

Evaluating the Preparation of Pre-Service School-Based Agricultural Education Teachers in Laboratory-Based Courses

Abstract

This study sought to examine laboratory-based instruction for pre-service school-based agricultural education (SBAE) teachers at various institutions across the nation. While research has indicated that laboratory-based instruction in SBAE programs is commonplace (Shoulders & Meyers, 2012), a myriad of literature has noted SBAE teachers are not adequately prepared to teach, manage, and facilitate learning activities in SBAE laboratories upon completing their teacher education programs (Burris et al., 2005; Hainline & Wells, 2019; Shoulders, 2012). To better understand the current state of SBAE pre-service teacher training in laboratory instruction, we surveyed 33 agricultural education certifying institutions across the country. Many of these institutions indicated they required pre-service teachers to take two laboratory-based instruction courses in the areas of agricultural mechanics (96.9%) and welding metal fabrication livestock (83.9%). However, only 46.7% of the responding institutions required students to take a greenhouse management course, and 29% required pre-service teachers to take a meat science course. The findings of this study also highlight if the laboratory-based courses had a pedagogical component, and the teacher educators were asked to provide their perceptions for a need for expansion of instruction in each context. Recommendations for practice and further investigation were provided.

Keywords: school-based agricultural education; laboratory-based courses; pre-service

Introduction and Literature Review

School-based agricultural education (SBAE) teachers represent 18% of all Career and Technical Educational (CTE) teachers and are charged with recruiting, training, and retaining the future skilled workforce (Nape, 2018b; U.S Department of Education, 2014). Agricultural mechanics has been a mainstay in the curriculum for agricultural education and is considered to be a foundational component comprising of topics ranging from electricity, welding / metalworking, and building construction systems (e.g., roof, wall, and floor systems) to biofuels, alternative energies, and mechanical systems (Burris et al., 2005; Hainline & Wells, 2019; McCubbins et al., 2016; Young et al., 2009). SBAE laboratories serve as a setting for the implementation of experiential learning activities (Shoulders et al., 2013) and the development of students' problem-solving skills, decision-making skills, and teamwork—which are considered fundamental principles within SBAE (Franklin, 2008; Phipps et al. 2008; Shoulders, 2012; Talbert et al., 2014).

Shoulders and Myers (2012) revealed that nearly 76% of SBAE programs in the United States have a greenhouse, mechanics, carpentry, and welding laboratory. Effectively using SBAE laboratories, teachers have the opportunity to provide students with a plethora of skills, which they can develop, hone, and apply, to bolster their career-readiness (Phipps et al., 2008; Wells et al., 2013). For more than a century, accurately, effectively, and safely utilizing laboratories has been of utmost importance and largely the main area of research within SBAE (Saucier et al., 2012; Schumacher & Johnson, 1990). Burris, (2005), Hainline and Wells (2019), Albritton and Roberts (2020), and Wells et al. (2021) found that current SBAE teachers, as well as teacher educators, have agreed that it is paramount that the rigor of instruction of agricultural mechanics knowledge and skills be increased to pre-service SBAE teachers. Burris et al., (2005) also indicated that further training in other laboratories for pre-service teachers is needed, and universities should consider offering courses to develop teaching and learning competencies in laboratory-based courses.

Historically, the SBAE curriculum has consistently had agricultural mechanics as a part of its curriculum, yet pre-service teacher training in mechanics has declined (Burris et al., 2005; Hainline & Wells, 2019). Furthermore, professionals and researchers recommend if SBAE laboratories are to remain a safe environment for student learning, pre-service teachers need to receive safety training and be exposed to teaching, facilitating, and laboratory management practices within SBAE laboratories (Wells et al., 2019). Beginning SBAE teachers could be assigned to teach technical skills and or manage a laboratory that they likely do not have formal training in (Albritton & Roberts, 2020). A majority of current students in SBAE teacher education programs have less experience in traditional agricultural technical skills due to societal changes (Phipps et al., 2008; Shoulders et al., 2011).

Furthermore, previous research has indicated the need for effective and adequately trained SBAE teachers who can collaborate with local industries and develop well-prepared students to enter the workforce (Hainline & Wells, 2019). Despite the indication of the importance of students developing these skills and the widespread presence of SBAE laboratories in schools across the nation, research has indicated SBAE teachers lack the competence and experience needed to effectively teach laboratory-based courses (Burris et al., 2005; Hainline & Wells, 2019; Shoulders, 2012).

Burris et al. (2005), conducted a study assessing the pre-service preparation of SBAE teachers in agricultural mechanics to determine their level of preparedness in terms of knowledge and technical skills. Findings from this study highlighted deficiencies in pre-service teacher training in multiple areas of agricultural mechanics, such as metal fabrication and electrical systems (Burris et al., 2005). Hainline and Wells (2019) discovered a plethora of technical skills (e.g., wiring three-way electrical circuits, using framing squares, land measurement, plasma cutting, etc.) and teacher skills (e.g., maintaining gas metal arc welding [GMAW] machines, recognizing unsafe equipment / conditions, knowledge of personal protective equipment [PPE], implementing proper laboratory clean up procedures) were needed by SBAE teachers in Iowa. Hainline and Wells (2019) recommended that agricultural teacher preparation programs could use their findings to reframe the training (e.g., courses) that pre-service SBAE teachers undergo to ensure career readiness for their pre-service teachers.

