Journal of Agricultural Systems, Technology, and Management

Volume 28
May 2017

Effects of an Applied Workshop on Teacher Self-Efficacy and Intent to Teach Hydraulics

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Abstract

Agricultural mechanics is an important component of school-based agricultural education programs, yet many university agricultural education programs lack the necessary facilities, personnel, and available credit hours to adequately prepare teachers in basic agricultural technologies, much less more advanced technologies. Technical workshops for inservice teachers may help fill this gap. This study investigated the effects of a one-day applied hydraulics workshop on teachers' ($n = 22$) self-efficacy and intent to teach hydraulics. Prior to the workshop, a majority of teachers had a negative perception of their understanding of hydraulic concepts and their ability to teach hydraulics. Upon completion of the workshop, a majority of respondents had positive perceptions of their understanding of hydraulics concepts and their ability to teach hydraulics. Teachers' participation in the workshop resulted in a statistically significant ($p < .001$) and large (Cohen's $d = 1.65$) overall increase in self-perceived understanding and ability to teach hydraulics. In addition, the percentage of teachers indicating they planned to teach hydraulics in one or more courses increased from 36.4% prior to the workshop to 87.3% after the workshop.

***Keywords*:** Hydraulics, inservice, self-efficacy, workshop

Introduction and Theoretical Framework

Agricultural mechanics is an important component of a majority of high school agricultural education programs (McCubbins, Anderson, Paulsen, & Wells, 2016). In order to teach agricultural mechanics effectively, teachers must possess appropriate content and pedagogical knowledge and skills (National Board for Professional Teaching Standards [NBPST], 2014). However, while agricultural mechanics remains a core component of the secondary program, agricultural mechanics coursework required by university teacher education programs has steadily declined in recent decades (Blackburn, Robinson, & Fields, 2015). Byrd, Anderson, Paulsen, and Schultz (2015) determined that a majority of Iowa agriculture teachers had completed either one (29.13%) or zero (34.95%) college courses in agricultural mechanics; yet, the number of courses completed had a significant positive association with self-perceived competency to teach agricultural mechanics. In a national study, Burris, Robinson, and Terry (2005) determined the modal requirement for coursework in agricultural mechanics was five to eight semester credit hours.

Bandura (1986) defined self-efficacy as a person's judgement of his or her capability "to organize and execute courses of action required to attain designated types of performances" (p. 391). According to self-efficacy theory, individuals are more likely to engage and persist in activities when they have confidence their efforts will result in successful task completion; conversely, they are less likely to engage or persist in activities when they lack confidence their efforts will be successful (Bandura, 1986). In the specific case of teaching, self-efficacy can be defined as "teachers' individual beliefs about their own abilities to successfully perform specific teaching and learning related tasks within the context of their own classrooms" (Dellinger, Bobbett, Olivier, & Ellett, 2008, p. 751). Teachers are more likely to teach a specific topic when they feel confident about their knowledge of and ability to successfully teach the topic (Paulsen, Han, Humke, & Ohde, 2014). Teacher self-efficacy is also positively related to student achievement with both antecedent and consequent effects (Holtzberger, Philipp, & Kunter, 2013).

Bandura (1986) posited that self-efficacy, and thus intended behavior, changes with experience and identified four types of experiences that affect self-efficacy. These four types of experiences, ordered from most to least powerful, are mastery experiences, vicarious experiences, social persuasion, and emotional state. Mastery experiences occur when an individual successfully completes a behavior or task; vicarious experiences occur when one person observes another person, perceived to be similar to the first person, successfully complete a behavior or task; social persuasion occurs when an individual receives positive statements or indications of confidence from another person concerning their ability to successfully complete a behavior or task (McKim & Velez, 2016). Finally, emotional state refers to how performing or contemplating performing a task affects the individual on a psychological level; for example, thinking about teaching a familiar topic might elicit a feeling of confidence, while thinking about teaching an unfamiliar topic might elicit a feeling of nervousness or dread (Lauermann & König (2016).

How can high school agriculture teachers, who are expected to include instruction in agricultural mechanics in their programs, attain knowledge and skills in this curricular area? Well-designed, hands-on inservice workshops can provide teachers with relevant mastery and vicarious experiences, provide supportive social persuasion, and positively affect teachers' emotional states when thinking about teaching new technologies (Paulsen et al., 2014). Thus, according to Bandura (1986), workshop participation should increase both teacher knowledge and self-efficacy about teaching new technologies and, as a consequence, make them more likely to provide instruction about these technologies.

