Early-Career Georgia Agriculture Teachers' Agricultural Mechanics Professional Development Needs

Authors

Christopher C. Crump
Banks County High School
christopher.crump@banks.k12.ga.us

Trent Wells
Murray State University
kwells23@murraystate.edu

Research Type: Quantitative
Research Areas: Teacher Education and School-Based Agricultural Education
Keywords: Agricultural mechanics; professional development

Early-Career Georgia Agriculture Teachers' Agricultural Mechanics Professional Development Needs

Abstract

Agricultural mechanics is a prominent agricultural subject matter area in many agricultural education programs throughout Georgia. Hainline and Wells (2024) indicated that early-career agriculture teachers often have different agricultural mechanics professional development (PD) needs than their more-experienced colleagues. Hence, our study focused on early-career agriculture teachers. We used human capital theory (HCT) to theoretically underpin our study. To conduct our study, we used a valid and reliable research instrument that contained eight demographics items and 65 agricultural mechanics items. Wells and Hainline (2021) previously used this instrument to conduct their national-level study of agriculture teachers' agricultural mechanics PD needs. We distributed this instrument via e-mail to 253 early-career agriculture teachers throughout Georgia; however, only 243 emails delivered successfully. Seventy-six teachers provided usable data, yielding a 31.3% response rate. Using mean weighted discrepancy scores (MWDS), we found that the greatest PD needs among early-career Georgia agriculture teachers were: (1) American Welding Society (AWS) standards for welding procedures, (2) Procedures for structural welding, and (3) Principles of metallurgy (ex. identifying metals, proper use of metals, etc.). We recommend that Georgia agricultural education stakeholders use our findings to structure PD sessions that address early-career Georgia agriculture teachers' greatest agricultural mechanics PD needs. We advise that scholars should engage with mid- and late-career Georgia agriculture teachers to examine their agricultural mechanics PD needs as well.

Introduction and Theoretical Framework

Undeniably, effective teachers are vital components of the agricultural education programs found within public schools across the United States. Considering the concept of effectiveness as professional educators, agriculture teachers must be knowledgeable and skilled in a wide range of agricultural subject matter to appropriately serve their students and their local communities (Eck et al., 2019). This is certainly applicable to agricultural mechanics as well (Granberry et al., 2023). Agricultural mechanics is broad in its nature and scope (Wells et al., 2021) and is popular with many students (Valdez & Johnson, 2020), including students in Georgia public schools (Georgia Agricultural Education, 2023). The teaching of agricultural mechanics subject matter in agricultural education programs presents a combination of learning opportunities for students, such as applying engineering concepts throughout a trailer fabrication project, and liability concerns for agriculture teachers, such as adequately supervising students during project activities (Wells & Hainline, 2021). Consequently, it is imperative that agriculture teachers be well-prepared to appropriately and professionally tackle the opportunities and challenges associated with this technical agriculture subject matter area (Granberry et al., 2023).

To help overcome potential deficits in agriculture teachers' current knowledge and skills, offering teacher-oriented learning opportunities via professional development (PD) sessions or workshops is a frequent approach. Conceptually, PD can be structured to fit a range of time frames and can be leveraged to meet a variety of targeted needs, such as improvements in agriculture teachers' pedagogical skills, strengthening their technical agriculture subject matter knowledge, and so forth. Ultimately, PD should be operationalized to help better prepare agriculture teachers to serve their students over both the short- and long-term (Grieman, 2010). Not surprisingly, agriculture teachers frequently need PD in agricultural mechanics subject matter to help them improve their capacities to serve students (Granberry et al., 2023; Wells & Hainline, 2021). However, as indicated by Hainline and Wells (2024) in their national-level study, agriculture teachers' agricultural mechanics PD needs vary based on their career phases. Specifically, early-career agriculture teachers tend to have greater agricultural mechanics PD needs in comparison to their mid- and late-career colleagues (Hainline & Wells, 2024). Further, Solomonson et al. (2021) noted that taking steps to improve agriculture teachers' (especially early-career teachers') confidence to teach technical agriculture curricula can help increase their likelihood to remain in the profession. Considering the abovementioned factors, we found it prudent to examine early-career Georgia agriculture teachers' agricultural mechanics PD needs.

We employed human capital theory (HCT) to undergird our study. Regarding HCT, Becker (1993) noted that investing in individuals' knowledge and skills yields improvements in their abilities to provide adequate returns. In the context of our study, we operationalized agricultural mechanics PD for early-career agriculture teachers as an investment. We characterized returns as improvements in early-career agriculture teachers' capacity to teach technical agriculture subject matter to their students to help better prepare them for opportunities in the agricultural industry. By working with students, agriculture teachers directly facilitate the development of human capital for the agricultural industry (Stripling & Ricketts, 2016). As such, we anticipate that defining early-career Georgia agriculture teachers' agricultural mechanics PD needs will be helpful for the state's agricultural industry stakeholders.

Purpose of the Study

The purpose of our study was to determine the agricultural mechanics PD needs of early-career Georgia agriculture teachers. Our approach helps facilitate the strategic development of PD sessions that directly address early-career Georgia agriculture teachers' actual needs.

Methods

Our study, which we framed via Borich's (1980) needs assessment model, used a census design and was a direct replication of Wells and Hainline's (2021) study, *Examining Teachers' Agricultural Mechanics Professional Development Needs: A National Study*. We used their valid and reliable instrument to collect our data. Their instrument contained several teacher demographics items and 65 agricultural mechanics items. The 65 agricultural mechanics items addressed diverse topics related to woodworking and structures construction, welding and metal fabrication, electricity, land surveying, plumbing, safety, project planning, construction, and tool and equipment usage. Their instrument included two five-point, Likert-type scales to collect data regarding the 65 agricultural mechanics items. One scale addressed agriculture teachers' perceived importance for each item to be taught in agricultural education programs (i.e., the *Importance* scale). The other scale addressed agriculture teachers' perceived competence to teach each item (i.e., the *Competence* scale). The *Importance* scale used the following anchors: (1) *Not important* (*NI*), (2) *Of little importance* (*LI*), (3) *Somewhat important* (*SI*), (4) *Important* (*I*), and

(5) *Very important* (*VI*). The *Competence* scale used the following anchors: (1) *Not competent* (*NC*), (2) *Little competence* (*LC*), (3) *Somewhat competent* (*SC*), (4) *Competent* (*C*), and (5) *Very competent* (*VC*). In contrast to Wells and Hainline (2021), our study's focus was solely on early-career agriculture teachers in Georgia during the 2023-2024 academic year (i.e., in years one through five as described by Solomonson and Retallick [2018]).

