© Journal of Agricultural Education
Volume 53, Number 2, pp 124–138
DOI: 10.5032/jae.2012.02124

Teachers' Use of Agricultural Laboratories in Secondary Agricultural Education

Catherine W. Shoulders, Graduate Assistant
Brian E. Myers, Associate Professor
University of Florida

Trends in the agriculture industry require students to have the ability to solve problems associated with scientific content. Agricultural laboratories are considered a main component of secondary agricultural education, and are well suited to provide students with opportunities to develop problem–solving skills through experiential learning. This study serves to examine the current availability and use of agricultural laboratories in secondary agricultural education, as well as their relationship to teacher perceptions regarding student learning, preparation requirements, and barriers to their use. Findings indicate that while many facilities are available and frequently used during instruction, teacher perceptions of student learning, preparation requirements, and barriers vary by facility.

Keywords: facilities, laboratory, agricultural education, teachers

Introduction/Theoretical Framework

Trends in the agriculture industry signal a need for agricultural education to teach scientific problem solving, spurring the United States Department of Agriculture to recommend that students seeking future employment in the agriculture industry have "basic science skills and the ability to solve problems with scientific applications" (USDA, 2005, p. 12). With the widespread assumption that secondary agriculture teachers make use of agricultural laboratories (Franklin, 2008; McCormick, 1994; Newcomb, McCracken, Warmbrod, & Whittington, 2004; Phipps, Osborne, Dyer, & Ball, 2008), those concerned with the improvement of science understanding through applied learning should have reason to be optimistic. By its very nature, agricultural education is in an ideal position to teach scientific content through an agricultural context (Enderlin & Osborne, 1992; NRC, 2009; Thompson, 1998; Washburn & Myers, 2008). However, many of the activities designed for use in agricultural laboratories focus on the improvement of psychomotor skills rather than the reinforcement of academics (Franklin, 2008; Johnson, Wardlow, & Franklin, 1997).

Agricultural laboratories, which can include mechanics laboratories, greenhouses, livestock facilities, land laboratories, and aquaculture laboratories, among others, are currently understood as a means for providing students practice in application of theories taught in the classroom (McCormick, 1994); however, the emergence of scientific agricultural education may provide opportunity for these laboratories to become a keystone in the teaching of scientific skills and problem solving. By designing laboratory instruction to focus on scientific problem solving, teachers can enhance student experiences to prepare them more effectively for scientifically–based careers in agriculture (Parr & Edwards, 2004). However, little research has been conducted on the current use of agricultural laboratories. The Agricultural Education and Communication National Research Agenda identified the determination of the relationship between instructional strategies and student achievement as a top priority initiative in order to increase the value of agricultural education on student achievement in science (Doerfert, 2011). This study served to address this priority initiative by investigating how teachers' access to and current use of agricultural laboratories may be associated with their perceptions of student learning, necessary preparation, and teaching barriers. Further, this study served as a starting point for an exploration into the value of one of the cornerstone components of agricultural education and its utility in improving student achievement in scientific problem solving through experiential learning.

The connection between teachers' perceptions and their utilization of agricultural laboratories to increase scientific problem solving is directly tied to Fishbein and Ajzen's (1975) Theory of Planned Behavior. As shown in Figure 1, an individual's intention to perform a behavior is linked to the emergence of the behavior (Ajzen, 1991).

