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Turning the Gears: Assessing Agricultural Educators' Perceptions of Importance and Competence to Teach Agricultural Mechanics

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Abstract

The power, structural, and technical systems (PST) pathway has been a key source of developing vital technical and employability skills in secondary-level students. While developing these skills is essential for success in the workforce, many educators report being unconfident in teaching within this pathway. Furthermore, several studies indicate that there are differences in how male and female educators perceive their ability to teach agricultural mechanics. This study aimed to assess the professional development needs of agricultural educators and evaluate the differences in how male and female educators value the importance of agricultural mechanics and their ability to teach agricultural mechanics. We utilized a descriptive correlational research design by distributing a quantitative survey to agricultural educators in Alabama and Georgia. We utilized the PST national agriculture, food, and natural resource (AFNR) standards to measure educators' professional development needs. The instrument used a modified Borich model to assess the professional development needs of educators. We found that educators needed professional development within the PST pathway. Additionally, the results indicated that female educators valued the PST content significantly more than their male colleagues but rated their ability to teach within this pathway considerably lower. The results also showed that female educators have different professional development needs than male educators. We recommend providing professional development specifically targeting the needs of female educators, and that agricultural education stakeholders evaluate the professional development offerings to ensure they are practical and pertinent.

Introduction

Since its inception, school-based agricultural education (SBAE) and career and technical education (CTE) have aimed to "prepare youth and adults for a wide range of high-wage, high-skill, high-demand careers" (ACTE, 2023, para 1). Among SBAE's key focus areas is the power, structural, and technical systems (PST) pathway, also known as agricultural mechanics (Fristoe, 2017). This pathway encompasses instruction in technical disciplines such as agricultural welding, carpentry, plumbing, electrical systems, energy, and precision agriculture (Hainline & Wells, 2019). Through SBAE, students gain hands-on experience and develop technical expertise in these areas (Ramsey & Edwards, 2011). Moreover, the National FFA Organization (2016) highlights that 59% of SBAE programs include coursework related to the PST pathway.

The PST pathway offers hands-on instruction that enables students to develop technical skills for employment in the agricultural industry (Hainline & Wells, 2019). Rankin (2021) identified that employers in the agricultural industry expect former secondary agricultural education students to possess technical skills in an entry-level position. Rinker et al. (2020) identified numerous technical and professional skills

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required of entry-level employees in agriculture, including being organized, trainable, and motivated, as well as demonstrating a strong work ethic and flexibility. Rankin (2021) found that one of the top skills agricultural industry employers want from their entry-level employees is the ability to apply mathematical concepts. Additionally, Norris et al. (2024) found that CTE administrators agreed that integrating science, technology, engineering, and mathematics (STEM) into agricultural mechanics is critical for it to remain relevant. This is concerning, considering that McKim et al. (2018) found science and math achievement to be lower among secondary agricultural education students. Furthermore, many educators feel unconfident in their ability to integrate STEM into agricultural mechanics topics (Norris & Roberts-Hill, 2024).

While the PST pathway has been a popular choice among SBAE programs (FFA, 2016), Schultz et al. (2014) found that educators perceive agricultural mechanics to be important but are not confident in teaching some areas, such as GPS use in agriculture, electrical safety, computer-aided design, and select welding processes. Wells et al. (2021) identified numerous technical and management skills educators need to teach agricultural mechanics effectively. While agricultural mechanics courses are in demand (FFA, 2016), many educators do not feel comfortable teaching the content (Byrd et al., 2023; Schultz et al., 2014; Wells & Hainline, 2021). Schultz et al. (2014) concluded that agricultural educators required more professional development within the agricultural mechanics pathway. Byrd et al. (2023) found that female agricultural educators did not feel comfortable teaching agricultural mechanics skills and did not enjoy teaching within the pathway. Additionally, Norris and Roberts-Hill (2024) found that female agricultural educators lacked confidence in applying STEM principles within agricultural mechanics. These gender-based differences could cause some female educators to avoid teaching this content area (Byrd et al., 2023).

