Education related to the agricultural field, particularly as implemented through school gardens, may provide the context for promoting scientific literacy through explorations of SSI such as food insecurity. However, literature is scant regarding specific methods used by agricultural educators to teach science through school gardening, and sparse literature exists on the use of SSI as a framework for positioning such a curriculum.

Therefore, this exploratory study seeks to address the following research questions: 1) How are high school agricultural teachers utilizing gardens to teach science? 2) How are high school agricultural educators utilizing gardens as a context to promote scientific literacy through SSI? To answer these questions, this study is developed within a theoretical framework of: 1) Scientific Literacy; 2) School Gardening; and 3) SSI.

Theoretical Framework

Scientific Literacy

The scienfically literate person is able to ask well defined questions and think critically about information (National Research Council, 2012). A science education reform document, *A Framework for K-12 Science Education* (henceforth, *Framework;* NRC, 2012), was designed with a commitment to "the strands of scientific proficiency" (National Research Council, 2012, p. 23). As described in *Taking Science to School: Learning and Teaching Science in Grades K-8*, a document preceding the *Framework,* "students who are proficient in science:"

1. know, use, and interpret scientific explanations of the natural world;
2. generate and evaluate scientific evidence and explanations;

3. understand the nature and development of scientific knowledge; and
4. participate productively in scientific practices and discourse. (Duschl, Schweingruber, Shouse, 2007, p. 2)

Why is scientific literacy important? Our society is full of challenges related to science that lack clear answers, such as over population, hunger, and homelessness. Being proficient in scientific literacy can help students engage in informal reasoning, make informed decisions, and problem solve. "Informal reasoning involves the generation and evaluation of positions in response to complex issues that lack clear-cut solutions" (Sadler, 2004, p. 514). To make informed decisions, it is important to evaluate different perspectives (Sadler, Barab, & Scott, 2007). Unfortunatly, however, classroom science does not always help students make informed decisions, as overemphasis on scientific content itself does not promote decision making (Arvai, Campbell, Baird, Rivers, 2004). Moreover, many agrue that classroom science often does not allow for students to use science productively since it is often taught in an abstract way that is not connected to students lives (Braund & Reiss, 2006; Zeidler, 2014).

Recent science reform documents point to the importance of looking at authentic issues in the classroom to help students gain informed argumentation skills (Yu & Yore, 2013). The reform document entitled, the *Framework and Excellence in Environmental Education - Guidelines for Learning (K-12)*, promotes an interdisciplinary approach to science, environmental education, and education regarding sustainable development, which includes agriculture (Vallera & Bodzin, 2016). Vallera & Bodzin (2016) state, "becoming 'literate' in each of these fields encourages individuals to make informed decisions regarding important personal and societal issues" (p. 102). The document, *The National Research Agenda: Agricultural Education and Communication Research Priority Areas and Initiatives*, states a major research priorty in the field should be to "Enhance decision making within the agricultural sectors of society" (Osborne, 2007, p. 5). There appears to be a great opportunity here—teachers can promote scientific literacy through agricultural education. Curriculum related to agricultural literacy, including food security, can now not only be facilitated for vocational students, but also to an additional population of students, those that use school gardens.

School Gardening

While the number of school gardens have increased significantly in the U.S. over the past decade, how science is being taught in that learning environment is largely unknown. In addition, the existing academic literature related to science achievement in the school garden setting is largely focused on elementary school education, leaving a gap in scholarly work that focuses on secondary school gardens. Many teachers believe students' content knowledge increases based on garden-related learning experiences (Graham & Zidenberg-Cherr, 2005; Joshi et al., 2008). Joshi et al., (2008) investigated teachers' perspectives on the benefits of school gardens for students. They concluded, "teachers perceived the garden to be somewhat to very effective at enhancing academic performance" (Joshi et al., 2008, p. 1798). Graham & Zidenberg-Cherr (2005) reported that teachers are utilizing school gardens for education in multiple topic areas, such as science, nutrition, environmental studies, language arts, math, and agricultural studies. In addition, other benefits of school gardening have been documented, such as healthy eating behaviors and increased physical activity (Joshi et al., 2008). Therefore, gardening can be used as a tool to help students academically, as well as physically. However, due to the pressure to cover certain core curriculum in the classroom, many teachers have expressed a need for school garden curricula that aligns with mandated standards (Graham & Zidenberg-Cherr, 2005).

