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Tractor and Machinery Instructor Training: Impact of Sequential Professional Development

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ABSTRACT. *Vocational and technical education programs continue to play a pivotal role in the development of workers' occupational safety and health skills in all industries (Schulte et al., 2005). The Agricultural Safety Education Initiative was first conducted in the summer of 2017 as a multiple year "Train the Trainer" program to improve teachers' tractor and machinery knowledge. The training was organized around the National Safe Tractor and Machinery Operations Program (NSTMOP) Curriculum (Pate et al., 2019). The agricultural safety education training was offered again during the summers of 2018 and 2019. Each seminar focused training activities on a specific safety theme. The safety theme for 2018 was All-terrain Vehicle Stability and Operation for Agricultural Tasks. The safety theme of the 2019 training was hitching/backing tractors and implement connections. The purpose of this study was to determine the efficacy of an agricultural safety education professional development model designed to increase instructors' knowledge to serve youth in developing safety competencies related to tractors and machinery operations. A total of 85 teachers participated in year three of the training program. Over half (57.6%, f = 49) of the participants identified as female. The average test score for all teachers was 41.9 out of 50 (SD = 3.62). Teachers who attended the training for the first time in 2019 scored lowered (40.8, SD = 4.41) than teachers who had attended the training during all three offerings (43.2, SD = 3.00). This difference approached statistical significance (Kruskal-Wallis H was 5.91 (2) p = .052). A benefit for participating teachers in this professional development was focused on higher order instructional or alternative assessment methods for tractor and machinery safety.*

Keywords. *Assessment, Education, Farm, Instructors, Safety, Tractor, Youth*

Introduction/Background

Vocational and technical education programs continue to play a pivotal role in the development of workers' occupational safety and health skills in all industries (Schulte et al., 2005). However, unlike other industries, agriculture continues to employ youth less than 16 years of age as a significant part of the labor force whether paid or unpaid in a variety of tasks deemed hazardous by the Department of Labor (DOL) (National Institute for Occupational Safety and Health [NIOSH], 2014; U.S. Department of Labor, n.d.). One such example is the operation of tractors and machinery. The Federal Fair Labor Standards Act provides an exemption allowing 14 and 15-year-old youth who have completed a tractor and machinery certification (TMC) program to work for a farm employer who is not a parent. The agencies specified by the labor regulations

to provide the TMC training are the cooperative Extension Service and vocational agriculture programs within secondary schools. This TMC training program came under review with proposed revisions in 2011 (76 Fed. Reg. 171, 2011). In the 2011 proposed rule change, it was reported that research documenting the impact of tractor and machinery youth certification program was limited (NIOSH, 2002). Public comments to the report documented a negative public reaction to the proposed changes which ultimately led to the withdrawal of the DOL proposal. The outcome resulted in a refocused collaborative effort on agricultural safety curriculum for youth led by USDA NIFA's Youth Farm Safety Education and Certification Program (YFSEC). In 2013, USDA NIFA awarded funds in support of the Safety in Agriculture for Youth (SAY) project, led by Pennsylvania State University.

Bush and Andrews (2013) noted the immense variation between states' career and technical education program structures, resulting in integration discrepancies among occupational safety and health curricula. Jepsen (2012) reported the impact of the TMC program is linked to implementation efforts of community-based instructors and emphasized that program evaluation efforts are daunting due to a variety of community based implementation factors. This has been documented for the secondary agricultural education programs as researchers have documented variation in safety programming and student training (Lawver et al., 2016; Mann & Jepsen, 2019; Pate et al., 2016). Murphy (1992) noted that since the inception of the TMC training, the DOL has provided limited surveillance to ensure program fidelity.

