

Integrating Agricultural Science in a STEM focused Engineering Camp

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Introduction

The National Academy of Engineering has defined fourteen “Grand Engineering Challenges” of the 21st century. One of those challenges is to manage the nitrogen cycle through sustainable agricultural practices. With a heavy emphasis on STEM in our schools today, the NCSU Engineering Camp staff designed a project combining engineering and agriculture. The project allows students to use creativity and the engineering design process to take on a real world agricultural challenge. Cohesion of two or more STEM subjects, in this case engineering and agricultural science, enhances the curriculum by integrating STEM content and STEM concepts and are taught in the context of real world agricultural challenges (Boone, 2013). In the case of this engineering camp, facilitators have reversed that concept and are teaching students agricultural concepts in the context of real world engineering challenges. The purpose of this engineering challenge activity was to facilitate thinking on all levels including evaluating and promoting STEM education through a relatable concept such as agriculture. According to Priority 4 of the National Research Agenda for Agricultural Education, there is a critical need for “designing, developing, and assessing meaningful learning environments that produce positive learning outcomes” (Doerfert, 2011, p. 22).

How It Works

Engineering campers were introduced to this activity on the third day of camp after being taught the engineering design process and implementing the process on a variety of simple engineering challenges. This challenge was presented beginning with an introduction on “Where Food Comes From.” Heavy emphasis was placed on the concept of a rapidly growing population with fewer farmers to meet the food demands as well as discussion on the cycle of food to the grocery store. With a solid understanding of the impact that agriculture has on their lives, students were then presented with the challenge: to design a tool or machine that will drop a seed every 5 centimeters for 60 centimeters with no restrictions on the source of power. Each team was given a budget on a “Farm Credit Card” and purchased their materials from a list provided by the “Farm Supply Store.” The designs were judged based on accuracy, cost efficiency, and energy efficiency. The entire activity was designed to resemble the complete process of an agricultural engineer from designing and budgeting to purchasing and revising.

Results

Before this challenge was given to students, it was given to the camp staff consisting of mostly math and science teachers. Of all the teachers that participated, none were able to successfully complete the challenge. Out of 50 campers grouped in pairs or threes, 7 groups successfully completed the challenge. Although not every design worked perfectly, the level of thinking that was demonstrated in each design was phenomenal. The teachers on the camp staff concluded the students were clearly more capable of using creativity and the engineering design process than they were. Lumpe and Oliver (1991) conclude engaging activities such as this engineering challenge engage students as active problem solvers and decision makers. This concept

was accurately demonstrated by success of the seven groups and the many other groups that learned from their failures.

Future Plans/ Advice to Others

This challenge has only been used at the high school level, but will continue to be used each year in all three grade levels (elementary, middle, and high). The results from each year will be compared to discover how different student populations respond to the challenge. The next group of campers to be given the challenge will be middle schoolers. Their results will be compared to the previous year's high school group.

Regardless of the age group, the best strategy for implementing this activity involves strategic grouping of students and precise operation of the "Farm Supply Store" and "Farm Credit Card." First, students should work in groups of two or three depending on the dynamics of the camper population. By working in small groups, students are able to experience working on a team like a real engineer, but are still held accountable for their workload because the group is small. Second, the projects the students produce display much deeper levels of thinking when the budget and materials are firmly implemented. The "Farm Credit Cards" must be distributed at the beginning of the challenge along with the stated budget and materials list. This way, students feel as if they are being treated as real engineers. The responsibility of having a budget and a materials list to order from helps to strengthen the seriousness of the activity for the students. The store should be set up separate from the setting in which the students are working, i.e. outside the room, in another room, or in the hallway. Before leaving their workroom, students present their design and budget to the facilitator to be able to visit the "Farm Supply Store." Facilitators suggest only letting students visit the store once to ensure adequate time planning and design are met, which is the first step in the engineering design process. Although these techniques have proven effective, each camp environment and student population is different, so adjustments are always needed to these plans to fit individual needs.

Costs/ Materials Needed

The Engineering Place at NC State University provides funding for the camp which covers the cost of materials such as tape, hot glue, scissors, and any additional materials. They also provide the lesson plans and challenge packet provided to each student. The staff of the camp must collect recycled material such as bottles and egg cartons to be used to construct the projects as well as seeds for testing of the materials. Overall, the cost of this activity is relatively low considering most classroom teachers have materials such as glue, scissors, and tape. Recycled material only requires collection.

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