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Analysis of a Multi-year Teacher Professional Development: Perspectives from the Final Year

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Abstract

Recognizing that the agriculture industry continues to have the highest worker fatality rate, a multi-year teacher professional development was conducted to improve teachers' tractor and machinery safety knowledge. The purpose of this study was to analyze participant knowledge throughout the professional development to better understand the role of continued engagement. A total of 97 teachers participated in year five of the five-year training program. Participant gender identification was nearly equal in terms of male and female. Beginning (0-2 years of experience) and mid-career (3-5 years of experience) educators accounted for over 80% of participants, with most participating in the training program during multiple years. This program utilized the National Safe Tractor and Machinery Operations Program (NSTMOP) curriculum. The average post-test score was 39 out of 50. Second-year attendees recorded the lowest test score average, while fifth-year attendees recorded the highest. On the post-test, participants were asked what attracted them to return to the training experience. Almost one-third reported that curriculum obtainment was the primary attractor. This study has implications for professional development coordinators looking to implement safety education programs. Future research should focus on evaluating the implementation of safe tractor and machinery operations in participating teachers' classrooms.

Introduction

Professional development, defined in various ways, is essential for all teachers in their pursuit to continue to grow and improve their classroom teaching quality. Darling-Hammond et al. (2017) defined professional development as improving teacher practices and students' learning outcomes. Scher and O'Reilly (2009) defined professional development as outcomes about teachers' knowledge, which can be

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immediate, outcomes that lead to changes in a teacher's instruction, and outcomes that lead to improvements in student achievement. Even with some variation in defining professional development, we can look at the development of teachers as a continuum from the time they are pre-service until they are considered veteran teachers.

As we consider a pre-service teacher's formal preparation program, they begin transitioning to their first year of teaching through induction (Moir & Glass, 2001). This initial stage involves ongoing training designed to help new teachers improve their teaching. A transition then occurs from the induction to the development phase, wherein a majority of a teacher's professional and skill development will continue to occur. Teachers often transition into the final state of renewal, which focuses on revitalizing one's practice, often accomplished through professional development. Over the last several years, literature has identified a need for agriculture teachers' professional development (Burris et al., 2005; Smalley et al., 2019). More specifically, the topic of content-specific professional development in agricultural mechanization, including agricultural safety (Burris et al., 2005; Byrd et al., 2015; McCubbins et al., 2017), has been well documented.

A need for safety education has been further identified as the agricultural industry continues to have a higher worker fatality rate than any other industry (Bureau of Labor Statistics [BLS], 2022). This number becomes more alarming as the National Children's Center (2022) fact sheet reported the highest number of occupational fatalities for youth ages 17 and younger. Educational areas within career and technical education, such as agricultural education, can directly impact providing education to youth and can further prepare students for employment related to the agricultural industry (Menger-Ogle et al., 2023; Schulte et al., 2005). Within agricultural education programming, students participate in supervised agricultural experiences (SAEs), where they can participate in work-based learning opportunities (FFA, 2023). These opportunities can provide the foundation for ensuring safe behaviors in future applications (Love et al., 2022; Pate et al., 2019).

Acknowledging that teachers' safety knowledge has been shown to increase as they gain additional teaching experience (Pate et al., 2019) and that professional development has the potential to alter teachers' knowledge, which can, in return, alter practice and improve student learning of safety (Kennedy, 2016), school-based agricultural educators are uniquely situated to address the issue of ever-increasing fatality rates in agriculture. To better understand the role of continued engagement in effective safety education professional development, additional research needs to examine participant knowledge gained from multi-year professional development events.

Conceptual Framework

Our study sought to analyze participant knowledge throughout a multi-year professional development to better understand the role of continued engagement. To ensure the quality of this training, we chose a framework that details effectiveness strategies and a theory for implementing action and applied it to curriculum development. Darling-Hammond et al. (2017) determined that effective professional development includes seven elements and focuses on a rigorous learning experience for teachers. The content centers on what will be taught in the classroom, and the content elements focus on active learning by teachers. This learning can involve collaboration among other educators, using models, and coaching, an element that combines reflection and feedback. Professional development over a sustained duration is critical for the content skills to be practiced and retained (Darling-Hammond et al., 2017).