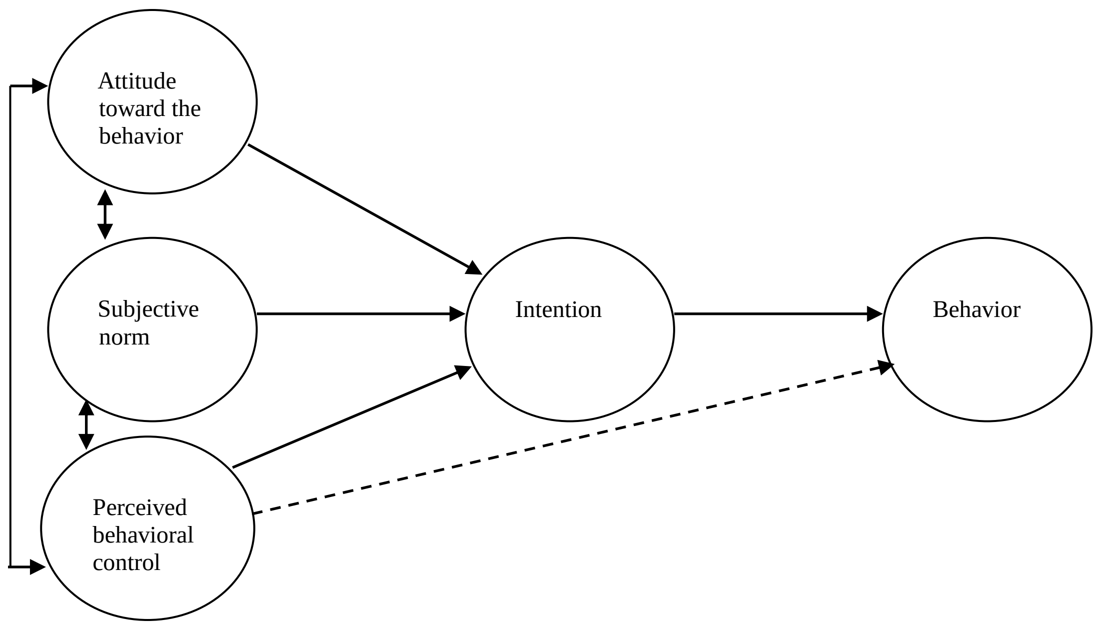

Figure 1. Theory of Planned Behavior (Ajzen, 1991).

While intentions are indicators of an individual's motivation to perform a behavior, emergence of the behavior is also linked to nonmotivational factors, such as availability of resources and opportunity. Impacting an individual's intentions to perform a certain behavior are the individual's perceived behavioral control, attitude toward the behavior, and subjective norms regarding the behavior. Perceived behavioral control "refers to people's perception of the ease or difficulty of performing the behavior of interest" (Ajzen, 1991, p. 183), and varies between situations. Attitudes are related to the behavioral beliefs an individual holds toward the behavior (Ajzen, 1988), and are developed via learning, action, and subsequent favorable or unfavorable results (Fishbein & Ajzen, 1975). Intentions and subsequent behaviors are also impacted by subjective norms, which are the perceived expectations of valued individuals (Ajzen, 2002). The Theory of Planned Behavior suggests that the general expectation for agriculture teachers to utilize laboratory facilities (Phipps et al., 2008), paired with teachers' attitudes regarding laboratory usage and their perceived control over how those laboratories are used to enhance student learning, can influence teacher uses of agricultural laboratories. Only after researchers have a grasp on the current uses of agricultural laboratories can they develop and evaluate strategies that may enhance student learning in these areas.

Laboratory settings have long been an integral component of agricultural education, and remain a crucial aspect today (Phipps et al., 2008). The skills developed through the appropriate use of experiential learning in agricultural laboratories (Figure 2) are diverse, yet directly relate to theories and concepts focused on in the classroom.

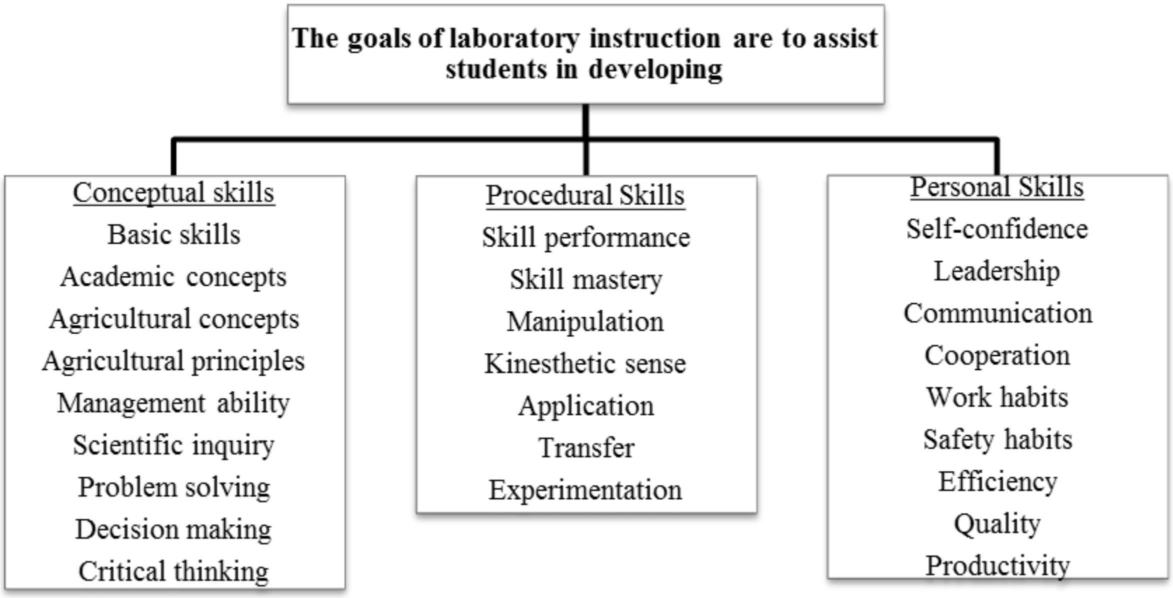

Figure 2. Goals of laboratory instruction (Phipps et al., 2008).