Purpose and Objectives

The purpose of this study was to evaluate the effects of a one-day applied hydraulics workshop on teachers' self-efficacy and intent to teach hydraulics. Specific objectives were to:

1) Determine teachers' self-efficacy and intent to teach hydraulics before and after completing a hydraulics inservice workshop; and
2) Determine the effects of workshop completion on teachers' self-efficacy and intent to teach hydraulics.

Methods

A two-day agricultural technology inservice workshop for secondary school agriculture teachers was held on the University of Arkansas campus in June 2016. The first day was devoted to agricultural hydraulics and the second day was devoted to tungsten inert-gas (TIG) welding. Teachers were free to participate in one or both workshop sessions, with each session scheduled for six hours of instruction.

The hydraulics portion of the workshop was designed to provide technical content and pedagogical approaches to teaching hydraulics in Arkansas agricultural education programs. In designing the workshop, the researchers were cognizant of the fact that most participating teachers would not have access to hydraulic trainers, test benches, and similar equipment in their schools. Thus, while hydraulic trainers were used for parts of the workshop, emphasis was placed on developing and modeling low-cost activities teachers could actually use in their classrooms.

After a brief welcome and orientation, the workshop instructor presented a brief (20 minute) illustrated lecture providing an orientation to hydraulic power transmission; basic principles such as Pascal's Law and force, pressure, area relationships; hydraulic system components, systems and schematics; and safety. A hydraulic wood splitter circuit animation was used to demonstrate component functions, symbols, basic calculations, and fluid flow when extending and retracting the cylinder and attached splitting wedge.

After the lecture, teachers were divided into six groups of three or four to complete a modified version of the hydraulic bottle jack activity described by Kirk, Fravel, and Massey (2012). The groups disassembled the bottle jacks and identified the reservoir, pumping piston and cylinder, check valves, lift piston and cylinder, flow control valve, and pressure relief valve. Once teachers had discussed these components and understood how they worked together as a system, the teachers used printed hydraulic symbols and color-coded wires (red for high-pressure lines and green for low-pressure lines) to develop a schematic that described the jack's operation (Figure 1). Teachers next measured the diameters and calculated the areas of the pumping and lift pistons and calculated the jack's theoretical hydraulic multiplication of force and the fluid pressure at maximum lift capacity (4-tons). A group discussion on use of this activity with high school students was conducted after teachers reassembled the jacks.

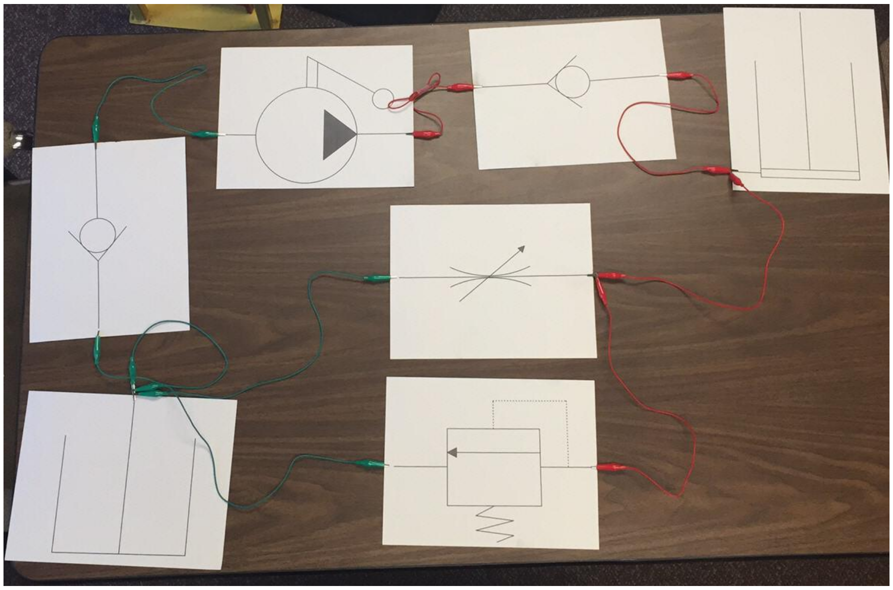

Figure 1. Example hydraulic bottle jack circuit schematic created during workshop.