Although there has been some academic-based curriculum written for school garden use (USDA, 2015), there is little information on what curriculum, if any, science teachers are utilizing. Therefore, there is very little information about how well school garden science experiences cover learning standards or pertinent social issues. Graves, Hughes & Balgopal (2016) conducted a case study with two 3rd grade teachers that explored the use of STEM in a school garden curriculum. The scholars found mixed results on whether school gardens address learning standards related to STEM (Graves et al., 2016). The researchers worked with two different STEM coordinators on the study to investigate how well their edible plant curriculum integrated STEM concepts. One coordinator believed the school garden curriculum provided inquiry based learning experiences that covered science standards while relating science to the students' everyday lives. However, the other STEM coordinator did not believe science standards were addressed in the curriculum. Rather, the learning experiences were considered "enrichment activities," as the teachers in the study referred to the garden learning experiences as "special" activities.

Many educators have utilized gardens as a context for teaching material related to the physical sciences (Joshi et al., 2008). While physical science concepts, such as biology and soil science, can be integrated in an interdisciplinary curriculum that is designed to promote scientific literacy, many students still lack the ability to understand other perspectives and make informed decisions. While gardens have been shown to increase science achievement (Klemmer et al., 2005; Smith & Motsenbocker, 2005), it seems only natural to create relevant interdisciplinary curriculum that can be used to promote scientific literacy. A few agricultural education scholars have utilized SSI to promote scientific literacy in the classroom (Shoulders & Myers, 2013; Wilcox, Shoulders, & Myers, 2014). SSI uses complex, often controversial, societal issues, such as climate change, to engage students in meaningful scientific inquiry. Perhaps the theoretical framework can be used to create garden based curriculum.

Socioscientific Issues (SSI)

SSI has been recognized as a research based educational framework that promotes scientific literacy (Zeidler, 2014). In fact, SSI curriculum often aligns well with the objectives related to scientific literacy of the PISA (Sadler & Zeidler, 2009). SSI are ill-structured controversial social issues, often highly visible through traditional or social media, which involve science. They have been referred to as "scientific issues with social ramifications" (Sadler, 2004, p. 513). Some examples of SSI are the GMO dilemma, land use decisions, or whether to eat organic food. A conceptual goal of SSI is to make "classroom science more reflective of the society in which it exists." (Sadler, 2004, p. 514). Sadler et. al (2006) states these controversial issues "bridge science and society" (p. 353). If students have an opportunity to discuss science that is relatable to their everyday lives, they may improve their conceptual understanding of science (Castano, 2008).

When students are engaged in science through SSI, they are encouraged to investigate various science standpoints while they proceed in informal reasoning and the decision-making process (Sadler et al., 2007). "Whereas scientific knowledge and inquiry practices can be useful for the negotiation of SSI, scientific practices alone cannot marshal solutions. Issue solutions are necessarily shaped by moral, political, social and economic concerns" (Sadler et al., 2007, p. 371). Students are encouraged to think critically and engage in informal reasoning before drawing their own conclusions. While science in the traditional classroom has often been taught in an autocratic fashion, SSI encourages students to understand and appreciate various perspectives on an issue (Zeidler, Applebaum, & Sadler, 2011). Braund & Reiss (2006) state this authoritative stance on science could be part of the reason students are not more engaged in the subject. Zeidler et al. (2011) stresses the importance of transforming science education practices towards a more progressive instructional paradigm. These transformative practices represent "deep structural shifts both in teacher pedagogy and students' conceptual understanding of subject matter and reflective thinking" (Zeidler et al., 2011, p. 279). Zeidler et al. (2011) have created a figure (below) to represent different aspects of the instructional paradigm continuum.

