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A Multi–State Factor–Analytic and Psychometric Meta–Analysis of Agricultural Mechanics Laboratory Management Competencies

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For more than 20 years, the 50 agricultural mechanics laboratory management competencies identified by Johnson and Schumacher in 1989 have served as the basis for numerous needs assessments of secondary agriculture teachers. This study reevaluated Johnson and Schumacher's instrument, as modified by Saucier, Schumacher, Funkenbusch, Terry, and Johnson (2008), to reduce the number of competencies and update the constructs of agricultural mechanics laboratory management competencies through factor–analytic and psychometric analyses. Five–hundred and three in–service secondary agriculture teachers from six states, surveyed between the spring of 2008 and the spring of 2010, served as the population for this study. As a result, the 70 agricultural mechanics laboratory management competencies included in the instrument modified by Saucier et al. (2008) were reduced to 33 competencies, in eight constructs. A further outcome was reflected in the psychometric evaluation of the eight constructs, which resulted in acceptable internal consistency reliabilities that ranged from .82 to .96. Multi–state benchmarks for agricultural mechanics laboratory management abilities of secondary agriculture teachers were also proposed. The results further indicated that the revised constructs were appropriate to assess agricultural mechanics laboratory management competencies across Huberman's (1989) five teacher career stages.

Keywords: factor analysis; psychometrics; meta–analysis; agricultural mechanics; laboratory management

Introduction

Laboratories are essential learning environments for quality secondary agriculture programs (Baker, Thoron, Myers, & Cody, 2008; Thoron & Myers, 2010). A review of literature identified that much of the instruction within the secondary agricultural mechanics curriculum takes place in a laboratory setting (Johnson & Schumacher, 1989; Saucier & McKim, 2011; Saucier, Terry, & Schumacher, 2009)—in some states, nearly 60% of the curriculum taught in agriculture courses included agricultural mechanics competencies (McKim & Saucier, 2011). Furthermore, Saucier et al. (2009) found that Missouri agricultural educators spent almost 10 hours per week supervising students in an agricultural mechanics laboratory. With the frequent use of laboratories by agricultural educators, the need for safe and effective laboratory instruction seems apparent.

For safe and effective laboratory instruction to take place, agricultural educators must be competent and knowledgeable in the area of laboratory management (Saucier et al., 2009). Hubert, Ullrich, Lindner, and Murphy (2003) stated, "If skill development is the focus of laboratory instruction, then thorough attention to all its components, including safety instruction, is essential" (p. 3). Fletcher and Johnson (1990) found that agricultural mechanics students are exposed to equipment, materials, tools, and supplies that are potentially hazardous to their health and could cause injury or death. Additionally, Phipps, Osborne, Dyer, and Ball (2008) noted that the agriculture teacher is responsible for identifying safety hazards, providing daily safety instruction, and maintaining safe working conditions for students in an agricultural mechanics laboratory.

Considering the amount of instructional time spent in agricultural mechanics laboratories across the U.S., it is critical that a needs assessment be conducted to determine the agricultural mechanics laboratory management needs of secondary agriculture teachers. To do so, a valid and reliable data collection instrument must be used to accurately gauge the agricultural mechanics laboratory management abilities of secondary agriculture teachers.

In 1989, Johnson and Schumacher identified 50 agricultural mechanics laboratory management competencies to assess the agricultural mechanics laboratory management abilities of secondary agriculture teachers. In the more than 20 years since Johnson and Schumacher identified those competencies, numerous studies (Johnson, Schumacher, & Stewart, 1990; McKim & Saucier, 2011; Saucier & McKim, 2011; Saucier & McKim, 2010; Saucier, Schumacher, Funkenbusch, Terry, & Johnson, 2008; Saucier et al., 2009; Schlautman & Shilletto, 1992; Swan, 1992) have been conducted using some iteration of the instrument. In 2008, Saucier et al. modified Johnson and Schumacher's instrument to split multiple–component—double–barreled and triple–barreled—competencies into single–component competencies. Thus, the original 50 competencies were expanded to 70 competencies.