The lack of agricultural mechanics training opportunities provided to educators may lead to a decrease in confidence in teaching the subject (Schultz et al., 2014). Trickett et al. (2023) suggested that agricultural mechanics coursework offered to preservice educators varies widely between institutions. Rankin and Edwards (2024) found that instruction in agricultural mechanics for preservice teachers has been significantly reduced at the post-secondary level. Clark et al. (2021) indicated that some preservice educators receive little to no training in some areas of agricultural mechanics. Furthermore, Granberry et al. (2022) found that while female preservice educators were nervous about their agricultural mechanics preparation, they were willing to accept the challenge and improve their skills, highlighting their resilience.

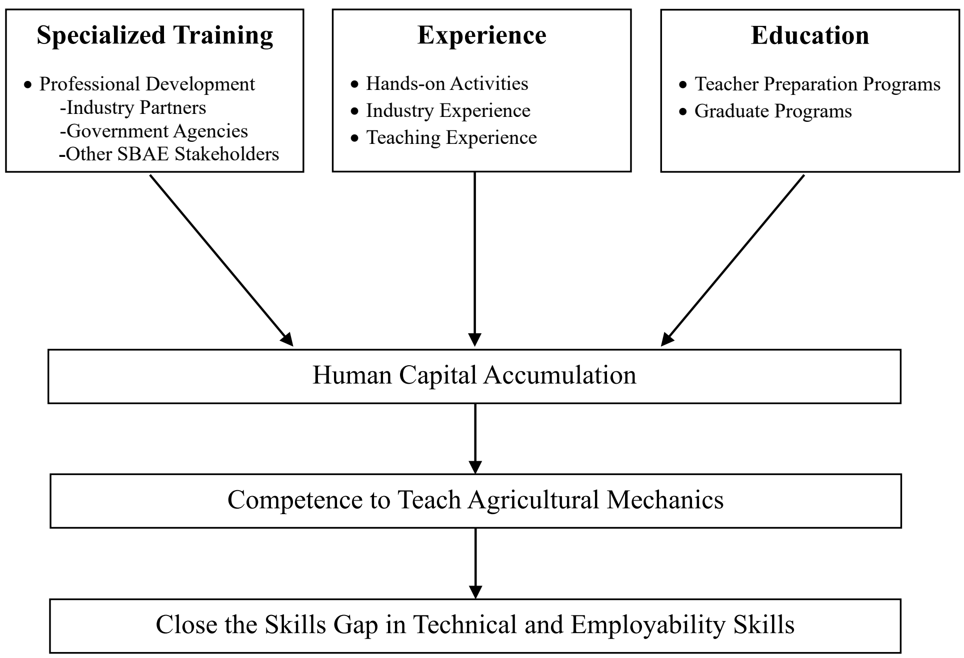
This inconsistency in the preparation of agricultural educators to teach within the agricultural mechanics pathway suggests that professional development may be needed (Norris et al., 2023; Schultz et al., 2014). Norris et al. (2023) found that educators needed professional development in agricultural mechanics. Additionally, Hainline and Wells (2024) suggested that professional development needs within agricultural mechanics may differ among teachers in different career phases. While the current literature has explored the professional development needs of educators in agricultural mechanics and evaluated gender-based differences in confidence to teach agricultural mechanics, there is a lack of knowledge on which topics male and female educators feel unconfident teaching.

Theoretical Framework

The human capital theory (HCT; Becker, 1993) provided the theoretical underpinning for this study. The HCT suggests that as individuals receive inputs such as experience, education, and specialized training, their knowledge and abilities within that area increase (Becker, 1993). In the context of agricultural educators' abilities to teach agricultural mechanics, the HCT theory suggests that providing targeted professional development and authentic experiences in mechanics can improve educators' knowledge and skills in this area. This preparation can be introduced through preservice teacher preparation programs or as in-service professional development. Rankin and Edwards (2024) found that the instruction of agricultural mechanics in teacher preparation programs has declined. This historical reduction in the agricultural mechanics preparation of SBAE educators means professional development could significantly impact educators' human capital in agricultural mechanics (Hainline & Wells, 2024). For professional development to maximize its effect on human capital, it must target areas of high need (Becker, 1993). This study assessed high-need areas within agricultural mechanics to ensure that practical and pertinent professional development can be offered to agricultural educators, thereby improving their competence in teaching agricultural mechanics. In the context of this study, competence was defined as the knowledge, skills, and abilities to teach PST content. Furthermore, providing targeted professional development to educators based on their gender could help alleviate differences in confidence in teaching agricultural mechanics (Byrd et al., 2023). In Figure 1, the model illustrates how elements from Becker's (1993) theory—specialized training, experience, and education—can influence educators' competence in teaching agricultural mechanics and ultimately improve the technical skills of their students. This increase in technical skills can help close the skills gap and train students for the workforce (Rankin, 2021).