Table 1

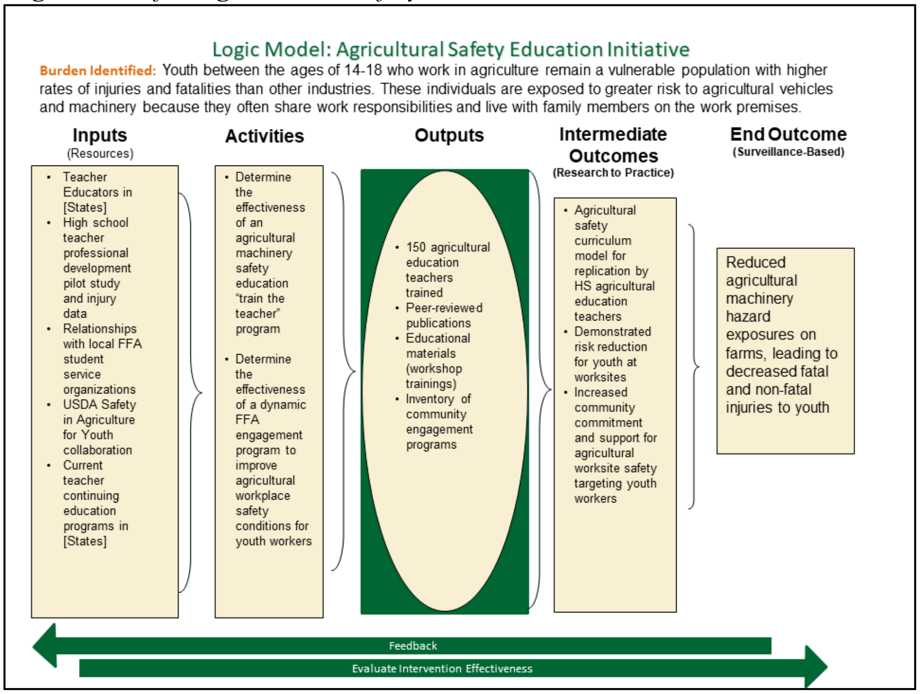
Elements of Effective Professional Development adapted from Darling-Hammond et al. (2017)

Elements	Description
Content Focus	Effective professional development focuses on the content that teachers teach.
Active Learning	Professional development must address both the what and the how of teaching.
Collaboration	Professional development should provide opportunities for teachers to work together.
Use of Models and Modeling	Professional development should provide clear examples or models of effective instruction.
Coaching and Expert Support	Professional development should provide for coaching teachers in the acquisition of new skills.
Feedback and Reflection	Professional development should promote, encourage, and provide teachers feedback on their performance.
Sustained Duration	Professional development should be of the duration necessary to allow for the six elements listed here.

Considering the effective teaching elements, a logic model was designed to guide our program (Figure 1). The developed model links theories and assumptions with inputs, activities, outputs, and outcomes (W.K. Kellogg Foundation, 2004). The agricultural safety professional development explored in our study connects the program's resources to its stakeholders. Stakeholders are an essential component of agricultural education programs, and having a strong interaction with students will assist in promoting safety within the local community. Through educator training and behavior modeling (Schwebel & Pickett, 2012), students can develop safe behaviors and sound decision-making skills in a workplace setting, including those found in SAEs. SAEs allow students to facilitate experiential learning, which can help students further develop career development skills (Barrick et al., 1992; Burke et al., 2006). More specific to the purpose of this study, Sanderson et al. (2010) concluded that farm safety can be learned through observation and modeling.

Figure 1

Logic Model for Agricultural Safety Education Initiative



Tractor and Machinery Safety Professional Development Model

According to Kennedy (2016) and building on effective professional development and modeling, a teacher's professional development should be guided by a theory of action comprised of a central problem. For this multi-year professional development program, the guiding theory of action was informed by a central problem of practice. This focused on SAE safety using a hands-on pedagogy to facilitate student instruction. Workshop development and teaching strategies followed Desimone's (2009) core features of professional development. The workshop focused on addressing the teaching problem (coherence) of how to improve student comprehension of tractor and machinery safety (content) using hands-on table-top demonstrations (active learning) and tractor operations walk-through examples (collective participation) of student activities during a 10-hour session (duration).