While these theoretical goals are far reaching and include scientific inquiry and problem solving, instructional strategies characteristic of traditional agricultural education utilize laboratories primarily to focus on development of students' psychomotor skills necessary for traditional occupations in agricultural production (Broyles, 2004; Johnson, 1989).

The development of instructional strategies to enhance the use of scientific inquiry and problem solving in agricultural laboratories requires an understanding of the laboratories available to teachers. Studies investigating the laboratories currently utilized in schools are few in number, and often regional. Young and Edwards (2005) identified the laboratory facilities available at 47 selected Oklahoma secondary agricultural education programs, which included agricultural mechanics laboratories, feeding facilities, greenhouses, land laboratories, horticulture facilities, and aquaculture laboratories. From a sample of Arizona agriculture teachers, Franklin (2008) reported that 76% had a greenhouse facility and 28.8% had a plant nursery. Because agriculture is regionally distinct, a larger study incorporating different regions could provide a more accurate picture of agricultural laboratories prevalent across the nation.

Research has identified barriers to utilizing laboratories which may compound the issue of incorporating strategies to enhance scientific inquiry and problem solving. Situated barriers such as teacher competency in laboratories and maintaining discipline procedures during laboratory activities may attribute to a decrease in the impact of laboratory use on content mastery (Franklin, 2008; Luiselli, Putnam, Handler, & Feinberg, 2005; Myers, Dyer, & Washburn, 2005).

Purpose and Objectives

The purpose of this study was to determine possible factors influencing secondary agriculture teachers' use of agricultural laboratories when instructing students. In order to address the above purpose, the following objectives were developed:

1. Describe the agricultural laboratories available to secondary agriculture teachers.
2. Determine the frequency with which agricultural laboratories are utilized in secondary agricultural education.
3. Determine the relationship between demographic factors and the frequency with which agriculture teachers utilize agricultural laboratories during instruction.

4. Determine the association between the frequency of laboratory use and teachers' perceptions regarding laboratory usage.

Methods

This study utilized a nonexperimental descriptive survey design to gather data regarding agriculture teachers' use of agricultural laboratories.

Participants

While the overall population consisted of all secondary agricultural education teachers in the United States, the accessible population consisted of all members of the National Association of Agricultural Educators (NAAE), the national professional organization of secondary agricultural educators (N = 6311). Limitations of this study stem from the sampling frame utilized. Although the study's demographic findings suggest that respondents may be similar to the overall population (Kantrovich, 2010), not all agriculture teachers are NAAE members, and so the authors caution against generalizing findings past the accessible population. Further, the NAAE member database lacks complete accuracy due to teachers retiring, moving schools, or having inaccurate emails on record. Therefore, the main limitation of this study is that not all members of the accessible population had an equal opportunity to be included in the sampling frame. Lastly, this study assumes that all responses are made in a truthful manner, and lack falsities based on social desirability.

NAAE members that were not listed as agriculture teachers were removed from the sampling frame for the purposes of this study. A simple random sample was drawn in order to ensure that all members of the sampling frame had the same probability of being selected. To complete the objectives, an email including a questionnaire invitation, designed for specific use in this study, was sent to the target sample (n = 530). This sample size was selected based on the population size, a 5% level of precision, and 95% confidence interval (Israel, 2009). The sample size was then increased by 20% to account for inaccurate or missing contact information and sample members who were no longer teaching (Israel, 2009).

According to Dillman, Smyth and Christian (2009), the most effective method of increasing participation rate on Internet surveys is multiple contacts. Because little research has been performed regarding the optimal combination of contacts, the number of contacts after the initial invitation is left up to the researcher (Dillman et al., 2009). However, Dillman et al. recommend that when response rate per reminder email stalls, the researcher ceases sending reminders. Therefore, the researchers sent six emails to each member of the sample, including a prenotice email, the first email containing a link to complete the questionnaire and four reminder/thank you emails, also containing the questionnaire link.