Figure 1

Human Capital Theory's Impact on Agricultural Educator Competence to Teach Mechanics



Note. Developed from Becker (1993).

Purpose and Objectives

We sought to assess the professional development needs of agricultural educators and evaluate the differences in how male and female educators value the importance of agricultural mechanics and their self-assessed competence in teaching within this pathway. The following research objectives guided this study:

1.) Assess educators' perceptions of the importance of PST content and their competence to provide instruction on each topic.
2.) Assess gender-based differences in educators' perceptions of the importance of PST content and their competence to provide instruction on each topic.
3.) Evaluate gender-based differences in PST professional development needs.

Methods

We executed the study's objectives using a descriptive-correlational research design. The population for this study was agricultural educators in Alabama and Georgia ($N = 685$). We utilized a census approach to reduce the risk of sampling bias. This research study was approved by the New Mexico State University Institutional Review Board (IRB) in January of 2024.

Instrumentation

The instrument used in this study was developed based on the nineteen AFNR standards within the PST pathway (National Council for Agricultural Education [NCAE], 2015). The NCAE created the AFNR standards as a national benchmark for SBAE courses. We used a five-point Likert-type scale (5 = *Extremely Important/Competent*, 4 = *Very Important/Competent*, 3 = *Moderately Important/Competent*, 2 = *Slightly Important/Competent*, 1 = *Not Important/Competent at all*) to measure the educators' perceptions of the importance of teaching each PST standard and their competence to teach the standard (see Table 1). The limits of the five-point Likert scale are as follows: 5.00 - 4.51 = *Extremely Important/Competent*, 4.50 - 3.51 = *Very Important/Competent*, 3.50 - 2.51 = *Moderately Important/Competent*, 2.50 - 1.51 = *Slightly Important/Competent*, 1.50 - 1.00 = *Not Important/Competent at all*. The second section of the instrument collected demographic data on the participants, including their race, gender, years of teaching experience, and other relevant details. The instrument was created in Qualtrics, which enabled its electronic distribution.

Table 1

Power, Structural, and Technical Systems Standards Included in the Instrument

PST.01 - Apply physical science principles and engineering applications to solve problems and improve performance in AFNR power, structural, and technical systems.
PST.01.01 - Apply physical science and engineering principles to assess and select energy sources for AFNR power, structural, and technical systems.
PST.01.02 - Apply physical science and engineering principles to design, implement and improve safe and efficient mechanical systems.
PST.01.03 - Apply physical science principles to metal fabrication using a variety of welding and cutting processes.
PST.02 - Operate and maintain AFNR mechanical equipment.
PST.02.01 - Perform preventative maintenance to maintain equipment, machinery, and power units used in AFNR settings.
PST.02.02 - Operate machinery and equipment while observing all safety precautions in AFNR settings.
PST.03 - Service and repair AFNR mechanical equipment.
PST.03.01 - Troubleshoot, service, and repair components of internal combustion engines using manufacturers' guidelines.
PST.03.02 - Service electrical systems of equipment and power systems using a variety of troubleshooting and/or diagnostic methods.
PST.03.03 - Utilize manufacturers' guidelines to diagnose malfunctions in machinery, equipment, and power source systems.
PST.04 - Plan, build, and maintain AFNR structures.
PST.04.01 - Create sketches and plans for AFNR structures.
PST.04.02 - Determine structural requirements, specifications and estimate costs for AFNR structures.
PST.05.03 - Apply geospatial technologies to solve problems and increase the efficiency of AFNR systems.
PST.04.03 - Follow architectural and mechanical plans to construct, maintain, and/or repair AFNR structures.
PST.05 - Use control, monitoring, geospatial and other technologies in AFNR power, structural and technical systems.
PST.05.01 - Apply computer and other technologies to solve problems and increase the efficiency of AFNR systems.

