Research

Effects of Activity Type and Gender on Cognitive Achievement in Hydraulics

Patterson P. Hilaire, Graduate Assistant
pphilair@uark.edu
Colton R. Teekell, Graduate Assistant
crteekel@uark.edu
Donald M. Johnson, Professor
dmjohnso@uark.edu
479-575-2035

Department of Agricultural Education, Communications, and Technology
205 Agriculture Building
University of Arkansas
Fayetteville, AR 72701

Introduction

Agricultural mechanics is an important component of a majority of high school agricultural education programs (McCubbins, Anderson, Paulsen, & Wells, 2016). National professional standards (American Association for Agricultural Education, 2017) call for teachers to be "aware of cutting edge technology" and to "teach students how to use technology appropriate to the agricultural industry" (p. 2). Yet, researchers (McCubbins et al., 2017) have found that many school-based agricultural education programs lack the necessary tools, equipment, and financial resources to teach the current curriculum, much less a more modernized curriculum. Thus, teachers are caught in a dilemma; urged to modernize, but lacking the necessary resources to do so (Johnson & Wardlow, 2017).

Educational simulations are "an artificial representation of a real world process to achieve educational goals through experiential learning" (Al-Elq, 2010, p. 35). Constructivist learning theory, which posits that students construct knowledge when they "attach meaning to an experience or activity" (Rutherford-Hemming, 2012, p. 133), supports the efficacy of educational simulations. This study sought to determine if there was a significant ($p < .05$) difference in cognitive achievement between students taught basic hydraulics using an inexpensive educational simulation activity as compared to a trainer-based activity ($10,000 per trainer; Iron Horse, 2016). A secondary purpose was to determine if there was a significant ($p < .05$) difference by gender or a Gender X Treatment interaction. This research replicates and extends research by Agnew and Shinn (1990) and supports development of a sufficient scientific and professional workforce (Stripling & Ricketts, 2017) for the agricultural industry.

Methodology

The accessible sample for this study consisted of students ($n = 47$) enrolled in two laboratory sections of a freshman-level university agricultural systems course taught in fall 2017. Prior to lab, we randomly assigned all enrolled students to the control or experimental groups; due to absences, 20 and 24 students participated in the control and experimental groups, respectively. The control group planned and constructed two hydraulic circuits using the hydraulic trainers by connecting components with hydraulic hoses; the experimental group planned and constructed the same two circuits by connecting printed hydraulic symbols using wires with clip-connectors. The control group manipulated the trainers and observed the operation of the system. The experimental group "operated" each circuit by manipulating the specially designed directional control valve symbol and tracing the path of oil flow through each circuit. Three or four students worked cooperatively with each trainer or set of symbol cards. As part of each lab activity, students in the control and experimental groups answered the same set of questions about the operation of each circuit. Immediately following the lab activity, each student completed a five-item multiple-choice quiz (*coefficient alpha* = .62) based on the content of the lab. The quiz was consistent in format and length with the lab quizzes normally administered after lab activities.

Results

The results of a 2 X 2 factorial ANOVA indicated no significant ($p < .05$) differences in quiz scores by the main effect of activity type (trainer or simulation) or the interaction of activity type and gender. The results did indicate a significant ($p = .03$) difference in quiz scores by the main effect of gender, with males scoring higher than females (Table 1). The η^2 of 0.12 indicated

gender explained 12% of the variance in quiz scores, while the Cohen's *f* of 0.36 indicated a medium effect (Cohen, 1988) for gender on quiz scores.

Table 1. *Means, Standard Deviations, and 2 X 2 Factorial ANOVA Results for Effects of Activity, Gender and Activity X Gender on Cognitive Achievement in Hydraulics*

				ANOVA	
Treatment	*n*	*M*	*SD*	*F* (1, 40)	*p*
Lab Activity				0.21	.65
Control (Trainers)	20	3.75	1.37		
Experimental (Simulation)	24	4.00	1.22		
Gender				5.43	.03
Female	22	3.45	1.22		
Male	22	4.32	1.21		
Treatment X Gender				0.27	.61
Control-Female	11	3.27	1.27		
Control-Male	9	4.33	1.32		
Experimental-Female	11	3.64	1.21		
Experimental-Male	13	4.31	1.18		

Conclusions

The results of this study indicated use of hydraulic trainers and simulations using hydraulic symbol cards were equally effective in teaching basic hydraulics when cognitive achievement was the instructional objective. These results agree with those of Agnew and Shinn (1990) and support the efficacy of an inexpensive simulation method of incorporating hydraulics into the curriculum. Further, the simulation method was equally effective with all students regardless of gender. The finding that males significantly out-performed females on the hydraulics quiz contradicts results reported by Johnson, Wardlow, and Franklin (1998) who reported females outperformed males in tests of applied mechanics and electricity.

Implications/Recommendations/Impact on the Profession

To the extent students enrolled in this freshman-level university agricultural systems course were similar to students in advanced high school agricultural mechanics courses; these results have important implications for high school agricultural education programs. The results indicated teachers can effectively use simulations with inexpensive hydraulic symbol cards to teach basic hydraulic system components, functions, principles, and circuits and be confident students will learn as well with these simulations as they would using expensive hydraulic trainers. This is an important finding because high school teachers have reported the lack of equipment as a major factor preventing them from incorporating hydraulics into the curriculum (Johnson & Wardlow, 2017).

The finding that females scored lower than males on the posttest raises some concern, given that 67% of all agricultural teacher education candidates in 2016 were female (Smith, Lawver, & Foster, 2016). However, because gender explained only 12% of the variance in quiz scores, additional research is needed before concluding this is a significant problem for the profession.

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