The enactment component of our program theory of action was guided by a prescriptive approach for integrating agricultural safety curriculum within school-based SAEs (Kennedy, 2016) using the National Safety Tractor Machinery Operations Program (NSTMOP) and the SAE Risk Assessment Protocol. This approach provided teachers with pre-established lesson plans that utilized closed-ended prompts for teachers and expected responses by students. The prescriptive curriculum allows teachers to implement without modifications as it provides what ought to happen, thus reducing the judgment teachers need to implement the teaching strategy (Kennedy, 2016). Kennedy (2016) noted that as a teacher, various requirements create conflicting curriculum priorities. Having a teacher sustain the implementation efforts can be challenging as teachers maintain district and state curriculum requirements for their students. We used this framework to guide the analysis of teacher professional development. Allowing researchers to understand educators' participation in professional development will aid in developing new professional development events.

Purpose and Objectives

To better understand the role of continued engagement in professional development, the purpose of this study was to analyze participant knowledge throughout a multi-year safe tractor and machinery operations professional development. The research objectives guiding the study were:

1. Describe the teachers who participated in the school-based agricultural education multi-year professional development training.
2. Determine if knowledge attainment differences existed according to the quantity of multi-year professional development events attended.
3. Determine if motivational factors existed among teachers attending a multi-year professional development focused on safety operations training.

Methods

A convenience sample of secondary agricultural educators who had participated in hands-on agricultural safety trainings from Montana, South Dakota, and Utah were recruited to participate in this study over the five-year professional development. Each state's training seminar was hosted separately, but the content and delivery were uniform in learning activities and experiences. Teacher educators in each state remained consistent and provided professional development to secondary agricultural educators in June of each year. The 10-hour professional development sessions focused on improving student comprehension of tractor and machinery safety using hands-on tabletop demonstrations. This was also completed by utilizing tractor operations walk-through examples of student activities. Resource materials, which involved safety materials and workshop curriculum, were provided to all participants. New lesson materials were developed yearly, including large group activities and rotations between small group, hands-on stations. Active engagement occurred with teachers throughout the training. This study examined data collected in the final year of the five-year professional development.

Instrument and Data Collection

Following each professional development training, participants completed a paper-based test constructed of NSTMOP knowledge items. This test had reliability established previously with youth. In addition, the test collected demographic questions and questions on motivation for returning to the training seminar. Test questions were focused on safe tractor operation, machinery safety, and general health and safety. The internal consistency reliability for dichotomous choices was measured by a KR-20 alpha, which measured dichotomous answer scoring (0 = incorrect, 1 = correct). The KR-20 alpha for the instrument was .89 when tested on 1,400 youth ages 14-18 (Smalley et al., 2022). For post-hoc reliability with the current sample of teachers, the KR-20 alpha was .54. For teacher-made tests, acceptable score reliability averages a KR-20 value of .50 (Frisbie, 1988). Factors that have been noted to affect reliability estimates include test content, group heterogeneity, item difficulty, and item discrimination (Frisbie, 1988). A low reliability score may have been attributed to the multidimensional content assessed by the items pulled from each seminar's safety lessons (Tractor Stability, ATV/UTV, and Safe Operation of Equipment). Tests that measure multiple content areas tend to yield lower reliability scores (Frisbie, 1988). An item analysis was conducted to identify specific test items of concern regarding item discrimination using point-biserial correlations and the item difficulty index, which are provided in Table 2. We concluded that the instrument was reliable based on the literature and prior reliability scores.

Table 2

Safety Test Item Discrimination and Difficulty Index

Item	Point Biserial Correlation	Item Difficulty Index
To prevent falls when mounting the tractor, you should have at least body part(s) in contact with the tractor at one time.	.177	.88
What is the purpose of personal protective equipment?	.120	.99
The "point of no return" for a rear tractor overturn is reached in how many seconds?	.122	.76
If a ditch is 6 feet deep, how far away should you keep the tractor from the embankment?	.052	.87
Heavy draft loads (i.e., tillage equipment) should be attached to which of the following?	.453**	.62
When working on a skid steer loader with the bucket in the raised position, the following safety practice is expected of all workers:	.329**	.85
According to the North American Guidelines for Children's Agricultural Tasks (NAGCAT), what is the recommended minimum age for operating a PTO-powered implement?	.369**	.48
How would you describe work on the farm?	.476**	.74
What percent of tractor-related fatalities are a result of tractor overturns?	.104	.82
Start a tractor engine with the:	.200	.93
When releasing a two-pedal direction and speed control, what position should you return it?	.173	.82
Before starting your tractor, you should:	.210	.96
To stop a diesel engine:	.302**	.75
The rear tires of older tractors may contain a commonly used corrosive liquid in the inner tube to add weight to the tractor to improve its traction. What is the liquid?	.207	.88
If a mechanical push-pull fuel switch is used, where should this switch be located?	.233*	.82
To prevent runaways when parked with heavy tractor loads, you should:	.207	.88
What may happen if you crank the tractor's starter motor too long?	.019	.84
To prevent heat-related illness, you should:	.275*	.95
What information about your tractor engine is shown in this picture? (RPM)	.237*	.87
Throttle controls next to the tractor seat increase engine speed when moved:	.324**	.75
The letters "ROPS" stand for:	.309**	.88
Which of the following increases the chance of a run-over?	.228*	.87
Which of the following scenarios is NOT a designed use of a farm tractor?	.120	.87
When using wheel-type tractors on silage surfaces, do NOT use with slopes greater than:	.348**	.85
When operating a high-lift bucket, where should you keep the bucket while the tractor is in motion?	.110	.93
To prevent untrained operators, children, and visitors from accidentally starting the tractor, you should:	.186	.89