Teacher educators are charged with preparing SBAE teachers to have both content-specific knowledge and technical skill knowledge to be considered an expert, all while constantly adapting and staying abreast with new technologies and practices in the field (Roberts & Ball, 2009). Research indicates that if pre-service teachers are not adequately prepared to teach, manage, and facilitate learning activities in SBAE laboratories, this could be the impetus for SBAE teacher attrition (Albritton & Roberts, 2020). Pre-service SBAE teachers need in-depth training to meet the needs of the agricultural curricula and receive continued professional development opportunities throughout their early careers (Blackburn & Robinson, 2008). Previous researchers have recommended training should consist of curriculum development, student learning styles, laboratory management skills, teaching methods and techniques, and incorporating core subjects in CTE content (Dobbins et al., 2003; Ruhland et al., 2002). Concerning laboratory management skills, preservice teachers will soon be tasked with the responsibility of managing various laboratories commonly found in SBAE programs such as greenhouses, mechanics laboratories, carpentry shops, and welding laboratories (Shoulders & Myers, 2012). This prominent responsibility of SBAE teachers in SBAE programs begs the question: what technical and pedagogical coursework are teacher preparation programs implementing to prepare preservice teachers to be competent in laboratory management?

Having adequate training would prepare teachers to manage, facilitate, and teach in agricultural education laboratories, which has multiple benefits for the teacher, students, and stakeholders (Smalley et al., 2019). This study sought to discover laboratory-based course offerings and the nature of these courses (e.g., course availability, course requirement, pedagogical focus, etc.) at institutions across the country to provide a snapshot of the current state of laboratory training for pre-service SBAE teachers. In addition to discovering the availability of laboratory courses, we also sought to understand teacher educators'

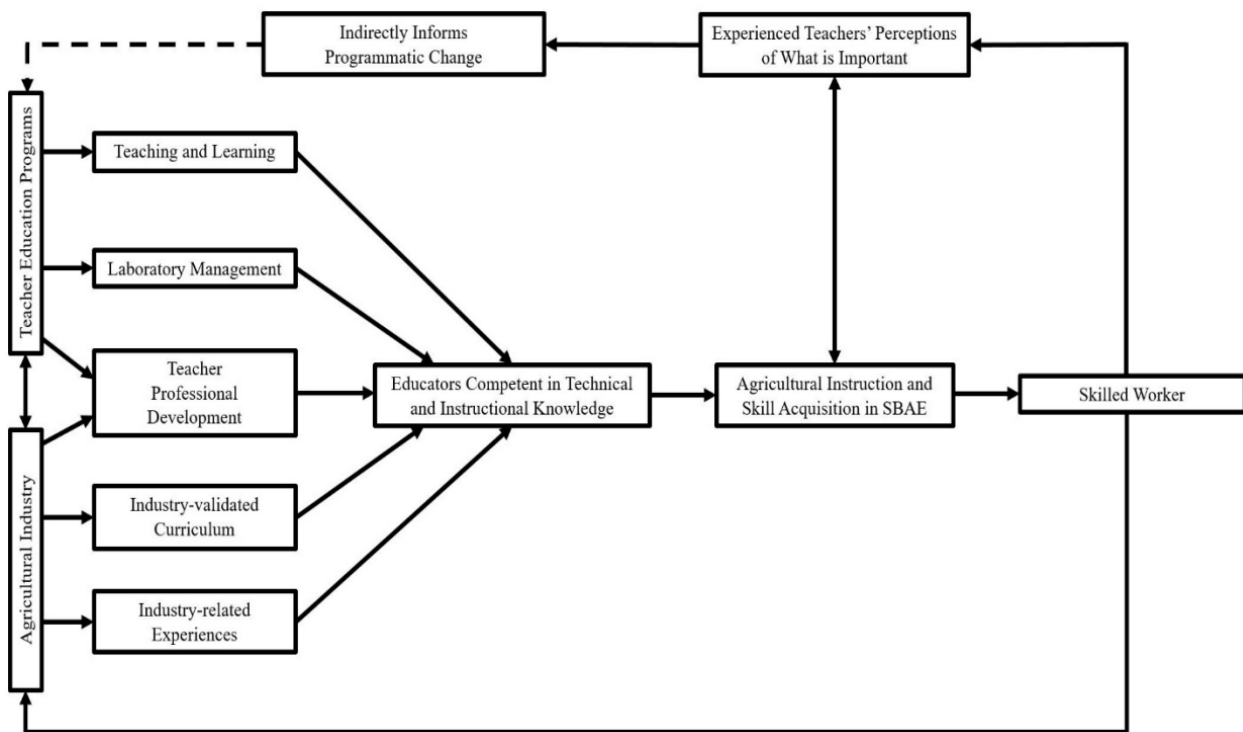
perceptions regarding the possible need for expansion of laboratory-based teacher preparation coursework / field-based experiences.

Conceptual Framework

This study was conceptually guided by Wells et al.’s (2021) agricultural teacher education and agricultural industry partnership model (see Figure 1).

Figure 1

The Agricultural Teacher Education and Agricultural Industry Partnership Model (Wells et al., 2021)



Wells et al. (2021) indicated this framework outlines the development of “SBAE teachers that purposefully includes training in teaching and learning, laboratory management, and technical knowledge while engaging with industry to ensure curricula and professional development are keeping pace with the ever-changing technical needs of the agricultural industry” (p. 162). The current study focused on the teacher education programs portion of this model. Specifically, we sought to identify how teacher education programs across the nation were providing teaching and learning and laboratory management training for preservice SBAE teachers.

Based on Wells et al.’s (2021) model, these aspects (i.e., teaching and learning and laboratory management) in conjunction with teacher professional development contribute to educators being competent in technical and instructional knowledge. Preservice teachers’ development of competency in laboratory management has commonly been cited as an important aspect of teacher education programs (Burris et al., 2005; Hainline & Wells, 2019; Tummons et al., 2017; Wells et al., 2017). Therefore, this study sought to discover what laboratory courses were being offered to prepare pre-service teachers to teach, manage, and facilitate learning activities in SBAE laboratories, and determine teacher educators’ perceptions regarding laboratory training.