Note. Likert-scale ranged from 5 = *Extremely Important/Competent*, 4 = *Very Important/Competent*, 3 = *Moderately Important/Competent*, 2 = *Slightly Important/Competent*, 1 = *Not Important/Competent at all*

We assembled a committee of three New Mexico State University faculty members and one graduate student to evaluate the instrument to ensure content, construct, and face validity. The committee found the instrument suitable for this audience. Additionally, we conducted a pilot study with New Mexico agricultural educators to ensure reliability further and strengthen the instrument's validity. Overall, the pilot study yielded n = 16 responses, meeting the threshold for a quality pilot study (Hill, 1998). We assessed the instrument's reliability using Cronbach's Alpha. The reliability coefficient for the construct measuring the perceived importance of the standards was .96, and the coefficient for the construct measuring competence to teach the standards was .97 (see Table 2). These meet the threshold for a very reliable instrument (Ary et al., 2010).

Table 2

Reliability Coefficients for Instrument

Constructs	α
Importance of Agricultural Mechanics	.96
Ability to Teach Agricultural Mechanics	.97

Note. Reliability Coefficients (Cronbach's Alpha) meet the threshold for a reliable analysis based on Ary et al.'s (2010) recommendation.

Data Collection

We developed the frame for the study using agricultural educator listservs maintained by the state agricultural education staff in Alabama and Georgia. These resources enabled us to compile an accurate list of SBAE teachers in these states with minimal frame error. We distributed the instrument using each potential participant's school district email. We followed the recommendations of Dillman et al. (2014) by sending an initial email requesting participation, and a reminder email was sent weekly for three consecutive weeks. We distributed the instrument to N = 685 Alabama and Georgia educators during the Spring 2024 semester. Overall, there are N = 302 agricultural educators in Alabama and N = 383 in Georgia. Ramsey and Shafer (2012) suggested that at least 30 responses are necessary for descriptive research. This study yielded n = 141 responses, resulting in a 20.6% response rate. During data collection, n = 63 partial responses were missing critical data, rendering them unusable for parametric analysis. This resulted in n = 78 usable responses, with n = 2 responses missing some demographic data but still usable for the study.

To assess non-response bias, we analyzed early and late responses using an independent samples *t*-test (Lindner et al., 2001). Early responses (f = 30) were those who responded to the first email distributed, and late responses (f = 48) were those who responded to the three reminder emails (Dillman et al., 2014). Overall, no statistically significant differences were found between early and late respondents (see Table 3), suggesting no concerns about non-response bias.

Table 3

Independent Samples t-tests Assessing Non-Response Bias

Constructs	*n*	*M*	*SD*	*t*	*df*	*p*	Cohen's *d*
Early Respondents	30	4.31	.65				
Importance of PST				.19	76	.85	.05
Late Respondents	48	4.29	.56				
Early Respondents	30	3.12	1.10				
Competence to Teach PST				-1.44	76	.15	-.34
Late Respondents	48	3.46	.93				

Note. α = .05.

Data Analysis

We analyzed the data for this study using SPSS 28.0. We used a modified Borich needs assessment model (Borich, 1980) to evaluate agricultural educators' perceived competence and importance in teaching each PST standard, as well as assessing in-service teachers' professional development needs. The recommendations of Narine and Harder (2021) were followed, and Ranked Discrepancy Scores (RDS) were used to analyze the data from research objectives one and three. Research objective two was analyzed using independent samples *t*-tests. To effectively evaluate research objective two using parametric statistics, items were grouped to form constructs (Johnson & Creech, 1983; Norman, 2010; Sullivan & Artino, 2013; Zumbo & Zimmerman, 1993). The normality of the data was assessed, and it met the assumption.

Demographics of the Participants

The participants in this study consisted of 65.4% males ($f = 51$), 33.3% females ($f = 26$), and 1.3% preferred not to say ($n = 1$). Additionally, 91.0% of participants were white ($f = 71$), 73.1% held an advanced degree ($f = 57$), 73.1% taught in a rural school system ($f = 57$), 76.9% were traditionally certified ($f = 60$), and 39.2% were in the middle career stage ($f = 29$). Furthermore, 84.2% had at least one agricultural mechanics class in college ($f = 64$), and 69.7% had at least one in high school ($f = 53$). The demographics of the participants are detailed in Table 4.