The refocus of youth farm safety through the USDA NIFA funded SAY project has generated a greater repository of multiple safety curriculums with increased visibility, access, and curriculum standard alignment. Yet, research efforts are still needed to determine how to best prepare and develop TMC instructors for delivering safety curriculum that meets the DOL standards. Unlike the OSHA Trainer certification requirements (Occupational Safety and Health Administration [OSHA], n.d.), the TMC training program requires no experience or professional development requirements for instructors other than the requirement of being employed as an extension agent or a vocational agriculture instructor. It has been documented that instructor preparation can vary widely (Rasty et al., 2017) and many teacher preparation programs have reduced capacity to provide teachers agricultural mechanics training.

To address the issue of teacher training, the Agricultural Safety Education Initiative Project was funded as part of the High Plains Intermountain Center for Agricultural Health and Safety (HICAHS) to develop an innovative educational program to be utilized by local agricultural teachers to improve safety practices and work environments that employ young agricultural workers between the ages of 14-18. With the goal of gaining insight into a professional development model for agricultural safety education, a specific aim of this project was to investigate the impact of a multiple year "Train the Trainer" program on teachers' tractor and machinery knowledge.

The Agricultural Safety Education Initiative was first conducted in the summer of 2017 and organized around the National Safe Tractor and Machinery Operations Program (NSTMOP) Curriculum (Pate et al., 2019). In 2017, the training focused on the safety theme of tractor stability and roll-over protection. Pate et al. (2019) initially found teachers' ($N = 116$) average NSTMOP pre-test score was 35.2 out of 48 ($SD = 3.3$) prior to completing the training and an average NSTMOP post-test score of 40.3 out of 48 ($SD = 4.1$) upon completing the training. The resulting test score increase was significant ($t(109) = 11.9$, $p < 0.001$). The training was offered again during the summers of 2018 and 2019. Each seminar focused training activities on a specific safety theme. The safety theme for 2018 was All-terrain Vehicle Stability and Operation for Agricultural Tasks. The safety theme of the 2019 training was hitching/backing tractors and implement connections.

It is undocumented how a multiple year experiential-based training program may influence instructor development related to tractor and machinery safety knowledge. It is imperative to determine the efficacy of an agricultural safety education professional development model designed to increase TMC instructors' capacity to serve youth in developing safety competencies related to tractors and machinery operations.

Conceptual Framework

A large body of literature has emerged related to in-service teacher professional development, teacher learning, and teacher change (Desimone et al., 2002; Desimone & Stuckey, 2014; Richardson, 2001; Richardson & Placier, 2001). While describing teacher professional development can be complex (Desimone et al., 2002) the intent of teacher professional development is to enhance professional knowledge, skills, and attitudes of teachers so that they might, in turn, impact student learning (Guskey, 2002).

Program evaluation is as much a practice as it is a skill, requiring on the job continuing professional development or formal classroom training as part of a degree program (McClure et al., 2012). The effectiveness of teacher professional

development programs is critical for program improvement and should be guided by a program theory of action. Program theory and program logic models have been utilized by evaluators to study the underlying assumptions about how programs are expected to work (Rogers et al., 2000). Weiss (1998) defines program theory as the mechanisms that mediate between the delivery (and receipt) of the program and the emergence of the outcomes of interest. Ideally, program theory guides an evaluation by identifying key program elements and articulating how these elements are expected to relate to each other (Cooksy et al., 2001). Program evaluation assesses whether a program is designed in a way that it can achieve its intended outcomes (Brousselle & Champagne, 2011). The program theory of action is often visualized in the form of a program logic model providing an integrative framework for evaluation (Cooksy et al., 2001). Weiss (1972) suggests using path diagrams to model the sequence of steps between program intervention and intended outcomes. A logic model depicts assumptions about the resources needed to support program activities and produce outputs and the activities and outputs to realize intended outcomes of a program (Wholey, 1995). Within the logic model, data is collected by different methods or from different sources on the same program to determine if a pattern of relationships exist (Denzin, 1970; Trochim, 1985).