Table 2

Safety Test Item Discrimination and Difficulty Index

Item	Point Biserial Correlation	Item Difficulty Index
Working as a non-family member farm employee, youth who are younger than 16 or older can fell trees with a butt diameter up to:	.319**	.84
Nationally, what fraction of all farm work fatalities are tractor-related?	.104	.56
According to the North American Guidelines for Children's Agricultural Tasks (NAGCAT), which age group should not operate a medium/large tractor (more than 70hp)	.370**	.71
The ROPS on a tractor:	.305**	.92
A safe work site should include which of the following:	.182	.95
Rather than an occupation, farming is commonly viewed as:	.227*	.78
A factor(s) that affect(s) your reaction time is/are:	-.154	.98
What must exist for OSHA to apply to a business or operation?	.353**	.78
You should avoid driving an ATV on:	.352**	.80
This pictorial warns you about which of the following potential hazards: (run over)	.059	.93
If you raise your arm vertically overhead (palm to the front) and rotate it in large horizontal circles, what hand signal are you using? (come to me)	.261*	.60
What personal protective equipment is recommended for ATV driving?	-.003	.96
Identify this public road hand signal. (stop)	.123	.93
Farm shops need adequate:	-.004	.94
What unit is used to measure sound?	.012	.95
Identify this public road hand signal. (left turn)	.015	.96
If someone draws his/her right-hand palm down across his/her neck in a throat-cutting motion from left to right, what should you do? (stop engine)	.079	.94
What does an arm extended horizontally sideward with palm down, waving a downward signal? (slow down)	.010	.94
Identify this public road hand signal. (left turn)	.038	.94
What does this symbol indicate? (alert)	.042	.87
Which of the following are ground-motion controls and should be orange color-coded?	.140	.78
Lifting heavy loads with the skid steer bucket can result in the center of gravity:	.347**	.75
PTO controls are designed to move rearward or downward to:	.341**	.60
Engine speed controls are operated with which of the following?	.074	.75

Note. * $p<0.05$; ** $p<0.01$

Data Analysis

For objective one, descriptive statistics were used to report teacher performance and demographics, including frequencies, percentages, means, and standard deviations. Once Levene's Test for equal variance was run to examine assumptions of homogeneity of variance, objective two was accomplished by utilizing a One-Way ANOVA to determine if there was a significant difference in knowledge and machinery operations between teachers participating in multiple years of professional development. Using G*Power 3.1.9.7, a sample size of 25 per group (five groups) was needed to detect a large effect size (0.80) with a power of .80 at an alpha level of 0.05 (Faul et al., 2007).

Objective three used open-ended items to assess participants' motivation for returning to the training seminar. Open responses were coded based on priori established themes using the conceptual framework for teacher professional development (Desimone, 2009; Kennedy, 2016). Responses were coded by researchers as 1 = knowledge, 2 = curriculum, 3 = scheduling, 4 = yes. 5 = incentives, 6 = other, and 7 = delivery. Data were compiled in Microsoft Excel and then analyzed in SPSS version 21.