Next, teachers went to the lab and the workshop instructor provided an overview of the hydraulic trainers, their components, operation, and safety. After the orientation, one-half of the teachers remained in the lab and worked in groups of two or three per trainer to build and operate the first five (of 10) common hydraulic circuits. These circuits incorporated different directional control valves (open-center, closed-center and tandem-center), actuators (hydraulic motors and cylinders), pressure valves (sequencing and pressure reducing), a hydraulic accumulator, and measurement devices (pressure gauges and flow meters). Figure 2 shows the schematic for an example circuit.

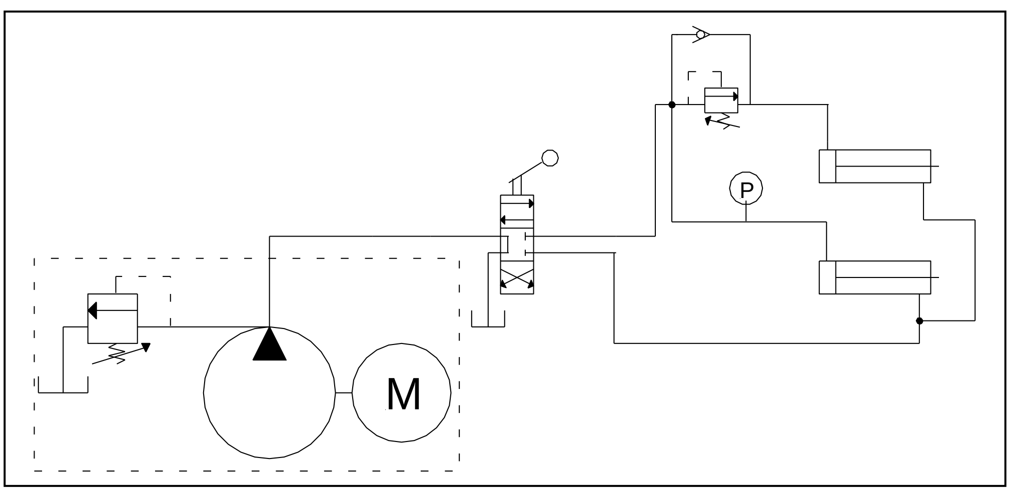

Figure 2. Example workshop hydraulic circuit with pressure-sequenced cylinders.

While the first group of teachers were building and operating circuits on the trainers, the other group of teachers went into the classroom and worked in groups of two or three to "build" the same hydraulic circuits using hydraulic symbol cards and color-coded wires. Teachers then used the constructed circuit schematics to visualize and explain the operation of each circuit.

After each group had constructed the first five circuits (on either the trainer or using the cards), the groups were reversed and the original lab groups used the cards to construct and discuss the circuits just built in the lab while the original classroom groups built and operated the first five circuits on the trainers. This same rotation process was then used as the groups built the remaining five circuits using both the cards and the trainers.

The workshop concluded with a discussion and question and answer session. The primary focus was on technical questions and on how to incorporate hands-on hydraulics instruction into high school agriculture classes using low-cost methods such as the hydraulic symbol cards and the hydraulic bottle jack activity. Each teacher received a printed copy of all workshop materials, including slides, activities, and hydraulic symbol templates.

Research Procedures

The target population for this study was the 26 Arkansas high school agriculture teachers who self-selected to attend the agricultural hydraulics workshop session. Evaluation data for the hydraulics workshop were collected at the beginning of the second day from the participating teachers who returned for the TIG welding session (n = 23); 22 (84.6%) teachers provided usable evaluation responses. The research protocol was approved as exempt by the university institutional review board.

The evaluation instrument contained 10 statements about teaching hydraulics and incorporated a retrospective pretest (Rockwell & Kohn, 1989) and a traditional posttest. Each participant responded twice to each item, indicating their level of agreement (strongly disagree, disagree, agree, or strongly agree) both before and after completion of the hydraulics workshop. According to Gouldthorpe and Israel (2013), retrospective pretests ask respondents to recall their perceptions prior to engaging in the treatment at the same time they evaluate their perceptions after completing the treatment. Gouldthorpe and Israel specifically recommended use of retrospective pretests when measuring attitude changes in short-duration educational workshops. Pratt, McGuigan, and Katzev (2000) stated, “A more accurate assessment of changes in self-reported knowledge and behavior may be produced by retrospective pretest designs than by the traditional pretest-posttest design [because] taking part in the program may show participants that they actually knew much less than they originally reported on the [traditional] pretest” (pp. 342-343.) The tendency for workshop participants to ‘not know what they don’t know’ about unfamiliar subjects is a threat to the internal validity of evaluation research when traditional pretests are used to measure baseline levels of self-perceived knowledge or ability (Pratt et al., 2001). Figure 3 shows an example item from the evaluation instrument.