Purpose and Objectives

The purpose of this study was to identify the courses / subject matter and training offered to pre-service SBAE teachers in laboratory settings. The following three objectives guided this qualitative study.

1. Describe the institutional characteristics of the SBAE teacher education preparation programs that responded to this study.
2. Identify the laboratory-based courses offered at SBAE teacher education preparation institutions and determine if each course is required and has a pedagogical focus.
3. Determine SBAE teacher educators' perceptions regarding possible needs or changes regarding preparing pre-service teachers associated with laboratory competencies.

This study aligns with Research Priority Three in the National Research Agenda (NRA) of the American Association of Agricultural Education (AAAE) (Stripling & Ricketts, 2020). Specifically, Research Priority Three specified the need to identify the competencies needed by the Agriculture, Food, and Natural Resource (AFNR) workforce which explicitly links to the purpose and objectives of this research study.

Methods and Procedures

This descriptive sought to determine the course offerings at various universities across the United States of America associated with the preparation of SBAE pre-service teachers related to teaching, managing, and facilitating learning activities in laboratories found within SBAE programs. In addition, we examined teacher educators' perceptions on the need to expand laboratory training in each laboratory area.

Instrumentation

The instrument used in this study contained 25 items and was developed and distributed via the Qualtrics survey platform. Four items were focused on identifying the institutional characteristics of the respondents. These items asked the respondents to identify their institutional classification (i.e., 1862 Land-grant institution, 1890 (HBCU) Land-grant institution, Regional (Public) institution, Private institution), types of degrees offered in Agricultural Education (i.e., Bachelors / Masters), credit hours requirements for degree programs, and the average student enrollment in teacher certification program.

The remaining 21 items focused on determining the availability and delivery format of laboratory-based courses offerings at each institution. Using prior research (Burris et al., 2005; Franklin, 2008; Shoulders & Myers, 2012) a list of laboratories commonly found in SBAE programs was compiled and organized into four main categories: (1) General Mechanics, (2) Plant Science, (3) Animal Science, and (4) Food Science. Within each category, specific subjects (e.g., Plant Science - Greenhouse Management, Forestry) were placed.

For each item, the teacher educators were prompted to specify if: (1) the course/portion of a course was currently available at their institution, (2) does the course have a pedagogical focus, (3) is the course required for pre-service teachers, and (4) if they felt instruction on this topic needed expansion. Regarding the availability of laboratory-based training on each topic, respondents were asked to specify whether the topic was offered as a stand-alone course, if the content was embedded in another course, or if it was not offered at their institution. The respondents were prompted to respond with a "yes" or "no" on the items pertaining to the pedagogical focus and if it was required coursework for teacher certification students.

The Agricultural Education teacher educators' perceptions regarding the need for expansion in coursework for each given laboratory-based contexts was assessed on a five-point scale (1 = *No Need* [NN], 2 = *Limited Need* [LN], 3 = *Moderate Need* [MN], 4 = *Significant Need* [SN], 5 = *Very Significant Need* [VSN]).

Participants

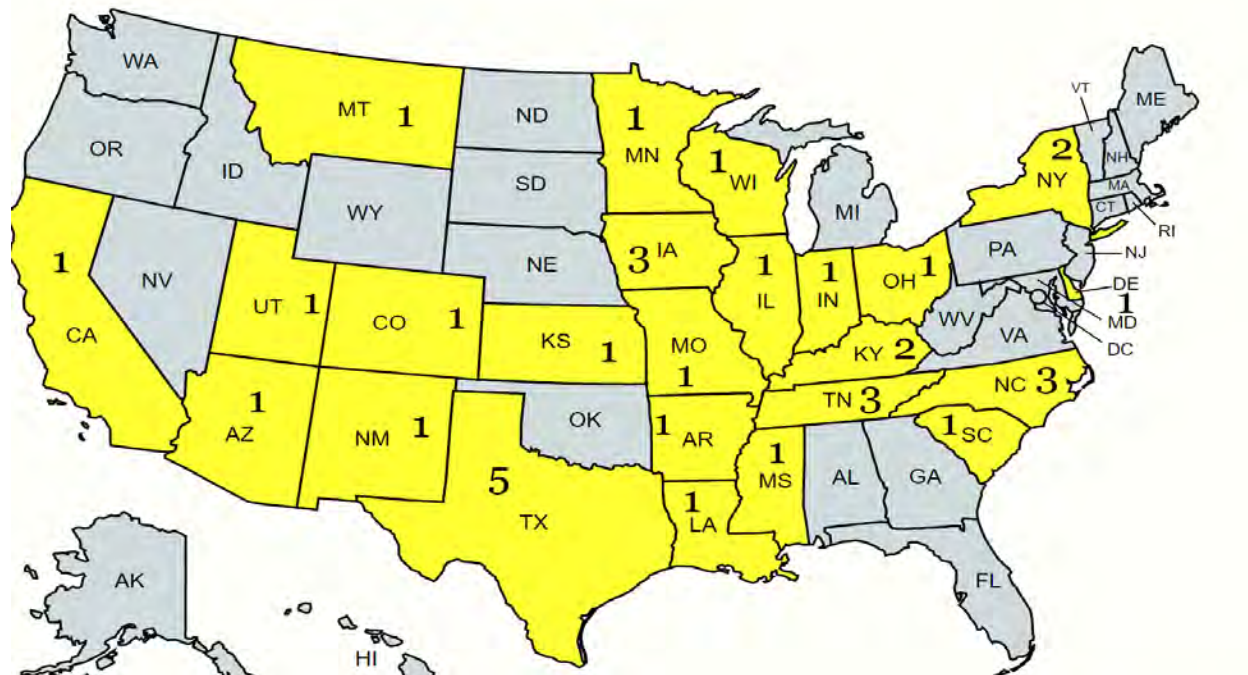
The target population for this study was Agricultural Education faculty members who served as teacher education coordinators at various institutions across the United States of America. We sought out the teacher education coordinators due to the amount of knowledge about laboratory-based courses that were available to pre-service SBAE teachers and laboratory course availability (e.g., if the course is a stand-alone course, if the course / content is embedded into another course). The publicly available, interactive map of Agricultural Education Programs on The National Association of Agricultural Educators (NAAE) website served as a frame for determining the population in this study. The NAAE “Find a College” map provides links to the websites of the SBAE teacher certification entities at each institution. While this was the most comprehensive, publicly available list of Agricultural Education institutions, the institutions which are not affiliated with NAAE, or not included on the map by possible error serve as frame error.