Upon completion of data collection, six teachers from the sample were removed by request and 122 teachers were removed from the study due to inaccurate or missing contact information, leading to a total response rate of 51.1% (n = 206). Twelve respondents with crucially incomplete submissions were also removed, leading to a usable response rate of 48.1% (n = 194). While not ideal, a response rate of less than 50% has been deemed acceptable in publications of similar populations (Lindner, Murphy, & Briers, 2001). Nonresponse error was addressed through a comparison of early to late respondents (Miller & Smith, 1983), as is common in agricultural education research (Lindner et al., 2001). This method of addressing nonresponse error has been deemed appropriate, as late respondents have been assumed to be similar to nonrespondents (Miller & Smith, 1983). Early respondents were identified as those responding after the initial survey invitation but before the first follow–up letter, while late respondents were identified as those responding after the first follow–up letter (Lindner et al., 2001). T–tests were conducted to determine whether the respondent groups differed in demographic variables, including age, length of teaching experience, and length of time spent as a secondary agriculture student. Chi–square tests were conducted to determine group differences in gender and the type of community in which the school was in. No significant differences were found between early and late respondents in any demographic area (p values were .46, .57, .74, .58, and .12, respectively); therefore, results of this study were able to be generalized to the accessible population (Lindner et al., 2001; Miller & Smith, 1983).

The demographics collected in this study are displayed in Table 1. Forty–five states were represented in the data; however, 4.6% (*n* = 9) did not supply their state. Respondents also displayed a wide range of teaching experience, with 5.2% (*n* = 10) not supplying their length of teaching experience. Over one–half of the respondents were students of secondary agricultural education for four years (*n* = 106); however, 5.2% (*n* = 10) did not supply their length of time as a secondary agricultural education student. The majority of respondents taught at schools in rural settings; however, 4.6% (*n* = 9) did not supply their school setting.

Table 1
Demographic Data of Respondents

Demographic	*n*	%
Gender		
Male	137	70.6
Female	57	29.4
Years of Teaching Experience		
1–5	37	19.1
6–10	39	20.1
11–15	31	16.0
16–20	15	7.7
21–25	24	12.4
26–30	24	12.4
31–35	11	5.7
36–40	3	1.5
Years as an Secondary Agriculture Student		
0	23	11.9
1	3	1.5
2	7	3.6
3	21	10.8
4	106	54.6
5	15	7.7
6	9	4.6
School Setting		
Urban	19	10.0
Suburban	31	16.0
Rural	135	69.6

Instrument

The instrument utilized in this study was based on previous research focusing on perceptions of secondary agriculture teachers, and was selected for use after an extensive search for appropriate instrumentation (Layfield, Minor, & Waldvogel, 2001; Myers & Washburn, 2008; Thompson & Balschweid, 1999; Thompson & Schumacher, 1998). Items were modified slightly to meet the objectives of this particular study, and two additional items were added to meet the study's first objective. Items measured teacher perceptions of agricultural laboratories on a five–point rating scale. Perceptions were grouped into three constructs that separated teachers' perceptions of the effect of using laboratories on student learning, the level of preparation required when using laboratories, and the intensity of barriers when using laboratories. The student learning construct measured teachers' perceptions regarding how agricultural laboratories impacted students' understanding of agricultural concepts and practices, and included level of agreement statements such as, *Agriculture concepts are easier for students to understand when agricultural facilities are integrated into the agricultural education program.* Teacher perceptions of the level of preparation required when utilizing laboratories were measured through the use of level of agreement statements such as, *Integrating agricultural facilities into the agricultural education program requires more preparation time than teaching in a more traditional classroom.* The barriers construct measured teachers' level of agreement with specified items being barriers to integrating facilities, including personal barriers (such as lack of experience in managing a facility), support–related barriers (such as lack of administrative support), and other external barriers (such as lack of agricultural jobs using facilities in the local community). The authors of the original instrument reported Cronbach's alpha as a measure of internal validity of .88. Reliability was calculated *ex post facto* for each of the perceptive constructs utilized in this study, including perceptions of preparation required when utilizing agricultural laboratories (α = .72), perceptions of effects of agricultural laboratory usage on student learning (α = .71), and perceptions of barriers to utilizing agricultural laboratories (α = .90).

Data Analysis

Data were analyzed using descriptive and correlational methods. Data were coded to be analyzed in SPSS, using either Pearson's correlation coefficient or Spearman's rho where appropriate to determine the magnitude of relationships sought from the objectives of the study. Magnitude was determined using Davis's convention (1971). According to Davis, relationships between .01 and .09 are negligible, those between .10 and .29 are low, those between .30 and .49 are moderate, those between .50 and .69 are substantial, and those over .70 are very strong.

Results

Availability of Laboratories

Objective 1 sought to identify the agricultural laboratories available to secondary teachers (Table 2). The majority of respondents have access to a greenhouse (72.2%, n = 140) and a mechanics/carpentry/welding facility (76.8%, n = 149). Approximately one–half of the respondents have access to a landscaping area (51.1%, n = 99). Aquaculture tanks/ponds, biotechnology/science laboratories, field crops, forestry plots, gardens, and livestock/equine facilities are accessible by between 20% and 40% of the respondents. The two least available laboratories are the apiary (1.0%, n = 2) and the vineyard (0.5%, n = 1).