We used a logic model design to guide the program which is seen in figure 1. The logic model links theories and assumptions with the inputs, activities, outputs, and outcomes of a project (W.K. Kellogg Foundation, 2004). This systematic evaluation of the agricultural safety professional development program aims to ascertain outcomes and justify resources associated with the program to key stakeholders. Within local communities, school-based agriculture teachers interact with students often and may serve a vital role in protecting student safety by providing safety training and helping their students develop logical thinking and sound decision making (Schwebel & Pickett, 2012). Students learn safe behaviors by modeling their teachers' behaviors, particularly during supervised work experiences. These experiences facilitate experiential learning to develop skills and abilities leading to an agricultural career (Barrick et al., 1992; Burke et al., 2006). Sanderson et al. (2010) concluded that as children become young adults they learn to farm safely through observation and modeling of mentors. For this multi-year professional development program, the theory of action guiding the program was informed by a central problem of practice concerning supervised agricultural experience safety using a hands-on pedagogy to facilitate contextualization of safety instruction for students.

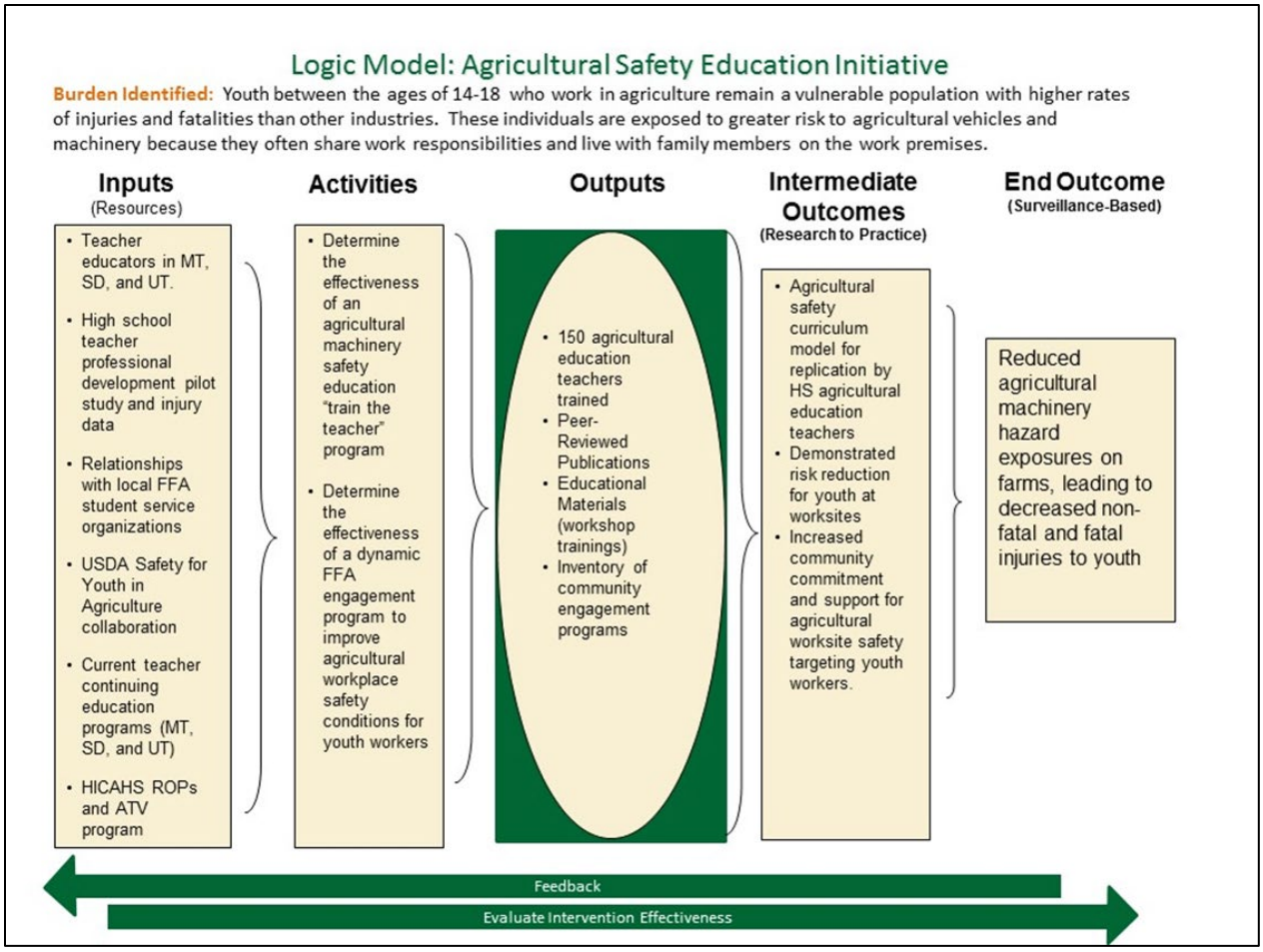

Figure 1. Logic model for Agricultural Safety Education initiative

Under Kennedy's (2016a) framework, teacher professional development should be guided by a theory of action

comprised of a central problem of practice and a pedagogy to help teachers enact new ideas into the context of their practice. Our workshop content addressed the teaching problem of portraying content for improved student comprehension by providing table-top demonstrations, tractor operations walk-through examples, and student activities. The enactment component of our program theory of action was guided by a prescription approach for integrating agricultural safety curriculum within school-based supervised agricultural experiences (Kennedy, 2016b) using National Safety Tractor Machinery Operations Program and the Supervised Agricultural Experience Risk Assessment Protocol. A prescriptive approach reduces the amount of judgement needed by teachers on implementation of the teaching strategy and focuses on program fidelity (Kennedy, 2016b). Kennedy noted that this approach can backfire if the professional development is limited in addressing challenges facing teachers. Kennedy (2016b) also warned that from a teacher's perspective, the educational system is filled with conflicting curriculum priorities created from a variety of educational requirement placed on them. Sustaining the implementation effort by teachers could prove daunting as teachers maintain district and state requirements for their students.

Purpose