Table 4

Demographic Data of Participating Agricultural Educators

Demographic Area	Demographic Sub-Area	Participants	
		f	%
Gender	Male	51	65.4
	Female	26	33.3
	Prefer Not to Say	1	1.3
Race	White/Caucasian	71	91.0
	African American	5	6.4
	Native American	1	1.3
	Hispanic	1	1.3
	Other	0	0.0
Highest Degree Earned	Bachelor's Degree	21	26.9
	Master's Degree	34	43.6
	Educational Specialist Degree	15	19.2
	Doctoral Degree	8	10.3
School System Type	Rural	57	73.1
	Suburban	17	21.8
	Urban	4	5.1
Years of Teaching Experience	Early Career (1-7 Years)	23	31.1
	Middle Career (8-20 Years)	29	39.2
	Late Career (20+ Years)	22	29.7
Certification Type	Traditional Certification	60	76.9
	Alternative Certification	18	23.1
# of Agricultural Mechanics Classes Taken in College	0	12	15.8
	1	20	26.3
	2	21	27.6
	3	11	14.5
	4+	12	15.8
# of Agricultural Mechanics Classes Taken in High School	0	23	30.3
	1	13	17.1
	2	15	19.7
	3	10	13.2
	4+	15	19.7

*Note***.** $n = 78$. The n may vary in some categories due to incomplete responses being retained.

Limitations

While this study provides a robust analysis of the agricultural mechanics professional development needs of educators, it does have limitations to its scope and impact. The study's results should not be generalized beyond the assessed participants because of its low response rate (20.6%). Additionally, this study utilized the national AFNR PST standards to gauge the perceptions of agricultural educators. Most states in the U.S. have state-level standards that dictate the content of an agricultural mechanics course. The state-level standards in Alabama and Georgia could differ from the national standards utilized in this study. Therefore, the content that an educator is expected to teach may differ from what was assessed in this study. Furthermore, the self-reported data collected may be skewed due to deviations between their perceptions and reality.

Results

Research Objective One

In this analysis, Ranked Discrepancy Scores (RDS) were utilized to assess the professional development needs of agricultural educators (Narine & Harder, 2021). The negative RDS for all 19 standards suggests that agricultural educators need professional development in these areas of agricultural mechanics. The RDS scores ranged from -63 to -33 (see Table 5).

Table 5

Ranked Discrepancy Scores for Educators' Perceived Importance and Competence to Teach PST

PST Standard	NR	PR	TR	RDS
PST.03.03 - Utilize manufacturers' guidelines to diagnose malfunctions in machinery, equipment, and power source systems.	51	2	25	-63
PST.05.02 - Prepare and/or use electrical drawings to design, install, and troubleshoot electronic control systems in AFNR settings.	51	3	24	-62
PST.05.03 - Apply geospatial technologies to solve problems and increase the efficiency of AFNR systems.	53	5	20	-62
PST.05 - Use control, monitoring, geospatial and other technologies in AFNR power, structural and technical systems.	53	6	19	-60
PST.05.01 - Apply computer and other technologies to solve problems and increase the efficiency of AFNR systems.	52	7	19	-58
PST.03.02 - Service electrical systems of equipment and power systems using a variety of troubleshooting and/or diagnostic methods.	49	6	23	-55
PST.02.01 - Perform preventative maintenance to maintain equipment, machinery, and power units used in AFNR settings.	43	3	32	-51
PST.03.01 - Troubleshoot, service, and repair components of internal combustion engines using manufacturers' guidelines.	44	4	30	-51
PST.01 - Apply physical science principles and engineering applications to solve problems and improve performance in AFNR power, structural, and technical systems.	43	4	31	-50
PST.03 - Service and repair AFNR mechanical equipment.	43	4	31	-50
PST.02 - Operate and maintain AFNR mechanical equipment.	41	4	33	-47
PST.01.03 - Apply physical science principles to metal fabrication using a variety of welding and cutting processes.	40	5	33	-45
PST.01.01 - Apply physical science and engineering principles to assess and select energy sources for AFNR power, structural, and technical systems.	40	5	33	-45
PST.02.02 - Operate machinery and equipment while observing all safety precautions in AFNR settings.	38	3	37	-45
PST.04.03 - Follow architectural and mechanical plans to construct, maintain, and/or repair AFNR structures.	38	6	34	-41
PST.01.02 - Apply physical science and engineering principles to design, implement and improve safe and efficient mechanical systems.	38	8	32	-38
PST.04 - Plan, build, and maintain AFNR structures.	36	7	35	-37
PST.04.01 - Create sketches and plans for AFNR structures.	35	8	35	-35
PST.04.02 - Determine structural requirements, specifications and estimate costs for AFNR structures.	33	7	38	-33