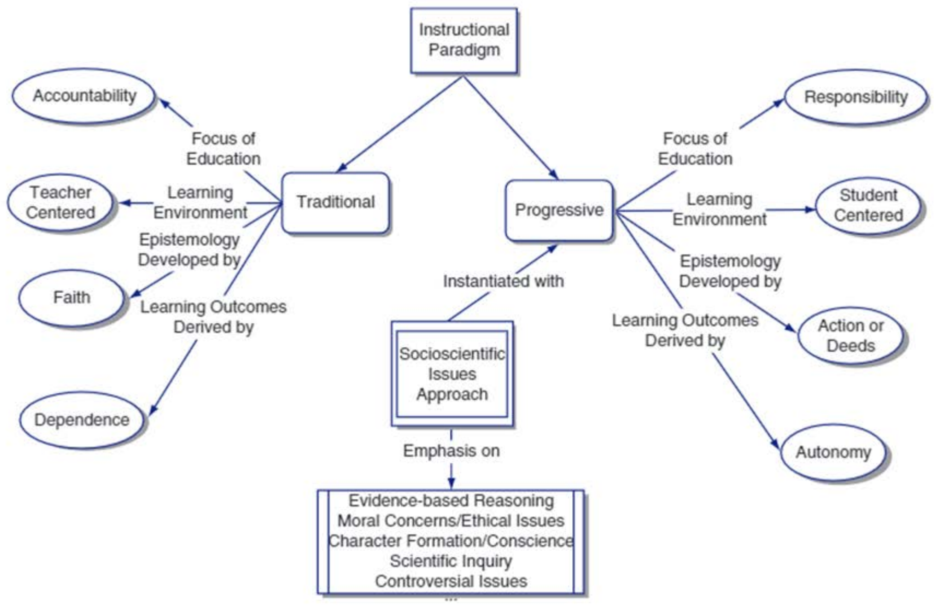

Figure 1. Continuum contrast of instructional paradigms. From "Enacting a socioscientific issues classroom: Transformative transformations," by D.L. Zeidler, S.M. Applebaum, & T.D. Sadler, 2011, In T.D. Sadler (Ed.), *In Socio-scientific Issues in the Classroom*, p. 279. Springer Science and Business Media. Reprinted with permission from Springer Nature.

On the continuum of instructional paradigms, the progressive method of instruction promotes independent thinking, which works to create democratic educational experiences. Rooted in experientialism, the progressive method is student centered and focuses on shared social experiences (Zeidler et al., 2011). In contrast, the traditional method is often teacher centric and has roots in social behaviorism (Zeidler et al., 2011). The traditional method is often based in dogma and therefore is often dependent on the teacher (Zeidler et al,, 2011; Zeidler & Nichols, 2009). The scholars state a clear difference in the nature of knowledge between the methods of instruction. For the progressive method, knowledge is "derived from the collective meanings of shared social experiences (actions and deeds)" (Zeidler et al., 2011, p. 280). Critics of SSI stress that, while the framework is sound, there is a need for new forms of education practice and assessment to successfully implement SSI in the curriculum (Levinson & Turner, 2001). In particular, they argue for curriculum that promotes students' active engagement as change agents who take an active role in addressing the societal challenge (Levinson, 2006). Such an approach warrants continuing education opportunities and pedagogical guidance related to SSI. This research illuminates the need for targeted SSI curriculum and professional development.

While many SSI are related to agricultural science, such as climate change, land use decisions, whether we should eat organic food, and the use of GMOs for food production, there is a scarcity of SSI scholarly research related to agriculture. Shoulders & Myers (2013) combined the disciplines and quantitatively assessed agriscience content knowledge of high school and middle school students in response to a six week SSI-based instructional unit intervention, which focused on the introduction of cultured meat in the mainstream food supply. Teachers participating in the study had to be teaching at least one Agriscience Foundations class during the school year. While eleven teachers expressed interest in implementing the curriculum, only four teachers participated for the entirety of the study. As the scholars discussed, this lack of participation inevitably effects the generalizability of the study. Overall, when data analysis was completed, the scholars determined students increased their proximal and distal content knowledge.