Table 2
Available Laboratories Identified by Respondents

Laboratory	*f*	%
Mechanics/Carpentry/Welding Facility	149	76.8
Greenhouse	140	72.2
Landscaping Area	99	51.0
Garden	75	38.7
Aquaculture Tank/Pond	64	33.0
Livestock/Equine Facility	56	28.9
Field Crops	52	26.9
Biotechnology/Science Laboratory	43	22.2
Forestry Plot	43	22.2
Food Science Laboratory	22	11.3
Nursery/Orchard/Grove	22	11.3
Turf Grass Management Area	22	11.3
Small Animal/Veterinary Laboratory	18	9.3
Meats Laboratory	8	4.1
Apiary	2	1.0
Vineyard	1	0.5

Frequency of Laboratory Use

The second objective sought to identify the frequency with which agricultural laboratories are utilized in secondary agricultural education (Table 3). Over one–half of teachers with access to a small animal/veterinary laboratory (94.4%), greenhouse (90.6%), mechanics/carpentry/ welding facility (90.6%), livestock/equine facility (69.7%), nursery/orchard/grove (68.1%), biotechnology/science laboratory (63.0%), meats laboratory (62.5%), garden (61.1%), aquaculture tank/pond (57.8%), turf grass management area (54.5%), or food science laboratory (50.0%), reported utilizing the laboratory at least once per week. No teachers that had access to an apiary or vineyard reported using the laboratories at least once per week. However, both of these laboratories had very low numbers of teachers reporting to have access to the laboratory, as shown through Objective 1.

Table 3
Frequency of Agricultural Laboratory Use

	Frequency						
Laboratory	Never	1x/ year	1x/ semester	1x/ month	1x/ week	1x/ day	>1x/ day
Apiary	0	0	2	0	0	0	0
Aquaculture Tank/Pond	2	6	9	10	17	14	6
Biotechnology/Science Laboratory	2	0	2	12	15	7	5
Field Crops	3	2	6	16	20	1	3
Food Science Laboratory	1	1	4	5	2	6	3
Forestry Plot	1	2	8	13	13	4	2
Garden	1	3	7	17	26	10	8
Greenhouse	1	0	5	7	28	58	40
Landscaping Area	2	3	13	30	34	10	3
Livestock/Equine Facility	1	1	8	7	11	14	14
Meats Laboratory	0	1	2	0	3	1	1
Mechanics/Carpentry/Welding Facility	3	2	1	8	13	50	72
Nursery/Orchard/Grove	1	2	1	3	10	3	2
Small Animal/Veterinary Laboratory	0	0	0	1	5	5	7
Turf Grass Management Area	0	1	4	5	8	3	1
Vineyard	0	0	0	1	0	0	0

The frequency of use of these laboratories provides the basis for measuring relationships in later objectives. Laboratories with low to very strong correlations are included in tables in discussion, while those with no and negligible correlations are omitted.

Relationship between Frequency of Use and Demographics

Objective 3 examined the relationship between teachers' frequency of use of laboratories and their demographics, including gender, years of teaching experience, school setting, and number of years as a secondary agriculture student. Correlations between frequency of laboratory use and gender are displayed in Table 4. Males were coded as 1 and females were coded as 0. A substantial negative correlation was found between gender and frequency of use of a meats laboratory (r = -.66). A moderate positive correlation was found between gender and frequency of use of the turf grass management area (r = .30).

Table 4
Correlations between Frequency of Use of Laboratories and Teacher Gender

Laboratory	*r*	Magnitude
Meats Laboratory	-.66	Substantial
Turf Grass Management Area	.30	Moderate
Biotechnology/Science Laboratory	.26	Low
Food Science Laboratory	.19	Low
Mechanics/Carpentry/Welding Facility	.17	Low
Landscaping Area	-.17	Low
Greenhouse	-.13	Low
Aquaculture Tank/Pond	.12	Low
Nursery/Orchard/Grove	-.10	Low

Note: female = 0; male = 1

Low, moderate, and very strong correlations were also found between frequency of use of specific laboratories and length of experience as an agriculture teacher (Table 5). Frequency of use of the meats laboratory was found to have a very strong positive correlation to length of agriculture teaching experience (r = .73) while correlations between length of agriculture teaching experience and frequency of use of the livestock/equine facility (r = .25), food science laboratory (r = .22), nursery (r = .21), and biotechnology/science laboratory (r = .17) were found to be low and positive. A moderate negative correlation was found between length of agriculture teaching experience and frequency of use of the small animal/veterinary laboratory (r = -.35).