Theoretical Framework

Bandura's theory of self–efficacy (1997) was used to guide this study. According to Bandura, self–efficacy is defined as the "beliefs in one's capabilities to organize and execute the course of action required to produce given attainments" (p. 3). Additionally, self–efficacy influences a person's choices, actions, the amount of effort they give, how long they persevere when faced with obstacles, their resilience, their thought patterns and emotional reactions, and the level of achievement they ultimately attain (Bandura, 1986).

In 2008, Knobloch found that the predetermined beliefs of teachers often influence how they connect academic content in the classroom to real–life applications in the laboratory. According to a review of literature, these beliefs are developed in part to personal beliefs about the curriculum or content (Borko & Putnam, 1996; Moseley, Reinke, & Bookout, 2002; Pajares, 1992), availability of time, availability instructional resources, level of preparation regarding the content (Thompson & Balschweid, 1999), comfort level with the content, (Knobloch & Ball, 2003), perceived value of the content (Lawrenz, 1985), past experiences with the content area (Calderhead, 1996; Thompson & Balschweid, 1999), teaching environment (Knobloch, 2001), and motivation (Bandura, 1997; Tschannen–Moran, Woolfolk–Hoy, & Hoy, 1998). A teacher's development and performance can also influenced by the interaction of these personal and environmental factors and the situations in which they teach (Knobloch, 2001).

Psychometric theory as described by Nunnally (1967) served as a secondary framework and guided the analyses of this study. Measuring secondary agriculture teachers' perceived level of efficacy to perform agricultural mechanics laboratory management competencies requires the measurement of psychological attributes, in the case of this study, self–efficacy. Psychometric "…measurement consists of rules for assigning numbers to objects to represent quantities of attributes. The term 'rules' indicates that procedures for assigning numbers must be explicitly formulated…" (Nunnally, 1967, p. 2). In this study, a numerical measure was attained by asking subjects to rate the importance of a series of agricultural mechanics laboratory management competencies and their self–perceived ability to perform those competencies. Measures of several unitary attributes (competencies) are then combined to form an overall objective appraisal or construct (Nunnally, 1967).

Purpose and Research Objectives

Numerous studies regarding agricultural mechanics needs assessment (McKim & Saucier, 2011; Saucier & McKim, 2011; Saucier & McKim, 2010; Saucier et al., 2008; Saucier et al., 2009; Schlautman & Shilletto, 1992; Swan, 1992) have been conducted using some iteration of the instrument developed by Johnson and Schumacher (1989). Those studies have provided guidance for the profession and for the advancement of agricultural mechanics in secondary and post–secondary settings.

Since 1989, Johnson and Schumacher's instrument has been modified and revised by researchers for various reasons, e.g. double– and triple–barreled questions, etc. By expanding the original 50 competencies to 70, subjects were asked to answer no less than 140 questions when considering, for each competency, subjects were asked to assess both the importance of the competency and their ability to perform it. The length of a questionnaire has been noted to have an effect on item response rates, accuracy of data collected, and individuals' willingness to participate, in both mailed (Dillman, Sinclair, & Clark, 1993) and web–based (Galesic & Bosnjak, 2009) surveys. Thus, reducing the number of items, while retaining as much of the original information as possible (Field, 2009), would likely increase the willingness of individuals to participate in the survey, increase item response rates, and the accuracy of data collected (Dillman et al., 1993; Galesic & Bosnjak)—a task often accomplished through factor–analytic and psychometric analyses (Field, 2009). A review of the literature did not yield an obvious factor–analytic or psychometric analysis of Johnson and Schumacher's original competencies or the expanded version (Saucier et al., 2008), in the more than 20 years since the original instrument was developed. Given the major revisions and expansions to the instrument and the extended amount of time elapsed since the previous assessment, a reassessment of Johnson and Schumacher's instrument, as revised, was warranted.

