Gear Down! Using the Tractor Pull Challenge to Support STEM-focused Agriculture Teacher Professional Development

Jay Solomonson, Ph.D.
Illinois State University
Department of Agriculture
140 Ropp Agriculture Building
Normal, IL 61790
jksolom@ilstu.edu

Trent Wells, Ph.D.
Murray State University
Hutson School of Agriculture
206 South Oakley Applied Science Building
Murray, KY 42071
kwells23@murraystate.edu

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Introduction

Science, technology, engineering, and mathematics (STEM) are integral, naturally-occurring components of school-based agricultural education (SBAE). STEM concepts are inherent to a wide range of agricultural subject matter areas found within SBAE, such as plant science, biotechnology, and agricultural mechanics (Swafford, 2017). Regarding agricultural mechanics, scholars (i.e., Parr et al., 2006; Wells & Parr, 2011; Young et al., 2009) have concluded that this subject matter area is prime for granting students opportunities to contextually apply academic concepts to solve agricultural problems. Moreover, the diversity of agricultural mechanics subject matter (Wells et al., 2021) creates numerous chances for agriculture teachers to illustrate applied academic concepts for their students (Parr et al., 2006).

Smith et al. (2015) noted that agriculture teachers perceive integrating STEM within their curricula to be of the utmost importance. Smith et al. (2015) also found that agriculture teachers are not as confident integrating engineering concepts within their curricula. Stubbs and Myers (2015) suggested that agriculture teachers who experience more professional development (PD) in STEM subject matter are better-prepared to contextually teach STEM concepts via agricultural subject matter. Perhaps STEM-focused, agricultural mechanics PD would help prepare agriculture teachers to address the underlying engineering concepts in their subject matter.

How it Works

During the Summer 2022 semester, we engaged 15 agriculture teachers from across Illinois in a multi-day agricultural mechanics and technology PD workshop. Our workshop's primary focus was on identifying and highlighting STEM concepts that could easily be implemented within their pre-existing agricultural mechanics curricula. To assist these 15 teachers with teaching power mechanics and power transfer systems units in their courses, we introduced them to the RealityWorks© RC Tractor Pull Challenge with Pulling Sled Kit. The kit was originally designed as a way to "explore tractor systems and structures and experiment with force and motion, friction and gravity, and other STEM concepts" (RealityWorks, 2024, para. 1). Because we only had scheduled half a day to engage in these concepts, we focused our efforts on the competitive, hands-on application of the tractor pull challenge.

After providing some introductory information about the activity and divvying the teachers into small groups, we demonstrated the use of the radio-controlled (RC) tractor pull kit. We then worked with the agriculture teachers to apply the embedded engineering concepts (e.g. gear rations, weight distribution, etc.) during the training. We subsequently tasked each group to, using only their STEM knowledge, mechanical skills, and provided resources within the kit, build the RC tractor that would drag a weighted pulling sled the farthest distance down our indoor track. We provided them with 90 minutes to configure and test their tractors before beginning our competitive tractor pull activity. At the conclusion of the activity, we led a discussion regarding how they could use this STEM-focused activity within their Agricultural Education programs.

Results and Implications

Anecdotally, we noted that teacher engagement and inquiry were consistency high throughout the duration of the tractor pull challenge activity. Intrigued by the challenge presented, the agriculture teachers spent their limited time configuring, reconfiguring, and testing the variables (e.g., the pinion gear, the spur gear, tire size, weight distribution, and hitch height) on our pulling track. The competitive aspect of the challenge was an attention-holding motivator for the participants and each group desired more time to work on their tractors. Our workshop evaluations provided evidence that the tractor pull challenge was one of their favorite activities during the week. We were further informed that several agriculture teachers who participated in the PD workshop subsequently purchased the RealityWorks© RC Tractor Pull Challenge with Pulling Sled Kit to use in their programs during the 2022-2023 academic year.

Beyond the PD workshop, we purchased and implemented additional kits to use in the introductory-level agricultural engineering course at Illinois State University (ISU). The activity is currently used as a laboratory exercise within the course's power transfer and transmissions module. Similar to the engagement we noticed during our PD workshop, the undergraduate students' engagement in the competitive tractor pull challenge activity has also been high. Moreover, the undergraduate students have also noted their perceived value of the activity both during in-class discussions and on their end-of-course evaluations.

Future Plans and Advice to Others

We plan to continue integrating the RealityWorks© RC Tractor Pull Challenge with Pulling Sled Kit into our summer agricultural mechanics PD workshops and the introductory-level agricultural engineering course at ISU. Based on the feedback provided by the agriculture teachers and the undergraduate students, we will likely increase the time devoted to this activity and dive deeper into the curriculum and extension activities provided. We recommend that other agricultural teacher educators and instructors of agricultural mechanics courses consider employing this activity as an approach to engage agriculture teachers and undergraduate students enrolled in introductory-level agricultural engineering courses when learning applied engineering concepts in agriculture.

Costs

The RealityWorks© RC Tractor Pull Challenge with Pulling Sled Kit cost $2,999.00. The kit includes five RC pulling tractors and one weighted pulling sled. Each tractor includes a RC remote, a rechargeable battery pack, 60 washer weights, two pinion gears, three spur gears, two pairs of tires, and a tractor cover. The pulling sled includes 12 sled weights. A downloadable curriculum and computer-aided design (CAD) drawings are also included in the kit. The CAD drawings can be used to 3-D print your own customizable tractor covers. An additional RC tractor pulling sled can also be purchased for $699.00. All other materials or supplies (e.g. calculators, computers / cell phones, string, tape measures, etc.) needed to complete this activity are commonly found in any Agricultural Education classroom or agricultural mechanics laboratory.

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