Upon Murray State University (MSU) Institutional Review Board (IRB) approval, we partnered with Georgia agricultural education state staff to obtain the school e-mail addresses for all 253 early-career agriculture teachers in Georgia. Once we obtained all 253 agriculture teachers' school e-mail addresses, we followed Dillman et al.'s (2014) advice and used five points of contact (i.e., e-mails) to conduct the data collection process via Qualtrics. These five e-mails included: (1) the initial e-mail that detailed the purpose of the study and contained an electronic link to the research instrument sent on Tuesday, October 3, 2023, (2) the first reminder e-mail sent on Tuesday, October 10, 2023, (3) the second reminder e-mail sent on Tuesday, October 17, 2023, (4) the third reminder e-mail sent on Tuesday, October 24, 2023, and (5), the fourth and final reminder e-mail sent on Tuesday, October 31, 2023. Of the five different contact e-mails sent, e-mails to 10 agriculture teachers bounced, yielding a failure rate of approximately 3.9%, thus reducing our potential respondents to 243. To help foster responses, we offered respondents a chance to win one of five $20.00 gift cards that we randomly drew after we concluded the data collection process. Because the data collection overlapped with the 2023 Georgia National Fair and the 2023 National FFA Convention, we elected to conclude our data collection on Friday, November 17, 2023 to help maximize responses.

Ninety-four respondents participated in our study. We elected, however, to analyze and report only the data from those 76 respondents who completed at least 75% of the research instrument, yielding a usable response rate of 31.3%. Both Sherman and Sorensen (2020) and Wells and Hainline (2021) reported similar response rates (26.8% and 27.5%, respectively). To identify the presence of non-response error, we compared early respondents (n = 29) to late respondents (n = 47) as recommended by Linder et al. (2001). We defined early respondents as those who responded prior to the first reminder e-mail that we distributed on Tuesday, October 10, 2023. We defined late respondents as those who responded on or after Tuesday, October 10, 2023. We used an independent samples *t*-test to compare the means of the two groups on the *Competence* scale of the research instrument. We determined that there were no statistically significant differences between early respondents and late respondents ($t(74) = .24$, $p = .81$).

We used Microsoft Excel to analyze our data. We employed a variety of descriptive statistics to analyze our respondents' demographics data and their responses on the *Importance* and *Competence* scales. To identify and rank our respondents' agricultural mechanics PD needs, we used McKim and Saucier's (2011) Excel-Based MWDS [mean weighted discrepancy score] Calculator. We acknowledge that because we employed a census design within our study, we cannot generalize our results beyond the 76 early-career Georgia agriculture teachers who participated in our study.

Results

Teacher Demographics

We reported the agriculture teacher demographics data in Table 1 (below). Fifty-four respondents (71.1%) identified as female while 22 respondents (28.9%) identified as male. Also, 55% of respondents (*f* = 42) stated that they had taught agricultural mechanics courses in the past three years and 47% (*f* = 36) had worked in the agricultural industry prior to their current teaching position. Respondents had been teaching agriculture for an average of 2.87 years (*SD* = 1.70). Also, the majority of respondents (*f* = 48; 63.2%) reported that they had initially gained their teacher certification via an undergraduate-level teacher preparation program (see Table 1).

Table 1

Agriculture Teacher Demographics

Item	*f*	%
What is your gender? (*n* = 76)		
Male	22	28.9
Female	54	71.1
Including this academic year, have you taught agricultural mechanics coursework in an agricultural education program during any of the past three academic years? (*n* = 76)		
Yes	42	55.3
No	34	44.7
Prior to your current agricultural education teaching position, did you previously work in the agricultural industry? (*n* = 76)		
Yes	36	47.4
No	40	52.6
Including this academic year, how many years have you have been teaching agricultural education? (*n* = 76)		
0	11	14.5
1	3	3.9
2	20	26.3
3	12	15.8
4	11	14.4
5	19	25
Which of the following best describes how you obtained your agricultural education teacher certification? (*n* = 76)		
Undergraduate-level teacher preparation program	48	63.2
Began teaching agricultural education after working in industry	17	22.4
Graduate-level teacher preparation program	7	9.2
Other (Alternative Certification, Provisional Certificate)	4	5.3

Note. Some percentages may not add to 100% due to rounding.

Perceived Importance to Teach

We reported the responses from the 65 agricultural mechanics items within the *Importance* scale in Table 2 (below). We bolded the highest mode for each item across the five categories (i.e., *Not important*, *Of little importance*, *Somewhat important*, *Important*, and *Very important*). Twenty items had a mode of five (*Very important*) and 44 items had a mode of four (*Important*). The item with the highest percentage of *Very important* rankings was *Safety procedures for agricultural mechanics activities* (*VI*: 90.5%, *f* = 74, *Md* = 5, *Mdn* = 5). While all 65 items had a mode of four (*I*) or five (*VI*), *Procedures for using legal land descriptions* (*VI*: 15.5%, *f* = 64, *Md* = 4, *Mdn* = 4) had the lowest percentage of *Very important* responses (see Table 2).