The purpose of this study was to determine the effectiveness of a multi-year professional development program to sustained teachers' knowledge and implementation of agricultural tractor and machinery safety training.

Research objectives guiding the study were:

1. Describe selected demographic characteristics of school-based agricultural education teachers who participated in a multi-year agricultural safety professional development.
2. Describe motivational factors for school-based agriculture teachers to continue participation in a multi-year professional development focused on tractor and machinery safe operation.
3. Determine the effect of sustained teacher participation on teachers' knowledge of safe tractor and machinery operation.

Methodology

During the summer of 2019, a convenience sample of secondary agricultural educators from Montana, South Dakota, and Utah was recruited for participation. Max enrollment was set at 50 participants per state. Past participants who agreed to participate in a ten-hour, hands-on agricultural safety training experience during the summer of 2017 and 2018 were notified and invited by email to participate in the 2019 seminar. Additionally, a convenience sample of teachers who had not participated was sought from Montana, South Dakota, and Utah. A recruitment invitation was sent via email to teachers who had not participated in the program in each state spring of 2019. Each state's training seminar occurred separately; however, content as well as delivery were uniform following a preset program plan. Learning activities were organized so that teachers participated together through a series of hands-on exercises (Pate et al., 2019). Incentives primarily comprised of safety materials and supplies as well as flash drives loaded with workshop curriculum. Additional incentives included professional development credit towards licensure and safety educational resources for students. The human subject research protocol was reviewed and approved under Utah State University's Institutional Review Board protocol 10514. An Institutional Review Board reliance agreement was established and approved between Montana State University and Iowa State University with Utah State University as the institution of record. Informed consent forms were provided to teachers.

The 2019 training focused on providing teachers with curriculum to demonstrate safe operation of equipment and tractors. Teachers performed tabletop exercises focused on backing and hitching of equipment. Hand-signals were emphasized to communicate with operators. Teachers were given demonstrations on backing equipment and connecting implements followed by hands-on practice using the equipment. Teachers were given instructions on laying out a driving course for tractor safety and then practiced implementing the strategy. Teachers completed the seminar with driving a utility tractor through an obstacle course.