To address the lack of participation in the previous study, a qualitative investigation was conducted to explore why seven teachers discontinued the study (Wilcox, Shoulders, & Myers, 2014). The scholars collected data by conducting semi-structured interviews and a focus group. In addition, the teachers had completed daily written journals during the intervention implementation period and the scholars analyzed these documents accordingly. Various themes were generated after data analysis was completed to attempt to capture teacher and student perceptions on the SSI instructional units. Wilcox, Shoulders, & Myers (2014) state, "Texts were organized into the following themes: initial excitement, expected uniqueness of agriculture classes, conditioned to need a right answer, loss of connection between content and student' lives, student disengagement, decisions to discontinue, and confirmation of adoption" (p. 22). Students were thought to have lacked engagement during the intervention for several reasons. Some students expected out of the classroom activities during their agriculture classes, which was not included in the SSI curriculum provided by the scholars. In fear of students dropping out of agriculture programs due to lack of engagement, some teachers decided to stop participating in the study. The theme of 'loss of connection between content and student' lives' seems ironic considering SSI scholars often argue students may be more engaged in science education when the topic matter relates to their daily lives, which is an objective of the SSI framework (Zeidler, 2011).

Literature also suggests SSI and agriculture education have been combined by scholars for postsecondary instructional units (Dauer & Forbes, 2016). In an introductory science literacy course at the University of Nebraska-Lincoln, scholars utilized the SSI educational framework to promote scientific literacy. All undergraduates in the university's College of Agriculture and Natural Resources are required to take the course. The scholars posed four controversial dilemmas, or SSIs, during the course. Three of the four SSI-based instructional units were based on topics related to agriculture, including whether people should eat organic food, burn corn ethanol for energy, and further restrict agricultural irrigation. The scholars investigated whether students changed stances on these topics by implementing pre- and post-intervention assessments. Overall, students held significantly different stances after the intervention.

While there is still a need for research that combines SSI curriculum and agricultural science, these studies suggest that the educational framework can successfully be combined with the discipline of agricultural science. However, research that combines SSI and school gardening is even more scant in the literature. While critics suggest there is a need for citizen activism regarding SSI (Bencze, Sperling, & Carter, 2012), perhaps SSI based instructional units that combine hands on consumer horticulture activities would benefit students. Perhaps teachers can promote scientific and agricultural literacy while involving students in food production to fight for food security.

Purpose and Objectives

This exploratory study investigates the following research objectives:

1. Examine agricultural educators' teaching methods for facilitating science learning experiences in secondary school gardens.

2. Explore agricultural educators' strategies for facilitating learning experiences in school gardens that relate to SSI.

Methods and Procedures

During this collective case study, I collected data by conducting semi-structured interviews with two high school FFA teachers in Ohio (From this point forward, "I" refers to the first author alone and "we" refers to both authors). Multiple cases were utilized to provide insight into the phenomenon (Creswell, 2015 ; Johnson & Christensen, 2014). While collective case studies can be used to generalize findings (Glesne, 2016, Johnson & Christensen, 2014; Patton, 2015), the purpose of this study is to provide insight on an issue through the exploration of two bounded systems. In this case, the "bounded systems" are individuals, however, in case study design, a bounded system can also refer to an activity, event, or process (Creswell, 2015). Such in-depth examinations often include gathering multiple forms of data, such as pictures, videotapes, and emails (Creswell, 2015). While this study investigates curriculum being utilized by teachers, I requested school garden curriculum from both participants, however, neither had any materials to share.

Semi-structured responsive interviews were conducted to gain understanding on how science is being taught in the school garden context as well as to investigate how teachers are utilizing the SSI framework. For semi-structured interviews, the researcher prepares some of the interview questions in advance based on research questions and the theoretical framework (Merriam, 2009), and then encourages participants to give detail by probing additional questions during the dialogue (Rubin & Rubin, 2012). In addition, observational data, including behavior, talk, and acts of participants (Glesne, 2016) was collected and utilized to support the interview data.

Research participants were selected via purposeful sampling based on a certain criterion to compare and contrast the individual cases. As Patton states, "the logic and power of purposeful sampling lies in selecting information rich cases for in-depth study" (Patton, 2015, p. 264). The "comparison-focused sampling strategy," discussed by Patton (2015), was utilized to compare and contrast the two cases for an in-depth analysis. "Comparison-focused sampling looks in depth at the significant similarities and differences between cases and the factors that explain those differences" (Patton, 2015, p. 277). A small sample size was chosen in order to complete an in depth cross case analysis.