Table 2

Early-career Georgia Agriculture Teachers' Perceived Importance to Teach Agricultural Mechanics

		%						
Item	*n*	*NI*	*LI*	*SI*	*I*	*VI*	*Mdn*	*Md*
Safety procedures for agricultural mechanics activities	74	0.0	0.0	0.0	9.5	**90.5**	5	5
Use of personal protective equipment (PPE)	74	0.0	0.0	0.0	12.2	**87.8**	5	5
Use of measuring tools (ex. tape measure, framing square, etc.)	72	0.0	0.0	0.0	12.5	**87.5**	5	5
Use of laboratory safety equipment (ex. fire extinguishers, eye wash stations, etc.)	74	0.0	0.0	1.4	10.8	**87.8**	5	5
Use of hand tools (ex. screwdriver, hammer, etc.)	69	0.0	0.0	1.5	20.3	**78.3**	5	5
Use of handheld power tools (ex. cordless drill, jig saw, etc.)	70	0.0	0.0	1.4	21.4	**77.1**	5	5
Use of fasteners (ex. screws, nails, glue, etc.)	74	0.0	0.0	2.7	41.9	**55.4**	5	5
Estimating materials for projects	74	0.0	0.0	2.7	**50.0**	47.3	4	4
Use of stationary power equipment (ex. band saw, table saw, etc.)	71	0.0	0.0	2.8	40.9	**56.3**	5	5
Principles of electrical theory (ex. conductors, insulators, alternating current [AC], direct current [DC], etc.)	65	0.0	1.5	1.5	46.2	**50.8**	5	5
Use of electrical measurement units (ex. amperes, volts, Ohms, etc.)	65	0.0	1.5	1.5	40.0	**56.9**	5	5
Procedures for wiring outlets	65	0.0	1.5	3.1	38.5	**56.9**	5	5
Use of electrical systems tools (ex. digital multi-meter, wire strippers, etc.)	65	0.0	1.5	3.1	38.5	**56.9**	5	5
Procedures for laying out projects	74	0.0	0.0	5.4	**51.4**	43.2	4	4
Procedures for building wood projects	72	0.0	0.0	5.6	**54.2**	40.3	4	4
Creating a bill of materials for projects	74	0.0	1.4	5.4	39.2	**54.0**	5	5
Use of marking tools (ex. chalk line, paint marker, etc.)	70	0.0	1.4	5.7	42.9	**50.0**	4.5	5
Procedures for wiring single-pole switch circuits	65	0.0	1.5	6.2	36.9	**55.4**	5	5
Procedures for wiring double-pole switch circuits	65	0.0	1.5	7.7	**46.2**	44.6	4	4
Procedures for reassembling small engines	64	0.0	4.7	4.7	**48.4**	42.2	4	4

Item	*n*	% *NI*	*LI*	*SI*	*I*	*VI*	*Mdn*	*Md*
Procedures for troubleshooting small engines	63	0.0	3.2	6.4	**46.0**	44.4	4	4
Principles of welding theory (ex. joint types, positions, etc.)	70	1.4	2.9	5.7	**48.6**	41.4	4	4
Procedures for disassembling small engines	65	0.0	4.6	6.2	**49.2**	40.0	4	4
Interpreting project blueprints	74	0.0	0.0	10.8	**51.4**	37.8	4	4
Procedures for wiring three-way switch circuits	65	0.0	1.5	10.8	41.5	**46.2**	4	5
Procedures for SMAW (Arc welding)	70	1.4	2.9	8.6	**45.7**	41.4	4	4
Procedures for GMAW (MIG welding)	70	1.4	2.9	8.6	**47.1**	40.0	4	4
Use of precision tools (ex. micrometer, dial caliper, etc.)	70	1.4	1.4	10	**47.1**	40.0	4	4
Procedures for agricultural equipment operation	65	1.5	1.5	10.8	40.0	**46.2**	4	5
Procedures for using PVC pipe	72	0.0	1.4	12.5	**51.4**	34.7	4	4
Principles of four-stroke engine operational theory	64	1.6	3.1	9.4	**46.9**	39.1	4	4
Drawing project plans to scale	73	0.0	1.4	13.7	**54.8**	30.1	4	4
Procedures for wiring trailer electrical systems	65	0.0	3.1	12.3	41.5	**43.1**	4	5
Principles of two-stroke engine operational theory	65	1.5	3.1	10.8	**47.7**	36.9	4	4
Procedures for structural welding	70	1.4	2.9	11.4	**47.1**	37.1	4	4
Principles of metallurgy (ex. identifying metals, proper use of metals, etc.)	69	1.5	1.5	13.0	**46.4**	37.7	4	4
American Welding Society (AWS) standards for welding procedures	69	1.5	1.5	13	39.1	**44.9**	4	5
Procedures for wiring four-way switch circuits	65	0.0	3.1	13.9	**43.1**	40.0	4	4
Principles of diesel engine operational theory	65	1.5	4.6	10.8	**47.7**	35.4	4	4
Procedures for building metal projects (ex. trailers, barbecue pits, etc.)	70	1.4	1.4	14.3	**50.0**	32.9	4	4
Procedures for oxy-fuel cutting	70	1.4	2.9	14.3	**42.9**	38.6	4	4
Use of handheld pneumatic (air) tools (ex. impact wrench, paint spray gun, etc.)	71	0.0	4.2	16.9	**43.7**	35.2	4	4
Procedures for plasma arc cutting	70	1.4	10.0	11.4	**41.4**	35.7	4	4
Principles of vehicle powertrain operational theory	64	1.2	4.7	17.2	**42.2**	34.4	4	4
Procedures for GTAW (TIG welding)	71	1.4	4.2	18.3	**43.7**	32.4	4	4
Procedures for building masonry projects	72	1.4	5.6	18.0	**48.6**	26.4	4	4
Use of hydraulic equipment (ex. shears, iron worker, etc.)	70	0.0	2.9	22.9	35.7	**38.6**	4	5
Procedures for cold metalworking bending	70	1.4	2.9	21.4	**48.6**	25.7	4	4