After the training, participants completed a paper-based exam constructed of NSTMOP knowledge items. This exam also collected demographic questions and questions on motivation for returning to the training seminar. Knowledge questions were focused on safe tractor operation, machinery safety, and general health and safety. Cronbach's alpha measure of reliability for the relevant knowledge items was .54. This value illustrates the multidimensional nature of the items. Researchers used an open-ended item to assess participants' motivation for returning to the training seminar. Respondents were asked to indicate what would keep them returning to the training. Researchers coded responses as 1 = knowledge and 2 = curriculum. Data was initially compiled in Microsoft Excel and then analyzed in SPSS version 21. A Kruskal-Wallis test was used determine if there was a significant difference in knowledge of safe tractor and machinery operations between teachers participating in multiple years of the professional development and teachers who participated less frequently.

Findings/Results

A total of 85 teachers participated in year three of the training program. Table 1 provides the distribution of teachers from each state. Over half (57.6%, $f = 49$) of the participants identified as "female." 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 (2) = 2.98 , p = .084). The average age of participants was 35.0 years (SD = 12.39).

Table 1. Distribution of Teachers by State

	f	%
Montana	32	37.6
South Dakota	33	38.8
Utah	20	23.5

Participants were asked how many times, including the current year participation, had they participated in the training program. Most participants ($f = 31$, 36.5%) had participated in the training at least twice. There were no teachers from Utah that had attended the training for all three offerings. Table 2 provides the distribution of teachers' participation experience with the training program.

Table 2. Distribution of Teacher Attendance

	Montana		South Dakota		Utah	
Attendance	*f*	%	*f*	%	*f*	%
First time attending	8	25.0	8	24.2	9	45.0
Second time attending	12	37.5	8	24.2	11	55.0
Third time attending	12	37.5	17	51.5	-	-

For years of experience teaching, five participants had 30 or more years of experience teaching. There were 17 (20.0%) participants with less than or equal to one year of experience teaching. For all participants, the median teaching experience in years was 7 (IQR = 13). First year attendees' average age was 33.1 years (SD = 2.66) with an average of 8.17 years of teaching experience (SD = 2.23). Second year attendees' average age was 32.9 years (SD = 1.84) with an average of 7.7 years of teaching experience (SD = 1.30). Third year attendees' average age was 39.1 (SD = 2.60) with an average of 15.4 years of teaching experience (SD = 2.26). Kruskal-Wallis test was used to check for significant differences between first, second, and third year attendees on age (χ^2 (2) = 6.38 , p = .041) and years of teaching experience (χ^2 (2) = 10.15 , p = .006).

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 mid-career, and 16 or more years as a veteran. Most teachers participating were classified as either beginning ($f = 33$, 38.8%) or mid-career ($f = 33$, 38.8%). There were 19 participants (22.4%) who were classified as veteran teachers. Age was recoded into an ordinal variable and renamed "age category" with 21-29 as "young adult", 30-39 as "middle aged adult", and ≥ 40 as "older adult."

The average test score was 41.9 (SD = 3.62) out of 50. Table 3 provides mean scores by classification of attendee. Third year attendees scored an average of 43.2 (SD = 3.00). Participants passed by correctly answering greater than 70% of the questions. Only two individuals (8.0%) failed the exam. To determine the effect of sustained teacher participation on teachers' knowledge of safe tractor and machinery operation, a Kruskal-Wallis H test was used. The result of the Kruskal-Wallis H was 5.91 (2) p = .052.