Moreover, a validation and reassessment of the reliability of a data collection instrument to be used to accurately gauge the agricultural mechanics laboratory management abilities of secondary agriculture teachers addresses challenges identified in the *National Research Agenda: American Association for Agricultural Education's Research Priority Areas for 2011 – 2015* (Doerfert, 2011), including assessing the efficiency and effectiveness of agricultural education programs at all levels. The outcome of this study will provide a more succinct and accurate measure of secondary agriculture teachers' professional development needs as related to agricultural mechanics laboratory management.

Therefore, the purpose of this study was to reevaluate the instrument developed by Johnson and Schumacher (1989), as modified by Saucier et al. (2008), and propose multi–state benchmarks for in–service secondary agriculture teachers. This study was guided by three research objectives:

1. Assess the factor–analytic and psychometric properties of the agricultural mechanics laboratory management instrument, based on the perceptions of secondary agriculture teachers regarding the importance of agricultural mechanics laboratory management competencies.
2. Describe the self–perceived agricultural mechanics laboratory management abilities of secondary agriculture teachers, to propose multi–state benchmarks for agricultural mechanics laboratory management competencies.
3. Using the construct outcomes of the factor–analytic and psychometric analyses included in research objective one, determine if the self–perceived agricultural mechanics laboratory management abilities of secondary agriculture teachers differ by teacher career stage.

Method and Results

Given the number of studies that have been conducted using some iteration of Johnson and Schumacher's instrument (1989), including studies of preservice and in–service secondary agriculture teachers, a meta–analytical approach was used for this study. "Meta–analysis is a form of secondary analysis of preexisting data that aims to summarize and compare results from different studies (Newton & Rudestam, 1999, p. 281). Furthermore, meta–analyses "serve to combine results from multiple studies and, consequently, allow us to diminish our reliance on statistical tests from individual studies" (p. 281). Therefore, a form of meta–analysis was conducted by including the results of studies conducted across six states within a two year period.

Conflicting findings existed in the literature regarding the effect of developmental stages of teachers on teacher efficacy (Burris, McLaughlin, McCulloch, Brashears, & Fraze, 2010; Layfield & Dobbins, 2002). Therefore, teacher career stage was considered to be a variable of interest. Thus, Huberman's (1989) Teacher Career Cycle Model provided guidance in the analysis of the data for this study. Within Huberman's model, teacher career stage is divided into five phases: Career entry–discovery and survival (1 to 3 years), stabilization (4 to 6 years), experimentation/diversification (7 to 18 years), serenity (19 to 30 years), and disengagement (31 years and beyond).

Instrumentation

The instrument developed by Johnson and Schumacher (1989) included 50 competencies developed with input from a national panel of agricultural mechanics education experts, through a Delphi technique. The 50 item instrument was again used by Johnson (1989) to assess secondary agriculture teachers' perceptions of importance of agricultural mechanics laboratory management competencies. As part of his study, Johnson conducted a principal component analysis with a varimax rotation to assess the statistical validity of his instrument, which yielded a five factor solution capable of explaining 46% of the variance. Johnson reported reliability estimates (Cronbach's α) that ranged from .63 to .88. Johnson and Schumacher's instrument was later modified by Johnson et al. (1990) to include a double–matrix format to assess the perceived importance of each competency and the perceived ability of the individual to perform each competency. The instrument was again modified by Saucier et al. (2008) who expanded the original 50 competencies to 70 competencies, as previously noted.

Data for this study were collected using the instrument developed by Johnson and Schumacher (1989), as modified to include 70 competencies by Saucier et al. (2008). Modifications to the design and format of the data collection instrument were guided by Dillman's (2007) suggestions. In the two–section data collection instrument, subjects were asked to respond to 70 statements representing agricultural mechanics laboratory management competencies, presented in a double–matrix configuration. The 5–point summated rating scale in a double–matrix configuration allowed subjects to respond to each statement twice; once rating the perceived importance of each competency (1 = *No Importance,* 2 = *Below Average Importance*, 3 = *Average Importance,* 4 = *Above Average Importance*, 5 = *Utmost Importance*), and once rating the individual's ability to perform each competency (1 = *No Ability*, 2 = *Below Average Ability*, 3 = *Average Ability,* 4 = *Above Average Ability*, 5 = *Exceptional Ability*).