Participants

Participants for this exploratory study included two Ohio FFA high school teachers that utilize school gardens for science instructional purposes. A list of possible participants was derived from an Agriculture Education Program Specialist with the Ohio Department of Education. The list was comprised of Ohio secondary instructors who taught subject matter related to school gardens. While this list was not comprehensive, other known possible participants that met the study criteria were added to the list. Several possible participants that were geographically closest were emailed and asked to participate. The first two people to respond were chosen as participants.

The two participants in this study, Sam and John, are FFA teachers at two different high schools in Ohio. As a previous agricultural educator in their communities, I worked with each of the teachers in the past, including guest lecturing for a few of their agriscience classes. While both teachers teach courses related to plant and animal sciences, Sam specializes in animal husbandry and John has an extensive background in agronomic sciences. I have observed both Sam and John interact with students in the classroom on a few occasions, both as an agricultural educator in their communities and as a researcher. For this study, both semi-structured interviews were completed in person, as I traveled to each of the participant's schools to collect data. In addition, each interview, lasting about 50 minutes, was audio recorded and later manually transcribed.

Analysis of Data

The constant comparative method (Glaser, 1965) was utilized to analyze the interview transcriptions and develop themes. As Glaser explains, the constant comparative method is used to generate properties about a general phenomenon. The scholar states these properties can include "conditions, consequences, dimensions, types, processes" (p. 438). Glaser describes the four stages of analyzing qualitative data using the constant comparative method: "(1) comparing incidents applicable to each category, (2) integrating categories and their properties, (3) delimiting the theory, and (4) writing the theory" (p. 439). As Glaser explains, the scholar first codes each transcription and then compares incidents. This process will help the researcher generate proposed categories and define the theoretical properties for each of them. The analyst then starts to compare each incident to the properties of the categories. During this process, the scholar explores how the properties of the categories may be integrated. As coding continues, reduction occurs in the third stage. In other words, terminology is reduced and the set of proposed concepts becomes smaller. This enables the scholar to determine the boundaries of each category and delimit the theory. When the analyst is able to delimit the original list of categories, it becomes easier to compare findings to other pieces of scholarly work found in the literature. Finally, categories will become theoretically saturated and a theory can be developed.

Following Glaser's (1965) guidance on the constant comparative method, first, each transcription was analyzed for codes individually. Then, the categories or themes generated for each interview (or incident) were compared. The interconnectedness of the categories were explored. After reduction of terminology, the original categories were reevaluated and delimited. Finally, when categories became theoretically saturated, themes were generated. To provide rigor, data source triangulation was utilized as a validation strategy. By having more than one participant, data source triangulation can add to the reliability, as well as the credibility, of findings (Patton, 2015). For trustworthiness, inter-rater reliability, which is used to nullify any bias one individual may have while analyzing data, was employed to corroborate generated codes (Creswell, 2015).

Results

Following transcription analysis, three themes emerged from the two research objectives: 1) difficulty meeting standards 2) importance of integrating applied science, and 3) hot topics in the classroom. All quotes are written verbatim.

Difficulty Meeting the Standards

Both participants, Sam and John, struggled to meet learning standards, which they both felt took away from their ability to teach applied science. John expressed some frustration regarding standardized testing. He said,

> …and that's one of the things that I guess frustrates me about education is that we just keep wanting to raise the bar and the kids are gettin further and further away from the bar… because, ahh, they don't read, you know, they only do what they have to do.. there's no there's no reason for them. Most of them don't see any reason to dig any deeper…even, only a few, only the very few that have a real desire or passion or interest go beyond that.

While Sam was discussing how he could not teach practical skills anymore, he claimed the pressure to meet science standards are getting in the way. When discussing whether practical science skills were in the mandated science standards, he says, "They are in there, but ya got so many...how do ya do it? Ya can't."