Table 5
Correlations between Frequency of Use of Laboratories and Length of Agriculture Teaching Experience

Laboratory	*r*	Magnitude
Meats Laboratory	.73	Very Strong
Small Animal/Veterinary Laboratory	-.35	Moderate
Livestock/Equine Facility	.25	Low
Food Science Laboratory	.22	Low
Nursery	.21	Low
Biotechnology/Science Laboratory	.17	Low

Moderate and low correlations were also found between frequency of use of specific laboratories and the number of years in which teachers were enrolled as secondary agriculture students, as shown in Table 6. A moderate positive correlation was found with regard to the nursery/orchard/grove (r = .30), while negative low correlations were found with regard to the greenhouse (r = -.19) and garden (r = -.11).

Table 6
Correlations between Frequency of Specific Laboratory Use and Length of time Enrolled in Secondary Agricultural Education

Laboratory	*r*	Magnitude
Nursery/Orchard/Grove	.30	Moderate
Forestry Plot	.28	Low
Turf Grass Management Area	.21	Low
Aquaculture Tank/Pond	.19	Low
Greenhouse	-.19	Low
Food Science Laboratory	.15	Low
Livestock/Equine Facility	.13	Low
Meats Laboratory	.12	Low
Garden	-.11	Low

Lastly, correlations between school setting (defined as rural, suburban, and urban school settings) and frequency of specific laboratory use were found with several laboratories, as is shown in Table 7. Urban, suburban, and rural school settings were coded as 1, 2, and 3, respectively. Moderate negative correlations were found between school setting and frequency of use of the food science laboratory (r_s = -.43), meats laboratory (r_s = -.38), biotechnology/science laboratory (r_s = -.35), landscaping area (r_s = -.35), nursery/orchard/grove (r_s = -.33), and livestock/equine facility (r_s = -.30). Low negative correlations were found between school setting and frequency of use of the garden (r_s = -.19), the small animal/veterinary laboratory (r_s = -.15), and the greenhouse (r_s = -.13). Only frequency of use of the turf grass management area was positively correlated with school setting (r_s = .13).

Table 7
Correlations between Frequency of Specific Laboratory Use and School Setting

Laboratory	r_s	Magnitude
Food Science Laboratory	-.43	Moderate
Meats Laboratory	-.38	Moderate
Biotechnology/Science Laboratory	-.35	Moderate
Landscaping Area	-.35	Moderate
Nursery/Orchard/Grove	-.33	Moderate
Livestock/Equine Facility	-.30	Moderate
Garden	-.19	Low
Small Animal/Veterinary Laboratory	-.15	Low
Greenhouse	-.13	Low
Turf Grass Management Area	.13	Low

Relationship between Teacher Perceptions and Frequency of Laboratory Use

The final objective sought to determine the relationship between teachers' frequency of use of specific agricultural laboratories and perceptions regarding the use of agricultural laboratories' impact on student learning (Table 8), preparation required to utilize laboratories during instruction (Table 9), and barriers to utilizing agricultural laboratories during instruction (Table 10). Low positive correlations between .11 and .23 were found between teachers' perceptions of the impact of using agricultural laboratories during instruction on student learning and the frequency of use of eight of the laboratories, as indicated in Table 8. However, negative correlations, two being above a low magnitude, were found between these same learning perceptions and frequency of use of the meats laboratory (*r* = -.51), small animal/veterinary laboratory (*r* = -.38), and turf grass management area (*r* = -.18).

Table 8
Correlations between Frequency of Use of Laboratories and Perceptions of Impact on Student Learning

Laboratory	*r*	Magnitude
Meats Laboratory	-.51	Substantial
Small Animal/Veterinary Laboratory	-.38	Moderate
Food Science Laboratory	.23	Low
Garden	.23	Low
Greenhouse	.18	Low
Turf Grass Management Area	-.18	Low
Landscaping Area	.17	Low
Biotechnology/Science Laboratory	.16	Low
Aquaculture Tank/Pond	.14	Low
Mechanics/Carpentry/Welding Facility	.12	Low
Field Crops	.11	Low

As seen in Table 9, positive low correlations were found between teachers' perceptions of preparation requirements when using agricultural laboratories and the frequency of use of the garden (*r* = .27), greenhouse (*r* = .17), and landscaping area (*r* = .15). However, negative low correlations were found between these same preparation perceptions and frequency of use of the nursery/orchard/grove (*r* = -.24), small animal/veterinary laboratory (*r* = -.20), meats laboratory (*r* = -.13), and livestock/equine facility (*r* = -.12).