BEFORE the Workshop (circle your response)				Statement	AFTER the Workshop (circle your response)			
SD	D	A	SA	I find it difficult to explain to students how hydraulics work.	SD	D	A	SA

Figure 3**.** Example item showing retrospective pretest and posttest response modes.

The instrument was based, in part, on selected items from the teaching self-efficacy construct of the Science Teaching Efficacy Beliefs Instrument (STEBI; Enochs & Riggs, 1990). Items were modified for use in this study by replacing the word “science” with “hydraulics”. Paulsen et al., (2014) used a modified version of the full STEBI to measure changes in teacher self-efficacy for teaching renewable energy as a result of workshop participation. A panel of three researchers with expertise in technical education and evaluation methods examined the instrument and judged it to possess face and content validity. Cronbach's alpha reliability estimates of .91 (pretest) and .77 (posttest) were obtained *post hoc*. The participants in this workshop were considered to be a time and place sample representative of the population of future workshop participants (Oliver & Hinkle, 1982). Data were analyzed using descriptive and inferential statistics.

Results

In retrospectively evaluating their ability and intent to teach hydraulics before completing the workshop (Table 1), a majority of teachers agreed or strongly agreed their level of knowledge prevented them from teaching about hydraulics (54.6%), found it difficult to explain how hydraulics work (54.6%), could not teach hydraulics as well as they did other subjects (77.3%), would not want their principal to evaluate them when teaching hydraulics (59.1%), and lacked sufficient equipment and supplies to teach hydraulics (64.7%). Somewhat contradictorily, a slight majority of respondents either agreed or strongly agreed they were able to answer student questions about hydraulics (52.3%) and possessed the hands-on skills necessary for teaching hydraulics (54.5%). A minority of respondents agreed or strongly agreed they knew how to effectively teach hydraulics (40.1%) or planned to teach hydraulics in one or more classes next year (36.4%).

In evaluating their ability and intent to teach hydraulics after completion of the workshop (Table 1), a majority of respondents disagreed or strongly disagreed their level of knowledge prevented them from teaching about hydraulics (95.4%), found it difficult to explain how hydraulics work (86.4%), could not teach hydraulics as well as they did other subjects (59.2%), would not want their principal to evaluate them when teaching hydraulics (68.2%), and lacked sufficient equipment and supplies to teach hydraulics (63.7%). Consistent with these increased levels of confidence, virtually all participants felt they were able to answer student questions about hydraulics (95.4%) and possessed the hands-on skills necessary for teaching hydraulics (100%). Upon completion of the workshop, approximately 90% of participants agreed or strongly agreed they knew how to teach hydraulics effectively (88.6%) and planned to teach hydraulics in one or more classes next year (90.9%).

To determine the change in agreement with individual statements regarding their ability to teach hydraulics as a result of the workshop, responses were dichotomized as either disagree (strongly disagree and disagree) or agree (agree and strongly agree) and *Fisher's exact test* probabilities were calculated to determine if there were significant ($p < .05$) associations between workshop completion and changes in teachers' self-efficacy and intent to teach hydraulics (Table 1). The results indicated completion of the workshop was associated with increases in perceived ability to teach hydraulics for 9 of the 10 statements; the level of agreement with the statement regarding the lack of equipment and supplies did not significantly change as a result of the workshop.

To further examine the overall effects of the workshop on teacher perceptions of their ability to teach hydraulics, negatively worded items were reverse-coded and pretest and posttest responses to the 10 items were summed (using the original four-point scale) and averaged to develop measures of hydraulics teaching self-efficacy before and after the workshop. As shown in Table 2, the mean teacher self-efficacy score before the workshop fell near the exact mid-point of the 1 to 4 scale, indicating teachers were uncertain of their ability to teach hydraulics. After the workshop, teacher self-efficacy for teaching hydraulics was reported as positive ($M = 3.04$, $SD = 0.37$), showing a statistically significant increase [$t(22) = 7.74$, $p < .001$] with a large effect size (Cohen, 1988).