The contact information of the teacher educators was derived from their departmental website. A total of 107 institutions / SBAE teacher education coordinators were identified through this search and were invited to participate in this study.

We had 33 agricultural teacher educators respond to our survey instrument, yielding a response rate of 30.8%. The figure below represents the states and how many institutions were represented in our study (see Figure 2).

Figure 1

Agricultural Education Universities Represented in This Study.



Validity and Reliability

The survey instrument was sent to a panel of experts (i.e., three Agricultural Education faculty members) to review for face and content validity. Each faculty member on the panel of experts was purposively selected to bring unique perspectives and experiences related to teaching in Agricultural Education laboratories. Moreover, the panel members were not included in the target population for this study. Panel member one was an associate professor at a regional university in a southern state, who currently teaches multiple laboratory-based courses. Panel member two was an associate professor at a Midwestern regional university who has taught multiple laboratory-based courses at both secondary and post-secondary levels and has created laboratory-based courses for his department for SBAE students. Panel member three was an assistant professor at a regional university in a southern state. At the time of the review, the panel member was currently instructing five undergraduate courses related to agricultural mechanics. We sent each panel member an email which included a description of the proposed study, a copy of the survey instrument, and a panel of experts form. The panel of experts form included instructions about the instrument and asked each panel member to assess the instrument for face and content validity. Augmentations were made to the instrument based on the feedback received from the panel (e.g., reworded items as recommended, reorganized the sequence of items) and the instrument was considered content and face valid.

Before data collection, we conducted a pilot study to evaluate the reliability of the survey instrument. The pilot study was conducted the semester before the formal study and included 25 agricultural education faculty members which were not listed as the teacher education coordinators at their respective institutions but were involved in SBAE teacher education. As recommended by Dillman et al. (2014), we sent a total of four iterations of contacts (i.e., pre-notice email about the study, initial invitation to the study, first reminder email, and final reminder email) to recruit participants for this pilot study. A reliability analysis was conducted on attitudinal data collected in the pilot study yielding a Cronbach's alpha coefficient of .95, which was deemed to be an acceptable level of reliability according to the interpretations provided by George and Mallery (2003). The reliability of the survey instrument in the official study was assessed by conducting a post-hoc reliability test. Similar to the results in the pilot study, the correlation coefficient ($\alpha = .91$) in the post-hoc test yielded an "Excellent" level of reliability (George & Mallery, 2003).

Data Collection

Data collection was conducted using the Qualtrics Survey Platform. We sent an email to all of the SBAE teacher educators identified on the NAAE interactive map of Agricultural Education Programs. Multiple contacts were made with the teacher educators to bolster the response rate (Dillman et al., 2014). Specifically, a total of five contacts were made via email: (1) pre-notice about study, (2) initial invitation to participate in study, (3) first reminder, (4) second reminder, and (5) third and final reminder / thank you email to respondents. The emails contained description of the study, the time commitment associated with participating in the study, the IRB-approved consent form, and a link to access the Qualtrics survey instrument.

A total of 33 Agricultural Education teacher educators responded in the formal study, which yielded a response rate of 30.8%. The "double-dip" method was used to assess non-response error (Linder et al., 2013; Miller & Smith, 1983). A random sample of 15% of the non-respondents were emailed again and the responses of the non-respondents were compared to the responses of the respondents in this study. We were able to gather 10 responses from the 15% of non-respondents selected in this study. No significant differences were identified based on the independent samples *t*-test ($t(41) = -1.2, p = .18$) we conducted to compare the two groups (i.e., respondents and non-respondents).

Data Analysis

Data were analyzed using IBM® Statistical Package for the Social Sciences (SPSS®). For objective one, we conducted descriptive statistics (i.e., means, standard deviations, frequencies and percentages) to evaluate the institutional characteristics of the teacher education programs included in this study. The second objective, the identification of the characteristics of laboratory-based courses offered at the post-secondary institutions, was analyzed by calculating the frequencies and percentages of responses related to the availability of laboratory coursework, the pedagogical focus of the courses, and the required nature of the class for teacher certification students. The perceptions of the teacher educators associated with the possible needs or changes regarding preparing pre-service teachers associated with laboratory competencies was assessed by calculating the frequencies, percentages and modes for each laboratory-based topic.