Prior to data collection, a panel of eight experts was asked to assess face and content validity of the instrument. Each member of the panel was considered an expert in the areas of agricultural education, agricultural systems management, instrument development, and/or research methods. A pilot test was conducted using individuals not selected in the samples for the study. Initial estimates of reliability of the instrument were calculated using the results of the pilot test, which yielded Cronbach's alpha coefficients for the importance and ability scales that ranged from .95 to .97 (n = 30).

Population

Data included in this study were collected from in–service secondary agriculture teachers in six states between the spring of 2008 and the spring of 2010 (see Table 1). Data collection efforts were made independently in each state. In each data collection effort, five points of contact were attempted (Dillman, Smyth, & Christian, 2009). Because of the nature of a meta–analysis—combining data from multiple studies—the objectives of this study were not inferential in nature. A more extensive description of the population (N = 503), including state, population of secondary agriculture teachers in each state, number of respondents, and semester of data collection, is provided in Table 1. Table 2 provides an overview of the secondary agriculture teachers' experience and the corresponding stage of teacher career cycle as defined by Huberman (1989), which served as one basis of comparison for analyses.

Table 1
Description of Secondary Agriculture Teachers in Multi–State Agricultural Mechanics Laboratory Management Studies from 2008–2010 (N = 503)

State	*N*	*n*	Semester of Data Collection
Arkansas	267	80	Spring 2009
Kentucky	247	87	Spring 2010
Missouri	424	110	Fall 2008
Oklahoma	436	111	Spring 2009
Tennessee	317	78	Spring 2010
Wyoming	47	37	Spring 2008

Table 2
Characteristics of Secondary Agriculture Teachers in Multi–State Agricultural Mechanics Laboratory Management Studies from 2008–2010 (N = 503)

			Stage of Teacher Career Cycle[a]									
	Yrs. Exper.[b]		1		2		3		4		5	
State	*M*	*SD*	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Arkansas	13.5	10.1	14	17.7	15	19.0	23	29.1	23	29.1	4	5.1
Kentucky	12.1	9.0	15	18.1	14	16.9	35	42.2	14	16.9	5	6.0
Missouri	12.2	9.2	23	20.9	15	13.6	44	40.0	23	20.9	5	4.5
Oklahoma	14.9	10.2	11	13.3	12	14.5	29	34.9	25	30.1	6	7.2
Tennessee	15.1	10.9	9	11.5	8	10.3	35	44.9	23	20.9	5	4.5
Wyoming	11.9	9.5	7	18.9	7	18.9	13	35.1	9	24.3	1	2.7
Total	13.3	9.8	79	16.8	71	15.1	179	38.1	108	23.0	33	7.0

Note. [a] Huberman, 1989; [b] Mean number years of secondary agricultural education teaching experience.

Data Analyses

Data analyses were guided by the recommendations of Newton and Rudestam (1999) regarding meta–analyses. All analyses were conducted using SPSS® version 17.0 for Windows™ platform computers. Prior to analyses, data were screened. Those who completed less than 50% of the instrument and who completed fewer than 50% of the items composing any factor were eliminated, resulting in 503 useable responses. Furthermore, because a meta–analysis requires combining data from multiple studies, before combining data collected during different semesters and in different states, a multivariate analysis of variance (MANOVA) was used to compare the initial variables of interest (importance, ability, state, and semester of data collection) and determine compatibility of data for the meta–analysis. A MANOVA is the appropriate analysis when "multiple independent and/or dependent variables and the measured variables are likely to be dependent on each other (i.e., to correlate)…. Thus, multivariate analysis allows for the examination of two variables while simultaneously controlling for the influence of the other variables on each of them" (Newton & Rudestam, 1999, p. 137).