Note. NR = *Negative Ratings*; PR = *Positive Ratings*; TR = *Tied Ratings*; RDS = *Ranked Discrepancy Scores*. Some standards are shortened to conserve space.

Research Objective Two

Research objective two reports the results from the independent samples *t*-tests used to assess differences in the perceptions of male and female agricultural educators regarding the importance of teaching the agricultural mechanics standards and their competence in teaching each standard. Overall, statistically significant gender-based differences $t(74) = -2.14$, $p = .03$ were found in the perceptions of male ($M = 4.19$, $SD = .61$) and female ($M = 4.49$, $SD = .55$) educators regarding the importance of teaching the PST standards (see Table 6). This analysis suggests that female educators value the PST content significantly more than their male colleagues.

Table 6

Samples t-test on the Importance of PST Standards by Gender

Constructs	*n*	*M*	*SD*	*t*	*df*	*p*	Cohen's *d*
Male	51	4.19	.61				
PST Standard Importance				-2.14	75	.03	-.52
Female	26	4.49	.55				

Note. α = .05

Additionally, research objective two assessed the differences in competence between male and female SBAE educators in teaching the PST standards. The results of this independent samples *t*-test $t(74) = 4.30$, $p < .001$ indicated that males ($M = 3.63$, $SD = .83$) rated their competence to teach the PST standards higher than the female teachers ($M = 2.69$, $SD = 1.02$; see Table 7). The lack of female self-perceived competence in teaching agricultural mechanics is contrasted with their higher valuation of the content's importance.

Table 7

Independent Samples t-test on Male and Female Teachers' Competence to Teach PST Standards

Constructs	*n*	*M*	*SD*	*t*	*df*	*p*	Cohen's *d*
Male	51	3.63	.83				
PST Standard Competence				4.30	75	<.001	1.04
Female	26	2.69	1.02				

Note. α = .05

Research Objective Three

The third research objective assessed the gender-based differences in PST professional development needs. Overall, the analysis further supports that females are less competent in teaching agricultural mechanics than their male colleagues. The female educators indicated a higher need for professional development in all nineteen standards than male teachers. Several of the standards (e.g., PST 05.01, PST 05.02, and PST 05.03) that were ranked at the top for both male and female educators focused on modern agricultural technologies, including electronic control systems, problem-solving using computers in an AFNR setting, and utilizing geospatial technology in agriculture (see Table 8).

Table 8

Gender-Based Differences in PST Professional Development Needs

PST Standard	MRDS	MR	FRDS	FR
PST.03.03 - Utilize manufacturers' guidelines to diagnose malfunctions in machinery, equipment, and power source systems.	-51	1	-85	7
PST.05.02 - Prepare and/or use electrical drawings to design, install, and troubleshoot electronic control systems in AFNR settings.	-47	2	-88	2
PST.05.03 - Apply geospatial technologies to solve problems and increase the efficiency of AFNR systems.	-47	2	-88	2
PST.05.01 - Apply computer and other technologies to solve problems and increase the efficiency of AFNR systems.	-45	4	-81	10
PST.05 - Use control, monitoring, geospatial and other technologies in AFNR power, structural and technical systems.	-43	5	-92	1
PST.03.02 - Service electrical systems of equipment and power systems using a variety of troubleshooting and/or diagnostic methods.	-37	6	-88	2
PST.02.01 - Perform preventative maintenance to maintain equipment, machinery, and power units used in AFNR settings.	-35	7	-81	10
PST.03.01 - Troubleshoot, service, and repair components of internal combustion engines using manufacturers' guidelines.	-31	8	-88	2
PST.01 - Apply physical science principles and engineering applications to solve problems and improve performance in AFNR power, structural, and technical systems.	-31	8	-85	7
PST.03 - Service and repair AFNR mechanical equipment.	-29	10	-88	2
PST.02.02 - Operate machinery and equipment while observing all safety precautions in AFNR settings.	-29	10	-73	13
PST.01.03 - Apply physical science principles to metal fabrication using a variety of welding and cutting processes.	-29	10	-73	13
PST.02 - Operate and maintain AFNR mechanical equipment.	-27	13	-85	7
PST.04 - Plan, build, and maintain AFNR structures.	-24	14	-73	13
PST.01.02 - Apply physical science and engineering principles to design, implement and improve safe and efficient mechanical systems.	-20	15	-73	13
PST.04.03 - Follow architectural and mechanical plans to construct, maintain, and/or repair AFNR structures.	-18	16	-81	10
PST.04.02 - Determine structural requirements, specifications and estimate costs for AFNR structures.	-18	16	-58	18
PST.04.01 - Create sketches and plans for AFNR structures.	-14	18	-58	18
PST.01.01 - Apply physical science and engineering principles to assess and select energy sources for AFNR power, structural, and technical systems.	-8	19	-69	17