Table 9
Correlations between Frequency of Laboratory Use and Perceptions of Preparation Requirements

Laboratory	*r*	Magnitude
Garden	.27	Low
Nursery/Orchard/Grove	-.24	Low
Small Animal/Veterinary Laboratory	-.20	Low
Greenhouse	.17	Low
Landscaping Area	.15	Low
Meats Laboratory	-.13	Low
Livestock/Equine Facility	-.12	Low

Lastly, Table 10 displays correlations between the construct examining teachers' perceptions of barriers to using agricultural laboratories and their frequency of laboratory use. Positive low correlations were found with the frequency of use of the biotechnology/science laboratory (*r* = .19), livestock/equine facility (*r* = .18), forestry plot (*r* = .15), and nursery/orchard grove (*r* = .13). Negative low correlations were found with the meats laboratory (*r* = -.18), aquaculture tank/pond (*r* = -.13), and food science laboratory (*r* = -.13).

Table 10
Correlations between Frequency of Laboratory Use and Perceptions of Barriers

Relationship	*r*	Magnitude
Biotechnology/Science Laboratory	.19	Low
Livestock/Equine Facility	.18	Low
Meats Laboratory	-.18	Low
Forestry Plot	.15	Low
Nursery/Orchard/Grove	.13	Low
Aquaculture Tank/Pond	-.13	Low
Food Science Laboratory	-.13	Low

Conclusions

Availability of a wide variety of agricultural laboratories was found to be very common among secondary agricultural education programs. This finding is consistent with previous state–based research that indicated the presence of mechanics laboratories, livestock feeding facilities, greenhouses, land laboratories, horticulture facilities, and aquaculture laboratories in agricultural programs (Franklin, 2008; Young & Edwards, 2005). The least available agricultural laboratories included a vineyard and an apiary, which were not found to be common in any of the available research regarding agricultural laboratories. Over one–half the teachers reported utilizing the majority of their facilities more than once per week. These results support Phipps et al.'s (2008) statements regarding the value of agricultural laboratories in agricultural education programs.

Females in this study tended to utilize the greenhouse, landscaping area, nursery/orchard/grove, and meats laboratory less than males, but tended to utilize turf grass management areas, biotechnology/science laboratories, food science laboratories, aquaculture tanks/ponds, and mechanics/carpentry/welding facilities more than males. Correlations indicate that 43.6% of the variance of frequency of use in of the meats laboratory and 9.2% of the variance of frequency of use in the turf grass management area were associated with gender. Gender was associated with the remaining correlated laboratories in lower amounts, ranging from 1.4% (aquaculture tank/pond) to 6.9% (biotechnology/science laboratory). Length of time enrolled as a secondary agriculture student was associated with between 1.5% and 9.0% of the variance in frequency of use of correlated laboratories. Correlations were also found between school setting and frequency of use of ten of the laboratories. Teachers in more urban schools tended to use nine of the ten correlated laboratories more often, while teachers in more rural schools tended to utilize these laboratories less often. Variation in school setting was associated with variance percentages ranging from 1.7% (greenhouse) to18.3% (food science laboratory).

Teachers using the food science laboratory, garden, greenhouse, landscaping area, biotechnology/science laboratory, aquaculture tank/pond, mechanics/carpentry/welding facility, and field crops more often tended to report more positive perceptions of student learning in laboratories, as has been reported by previous research (Arnold, Warner, & Osborne, 2006). These positive correlations are also supported by Fishbein and Ajzen's (1975) Theory of Planned Behavior, which states that attitude toward a behavior directly impacts intentions to perform that behavior. However, negative correlations between perceptions of student learning and the turf grass management area, small animal/veterinary laboratory, and meats laboratory indicate that teachers using these laboratories more often tended to report more negative perceptions of student learning in agricultural laboratories, which may suggest that other aspects impact teachers' intentions (Ajzen, 1991). Frequency of use of the laboratories was associated with between 1.2% (field crops) and 25.7% (meats laboratory) of the variance in perceptions of student learning.

Correlations indicate that teachers using the garden, greenhouse, or landscaping area more frequently tended to perceive greater preparation requirements when using laboratories, while teachers using the livestock/equine facility, meats laboratory, small animal/veterinary laboratory, or nursery/orchard/grove more frequently tended to perceive fewer preparation requirements when utilizing laboratories. Again, these differences in how attitudes impact teachers' intentions by laboratory setting may suggest that other aspects impact teachers' intentions (Ajzen, 1991). Associations between frequency of use of laboratories and variance perceptions of preparation requirements ranged from 1.5% (livestock/equine facility) to 7.0% (garden). While teachers have reported increased preparation requirements when using experiential learning in agricultural education previously (Arnold et al., 2006), perceptions of lesser preparation requirements associated with experiential learning in specific laboratories remains unexplained, and therefore lends itself well to future research.