Box's test of equality of covariance was not significant (semester of data collection, $p = .44$; state, $p = .09$), which was an indicator that the assumption of equality of covariance was not violated (Field, 2009). The results of the MANOVAs were interpreted using Wilks' lambda (Λ). There was not a significant effect of semester of data collection on the dependent variables (importance and ability) $\Lambda = .99$, $F(6, 930) = .62$, $p = .71$, $\eta_p^2 = .004$. Also, there was not a significant effect of state on the dependent variables (importance and ability) $\Lambda = .97$, $F(10, 926) = 1.25$, $p = .26$, $\eta_p^2 = .013$. Thus, semester of data collection and state did not affect the data; therefore, it was appropriate to combine the 503 responses to address the objectives of this study and propose multi–state benchmarks for agricultural mechanics laboratory management competencies. Additionally, these benchmarks may be used as a basis of comparison, to assess agricultural mechanics laboratory management competency of secondary agriculture teachers.

Common methods variance (CMV) has been routinely noted as a pervasive problem in social science research, "one that undermines good science and biases empirical conclusions" (Lance, Dawson, Birkelbach, & Hoffman, 2010, p. 436). CMV is important when involving self–reported measures, such as collecting independent variables and dependent variables via the same method; e.g. self–administered questionnaire. Among the various methods of assessment reported to be effective in controlling for CVM (e.g. Harmon's single factor test, partial correlation, etc.) those based on factor analysis tend to be the most rigorous (Meade, Watson, & Kroustalis, 2007). Therefore, a principal component analysis was conducted, using SPSS® version 17.0 for Windows™ platform computers, as a method for controlling CVM. Field's (2009) outline of methods for analyses and interpretation of the data served as the primary guidance for the exploratory factor analysis. Tabachnick and Fidell (2007) served as a secondary source of guidance.

Research Objective One

The purpose of research objective one was to assess the factor–analytic and psychometric properties of the agricultural mechanics laboratory management instrument, based on the perceptions of secondary agriculture teachers regarding the importance of agricultural mechanics laboratory management competencies. Hence, 70 importance scale items from the instrument revised by Saucier et al. (2008) were included in the principal component analysis using a varimax rotation; coefficients with an absolute value less than .45 were suppressed to eliminate double–loadings. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was .95 and the Bartlett test of sphericity was significant (p < .001). All commonalities were greater than .48. Field (2009) noted that KMO values above .90 are considered to be *superb*; therefore, data were suitable for factor analytic procedures.

Sixteen items were not included in the components because they had coefficients with an absolute value less than .45. Six items were removed, because they loaded in components consisting of less than three items. Cronbach's alpha coefficients associated with the eight components were calculated and ranged from .82 to .95 (n = 457). According to Field (2009), alpha coefficients of .80 or greater are considered to be acceptable. Therefore, six components, consisting of 15 items, were removed, because the associated alpha coefficients were less than .80. The remaining 33 items composed the eight–component solution that accounted for 73.15% of the total variance; components were then treated as independent constructs and served as the dependent variables for the study. Eigenvalues, percentages of variance, cumulative percentages, and Cronbach's alpha coefficients for each construct are reported in Table 3. Construct loadings from the principal component analysis of the items are reported in Table 4.

Table 3
Eigenvalues, Percentages of Variance, and Cumulative Percentages for Constructs

	Eigenvalue	% of variance	Cumulative %	Cronbach's α
Construct 1	3.897	11.808	11.808	.887
Construct 2	3.685	11.167	22.975	.853
Construct 3	3.130	9.485	32.461	.858
Construct 4	3.059	9.271	41.732	.875
Construct 5	2.802	8.491	50.222	.953
Construct 6	2.685	8.135	58.358	.957
Construct 7	2.612	7.916	66.273	.836
Construct 8	2.269	6.877	73.150	.823

Table 4
Construct Loadings from Principal Component Analysis with Varimax Rotation