Note. MRDS = Male Ranked Discrepancy Scores; FRDS = Female Ranked Discrepancy Scores; MR = Male Ranking; FR = Female Ranking.

Conclusions, Implications, and Discussion

The first research objective of this study sought to assess agricultural educators' perceptions of the importance of teaching AFNR PST standards and their competence in teaching each standard. The ranked discrepancy scores in research objective one suggested that agricultural educators need more professional development in agricultural mechanics. This result is consistent with the findings of Hainline and Wells (2024), who came to a similar conclusion. The areas of highest need were utilizing modern agricultural technology in the classroom, including computer-integrated technologies (e.g., electronic control systems, geospatial technology) and implementing manufacturer guidelines to diagnose malfunctions. These precision agriculture topics are crucial to the sustainability of the agricultural industry, as they reduce adverse environmental impacts, increase production, and lower costs (Shannon et al., 2018). While SBAE and CTE aim to prepare students for careers (ACTE, 2023), Reynolds et al. (2023) found that SBAE teachers lack knowledge of precision agriculture. King et al. (2019) suggested that precision agriculture presents numerous opportunities for educators to integrate STEM subjects into their curriculum. Furthermore, Norris et al. (2024) found that CTE administrators agree that integrating STEM into the agricultural mechanics curriculum is critical to remain relevant. If targeted professional development can be provided, it could enhance educators' human capital (Becker, 1993) in the context of agricultural mechanics, thereby improving their competence in teaching the subject matter.

The second research objective assessed gender-based differences in the perceptions of agricultural educators regarding the importance of teaching agricultural mechanics and their competence in teaching each standard. The independent samples *t*-tests in the second research objective suggested that female agricultural educators valued teaching agricultural mechanics significantly more than their male colleagues. In contrast, female agricultural educators felt their competence to teach the content of the agricultural mechanics pathway was significantly less than that of male agricultural educators. This finding is similar to Byrd et al. (2023), who suggested that female SBAE teachers are uncomfortable teaching in the PST pathway. Norris and Roberts-Hill (2024) also determined that female agricultural educators struggle to implement STEM concepts into agricultural mechanics. Yaniz et al. (2024) highlight the gender gap in STEM fields, noting that most STEM fields are male-dominated. This societal construct may explain the lack of self-perceived competence among female educators in teaching agricultural mechanics, which is attributed to the curriculum's focus on STEM and applied engineering concepts. Additionally, Decker et al. (2024a) found that female students in a welding course reported lower tinkering self-efficacy, suggesting males are naturally more inclined to 'tinker' with mechanical equipment. Additionally, Decker et al. (2024b) determined that many agricultural mechanics students prefer to learn welding from someone of the same gender. With agricultural mechanics being a male-dominated field, this could lead to fewer learning opportunities for female students.