Item	n	% NI	LI	SI	I	VI	Mdn	Md
Procedures for oxy-fuel welding	70	2.9	5.7	17.1	**41.1**	32.9	4	4
Procedures for FCAW (Flux-core arc welding)	71	2.8	5.6	18.3	**45.0**	28.1	4	4
Procedures for painting projects	74	0.0	2.7	24.3	**47.3**	25.7	4	4
Procedures for hot metalworking cutting	70	1.4	5.7	20.0	**45.7**	27.1	4	4
Procedures for cold metalworking cutting	70	1.4	4.3	21.4	**47.1**	25.7	4	4
Procedures for building fence projects	72	0.0	4.1	23.6	**41.7**	30.6	4	4
Procedures for using PEX pipe	72	0.0	6.9	20.8	**44.4**	27.8	4	4
Procedures for hot metalworking bending	70	2.9	2.9	22.9	**41.4**	30.0	4	4
Procedures for using copper pipe	72	1.4	9.7	20.8	**43.0**	25.0	4	4
Procedures for hot metalworking shaping	70	1.4	7.1	24.3	**40.0**	27.1	4	4
Procedures for cold metalworking shaping	70	1.4	4.3	27.1	**41.4**	25.7	4	4
Procedures for oxy-fuel brazing	69	2.9	7.3	23.2	**43.5**	23.2	4	4
Use of computer numerical control (CNC) systems	71	0.0	15.5	23.9	**32.4**	28.2	4	4
Procedures for using legal land descriptions	64	3.1	18.8	18.8	**43.8**	15.6	4	4
Procedures for using land surveying equipment	64	1.6	14.1	25.0	**35.9**	23.4	4	4
Procedures for conducting land surveys	64	3.1	12.5	26.6	**35.9**	21.9	4	4

Note. Importance scale: 1 = *Not important* (*NI*), 2 = *Of little importance* (*LI*), 3 = *Somewhat important* (*SI*), 4 = *Important* (*I*), 5 = *Very important* (*VI*); *Mdn* = Median*; Md* = Mode.

Perceived Competence to Teach

We reported the responses from the 65 agricultural mechanics items within the *Competence* scale in Table 3 (below). We bolded the highest mode for each item across the five categories (i.e., *Not competent*, *Little competence*, *Somewhat competent*, *Competent*, and *Very competent*). Two items had a mode of five, 24 items had a mode of four, four items had a mode of three, two items had a mode of two, and 24 items had a mode of one. Nine items had two modes. The item that had the highest reported combined *Very competent* and *Competent* ratings was *Use of laboratory safety equipment (ex. fire extinguishers, eye wash stations, etc.)* (*VC*: 39.2%, *C*: 56.8%, *f* = 74, *Md* = 4, *Mdn* = 4). The area that had the highest percentage of *Not competent* ratings (*Md* = 1) was *Procedures for using unmanned aerial vehicles in land surveying* (*NC*: 43.8%, *f* = 64) (see Table 3).

Table 3

Early-career Georgia Agriculture Teachers' Perceived Competence to Teach Agricultural Mechanics

Item	n	% NC	LC	SC	C	VC	Mdn	Md
Use of laboratory safety equipment (ex. fire extinguishers, eye wash stations, etc.)	74	0.0	0.0	4.1	**56.8**	39.2	4	4
Use of personal protective equipment (PPE)	74	0.0	1.4	5.4	35.1	**58.1**	5	5

Item	*n*	%					*Mdn*	*Md*
		NC	*LC*	*SC*	*C*	*VC*		
Use of hand tools (ex. screwdriver, hammer, etc.)	69	0.0	0.0	13.0	34.8	**52.2**	5	5
Use of measuring tools (ex. tape measure, framing square, etc.)	72	1.4	0.0	19.4	**41.7**	37.5	4	4
Use of fasteners (ex. screws, nails, glue, etc.)	74	1.4	6.8	16.2	**41.9**	33.8	4	4
Use of handheld power tools (ex. cordless drill, jig saw, etc.)	70	5.7	2.9	17.1	**40**	34.3	4	4
Procedures for SMAW (Arc welding)	70	1.4	4.3	21.4	**47.1**	25.7	4	4
Safety procedures for agricultural mechanics activities	74	1.4	5.4	21.6	**36.5**	35.1	4	4
Use of marking tools (ex. chalk line, paint marker, etc.)	70	1.4	2.9	25.7	**41.4**	28.6	4	4
Procedures for painting projects	74	2.7	6.8	25.7	**44.6**	20.3	4	4
Procedures for wiring single-pole switch circuits	65	12.3	9.2	15.4	**40.0**	23.1	4	4
Procedures for wiring outlets	65	9.2	10.8	18.5	**40.0**	21.4	4	4
Procedures for building wood projects	72	4.2	12.5	23.6	**44.4**	15.3	4	4
Use of electrical systems tools (ex. digital multi-meter, wire strippers, etc.)	65	10.8	6.2	26.2	**38.5**	18.5	4	4
Creating a bill of materials for projects	74	5.4	6.8	**32.4**	24.3	31.1	4	3
Use of stationary power equipment (ex. band saw, table saw, etc.)	71	5.6	14.1	25.4	**28.2**	26.8	4	4
Estimating materials for projects	74	5.4	13.5	27.0	**36.5**	17.6	4	4
Use of electrical measurement units (ex. amperes, volts, Ohms, etc.)	65	9.2	7.7	29.2	**38.5**	15.4	4	4
Principles of electrical theory (ex. conductors, insulators, alternating current [AC], direct current [DC], etc.)	65	9.2	10.8	26.2	**36.9**	16.9	4	4
Use of handheld pneumatic (air) tools (ex. impact wrench, paint spray gun, etc.)	71	4.2	19.7	22.5	**39.4**	14.1	4	4
Procedures for wiring double-pole switch circuits	65	13.9	10.8	23.1	**35.4**	16.9	4	4
Procedures for wiring three-way switch circuits	65	15.4	13.9	21.5	**30.8**	18.5	3	4
Procedures for laying out projects	74	9.5	10.8	31.1	**35.1**	13.5	3	4
Procedures for using PVC pipe	72	8.3	13.9	**31.9**	**31.9**	13.9	3	3 / 4
Procedures for building fence projects	72	12.5	15.3	29.2	**30.6**	12.5	3	4
Drawing project plans to scale	73	9.6	20.6	27.4	**31.5**	11.0	3	4
Procedures for GMAW (MIG welding)	70	22.9	18.6	17.1	**28.6**	12.9	3	4
Use of precision tools (ex. micrometer, dial caliper, etc.)	70	8.6	22.9	**28.6**	24.3	15.7	3	3
Procedures for agricultural equipment operation	65	**26.2**	13.9	21.5	24.6	13.9	3	1