Item	Loading
Construct 1: Hazardous Material Management	
Safely storing hazardous materials	0.820
Safely disposing of hazardous materials	0.817
Safely handling hazardous materials	0.803
Properly installing and maintaining safety devices and emergency equipment	0.521
Correcting hazardous laboratory conditions	0.479
Construct 2: Laboratory Equipment Maintenance	
Making minor repairs to the agricultural mechanics laboratory facility	0.622
Making minor agricultural mechanics lab equipment repairs	0.617
Performing routine maintenance of agricultural mechanics lab equipment	0.611
Installing stationary power equipment	0.579
Utilizing technical manuals to order replacement/repair parts for agricultural mechanics lab equipment	0.484
Construct 3: Curriculum and Lesson Development	
Maintaining a file of educational projects/activities for students	0.790
Developing a file of educational projects/activities for students	0.772
Selecting current references/technical manuals	0.561
Identifying current references/technical manuals	0.522
Construct 4: Program Public Relations and Recruitment	
Implementing student recruitment activities for the agricultural mechanics program	0.834
Planning student recruitment activities for the agricultural mechanics program	0.829
Conducting an agricultural mechanics public relations program	0.721
Planning an agricultural mechanics public relations program	0.694
Construct 5: Student Behavior Management	
Maintaining a student discipline policy	0.839
Enforcing a student discipline policy	0.800
Developing a student discipline policy	0.792
Construct 6: Laboratory Activity Preparation	
Identifying equipment required to teach agricultural mechanics skills	0.781
Identifying tools required to teach agricultural mechanics skills	0.749
Identifying supplies required to teach agricultural mechanics skills	0.721
Construct 7: Laboratory Facility and Program Management	
Developing an agricultural mechanics laboratory budget	0.709
Operating within the constraints of an agricultural mechanics budget	0.621
Estimating time required for students to complete projects/activities	0.517
Maintaining computer based student academic records	0.508
Promoting laboratory safety by color coding equipment/marking safety zones/posting appropriate safety signs and warnings	0.471
Developing objective criteria for evaluation of student projects/activities	0.462
Construct 8: Personal Protection Equipment Management	
Storing protective equipment for student use	0.748
Maintaining protective equipment for student use	0.705
Selecting protective equipment for student use	0.658

According to Field (2009), individual items should measure the same underlying dimension, in this case, agricultural mechanics laboratory management competencies. Field noted that intercorrelations should range between "about .3" to no higher than .80 (p. 648). "If any variables have lots of correlations below .3 then consider excluding them" (p. 648). Intercorrelations greater than .80 could indicate issues related to multicolinearity, thus, those items should be removed as well. None of the remaining 33 items had an associated correlation scores less than .30 or greater than .80 (see Table 5). Similarly, constructs should correlate, even if measuring different aspects of the same thing. One bivariate correlation score of .23 existed between constructs 4 and 5; however, the constructs were not eliminated, because one low correlation among 27 acceptable bivariate correlations was not considered sufficient cause to eliminate the constructs.

Table 5
Bivariate Correlations Between Constructs

Construct	1	2	3	4	5	6	7	8
1	—							
2	.498	—						
3	.388	.640	—					
4	.331	.439	.456	—				
5	.467	.537	.413	.227	—			
6	.485	.669	.507	.367	.568	—		
7	.471	.670	.610	.444	.583	.606	—	
8	.548	.472	.359	.382	.415	.430	.470	—

Research Objective Two

The purpose of research objective two was to describe the self–perceived agricultural mechanics laboratory management abilities of the 503 secondary agriculture teachers to propose multi–state benchmarks for agricultural mechanics laboratory management competencies. Hence, mean, median, and standard deviation for secondary agriculture teachers' perceived ability to perform each agricultural mechanics laboratory management competency are reported in Table 6, by construct.

Table 6
Mean Scores for Agriculture Teachers' Abilities to Perform Competencies by Construct