Results

This research instrument sought to discover the laboratory-based courses which were currently being offered at SBAE teacher certifying universities. A total of 33 teacher educators, representing 33 unique institutions, responded to this survey instrument. Of the Agricultural Education teacher educators which responded in this study, 15 (45.5%) were on faculty at Land-grant universities, 11 (33.3%) worked at regional (public) universities, four (12.1%) led the teacher education program at private universities, two (6.1%) were at 1890 (HBCU) universities, and one faculty member (3.0%) worked at a Hispanic serving institution (see Table 1).

Table 1

Demographics of Teacher Education Programs

Characteristic	<i>f</i>	%
University Classification		
Land-grant institution	5	45.5
Regional (Public) institution	1	33.3
Private institution		12.1
1890 (HBCU) institution	2	6.1
Other – Hispanic Serving Institution	1	3.0
Types of Degrees Offered		
Master’s	1	63.6
Bachelor’s	2	100.0

Note. One university did not respond to offering a bachelor’s degree.

These institutions reported an average of 118.8 (*SD* = 23.9) credit hours for a bachelor’s degree and an average of 53.5 (*SD* = 84.4) credit hours for a master’s degree in Agricultural Education. At the time of this study, the programs had an average of 32.9 (*SD* = 38.3) students enrolled in the bachelor’s and master’s Agricultural Education programs. When respondents were asked about the degrees offered at their institutions, 32 indicated they offered bachelor’s degrees in Agricultural Education while 21 of the institutions offered master’s degrees in Agricultural Education.

Concerning the teacher educators’ responses on General Mechanics, a majority (*f* = 28; 84.8%) of the respondents indicated having a stand-alone course in Agricultural Mechanics, four respondents (12.1%) indicated their university embed Agricultural Mechanics into another course, and one (3.0%) reported Agricultural Mechanics was not available at their institution. Slightly over half (*f* = 18; 56.3%) of the respondents reported having a stand-alone course in Welding / Metal Fabrication, 12 respondents

(37.5%) indicated their university embed Welding / Metal Fabrication into another course, and two (6.3%) reported Welding / Metal Fabrication was not available to their students. Thirty-one universities (96.9%) required Agricultural Mechanics and 26 universities (83.9%) required a Welding / Metal Fabrication course for pre-service agricultural educators. Sixteen universities (51.6%) indicated their Agricultural Mechanics course had a pedagogical focus and nine (32.1%) respondents indicated their Carpentry course had a pedagogy focus (see Table 2).

Table 2

Availability and format of Laboratory-based courses offered in General Mechanics.

Course / Content	n	f(%)			n	Required Course?		n	Pedagogy Focus?	
		Stand-alone	Embedded	Not Offered		Yes	No		Yes	No
		Agricultural Mechanics	33	28 (84.8)		4 (12.1)	1 (3.0)		32	31 (96.9)
Carpentry	33	7 (21.2)	20 (60.6)	6 (18.2)	29	19 (65.5)	0 (34.5)	28	32.1)	19 (67.9)
Welding/Metal Fabrication	32	18 (56.3)	12 (37.5)	2 (6.3)	31	26 (83.9)	(16.1)	31	19.4)	25 (80.6)
Biotechnology	31	6 (19.4)	11 (35.5)	14 (45.2)	25	9 (36.0)	6 (48.5)	25	17.4)	19 (82.6)
Farm Power	7	7 (21.0)	1 (3.0)	1 (3.0)	8	5 (15.2)	3 (9.1)	8	5 (15.2)	3 (9.1)

Along with Agricultural Mechanics coursework, the teacher educators were also asked to provide detail on the course offerings at their universities related to Plant Science. For the course / content of Greenhouse Management, 20 universities (64.5%) reported having a stand-alone course, nine universities (29.0%) embed it into another course, and two (6.1%) universities did not offer a course in Greenhouse Management. For the course / content of Turf Grass Management, 16 institutions (51.6%) reported this course was offered as a stand-alone course, seven institutions (22.6%) embed this content into another course, and eight institutions (25.8%) did not offer a course / content in Turf Grass Management. For the course / content of Forestry, 12 institutions (38.7%) reported they offered this content in a stand-alone course, four institutions (12.9%) embed it into another course, and 15 institutions (48.4%) did not offer a course / content in Forestry.

Fourteen universities (46.7%) required Greenhouse Management, and five universities (17.2%) required Turf Grass Management courses / content for pre-service agricultural educators. Three universities (13.6%) required Forestry for pre-service agricultural educators, and 19 (86.4%) institutions indicated they did not require pre-service teachers to take this course / content. A total of six universities (19.4%) indicated their Greenhouse Management course has a pedagogical focus and only two universities (7.1%) indicated

their Turf Grass Management course has a pedagogical focus. Moreover, two universities (8.3%) indicated their Forestry course has a pedagogy focus (see Table 3).

Table 3

Availability and Format of Laboratory-based Courses Related to Plant Science.

Course / Content	n	f(%)			n	Required Course?		n	Pedagogy Focus?	
		Stand-alone	Embedded	Not Offered		Yes	No		Yes	No
		Greenhouse Management	31	20 (64.5)		9 (29.0)	2 (6.1)		30	14 (46.7)
Landscape Design	31	12 (38.7)	9 (29.0)	10 (32.3)	27	5 (18.5)	22 (81.5)	2 9	3 (10.3)	26 (89.7)
Hydroponics	31	4 (12.9)	16 (51.6)	11 (35.5)	26	7 (26.9)	19 (73.1)	2 7	2 (7.4)	25 (92.6)
Forestry	31	12 (38.7)	4 (12.9)	15 (48.4)	22	3 (13.6)	19 (86.4)	2 4	2 (8.3)	22 (91.7)
Nursery / Orchard / Grove Mgmt.	30	12 (40.0)	11 (36.7)	7 (23.3)	28	6 (21.4)	22 (78.6)	2 7	4 (14.8)	23 (85.2)
Turf Grass Mgmt.	31	16 (51.6)	7 (22.6)	8 (25.8)	29	5 (17.2)	24 (82.8)	2 8	2 (7.1)	26 (92.9)
Viticulture	30	9 (30.0)	3 (10.0)	18 (60.0)	25	2 (8.0)	23 (92.0)	2 4	2 (8.3)	22 (91.7)

The teacher educators were also asked to provide detail on the course offerings at their universities related to Animal Science. For the course / content of Livestock Management, 25 universities (78.1%) reported it was offered as a stand-alone course, five universities (15.6%) noted this content was embed it into another course, and two universities (6.3%) did not offer a course / content in Livestock Management.