Importance of Integrating Applied Science

Both teachers focused on applied science while teaching sessions related to gardening. Sam and John both felt their students needed science to be applied. John said,

> They don't know how to apply what they know…But they have that little bit of knowledge with.. I guess that's the kind of thing that frustrates me. It frustrates me a little with education. Kids don't have that desire…Ya know, now the kids that have a true interest in agriculture, yeah, but, ya gotta show them how it applies to them…

Both teachers seemed proud to state their students were applying the garden knowledge they learned in the classroom at home. When discussing the hands-on educational gardening experiences, Sam stated, "I want them to be able to take that home." Both teachers were told by parents that the students garden more at home based on their classroom experience. John stated,

> well, you know what, I've had kids and parents both tell me that they do plant their own gardens or they do buckets or whatever…because of what they did in class…I've had both parents and kids tell me hey I've planted this or I've planted that or I tried this…

Hot Topics in the Classroom

Both teachers talked about an SSI topic, use of GMOs, during classroom time. However, these discussions did not seem to be well organized nor did they promote scientific reasoning. Therefore, the SSI educational framework was not being utilized. When Sam was asked if his class ever discussed societal issues, such as whether or not to eat organic food or about GMOs, he responded

> Quite a few of umm..we get into these social conversations all the time…we do. We hit the hot topics. We do talk about GMOs…and corn GMOs. And I'll pick whatever sides loosin…(laughs) sometimes that's all we talk about.

When asked if students were encouraged to look up materials when discussing topics related to SSI, Sam stated, "a lot of times we pull stuff up...and talk about it. kids will go in, especially when we get a good argument...And look at it, but we generally do that as we dialogue." While Sam discussed a SSI topic, use of GMOs, with his class, it was not an organized activity, but more of an impromptu discussion.

Classroom discussions related GMOs also came up during the interview with John. When the teacher spoke of GMOs, he said he told his students how beneficial they were. The other side of the controversial issue did not appear to be discussed. It also appeared that the students were not really part of the discussion. John stated,

> Back to the plant that plant and the GMOs and stuff.. we talk a lot about how we have advanced, I mean, ya know, explain how GMOs are very beneficial…I mean,

> explain the round up ready corn and how we don't have to use as many and and different types and it it clicks with most of the kids…Most of them can figure..most of them have heard of round up and they can figure, I mean, they know what round up is.

When John was asked if the students read material about GMOs, he said "Ya know what, I don't know if they read about it."

While both teachers discussed GMOs in the classroom, there did not seem to be an organized classroom activity that included informal reasoning or evidence-based argumentation. Students were not encouraged to make a decision on the controversial topic or critically evaluate the impacts of their decision on society or the environment. Based on these interviews, it seems both teachers could utilize SSI curriculum on the topic of GMOs. While there were only two participants in this study, more research needs to be conducted to produce any generalizations. However, while the nature of a case study is to provide an in-depth understanding of the phenomena, one individual, or one case, is all that is required (Creswell, 2015).

Conclusion

The first two themes, "Difficulty meeting the standards" and "Importance of integrating applied science," align well with findings from other studies. Secondary school agricultural education teachers have communicated that it is important to integrate applied science into their agriscience curriculum (Warnick, Thompson, & Gummer, 2004). A study conducted in Oregon found that principals of secondary schools with agricultural education programs believed that integrating science into the agricultural education curriculum would help students meet mandated standards and advance educational reform (Thompson, 2001). In a later study, Warnick, Thompson, & Gummer (2004) found that most secondary agricultural teachers in Oregon also agreed that integrating science into the curriculum could help students meet standards. However, as this study corroborates, some agricultural education teachers have experienced difficulty implementing standards (Stair, Warner, Culbertson, & Blanchard, 2016).