Item	Ability		
	M	*SD*	*Mdn*
Construct 1: Hazardous Material Management			
Safely handling hazardous materials	3.95	0.82	4.00
Safely storing hazardous materials	3.88	0.87	4.00
Correcting hazardous laboratory conditions	3.79	0.81	4.00
Properly installing and maintaining safety devices and emergency equipment	3.73	0.83	4.00
Safely disposing of hazardous materials	3.70	0.93	4.00
Making minor agricultural mechanics lab equipment repairs	3.78	0.86	4.00
Construct 2: Laboratory Equipment Maintenance			
Performing routine maintenance of agricultural mechanics lab equipment	3.75	0.85	4.00
Utilizing technical manuals to order replacement/repair parts for agricultural mechanics lab equipment	3.66	0.84	4.00
Making minor repairs to the agricultural mechanics laboratory facility	3.61	0.87	4.00
Installing stationary power equipment	3.50	0.90	3.00
Construct 3: Curriculum and Lesson Development			
Maintaining a file of educational projects/activities for students	3.45	0.83	3.00
Developing a file of educational projects/activities for students	3.44	0.82	3.00
Identifying current references/technical manuals	3.34	0.76	3.00
Selecting current references/technical manuals	3.31	0.78	3.00
Construct 4: Program Public Relations and Recruitment			
Planning student recruitment activities for the agricultural mechanics program	3.38	0.84	3.00
Implementing student recruitment activities for the agricultural mechanics program	3.31	0.83	3.00
Conducting an agricultural mechanics public relations program	3.14	0.85	3.00
Planning an agricultural mechanics public relations program	3.12	0.80	3.00
Construct 5: Student Behavior Management			
Enforcing a student discipline policy	3.98	0.85	4.00
Developing a student discipline policy	3.96	0.82	4.00
Maintaining a student discipline policy	3.96	0.82	4.00
Construct 6: Laboratory Activity Preparation			
Identifying tools required to teach agricultural mechanics skills	3.93	0.81	4.00
Identifying equipment required to teach agricultural mechanics skills	3.90	0.80	4.00
Identifying supplies required to teach agricultural mechanics skills	3.87	0.79	4.00
Construct 7: Laboratory Facility and Program Management			
Maintaining computer based student academic records	3.72	0.92	4.00
Operating within the constraints of an agricultural mechanics budget	3.63	0.90	4.00
Developing objective criteria for evaluation of student projects/activities	3.57	0.76	4.00
Developing an agricultural mechanics laboratory budget	3.56	0.86	3.00
Estimating time required for students to complete projects/activities	3.42	0.82	3.00
Promoting laboratory safety by color coding equipment/marking safety zones/posting appropriate safety signs and warnings	3.42	0.88	3.00
Construct 8: Personal Protection Equipment Management			
Selecting protective equipment for student use	4.13	0.73	4.00
Maintaining protective equipment for student use	3.86	0.79	4.00
Storing protective equipment for student use	3.76	0.79	4.00

Note. 1 = No Ability, 2 = Below Average Ability, 3 = Average Ability, 4 = Above Average Ability, 5 = Exceptional Ability

Summated mean and standard deviation for each agricultural mechanics laboratory management construct, based on the self–perceived abilities of secondary agriculture teachers, are reported in Table 7. These summated means are proposed as multi–state benchmarks for agricultural mechanics laboratory management competencies. Based on the responses of 503 secondary agriculture teachers, in six states, teachers should have at least an above average ability to perform each agricultural mechanics laboratory management competency.

Table 7
Construct Benchmark Scores for Agriculture Teachers' Ability to Perform Competencies

Construct	*M*	*SD*
Student Behavior Management	3.95	0.80
Personal Protection Equipment Management	3.91	0.68
Laboratory Activity Preparation	3.90	0.77
Hazardous Material Management	3.80	0.71
Laboratory Equipment Maintenance	3.65	0.73
Laboratory Facility and Program Management	3.55	0.64
Curriculum and Lesson Development	3.38	0.67
Program Public Relations and Recruitment	3.23	0.69

Note. 1 = No Ability, 2 = Below Average Ability, 3 = Average Ability, 4 = Above Average Ability, 5 = Exceptional Ability

Research Objective Three

The purpose of research objective three was to use the construct outcomes of the factor–analytic and psychometric analyses included in research objective one to determine if the self–perceived agricultural mechanics laboratory management abilities of secondary agriculture teachers differed by teacher career stage. Testing if teacher career stage (Huberman, 1989) had an effect on the self–perceived ability of the 503 secondary agriculture teachers to perform agricultural mechanics laboratory management competencies was important, because if a significant effect existed, the revised competencies and constructs from this study could not be used to assess teachers in each career stages.