Findings

As this was a multi-state project that included teachers from varying backgrounds, the purpose of objective one was to describe program participants. A total of 97 teachers participated in year five of the training program. Table 3 provides the distribution of teachers from each state. Participants were nearly split in gender identification, with 45 (46.39%) identifying as female and 50 (51.55%) as male. Teaching experience was collapsed as an ordinal variable and renamed "Teacher Life Cycle Stage," with 1-5 years of teaching experience classified as a beginning teacher, 6-15 years as a mid-career, and 16 or more years as a veteran. Beginning and mid-career educators accounted for over 80% (f = 77, 81.05%) of participants. The chi-square test of association was used to determine if there was a significant association between first-year attendees and multi-year attendees. There was no significant association between years of attendance and gender (χ^2 (4) = 6.42, p = .169). The average participant was 35.0 years of age (SD = 11.85). For years of teaching experience, six participants had 30 or more years, with the highest having 41 years of experience. Only 9 (9.28%) participants had less than or equal to one year of experience. The median teaching experience in years was eight.

Table 3
Demographics of Professional Development Participants

Distribution of teachers by State	*f*	%
Montana	43	44.33
South Dakota	23	23.71
Utah	31	31.96
Total Responses	97	100.00
Gender		
Female	45	46.39
Male	50	51.55
Missing/Other	2	2.06
Total Responses	97	100.00
Years of Experience		
Beginning (1-5)	39	41.05
Mid-Career (6-15)	38	40.00
Veteran (16 plus)	18	18.95
Total Responses	95	100.00
Age		
Young Adult (21–29)	41	43.62
Middle Aged Adult 30-39)	25	26.60
Older Adult	28	29.79
Total Responses	94	100.00

Objective two sought to determine if knowledge attainment differences existed according to the quantity of multi-year professional development events attended. Participants were asked how many times, including the current year, they had participated in the training program. This was the first time attending the training program for over one-third ($f = 35$, 36.08%) of participants, with Utah experiencing the highest number of first-year attendees ($f = 17$, 54.84%). Most participants ($f = 62$, 63.92.5%) had participated in the training at least twice, and Montana had 7 (15.91%) participants who had participated in all five years of training. Table 4 provides the distribution of teachers' participation experience.

Table 4
Distribution of Teacher Attendee Category by State

Attendance Category	Montana		South Dakota		Utah		Combined	
	f	%	*f*	%	*f*	%	*f*	%
First time	12	27.27	6	26.09	17	54.84	35	36.08
Second time	5	11.36	4	17.39	8	25.81	17	17.53
Third time	10	22.73	6	26.09	1	3.23	17	17.53
Fourth time	9	20.45	7	30.43	4	12.90	20	20.62
Fifth time	7	15.91	0	0.00	1	3.23	8	8.25

When combining the attendee category with participant demographics, the average first-year attendee age was 34.34 years (*SD* = 11.53), and they had an average of 10.02 years of teaching experience (*SD* = 9.67). Second-year attendees' average age was 31.47 years (*SD* = 8.97), with an average of 7.65 years of teaching experience (*SD* = 8.62). Third-year attendees' average age was 33.18 (*SD* = 10.14), with an average of 10.5 years of teaching experience (*SD* = 9.81). The average fourth-year attendee age was 42.71 (*SD* = 12.35), and they had an average of 16.26 years of teaching experience (*SD* = 9.55). Fifth-year attendees' average age was 37.38 (*SD* = 10.13), with an average of 10.63 years of teaching experience (*SD* = 5.71).

The average test score was 39.0 (*SD* = 3.69) out of 50. Table 5 provides mean scores by attendee category and state. Second-year attendees recorded the lowest test score average (*M* = 37.82, *SD* = 3.66), while fifth-year attendees recorded the highest (*M* = 41.25, *SD* = 2.60). A passing test performance was considered 70%, or correctly answering at least 35 questions. Only ten individuals (10.3%) failed the test. An ANOVA was used to compare the means according to attendance category to determine the effect of sustained teacher participation on teachers' knowledge of safe tractor and machinery operation. Levene's Test of Equal Variance showed that the assumption of homogeneity of variance for ANOVA was met (F, (4,92) = 1.08, p = .37). The resulting difference was not statistically significant.