For the course / content of Equine Science, 24 universities (75.0%) reported offering this as a stand-alone course, three universities (9.4%) embed it into another course, and five universities (15.6%) did not offer a course / content related to Equine Science. Twenty universities (64.5%) required Livestock Management and seven universities (25.9%) required Wildlife Management courses / content for pre-service Agricultural Educators teachers. The three course content areas which were most frequently infused with a pedagogical component were Livestock Management ($f = 3$, 9.4%), Apiculture ($f = 2$, 7.4%), Equine Science ($f = 2$, 6.5%) and Aquaculture / Aquatic Sciences ($f = 2$, 6.5%; see Table 4).

Table 4

Availability and Format of Laboratory-based Courses Related to Animal Science

Course / Content	f (%)				n	Required Course?		n	Pedagogy Focus?	
	n	Stand-alone	Embedded	Not Offered		Yes	No		Yes	No
Livestock Management	32	25 (78.1)	5 (15.6)	2 (6.3)	31	20 (64.5)	11 (35.5)	32	3 (9.4)	29 (90.6)
Small / Companion Animal Management	32	16 (50.0)	8 (25.0)	8 (25.0)	27	5 (18.5)	22 (81.5)	29	1 (3.4)	28 (96.6)
Poultry Science	32	11 (34.4)	10 (31.3)	11 (34.4)	26	5 (19.2)	21 (80.8)	28	1 (3.6)	2 (7.4)
Apiculture (Beekeeping)	32	8 (25.0)	2 (6.3)	22 (68.7)	25	2 (8.0)	23 (92.0)	27	2 (7.4)	25 (92.6)
Equine Science	32	24 (75.0)	3 (9.4)	5 (15.6)	28	5 (17.9)	23 (82.1)	31	2 (6.5)	29 (93.5)
Veterinarian Science	32	17 (53.1)	8 (25.0)	7 (21.9)	27	3 (11.1)	24 (88.9)	29	1 (3.4)	28 (96.6)
Wildlife Management	32	18 (56.3)	5 (15.6)	9 (28.1)	27	7 (25.9)	20 (74.1)	30	1 (3.3)	29 (96.7)
Aquaculture / Aquatic Sciences	32	9 (28.1)	8 (25.0)	15 (46.9)	28	4 (14.3)	24 (85.7)	31	2 (6.5)	29 (93.5)

Lastly, teacher educators were asked to provide detail on the course offerings at their universities related to Food Science. For the course / content of Meat Sciences, 23 universities (71.9%) reported it as a stand-alone course, three universities (9.4%) embed it into another course, and six universities (18.8%) did not offer Meat Sciences courses / content. Nine universities (29.0%) required Meat Sciences for pre-service agricultural educators and only one university (3.1%) indicated their Meat Sciences course had a pedagogical focus. In regard to Food Science Courses / content, over half (56.3%) of the respondents indicated they offered this topic as a stand-alone course. Moreover, only seven (22.6%) institutions indicated they require teacher certification students to take this course, and only one (3.2%) respondent noted that their Food Science course had a pedagogical focus.

Table 5

Availability and Format of Laboratory-based Courses Related to Food Science.

Course / Content	f (%)				n	Required Course		n	Pedagogy Focus?	
	n	Stand-alone	Embedded	Not Offered		Yes	No		Yes	No
Food Sciences	32	18 (56.3)	5 (15.6)	9 (28.1)	32	7 (22.6)	24 (77.4)	3	1 (3.2)	30 (96.8)
Meat Sciences	32	23 (71.9)	3 (9.4)	6 (18.8)	31	9 (29.0)	22 (71.0)	3	1 (3.1)	31 (96.9)

The third research objective was to determine the teacher educators' perceptions regarding possible needs or changes regarding laboratory-based training and related course offerings. For each laboratory-based course / content, the respondents were asked to gauge their perceptions for the need of expansion of instruction on each topic on a five-point scale (1 = *No Need (NN)*, 2 = *Limited Need (LN)*, 3 = *Moderate Need (MN)*, 4 = *Significant Need (SN)*, 5 = *Very Significant Need (VSN)*).

Metal / Welding Fabrication was the only course to have a mode of five, *Very Significant Need (VSN)* and three, *Moderate Need (MN)*. There were 11 courses with a mode of three, *Moderate Need (MN)*, and one course, Equine Science, with a split mode of three, *Moderate Need (MN)*, and two *Limited Need*

(LN). There were six courses with a mode of two, *Limited Need (LN)* and two courses, Veterinary Science and Aquaculture / Aquatic Sciences, with a split mode of two, *Limited Need (LN)*, and three, *Moderate Need (MN)*.

The course with the highest need for expansion was Metal / Welding Fabrication, which also had a split mode of five, *Very Significant Need (VSN)* and three, *Moderate Need (MN)*. A total of seven respondents (23.3%) indicated a *Very Significant Need (VSN)* for expansion and seven respondents (23.3%) noted a *Moderate Need (MN)* for expansion.