				%				
Item	*n*	*NC*	*LC*	*SC*	*C*	*VC*	*Mdn*	*Md*
Procedures for wiring four-way switch circuits	65	20.0	20.0	21.5	**24.6**	13.9	3	4
Procedures for disassembling small engines	65	**26.2**	12.3	**26.2**	23.1	12.3	3	1 / 3
Procedures for wiring trailer electrical systems	65	18.5	**26.2**	20.0	**26.2**	9.2	3	2 / 4
Procedures for reassembling small engines	64	**25.0**	17.2	23.4	21.9	12.5	3	1
Procedures for oxy-fuel cutting	70	**27.1**	18.6	21.4	17.1	15.7	3	1
Use of hydraulic equipment (ex. shears, iron worker, etc.)	70	21.4	18.6	**27.1**	17.1	15.7	3	3
Principles of four-stroke engine operational theory	64	**25.0**	17.2	**25.0**	21.9	10.9	3	1 / 3
Principles of two-stroke engine operational theory	65	**24.6**	18.5	**24.6**	21.5	10.8	3	1 / 3
Principles of welding theory (ex. joint types, positions, etc.)	70	**25.7**	**25.7**	17.1	18.6	12.9	2	1 / 2
Procedures for plasma arc cutting	70	**28.6**	25.7	14.3	21.4	10.0	2	1
Interpreting project blueprints	74	10.8	14.9	**46.0**	18.9	9.5	3	3
Procedures for troubleshooting small engines	63	**27.0**	19.1	**27.0**	14.3	12.7	3	1 / 3
Procedures for using PEX pipe	72	**29.2**	25.0	19.4	15.3	11.1	2	1
Procedures for structural welding	70	**35.7**	24.3	15.7	15.7	8.6	2	1
Principles of metallurgy (ex. identifying metals, proper use of metals, etc.)	69	**31.9**	24.6	20.3	15.9	7.3	2	1
Procedures for building metal projects (ex. trailers, barbecue pits, etc.)	70	**37.1**	22.9	17.1	14.3	8.6	2	1
American Welding Society (AWS) standards for welding procedures	69	**37.7**	20.3	20.3	13.0	8.7	2	1
Procedures for FCAW (Flux-core arc welding)	71	**42.3**	21.1	15.5	14.1	7.0	2	1
Procedures for GTAW (TIG welding)	71	**39.4**	22.5	16.9	15.5	5.6	2	1
Procedures for building masonry projects	72	26.4	**33.3**	19.4	15.3	5.6	2	2
Procedures for oxy-fuel welding	70	**40.0**	17.1	22.9	14.3	5.7	2	1
Procedures for conducting land surveys	64	**32.8**	28.1	20.3	14.1	4.7	2	1
Procedures for cold metalworking cutting	70	**38.6**	31.4	11.4	12.9	5.7	2	1
Principles of diesel engine operational theory	65	27.7	**29.2**	24.6	13.9	4.6	2	2
Use of computer numerical control (CNC) systems	71	**36.6**	25.4	19.7	11.3	7.0	2	1
Procedures for oxy-fuel brazing	69	**43.5**	24.6	14.5	13.0	4.4	2	1
Procedures for hot metalworking bending	70	**38.6**	28.6	15.7	10.0	7.0	2	1
Procedures for using copper pipe	72	**30.6**	**30.6**	22.2	8.3	8.3	2	1 / 2
Procedures for hot metalworking cutting	70	**38.6**	28.6	17.1	11.4	4.3	2	1
Principles of vehicle powertrain operational theory	64	**34.4**	25.0	25.0	10.9	4.7	2	1

Item	n	% NC	LC	SC	C	VC	Mdn	Md
Procedures for using land surveying equipment	64	**31.3**	21.9	**31.3**	12.5	3.1	2	1 / 3
Procedures for cold metalworking bending	70	**40.0**	28.6	17.1	10.0	4.3	2	1
Procedures for cold metalworking shaping	70	**40.0**	30.0	17.1	8.6	4.3	2	1
Procedures for hot metalworking shaping	70	**38.6**	30.0	20.0	7.1	4.3	2	1
Procedures for using legal land descriptions	64	**35.9**	32.8	21.9	6.3	3.1	2	1
Procedures for using unmanned aerial vehicles in land surveying	64	**43.8**	34.4	12.5	7.8	1.6	2	1

Note. Competence scale: 1 = *Not competent* (*NC*), 2 = *Little competence* (*LC*), 3 = *Somewhat competent* (*SC*), 4 = *Competent* (*C*), 5 = *Very competent* (*VC*); *Mdn* = Median; *Md* = Mode.