Hence, construct scores, based on secondary agriculture teachers' perceived ability to perform each competency, served as the dependent variables; teacher career stage served as the independent variable. The alpha level was set *a priori* at .05. The result of the MANOVA was interpreted using Wilk's lambda (Λ). There was not a significant effect of teacher career stage on the dependent variables, the constructs identified in research objective one, Λ = .91, F(32, 1683.24) = 1.34, p = .10, η_p^2 = .02. Additionally, the observed power (1 - β = .965) met the minimum power cut–off of 0.80, meaning that significant differences did not exist due to chance or error. Therefore, when interpreted by summated construct mean, the revised 33 competencies are appropriate for future assessments of secondary agriculture teachers to perform agricultural mechanics laboratory management competencies, for all five teacher career stages.

Conclusions, Implications, & Recommendations

As a result of this study, the 70 agricultural mechanics laboratory management competencies included in the instrument modified by Saucier et al. were reduced to 33 competencies through factor–analytic procedures. A further outcome was reflected in the psychometric evaluation of the newly identified eight agricultural mechanics laboratory management constructs, which resulted in acceptable internal consistency reliabilities, as measured by Cronbach's alpha coefficients greater than .80 (Field, 2009).

Prior to this study, a benchmark for agricultural mechanics laboratory management abilities of secondary agriculture teachers was not obvious in the literature. Although it is important to acknowledge that the benchmarks proposed in this study are not normative data, the benchmarks serve as a point of reference for future needs assessments of secondary agriculture teachers' ability to perform agricultural mechanics laboratory management competencies. Because the 33 competencies were appropriate to assess agricultural mechanics laboratory management competencies across all five teacher career stages, as interpreted by construct mean, those competencies and benchmarks provide an updated, succinct, and accurate measure for assessing secondary agriculture teachers' professional development needs related to agricultural mechanics laboratory management.

Because beliefs of teachers are developed in part to the level of preparation regarding the content (Thompson & Balschweid, 1999), comfort level with the content, (Knobloch & Ball, 2003), perceived value of the content (Lawrenz, 1985), and past experiences with the content area (Calderhead, 1996; Thompson & Balschweid, 1999), teacher education programs and entities responsible for revising National Council for Accreditation of Teacher Education (NCATE) standards should ensure that preservice teachers are receiving adequate education and exposure to the areas of agricultural mechanics laboratory management identified in this study. Although adding or replacing coursework in teacher preparation programs may be difficult at many institutions, teacher educators can engrain the concept of self–directed learning (Knowles, Holton III, & Swanson, 2005) in their students, so that when needs are identified, teachers understand that it is their obligation to remediate or expand their knowledge and abilities.

The *National Research Agenda: American Association for Agricultural Education's Research Priority Areas for 2011 – 2015* indicated the need to identify the professional development needs of agricultural educators and assess the efficiency and effectiveness of agricultural education programs at all levels. The 33 competencies identified in this study are a valid and reliable means to assess secondary agriculture teachers professional development needs related to agricultural mechanics laboratory management. Furthermore, the benchmarks proposed in this study can serve as a comparison for future needs assessments that include the 33 items identified in this study. Therefore, state agencies or associations responsible for conducting assessments of secondary agriculture teachers' ability to perform agricultural mechanics laboratory management competencies should use the competencies and benchmarks proposed in this study to assess the secondary agriculture teachers ability to perform agricultural mechanics laboratory management competencies in their states.

To further address the professional development needs of secondary agriculture teachers, competency–based needs assessments should be developed for other areas of agricultural mechanics, such as technical competencies, and program planning, development, and evaluation (Garton & Chung, 1997). Also, methods of evaluating professional development needs should extend beyond common measures of self–perceived competency. Researchers should consider other avenues of assessing teacher competency, such as authentic assessment or performance–based assessment, much like those used in industry. Although the focus of this study was confined to laboratory management competencies related to agricultural mechanics, the need for safe and effective laboratory instruction and management spans far beyond the scope of agricultural mechanics—and perhaps agricultural education—to include other core–academic and career and technology education pathways.

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