Perceptions of barriers to using agricultural laboratories were positively correlated with frequency of use of the biotechnology/science laboratory, livestock/equine facility, forestry plot, and nursery/orchard/grove, indicating that teachers using these laboratories more often perceived greater barriers to utilizing agricultural laboratories. However, negative correlations indicated that teachers using the aquaculture tank/pond, food science laboratory, or meats laboratory more often perceived fewer barriers to utilizing agricultural laboratories. Associations between perceptions of barriers and frequency of agricultural laboratory use ranged from 1.6% (nursery/orchard/grove) to 3.5% (biotechnology/science laboratory). According to the Theory of Planned Behavior, perceptions of less control in using laboratories decrease teachers' intentions to utilize them, and this was seen in some of the facilities (Ajzen, 1991). However, facilities with positive correlations indicate that other aspects may impact teachers' intentions.

Implications and Recommendations

As noted in previous research, the presence and usage of agricultural laboratories to some degree is included in the basic philosophy of secondary agricultural education (Franklin, 2008; McCormick, 1994; Newcomb et al., 2004; Phipps et al., 2008). The results of this study regarding laboratory availability and frequency of use support this statement, encouraging researchers and teacher educators to focus on instructional strategies designed for specific contexts available to and used by a large number of agriculture teachers, as is recommended in teacher education (Desimone, 2009).

The number of years teachers were students in secondary agricultural education was associated with a range of variation in frequency of use of specific facilities, providing support for the use of experiential learning in specific facilities in teacher education programs. Results also indicate that gender is associated with a wide range of percentages of variance in the frequency of use of specific facilities, further supporting the need for exposure to agricultural laboratories before entering the profession. This need for experiential learning in the context of agricultural laboratories is of great importance currently, as the number of females entering the profession of agricultural education is on the rise (Rocca & Washburn, 2008). Lastly, teachers in more rural schools reported using nine of the agricultural laboratories less frequently than those at suburban or urban schools. This may imply that the subjective norms perceived by a teacher may be dependent on the facility and the community, thereby impacting teachers' intentions to utilize certain facilities in different amounts based on their communities' expectations (Ajzen, 1991). With the majority of the nation's agriculture students learning in rural schools, agricultural educators must provide instruction and support to help these teachers utilize agricultural laboratories effectively.

Experiential learning in agricultural laboratories has been established as an ideal method to teach scientific content and problem solving skills to agriculture students in an effort to better prepare them for careers in the science–based agriculture industry (Enderlin & Osborne, 1992; Myers & Washburn, 2006; NRC, 2009; Thompson, 1998; Washburn & Myers, 2008), implying a subjective norm among the profession that views the use of agricultural facilities as a recommended practice (Fishbein & Ajzen, 1975). Fishbein and Ajzen's (1975) Theory of Planned Behavior states that teachers' intentions to utilize agricultural laboratories are also influenced by their perceptions of the control they have over the behavior and their attitude regarding the behavior. Associations between frequency of laboratory use and teacher perceptions regarding the impact of using specific agricultural laboratories on student learning, the preparation required to effectively use specific agricultural laboratories during instruction, and barriers to using agricultural laboratories vary by laboratory. These findings suggest that while subjective norms, attitudes, and perceived behavioral control influence teachers' use of agricultural laboratories (Fishbein &Ajzen, 1975), the impact of these factors on teacher intentions and behavior may vary by laboratory setting. Further, demographic factors, such as community setting, may influence subjective norms, attitudes, and perceived behavioral control, adding increased variability in teachers' use of specific laboratory settings.

In order for students to gain valuable experiences that enhance their scientific content and problem solving skills, researchers must work to investigate the causes of these differences in teacher perceptions and their relationship to frequency of use of specific facilities. While self–reporting studies such as this are a useful starting point, more information regarding the actual use of laboratories could be obtained by observational or qualitative research methods. An array of research methods focusing on how teachers utilize laboratories to enhance student experiences and learning can shed further light on the value of agricultural laboratories in secondary education. Examination of teachers' intentions and plans for student learning in laboratories compared with actual practices may provide insight into barriers teachers face when utilizing agricultural laboratories. Focus groups with students can provide a more thorough understanding for how specific laboratories impact students' experiences and learning. Upon further study, teacher educators should work with teachers to reduce barriers to utilizing laboratories, develop strategies to make preparation in specific laboratories less daunting, and maximize the impact of agricultural laboratories on student learning.

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CATHERINE W. SHOULDERS is a Graduate Assistant in the Department of Agricultural Education and Communication at the University of Florida, PO Box 110540, Gainesville, FL 32611, katewoggs@ufl.edu

BRIAN E. MYERS is an Associate Professor of Agricultural Education in the Department of Agricultural Education and Communication at the University of Florida, PO Box 110540, Gainesville, FL 32611, bmyers@ufl.edu