Agricultural Mechanics PD Needs Ranked by MWDS

We reported early-career Georgia agriculture teachers' agricultural mechanics PD needs within each of the 65 different agricultural mechanics items in Table 4 (below). As indicated by their positive MWDS, the five greatest agricultural mechanics PD needs for early-career Georgia agriculture teachers were: (1) *American Welding Society (AWS) standards for welding procedures* (MWDS = 8.06), (2) *Procedures for structural welding* (MWDS = 7.42), (3) *Principles of metallurgy (ex. identifying metals, proper use of metals, etc.)* (MWDS = 7.32*,* (4) *Procedures for building metal projects (ex. trailers, barbeque pits, etc.)* (MWDS = 7.29), and (5) *Procedures for cold metalworking bending* (MWDS = 7.27). Conversely, the five lowest agricultural mechanics PD needs for early-career Georgia agriculture teachers were: (1) *Use of marking tools (ex. chalk line, paint marker, etc.)* (MWDS = 2.14), (2) *Use of personal protective equipment (PPE)* (MWDS = 1.85), (3) *Use of hand tools (ex. screwdriver, hammer, etc.)* (MWDS = 1.80), (4) *Procedures for SMAW (arc welding)* (MWDS = 1.33), and (5) *Procedures for painting projects* (MWDS = 0.91) (see Table 4).

Table 4

Early-career Georgia Agriculture Teachers' Agricultural Mechanics Professional Development Needs by MWDS

Item	n	Rank	MWDS	Importance M	Importance SD	Competence M	Competence SD
American Welding Society (AWS) standards for welding procedures	69	1	8.06	4.25	0.85	2.35	1.34
Procedures for structural welding	70	2	7.42	4.16	0.85	2.37	1.34
Principles of metallurgy (ex. identifying metals, proper use of metals, etc.)	69	3	7.32	4.17	0.82	2.42	1.29
Procedures for building metal projects (ex. trailers, barbecue pits, etc.)	70	4	7.29	4.11	0.81	2.34	1.34
Procedures for cold metalworking bending	70	5	7.27	3.94	0.85	2.10	1.17
Procedures for troubleshooting small engines	63	6	7.13	4.32	0.74	2.67	1.36

Item	*n*	Rank	*MWDS*	Importance *M*	Importance *SD*	Competence *M*	Competence *SD*
Principles of vehicle powertrain operational theory	64	7	7.12	4.03	0.93	2.27	1.19
Principles of diesel engine operational theory	65	8	7.08	4.11	0.89	2.38	1.17
Procedures for GTAW (TIG welding)	71	9	7.07	4.01	0.90	2.25	1.28
Procedures for hot metalworking cutting	70	10	6.93	3.91	0.91	2.12	1.18
Procedures for cold metalworking shaping	70	11	6.89	3.86	0.91	2.07	1.15
Procedures for cold metalworking cutting	70	12	6.88	3.91	0.88	2.16	1.24
Procedures for hot metalworking bending	70	13	6.85	3.93	0.95	2.19	1.25
Principles of welding theory (ex. joint types, positions, etc.)	70	14	6.75	4.26	0.81	2.67	1.38
Procedures for hot metalworking shaping	70	15	6.75	3.84	0.96	2.09	1.13
Procedures for oxy-fuel welding	70	16	6.61	3.96	1.00	2.29	1.29
Procedures for FCAW (Flux-core arc welding)	71	17	6.54	3.90	0.97	2.23	1.32
Procedures for reassembling small engines	64	18	6.35	4.28	0.77	2.80	1.37
Procedures for oxy-fuel brazing	69	19	6.28	3.77	0.99	2.10	1.23
Procedures for wiring trailer electrical systems	65	20	6.08	4.25	0.79	2.82	1.27
Procedures for agricultural equipment operation	65	21	6.05	4.28	0.84	2.86	2.00
Procedures for disassembling small engines	65	22	6.01	4.25	0.77	2.83	1.38
Procedures for building masonry projects	72	23	6.01	3.93	0.89	2.40	1.19
Principles of four-stroke engine operational theory	64	24	5.95	4.19	0.85	2.77	1.34
Principles of two-stroke engine operational theory	65	25	5.82	4.15	0.85	2.75	1.33
Procedures for oxy-fuel cutting	70	26	5.74	4.14	0.87	2.76	1.43
Procedures for plasma arc cutting	70	27	5.66	4.00	1.00	2.59	1.37
Procedures for using copper pipe	72	28	5.60	3.81	0.97	2.33	1.23
Procedures for GMAW (MIG welding)	70	29	5.54	4.21	0.83	2.90	1.38
Use of computer numerical control (CNC) systems	71	30	5.47	3.73	1.04	2.27	1.26
Procedures for using PEX pipe	72	31	5.46	3.93	0.88	2.54	1.35
Interpreting project blueprints	74	32	5.37	4.27	0.65	3.01	1.08
Procedures for wiring four-way switch circuits	65	33	5.36	4.20	0.79	3.92	1.35
Procedures for using unmanned aerial vehicles in land surveying	64	34	5.09	3.39	1.11	1.89	1.01
Use of hydraulic equipment (ex. shears, iron worker, etc.)	70	35	5.04	4.10	0.85	2.87	1.36
Procedures for using legal land descriptions	64	36	4.98	3.50	1.07	2.08	1.06
Use of electrical measurement units (ex. amperes, volts, Ohms, etc.)	65	37	4.94	4.52	0.62	3.43	1.13
Procedures for using land surveying equipment	64	38	4.80	3.66	1.04	2.34	1.14
Procedures for conducting land surveys	64	39	4.74	3.61	1.10	2.30	1.20
Procedures for wiring three-way switch circuits	65	40	4.72	4.32	0.73	3.23	1.33