The top three courses for mode three (MN) were Agricultural Mechanics, Poultry Science, and Carpentry. In the content area of Agricultural Mechanics, 13 teacher educators (41.9%) indicated a *Moderate Need (MN)* for expansion. For the content area of Poultry Science, 12 teacher educators (42.9%) indicated a *Moderate Need (MN)* for instruction expansion; for the content area of Carpentry, 12 teacher educators (40.0%) indicated a *Moderate Need (MN)* to expand instruction (see Table 6).

Table 5

Teacher Educators' Perceptions on Expanding Instruction in Lab-based Content Areas.

Content Area	f (%)						Mode
	n	1 NN	2 LN	3 MN	4 SN	5 VSN	
Welding / Metal Fabrication	30	6 (20.0)	6 (20.0)	7 (23.3)	4 (13.3)	7 (23.3)	5/3
Agricultural Mechanics	31	2 (6.5)	6 (19.4)	13 (41.9)	4 (12.9)	6 (19.4)	3
Poultry Science	28	6 (21.4)	6 (21.4)	12 (42.9)	2 (7.1)	2 (7.1)	3
Carpentry	30	5 (16.7)	7 (23.3)	12 (40.0)	2 (6.7)	4 (13.3)	3
Hydroponics	24	3 (12.5)	6 (25.0)	11 (45.8)	3 (12.5)	1 (4.2)	3
Food Science	29	4 (13.8)	5 (17.2)	11 (37.9)	7 (24.1)	2 (6.9)	3
Landscape Design	25	4 (16.0)	8 (32.0)	10 (40.0)	3 (12.0)	0	3
Wildlife Management	28	4 (14.3)	6 (21.4)	10 (35.7)	5 (17.9)	3 (10.7)	3
Equine Science	28	4 (14.3)	10 (35.7)	10 (35.7)	3 (10.7)	1 (3.6)	3/2
Greenhouse Management	27	4 (14.8)	4 (14.8)	9 (33.3)	3 (11.1)	7 (25.9)	3
Small Companion Animal Management	28	5 (17.9)	6 (21.4)	9 (32.1)	7 (25.0)	1 (3.6)	3
Biotechnology	24	1 (4.2)	5 (20.8)	8 (33.3)	7 (29.2)	3 (12.5)	3
Meat Science	30	6 (20.0)	7 (23.3)	8 (26.7)	7 (23.3)	2 (6.7)	3
Nursery / Orchard / Grove Management	25	3 (12.0)	11 (44.0)	7 (28.0)	3 (12.0)	1 (4.0)	2
Viticulture	25	7 (28.0)	11 (44.0)	4 (16.0)	2 (8.0)	1 (4.0)	2
Turf Grass Management	27	6 (22.2)	10 (37.0)	5 (18.5)	5 (18.5)	1 (3.7)	2
Apiculture (Beekeeping)	27	7 (25.9)	9 (33.3)	7 (25.9)	2 (7.4)	2 (7.4)	2
Veterinary Science	28	4 (14.3)	9 (32.1)	9 (32.1)	2 (7.1)	4 (14.3)	2/3

Table Continued

Livestock Management	29	5 (17.2)	9 (31.0)	8 (27.6)	3 (10.3)	4 (13.8)	2
Aquaculture / Aquatic Sciences	27	6 (22.2)	8 (29.6)	8 (29.6)	4 (14.8)	1 (3.7)	2/3
Forestry	23	4 (17.4)	7 (30.4)	6 (26.1)	5 (21.7)	1 (4.3)	2
Farm Power	8	1 (3.0)	2 (6.1)	1 (3.0)	1 (3.0)	1 (3.0)	2

Note. 1 = No Need (NN), 2 = Limited Need (LN), 3 = Moderate Need (MN), 4 = Significant Need (SN), 5 = Very Significant Need (VSN)

A total of seven courses / areas of content (i.e., Nursery / Orchard / Grove Management; Viticulture; Turf Grass Management; Apiculture (Beekeeping); Livestock Management; Forestry; Farm Power) had a mode of two, which indicated the teacher educators perceived a *Limited Need* for expansion on these topics. Courses / content areas such as Equine Science, Veterinary Science, and Aquaculture / Aquatic Sciences were bimodal with an equal number of respondents indicating a *Limited* and *Moderate* need for expansion.

Conclusions, Limitations, Implications, & Recommendations

This study produced an extensive list of laboratory-based courses that were offered to prepare pre-service SBAE teachers to teach, manage and facilitate learning activities in secondary agricultural education laboratories. The courses were categorized into four areas: General Mechanics, Plant Science, Animal Science, and Food Science. The most commonly offered laboratory-based coursework for preservice teachers were Agricultural mechanics ($n = 33$, %) Livestock Management ($n = 20$, 64.5%)

We discovered 28 (84.8%) of the agricultural teacher education programs ($n = 33$) offered an Agricultural Mechanics course, 25 programs (78.1%) offered a Livestock Management course, 20 (64.5%) offered a Greenhouse Management course, and 18 (56.3%) offered a Welding / Metal Fabrication course. Of all the laboratory-based courses the universities ($n = 33$) offered, 31(96.9%) universities required pre-service teachers to take Agricultural Mechanics, 26 (83.9%) universities required Welding / Metal Fabrication, 20 (64.5%) universities required Livestock Management, and 14 (46.7%) universities required Greenhouse management for pre-service SBAE teachers. The teacher educators' responses regarding the laboratory-based course offerings and degree requirements for preservice teachers coincide with the laboratories which are most commonly found in SBAE programs (Franklin, 2008; Phipps et al., 2008; Shoulders & Myers, 2012; Twenter & Edwards, 2017).