Table 1. Teachers' Level of Agreement with Selected Statements about Teaching Hydraulics Before and After Workshop Completion

	Before Workshop (n = 22)				After Workshop (n = 22)				
Evaluation Statement	*SD* %	*D* %	*A* %	*SA* %	*SD* %	*D* %	*A* %	*SA* %	*Fisher's Exact p*[a]
I understand hydraulics well enough to be effective in teaching students about it.	9.1	36.4	50.0	4.6	0.0	0.0	68.2	31.8	.001
I find it difficult to explain to students how hydraulics work.	13.6	31.8	54.6	0.0	27.3	59.1	9.1	4.6	.009
I know how to teach effectively about hydraulics.	0.0	59.1	36.4	4.6	4.6	6.8	65.9	22.7	.002
I am able to answer students' questions about hydraulics.	4.6	43.2	47.7	4.6	0.0	4.6	72.7	22.7	.002
Even when I try very hard, I don't teach hydraulics as well as I do most subjects.	4.6	18.2	77.3	0.0	4.6	54.6	36.4	4.6	.009
I have the necessary hands-on skills to teach about hydraulics.	4.6	40.9	45.4	9.1	0.0	0.0	72.7	27.3	.005
Given a choice, I would not invite my principal to evaluate my teaching of hydraulics.	18.2	22.7	59.1	0.0	27.3	43.2	25.0	4.6	.040
I will teach about hydraulics in one or more classes next year.	9.1	54.6	27.3	9.1	4.6	4.6	63.6	27.3	.000
The lack of equipment and supplies will prevent me from teaching about hydraulics.	9.1	27.3	55.6	9.1	9.1	54.6	27.3	9.1	.082
My level of knowledge will prevent me from teaching about hydraulics.	13.6	31.8	54.6	0.0	22.7	72.7	4.6	0.0	.001

[a]Responses were collapsed into two categories, disagree (combination of strongly disagree and disagree) and agree (combination of agree and strongly agree), prior to statistical testing.

Table 2. Teachers' Overall Self-Efficacy about Teaching Hydraulics Before and After Workshop Completion

	n	*M*	*SD*	*t*	*p*
Before Workshop	22	2.48	0.54	7.74	<.001
After Workshop	22	3.04	0.37		

Note: Cohen's d = 1.65.

Conclusions and Recommendations

Before completing the workshop, a majority of teachers agreed that their level of knowledge prevented them from teaching about hydraulics. However, statistical analyses indicated that completion of the workshop significantly increased participants' perceived knowledge of hydraulics principles and practices. Further, a majority of respondents indicated that their new level of knowledge would not prevent them from teaching about hydraulics and a majority planned to teach hydraulics in one or more classes the next year. Analyses also indicated that participation in the workshop significantly increased teachers' self-efficacy to teach hydraulics.

Given the importance of agricultural mechanics in the high school curriculum (McCubbins et al., 2016) and concerns about the limited agricultural mechanics coursework for preservice agriculture teachers (Burris et al., 2005), the results of this study document the viability of inservice workshops as a mechanism for providing current teachers with the skills, knowledge and self-efficacy necessary to teach important agricultural technologies (NBPST, 2014). Thus, these results are consistent with Bandura (1986) and support the findings of Paulsen et al. (2014) concerning the effects of workshop participation on teachers' self-efficacy and intent to teach new technologies.

If success at learning is affected by peoples' self-perceptions of their abilities to learn and this self-efficacy is derived, in part, from participation in mastery experiences based on successful hands-on practice including experiencing positive beliefs in one's ability versus anxiety over possible failure Bandura (1986), then individuals learn best when they have opportunity to practice applications of new knowledge to achieve some level of mastery. For teachers to be effective at supporting positive student learning, they must master the subject matter and have positive self-efficacy about teaching the subject. This study indicated that a hands-on workshop for teachers increased their self-efficacy and intent to teach hydraulics. A follow-up contact will be made with participating teachers to determine if they acted on their stated intent to teach hydraulics.

As University teacher education programs offer fewer courses and experiences in agricultural mechanical technologies each year, even as this subject area remains a significant component of high school agriculture programs, how can high school teachers of agriculture attain and maintain levels of knowledge and skills appropriate to teach it? One or two day intensive workshops appear to be an effective method of supporting teachers in their attempt to teach technologies they did not have the opportunity to study as preservice teachers.

The agricultural education department at the University of Arkansas has offered intensive technology-oriented workshops for teachers each summer for several years. The results of this study suggest these workshops are an effective method of encouraging and enabling teachers to incorporate advanced agricultural mechanics instruction into their local programs. As competition for university and state resources increase, results of studies such as this should be widely shared with client groups and budgetary decision makers.

Acknowledgements

This work was supported, at least in part, by the USDA National Institute of Food and Agriculture, Hatch project No. 1007996 and the University of Arkansas, Division of Agriculture.

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