Item	*n*	Rank	*MWDS*	Importance		Competence	
				M	*SD*	*M*	*SD*
Principles of electrical theory (ex. conductors, insulators, alternating current [AC], direct current [DC], etc.)	65	41	4.67	4.46	0.61	3.42	1.17
Use of electrical systems tools (ex. digital multi-meter, wire strippers, etc.)	65	42	4.65	4.51	0.64	3.48	1.19
Procedures for laying out projects	74	43	4.62	4.38	0.59	3.32	1.14
Use of precision tools (ex. micrometer, dial caliper, etc.)	70	44	4.53	4.23	0.80	3.16	1.20
Safety procedures for agricultural mechanics activities	74	45	4.51	4.91	0.29	3.99	0.96
Procedures for wiring double-pole switch circuits	65	46	4.47	4.34	0.69	3.31	1.27
Use of stationary power equipment (ex. band saw, table saw, etc.)	71	47	4.41	4.54	0.56	3.56	1.19
Procedures for wiring outlets	65	48	4.37	4.51	0.64	3.54	1.21
Estimating materials for projects	74	49	4.33	4.45	0.55	3.47	1.10
Procedures for wiring single-pole switch circuits	65	50	4.19	4.46	0.69	3.52	1.29
Drawing project plans to scale	73	51	4.14	4.14	0.69	3.14	1.16
Use of handheld power tools (ex. cordless drill, jig saw, etc.)	70	52	3.87	4.76	0.46	3.94	1.08
Procedures for using PVC pipe	72	53	3.79	4.20	0.70	3.29	1.13
Use of measuring tools (ex. tape measure, framing square, etc.)	72	54	3.59	4.88	0.33	3.14	0.83
Procedures for building wood projects	72	55	3.50	4.35	0.59	3.54	1.03
Creating a bill of materials for projects	74	56	3.43	4.46	0.67	3.69	1.15
Procedures for building fence projects	72	57	3.32	4.00	0.85	3.15	1.21
Use of handheld pneumatic (air) tools (ex. impact wrench, paint spray gun, etc.)	71	58	2.89	4.10	0.83	3.39	1.09
Use of laboratory safety equipment (ex. fire extinguishers, eye wash stations, etc.)	74	59	2.50	4.86	0.38	4.35	0.56
Use of fasteners (ex. screws, nails, glue, etc.)	74	60	2.39	4.53	0.55	4.00	0.95
Use of marking tools (ex. chalk line, paint marker, etc.)	70	61	2.14	4.40	0.67	3.93	0.89
Use of personal protective equipment (PPE)	74	62	1.85	4.88	0.33	4.50	0.67
Use of hand tools (ex. screwdriver, hammer, etc.)	69	63	1.80	4.77	0.46	4.39	0.71
Procedures for SMAW (Arc welding)	70	64	1.33	4.23	0.84	3.91	0.88
Procedures for painting projects	74	65	0.91	3.96	0.78	3.73	0.96

Note. Importance Scale: 1 = *Not important* (*NI*), 2 = *Of little importance* (*LI*), 3 = *Somewhat important* (*SI*), 4 = *Important* (*I*), 5 = *Very important* (*VI*); Competence Scale: 1 = *Not competent* (*NC*), 2 = *Little competence* (*LC*), 3 = *Somewhat competent* (*SC*), 4 = *Competent* (*C*), 5 = *Very competent* (*VC*); *MWDS* = Mean weighted discrepancy score; *M* = Mean; *SD* = Standard deviation.

Conclusions, Discussion, Recommendations, and Limitations

The purpose of our study was to determine the agricultural mechanics PD needs of early-career Georgia agriculture teachers. Based upon our findings, we concluded that early-career Georgia agriculture teachers have PD needs in all 65 agricultural mechanics items included in our instrument. Consequently, therein lie opportunities for Georgia agricultural education stakeholders to strategically plan and implement a wide range of agricultural mechanics PD sessions that would potentially benefit early-career agriculture teachers throughout the state. More specifically, we further concluded that early-career Georgia agriculture teachers' agricultural mechanics PD needs relate primarily to welding and metal fabrication. When examining Table 4, numerous items within welding and metal fabrication had high MWDS. Consequently, special consideration must be given to welding and metal fabrication-related items when developing PD sessions for early-career agriculture teachers in Georgia. To maximize the potential to address multiple items within this broad area, we recommend that Georgia agricultural education stakeholders consider facilitating long-duration (i.e., one day-long or longer) PD sessions. Examples of potential PD sessions that could likely address multiple items underneath the welding and metal fabrication umbrella may include beginner-level, skill development-oriented workshops along with more advanced, project-focused workshops.

We did note that the majority of our respondents did perceive all 65 agricultural mechanics items to be important to teach within agricultural education programs. Because agricultural mechanics instruction is popular with students in the state (Georgia Agricultural Education, 2023), we found it reassuring that early-career Georgia agriculture teachers indicated that this subject matter area is important to teach. In contrast, however, many respondents did not identify themselves as either *Competent* or *Very competent* on a wide range of the 65 agricultural mechanics items on our research instrument. We found this to be particularly evident with the highly-technical agricultural mechanics items (e.g., *Use of computer numerical control [CNC] systems* and *Procedures for GTAW [TIG welding]*) in comparison to the fundamental, introductory-level agricultural mechanics items (e.g., *Use of hand tools [ex. screwdriver, hammer, etc.]* and *Procedures for painting projects*). This gap was likely produced via a combination of both limited exposure to agricultural mechanics before entering a university (as was often found by Whitehair et al. [2020]) and limited undergraduate-level agricultural teacher education programming addressing agricultural mechanics.

As Granberry et al. (2023) noted, the credit hours within agricultural teacher education programs intended to prepare pre-service teachers to teach agricultural mechanics remain limited. As such, early-career Georgia agriculture teachers may not be prepared to adequately address their students' learning needs, which may disrupt to the development of human capital for the state's agricultural industry. Per HCT (Becker, 1993), investing in professionals' knowledge and skills (i.e., developing and offering agricultural mechanics PD for early-career agriculture teachers) can produce quantifiable, measurable returns on investment. As agriculture teachers are vital developers of human capital for the agricultural industry (Stripling & Ricketts, 2016), they must be prepared to adequately deliver instruction in agricultural mechanics (Wells & Hainline, 2021).

Regarding further research to support agricultural education programming in Georgia, we recommend that scholars replicate our study with mid- and late-career Georgia agriculture teachers. On a national level, Hainline and Wells (2024) found that agriculture teachers have different agricultural mechanics PD needs based on career phase. Consequently, we believe that Georgia agriculture teachers may likewise have differing agricultural mechanics PD needs based on their respective career phases. Such data would be useful for Georgia agricultural education stakeholders as they work to strategically address agriculture teachers' technical agriculture knowledge and skill shortcomings.