Table 3. Test score averages by teacher attendance category

Attendance Category	Test Score	
	M	*SD*
First Time Attendee	40.8	4.41
Second Year Attendee	41.7	3.16
Third Year Attendee	43.2	3.00

A Kruskal-Wallis test was used to determine if there were significant differences in safety knowledge between teacher life cycle stages (χ^2 (2) = 2.110 , p = .348). Another Kruskal-Wallis test was used to determine if there were significant differences in safety knowledge between teacher age categories (χ^2 (2) = 2.189 , p = .335).

When participants were asked on the post-experience NSTMOP exam what attracted them to attend the training experience, 31.6% (f = 12) reported knowledge acquisition while 68.4% (f = 26) reported curriculum obtainment. Other responses included incentives as PD credit, gift card, or food (f = 9, 10.6%) and fun (f = 3, 3.5%). There were 13 participants (15.9%) who responded with an affirmative "yes" but did not indicate factors that would bring them back to the training. There were three participants that noted their return was dependent on scheduling of other professional development. Table 4 provides frequencies and percentages of attendees' justification for returning to the training.

Table 4. Frequencies and Percentages of attendees' justification for returning to the training

	Knowledge Acquisition		Curriculum Obtainment	
Attendance	*f*	%	*f*	%
First time attending	1	16.7	5	83.3
Second time attending	8	42.1	11	57.9
Third time attending	3	23.1	10	76.9

Conclusions/Recommendations/Implications

Several limitations should be noted which prevents the generalization of these results beyond the participants of this study. There was no pre-test to determine any preexisting differences in knowledge between first year attendees and those who had attended previous trainings. However, it was assumed that multiple year attendees would have higher knowledge due to their experience with the program. We examined differences in age and teaching experience between first year and multi-year attendees. There were significant differences noted between teacher demographics. There was no significant association between gender and frequency of training attendance. Only two individuals failed the exam. These individuals were self-identified as female. This created two cells with expected counts less than five. Therefore, Fisher's exact test was used to determine if teacher gender was significantly associated with a passing score. Fisher's exact test results revealed no significant association between gender and passing score (p = .506). There were no significant differences in safety knowledge between teacher age categories or teacher life cycle stages. We conclude that age and teaching experience did not influence safety knowledge gains post-training.

Based on the findings, we conclude that the training was viewed favorably by all participants. Third year attendees were more likely to be older and have more teaching experience. It should be noted that third year attendees averaged a higher score, but this result was not statistically significant. Due to the convenience sampling which violates assumptions of parametric statistical tests, non-parametric tests were used to check for statistical significance. The Kruskal-Wallis test is noted to have low power which requires a larger sample size to detect a statistically significance difference in test scores. We note that the p-value approached the .05 alpha level but conclude that a larger sample size is needed to determine if this effect is sustained. Based on these results, we recommend continued and sustained professional development for these participating teachers to facilitate gains in safety knowledge. For these participants, a "one and done" approach to professional development targeting teachers' safety knowledge is not encouraged. Results from this research suggest that TMC instructors would benefit from sustained professional development activities over their teaching career. Continued research is needed to determine effective methods for addressing safety knowledge over a teacher's life cycle. It should be noted that a larger percentage of multi-year attendees were more interested in curriculum obtainment than knowledge gain. A qualitative approach to understanding teachers' motivation and interest in safety training professional development is recommended.

Safety professional should note from this research that active engagement is a desired feature of professional development among teachers. A benefit for participating teachers in this professional development was focused on higher order instructional or alternative assessment methods for tractor and machinery safety. Desimone et al. (2002) found that professional development characterized by "active learning," where teachers are not passive "recipients" of information increases the impact of the professional development activities. Desimone et al. (2002) found a substantial benefit when teachers participated in professional development that focused on higher order instructional or alternative assessment methods. To help address barriers of implementation, efforts among professional development specialists should focus on teacher demands and areas to facilitate integration of training within existing structures used by teachers. Imel (2000) suggested "Adult educators frequently act as change agents, although they may not be conscious that they are playing this role. Like learning, change is a complex process and understanding the relationship between learning and the change process can help adult educators be more purposeful in assisting with change." (p. 5)

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