Table 5

Test Score Averages by Teacher Attendance Category

Attendance Category	Montana Test Score		South Dakota Test Score		Utah Test Score		Combined Test Score	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
First time	38.67	2.71	40.50	4.23	37.35	2.50	38.34	3.05
Second time	38.40	3.58	41.75	0.96	35.50	2.78	37.82	3.66
Third time	37.40	4.03	43.50	2.07	33.00	-	39.16	3.67
Fourth time	40.00	4.64	41.43	2.37	37.50	3.42	40.00	3.84
Fifth time	42.00	1.63	-	-	36.00	-	41.25	2.60

Objective three explored the motivational factors among teachers attending a multi-year professional development focused on safety operations training. On the post-experience NSTMOP test, participants were asked what attracted them to attend the training experience. Almost one-third (*f* = 30, 30.93%) reported *Curriculum Obtainment* as the primary attractor. Although accounting for only 12.37% (*f* = 12) of total responses, *Delivery Method* represented 29.41% of second-year attendees' reasons to return. Other responses included incentives such as PD credit, gift cards, or food (*f* = 6, 6.19%). Also of note, 23 (23.71%) participants responded with an affirmative *Yes* but did not indicate factors that would bring them back to the training, and 18 (18.56%) answered *Other*. Table 6 provides frequencies and percentages of attendees' justification for returning to the training.

Table 6

Frequencies and Percentages of Attendees' Justification for Returning to the Training

Attendance	Knowledge Acquisition		Curriculum Obtainment		Scheduling		Incentives		Delivery	
	f	%	*f*	%	*f*	%	*f*	%	*f*	%
First time	2	5.71	9	25.71	1	2.86	2	5.71	3	8.57
Second Time	0	0.00	5	29.41	0	0.00	2	11.76	5	29.41
Third time	1	5.88	7	41.18	0	0.00	1	5.88	1	5.88
Fourth time	2	10.00	7	35.00	1	5.00	1	5.00	1	5.00
Fifth time	1	12.50	2	25.00	0	0.00	0	0.00	2	25.00
Total	6	6.19	30	30.93	2	2.06	6	6.19	12	12.37

Conclusions and Recommendations

The purpose of this study was to analyze participant knowledge throughout a multi-year professional development to better understand the role of continued engagement in safety training. A limitation of this study should note that the generalizability of these results should not go beyond the study's participants. However, valuable information on the multi-year professional development has been acquired and helped form a series of implications for practice and recommendations for research.

Findings from objective one showed strong participation from each of the teacher life cycle stages, with many participants representing beginning and mid-career teachers. Moir and Glass (2001) would suggest this group is focused on ongoing training designed to help new teachers gain effectiveness in their teaching and begin the transition to skill development. As such, future professional development should include attention to effective teaching strategies that complement specific skill development. Even though most participants were categorized as beginning and mid-career teachers, almost twenty percent were considered veterans. During this cycle stage, teachers often focus on revitalizing their practice (Moir & Glass, 2001). Ideally, professional development events that include teachers from multiple life cycle stages would capitalize on the veteran experience and offer specific environments for coaching and expert support, as Darling-Hammond et al. (2017) outlined.

Objective two sought to determine if knowledge attainment differences existed according to the quantity of multi-year professional development events attended. Despite a significant association between participants attending for the first time versus multiple years, participants did well on the safe tractor and machinery operations knowledge test. Most participants received passing scores above 70% and had been part of the professional development for more than two years. Recommendations for practice are grounded in Darling-Hammond et al.'s (2017) Elements of Effective Professional Development, guided by Desimone's (2009) core features of professional development and supported by this study's findings. As suggested by Darling-Hammond et al. (2017) and observed throughout our multi-year professional development, effective safety education professional development should include activities with classroom relevance, be delivered through an active learning approach, and allow for collaboration among participants. The long-term goal of this approach would be the attainment of outcomes that lead to improvements in student achievement (Scher & O'Reilly, 2009).

Objective three explored participants' motivational factors by asking what attracted them to attend and return to the training experience. Reinforcing Moir and Glass's (2001) conclusions, almost one-third of participants reported curriculum obtainment as the primary attractor. Also noteworthy was the participants' recognition of the role of delivery methods in attending and returning to professional development events. This would seem to align with Darling-Hammond et al.'s (2017) suggestions for effective professional development, especially concerning active learning that addresses the what and the how of teaching. Incentives such as PD credit, gift cards, or food did not factor into participant motivation as strongly as anticipated, implying that professional development facilitators could reallocate resources to other aspects of the training that factored more strongly into participants' willingness to engage in continued professional development.

Ultimately, with the seven elements of effective professional development (Darling-Hammond et al., 2017) being incorporated throughout the planning and implementation process, it was promising to see growth and commitment over several years. Future research should focus on evaluating the implementation of safe tractor and machinery operations in participating teachers' classrooms, as this is where authentic student behavioral changes will begin to address the issue of rising agricultural accidents. This study has implications for professional development coordinators looking to implement safety education programs and enhance safety within existing curriculum.

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