Regarding limitations of our study, we identified that our response rate (31.3%) was a primary limitation. Ideally, we intended to collect data from all 253 early-career Georgia agriculture teachers. While a response rate of 31.3% is usable, it is certainly not the ideal. However, our response rate was similar to recent national-level studies (Sherman & Sorensen, 2020; Wells & Hainline, 2021), indicating that other scholars are encountering challenges with response rates. A higher response rate in our study would have provided a more complete picture of the agricultural mechanics PD needs that early-career Georgia agriculture teachers have. We further acknowledge that because our study used a census design and we obtained a fairly-low response rate, we cannot generalize our results to all early-career Georgia agriculture teachers.

Both the timing of our data collection and the Qualtrics platform itself may have also served as limitations to potential respondents. Due to the 2023 Georgia National Fair and the 2023 National FFA Convention, many early-career Georgia agriculture teachers were likely traveling with (and supervising) their students while we were collecting data. Consequently, some potential respondents may have attempted to complete our research instrument on their mobile devices (i.e., smartphones). Our research instrument used a two-part, Likert-type scale that required scrolling back and forth as well as up and down. This may have led to some respondents either exiting our research instrument prior to answering all the items or electing to not respond at all. We recommend that scholars who elect to replicate our study carefully consider both data collection timing and the formatting of the research instrument when using Qualtrics.

References

Becker, G. S. (1993). *Human capital: A theoretical and empirical analysis with special reference to education* (3rd ed.). The University of Chicago Press.

Borich, G. (1980). A needs assessment model for conducting follow-up studies. *Journal of Teacher Education, 31*(3), 39-42. https://doi.org/10.1177/002248718003100310

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2014). *Internet, phone, mail, and mixed-mode surveys: The tailored design method* (4th ed.). John Wiley & Sons, Inc.

Eck, C. J., Robinson, J. S., Ramsey, J. W., & Cole, K. L. (2019). Identifying the characteristics of an effective agricultural education teacher: A national study. *Journal of Agricultural Education, 60*(4), 1-18. https://doi.org/10.5032/jae.2019.04001

Georgia Agricultural Education. (2023, July). *Georgia agricultural education 2022-2023 annual report*. https://www.georgiaffa.org/docs/48404_2022-2023%20Georgia%20Ag%20Ed%20Annual%20Report.pdf

Granberry, T., Blackburn, J. J., & Roberts, R. (2023). The state of agricultural mechanics in the preparation of school-based agricultural education teachers. *Journal of Agricultural Education, 64*(4), 144-158. https://doi.org/10.5032/jae.v64i4.160

Grieman, B. C. (2010). Continuing professional development. In R. M. Torres, T. Kitchel, A. L. Ball (Eds.) *Preparing and advancing teachers in agricultural education* (pp. 180-201). The Ohio State University.

Hainline, M. S., & Wells, T. (2024). Examining differences in teachers' agricultural mechanics professional development needs: A national study. *Journal of Agricultural Education, 65*(1), 245-264. https://doi.org/10.5032/jae.v65i1.2473

Lindner, J. R., Murphy, T. H., & Briers, G. E. (2001). Handling nonresponse in social science research. *Journal of Agricultural Education, 42*(4), 43-53. https://doi.org/10.5032/jae.2001.04043

McKim, B. R., & Saucier, P. R. (2011). An Excel-based mean weighted discrepancy score calculator. *The Journal of Extension, 49*(2). https://www.joe.org/joe/2011april/pdf/JOE_v49_2tt8.pdf

Sherman, A., & Sorensen, T. J. (2020). A national examination of the predictors of volunteer utilization in school-based agricultural education. *Journal of Agricultural Education, 61*(2), 339-357. https://doi.org/10.5032/jae.2020.02339

Solomonson, J. K., & Retallick, M. S. (2018). Over the edge: Factors nudging mid-career, school-based agriculture teachers out of the profession. *Journal of Agricultural Education, 59*(4), 1-19. https://doi.org/10.5032/jae.2018.04001

Solomonson, J. K., Still, S. M., Maxwell, L. D. (2021). Factors influencing the decision of Illinois school-based agricultural education teachers to remain in the profession. *Journal of Agricultural Education, 62*(3), 121-137. https://doi.org/10.5032/jae.2021.03121

Stripling, C. T., & Ricketts, J. C. (2016). Research priority 3: Sufficient scientific and professional workforce that addresses the challenges of the 21st century. In T. G. Roberts, A. Harder, & M. T. Brashears. (Eds.), *American Association for Agricultural Education national research agenda: 2016-2020.* University of Florida Department of Agricultural Education and Communication.

Valdez, E. D., & Johnson, S. (2020). *Mismatch? Aligning secondary career and technical education with regional workforce demand*. Texas Public Policy Foundation. https://files.texaspolicy.com/uploads/2020/05/05112536/Valdez-Johnson-Workforce-Demand.pdf

Wells, T., & Hainline, M. S. (2021). Examining teachers' agricultural mechanics professional development needs: A national study. *Journal of Agricultural Education, 62*(2), 217–238. https://doi.org/10.5032/jae.2021.02217

Wells, T., Hainline, M. S., Rank, B. D., Sanders, K. W., & Chumbley, S. B. (2021). A regional study of the agricultural mechanics knowledge and skills needed by school-based agricultural education teachers. *Journal of Agricultural Education, 62*(2), 148-166. https://doi.org/10.5032/jae.2021.02148

Whitehair, R. L., Schramm, K. R. S., Wells, T., & Hainline, M. S. (2020). Preservice teachers' conceptualizations of agricultural mechanics. *Journal of Agricultural Education, 61*(3), 60-74. https://doi.org/10.5032/jae.2020.03060