As mentioned, regarding the theme, "Hot topics in the classroom," both teachers had classroom discussions on controversial subject matter, such as the use of GMOs. While whether to use GMOs is an SSI, this topic was not discussed in a way that aligns with the SSI educational framework. These classroom discussions did not seem to promote informal reasoning or scientific literacy as they did not explore the consequences of their actions/inactions or promote perspective taking of those that had differing opinions. A discussion on a SSI should be facilitated or guided by the instructor, who must have the confidence and knowledge base to guide classroom discourse in an open and unbiased manner (Levinson & Turner, 2001). Neither teacher in the present study demonstrated having adequate content knowledge to facilitate a session on GMOs that promotes scientific literacy. In fact, they both tended to make their own positionality clear to students. During a successful facilitation activity, the teacher would not make their perspective known. It is of utmost importance that teachers stay neutral when teaching these controversial topics (Oulton, Dillon, & Grace, 2004). As John and Sam explained their teaching experiences, it was clear students were infrequently part of the decision-making process. For example, both teachers taught hands-on horticulture solely with the use of commercial fertilizer, which is a non-organic method. Furthermore, at one point, John actually mentioned the lack of student decision making. As he was discussing frustrations regarding the lack of critical thinking among students, he paused, looked down, and said…"and I think it's because we've always made all the decisions for them." It seemed that students were rarely offered a choice or asked to participate in an informed decision-making process. Scholars working in the SSI discipline have encouraged students to engage in informal reasoning and to make a personal decision (Dauer, & Forbes, 2016).

While secondary school agricultural education and SSI may seem like a natural fit, there has been a lack of scholarly work that unites the disciplines (Shoulders & Myers, 2013). As these scholars suggest, and this study corroborates, there is a need for more research that connects SSI and secondary school agricultural education. Perhaps more research related to the theoretical framework needs to be conducted with secondary agricultural teachers. SSI based instruction has had positive effects on student learning in the agriscience classroom (Shoulders & Myers, 2013), and there are several SSI issues that can fit easily into the agricultural education curriculum. While sources of SSI curriculum for secondary education exists (Zeidler & Kahn, 2014), there is a need for SSI curriculum that relates to agricultural topics. In addition, as for future research, it would be interesting to see if any agricultural educators are utilizing SSI in the classroom. If so, how is the framework being utilized? Perhaps the narratives of those teachers can add to the SSI knowledge base by providing much-needed information on: 1) What are the challenges to the teacher in implementing SSI; 2) What training/resources would be helpful in overcoming those challenges? 3) How does teachers' understanding of the SSI framework align with the framework itself? Perhaps a survey followed by an interviewing procedure, a mixed methods design, would be helpful when investigating this phenomenon. While questionnaire results can provide generalizable data (Creswell, 2012), qualitative research, which is exploratory in nature (Patton 2015; Patton 1990), may help disclose hidden curriculum, as we have seen here.

Several SSI topics relate to a huge international problem, food insecurity. These SSI issues are the use of GMOs, land use issues, whether to eat organic food, and climate change. These four issues are also related to gardening. Perhaps science educators can use these separate topics to address food insecurity, a social justice issue. In recent years, scholars have looked at the idea of using science education to tackle social justice issues (Barton, 2003; Braund & Reiss, 2006). While science related classes are often based solely on physical science content, students can also be engaged in informal reasoning and hands on SSI problem solving activities. This can even result in student-led activism. "There may be a need for new curricular and pedagogical frameworks that teachers can use to promote student-led activism on SSI." (Bencze, Sperling, & Carter, 2012, p. 134). Perhaps science teachers can use these separate SSI topics (the use of GMOs, land use issues, whether to eat organic food, and climate change) to facilitate student led activism projects surrounding food security and gardening. Perhaps they already are. Regardless, there may be ample opportunities for science education researchers to work with agricultural educators on such scholarly projects.

Teachers may be able to utilize school gardens for SSI based instruction to promote scientific literacy. However, our findings suggest there is a demonstrated need for curriculum and professional development opportunities for agricultural teachers regarding use of the SSI educational framework. Likewise, there is a need for professional development related to teaching with school gardens (Blair, 2009). Professional development opportunities can accomplish both. It is vital that teachers do not push their beliefs on their students, as we have seen in this study. Doing so aligns with the traditional instructional paradigm, instead of the progressive paradigm. A professional development opportunity could focus on understanding the instructional paradigm continuum. Specialists in the scientific community, including teachers and researchers, must continue to work together to develop progressive science education pedagogy, that is not only relevant to learners, but also promotes student autonomy.

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