While all teacher education programs in this study offered an agricultural mechanics course, and 96.9% of the programs required preservice teachers to take these courses as part of their certification requirements, the teacher's educators still noted the need for expansion associated with agricultural mechanics training. In fact, 23.3% of the teacher educators signified there was a *Very Significant Need* to expand instruction in Welding / Metal Fabrication. This notion for the need of expansion of agricultural mechanics courses reverberates findings and recommendations from former studies (Burris et al., 2005; Ford et al., 2008). The need for further training on these topics is further bolstered based on the lack of preservice teacher preparation to teach agricultural mechanics content (Blackburn et al., 2015; Granberry et al., 2021). Aside from agricultural mechanics training, the teacher educators also expressed a need for expansion on preservice preparation in greenhouse management. Over a quarter of the respondents noted there was a *Very Significant Need* for expansion. Franklin (2008) recommended that the training on greenhouse management should focus on the components and operation of a greenhouse along with pedagogical aspects.

The results of this study are congruent with other studies (Burris et al., 2005; Hainline & Wells, 2019; Wells et al., 2021) indicating a significant need for expanding laboratory instruction for pre-service teachers. These researchers' literature shows an increased exposure in laboratory settings (i.e., laboratory-based courses, PD, etc.) to students will help close the gap found in pre-service SBAE teachers' laboratory competencies. Per Phipps et al., (2008), Hainline and Wells (2019), and Wells et al., (2021), SBAE teachers who can effectively use SBAE laboratories have the opportunity to provide students with a plethora of skills that they can develop, hone, and apply in preparation for career readiness.

Furthermore, the need for effective and adequately trained SBAE teachers that can collaborate with industry and develop well-prepared students to enter the workforce is a skill that pre-service SBAE teachers should obtain (Hainline & Wells, 2019). Burris (2005), Hainline and Wells, (2019), Wells et al., (2017), and Tummoms et al., (2017), reported that SBAE teacher educators, expert SBAE teachers, and industry representatives alike, agree that there is an immediate and paramount need for extensive training for pre-service teachers in technical laboratories.

Previous Agricultural Education researchers have postulated that an increase in training of laboratory management would better prepare pre-service teachers to be able to teach, manage, and facilitate learning activities in agricultural education laboratories, and further laboratory preparation would help contribute to teacher retention. (Albritton & Roberts, 2020; Burris et al., 2005; Burris et al., 2010; Hainline & Wells, 2019; Ingersoll et al., 2014; Papay et al., 2017; Phipps et al., 2008; P. R. Saucier et al., 2014) who postulate Studies such as (Burris et al., 2010; Ingersoll et al., 2014; Papay et al., 2017).

A limitation of this study was the failed attempt to reach a full census. We recommend this study be completed by using a probabilistic sample so the results can be made more generalizable and inferred upon the population. Based on this limitation, the results of this study should not be generalized to all teacher education programs.

Reflecting on the agricultural teacher education and agricultural industry partnership model (Wells et al., 2021) these laboratory management courses offered across the various institutions serve to prepare preservice teachers to be competent educators in technical knowledge. Aside from technical knowledge, the model also indicates the need for pedagogical training to enhance the preservice teachers' instructional knowledge. Collectively, the teacher educators signified that 40 of the general mechanics courses were enhanced with a pedagogical component, and a total of 21 plant science classes included a focus on pedagogy. Additionally, 13 animal science courses and two food science courses had a pedagogy focus. When teaching and learning are listed as a crucial antecedent to preparing competent educators (Wells et al., 2021), what can explain the deficit of courses taught with a pedagogical focus? Possibly the disequilibrium between the number of pedagogy enriched courses associated with general mechanics and other contests (e.g., animal science or food science) can be attributed to fact that most general mechanics teacher education courses are taught by teacher educators at the various teacher education programs. Teacher educators should carefully evaluate this discrepancy and determine how these laboratory-based courses could be enhanced by incorporating methods components. This might involve the collaboration between teacher educators and faculty members outside of the teacher preparation program. Moreover, in various context where the incorporation of pedagogy aspects might be difficult, teacher educators should offer teacher professional development to bolster the preparedness of inservice teachers.

We further recommend that teacher education programs use this list of laboratory-based courses as a guide to reframe their curriculum to help close the gap in laboratory deficiencies found in their pre-service teachers. These course offerings, or lack thereof, could be compared to the deficiencies found within pre-service SBAE teachers, thus each agricultural teacher prep program would know which courses they should offer to bolster pre-service teachers' competencies.

As the agriculture industry continues to evolve, becoming more efficient and highly productive, the ever-growing gap of people who lived and worked on a farm, and which by doing so, obtained a certain level of agricultural skills (e.g., asexual propagation techniques, general knowledge of electrical systems, mechanical functions, animal care, etc.), is widening (Moore, 1994; Moore, 1987; Myers & McKnight, 2010). Thus meaning, individuals who desire to become SBAE teachers may not be getting the same farm experience as the previous generation of agricultural educators.

Perhaps this generation of aspiring agricultural educators needs more technical skills due to a societal shift in moving away from an agrarian-based economy to an urban-based economy. Perhaps administration in higher education (i.e., agricultural teacher prep institutions), stakeholders, and school systems view 'agricultural mechanics' type skills as dated and no longer needed. It is paramount that pre-service SBAE teachers be prepared to teach in a variety of laboratories and as the agricultural industry advances creating new and relevant skills, the subjects, practices, and equipment used in SBAE laboratories should reflect those advancements and be implemented into teacher training.

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