The third research objective examined the gender-based differences in the professional development needs of agricultural mechanics. Overall, the results of this research objective provided further evidence of differences between male and female educators in their need for agricultural mechanics professional development, with females' discrepancy scores ranging from 66.7% to 762.5% higher than those of male educators. Additionally, these results suggested that while female educators indicated a higher need for professional development in agricultural mechanics, the specific topics of importance were relatively consistent among male and female educators. The top ten rankings for male and female educators were consistent with only minor deviations (e.g., PST 02.02, PST 01.03, and PST 04.03).

The findings of this study align with the Human Capital Theory (HCT), which underpinned this research. The HCT in the context of this study suggests that as individuals add inputs such as specialized training, experience, and education, their abilities in agricultural mechanics increase. Male agricultural educators self-reporting a higher competence in agricultural mechanics, juxtaposed to female educators' higher valuation of its importance, could suggest that learning opportunities in agricultural mechanics did not provide equitable human capital development opportunities. This divergence indicates that while males report having more competence in agricultural mechanics, this could be due to prior investments in their skills and education. In the future, females' higher valuation of the subject could be instrumental in their motivation to develop skills, knowledge, and human capital in agricultural mechanics. Such insights underscore the importance of providing equitable professional development opportunities to support all educators in building human capital in this area.

Recommendations for Future Practice

The results of this study suggest that female agricultural educators feel less competent in teaching agricultural mechanics than their male colleagues, but find the content more important than their male counterparts. This contrast suggests that female educators are interested in learning more about agricultural mechanics, which aligns with the findings of Granberry et al. (2022), who found that while many female educators feel uncomfortable teaching agricultural mechanics, they are willing and eager to learn more about the subject. Furthermore, the results of research objective three found slight differences in the professional development needs of female educators. These findings lead us to recommend targeted professional development for agricultural mechanics professionals tailored to the needs of female educators. Decker et al. (2024) suggested that females often have lower levels of tinkering self-efficacy, meaning that males are naturally more apt to 'tinker' with mechanical equipment. This natural difference may explain the gender-based differences in self-perceived competence in teaching agricultural mechanics. The Human Capital Theory (Becker, 1993) suggests that for professional development to reach maximum impact, it must target the areas of highest need. The results of this study suggest that females require professional development in geospatial technology, electronic controls, small gas engines, and computer-aided design and controls. Integrating these modern agricultural technologies into the SBAE curriculum increases the curriculum's relevance to industry practices and provides ample opportunities for STEM engagement. This practice is critical, considering CTE administrators report that integrating STEM into the agricultural mechanics curriculum is vital for it to remain relevant (Norris et al., 2024). If professional development were offered to female agricultural educators in areas of high need (e.g., geospatial technology, small gas engines. etc.), it could provide opportunities and encouragement to explore tinkering and improve tinkering self-efficacy, ultimately increasing competence and confidence in teaching agricultural mechanics. It is recommended that agricultural education stakeholders seek extramural funding opportunities to provide educators with robust and targeted professional development. These funding opportunities could be from industry partners who would benefit from competent agricultural educators teaching key curriculum relevant to their business. Additionally, seeking funding from government organizations (e.g., United States Department of Agriculture [USDA], United States Department of Education [USDE], etc.) could provide further opportunities to support educators.

Recommendations for Future Research

The findings in this study provide ample opportunity for additional scholarly exploration into this phenomenon. Overall, there is a lack of literature on the professional development needs of educators in agricultural mechanics. While the results of this study provide some insight into the gender-based differences in professional development needs, the study only evaluated educators in Alabama and Georgia. A national quantitative study on the agricultural mechanics professional development needs of educators would provide a robust analysis and insight into improving educator competence. Furthermore, this study did not evaluate every content area in agricultural mechanics. This study utilized the national AFNR PST standards, but most states in the U.S. have individualized agricultural mechanics standards that could differ from the national standards. This difference in content expectations for an agricultural mechanics course warrants additional studies using state standards, which could be more representative of what an educator is expected to teach in their respective state. Additionally, a qualitative inquiry into the professional development needs of agricultural educators would provide a more in-depth exploratory analysis of the factors influencing teachers' perceptions of the importance of agricultural mechanics and their competence to teach the content. The findings of this study also suggest that female agricultural educators report significantly less competence in teaching agricultural mechanics but find the content more important than their male colleagues. This warrants further inquiry into the factors influencing a lack of self-perceived competence in teaching agricultural mechanics and the factors impacting males' lower valuation of the content.

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