

Purposeful STEM Integration in Agricultural Teacher Preparation at Oklahoma State University

Christopher J. Eck
Oklahoma State University
458 Agricultural Hall
Stillwater, OK 74078
chris.eck@okstate.edu

Haley Kinney
Oklahoma State University
205 4-H Youth Development
Stillwater, OK 74078
haley.kinney@okstate.edu

J. Shane Robinson
Oklahoma State University
304B PIO Building
Stillwater, OK 74078
shane.robinson@okstate.edu

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Introduction

“The health of American democracy in the twenty-first century will depend on the development of a larger number of scientifically literate citizens” (Miller, 2010, p. 241). Further, Miller (2010) identified only approximately 17 percent of adults in the U.S. were scientifically literate. Fortunately, school-based agricultural education (SBAE) teachers have been identified as a source to increase student aptitudes in science, technology, engineering, and math (STEM) through highlighting such in the context of agriculture (Haynes, Robinson, Edwards, & Key, 2012; Myers & Washburn, 2008; Parr, Edwards, & Leising, 2006; Thoron & Myers 2012). Therefore, the need for integrating STEM in SBAE teacher preparation programs is evident (Stubbs & Myers, 2016).

In addition to teacher preparation coursework, the SBAE teacher preparation program at Oklahoma State University (OSU) provides content-specific coursework in agriculture (i.e., animal science, horticulture, natural resources, plant science, and soil science). In addition to pedagogy and content knowledge, a need remains for pre-service teachers to integrate STEM. The American Association for Agricultural Education *National Research Agenda* prioritized the identification of effective methods to integrate STEM curriculum in SBAE (Roberts, Harder, & Brashears, 2016). To help address this concern, five agriculturally-based STEM laboratories were introduced to pre-service teachers in the teaching methods course at OSU, during the Fall 2019 semester.

How It Works

During regularly scheduled laboratory time in the agricultural education teaching methods course, substantiable bioenergy laboratory experiments were organized for the pre-service teachers to participate. The sustainable bioenergy curriculum was compiled from Oklahoma Ag in the Classroom (n.d.) curriculum, National 4-H Council (2016) activities, and OSU Department of Plant and Soil Sciences developed modules. The curriculum consists of five modules, including bioenergy history and biodiesel, bioplastics readings, plant growth readings, ethanol and fermentation, and oil extraction. Each of the modules includes delivery of critical content through readings or modified lecture, followed by a laboratory experiment. The curriculum was developed originally for in-service teacher workshops targeted at secondary science teachers. The five laboratories delivered included biodiesel, bioplastic, soybean, Arabidopsis germination, ethanol, and oil extraction from vegetable matter. Use and importance of the scientific method is embedded within each laboratory experiment. The students were provided content from Oklahoma Ag in the Classroom and other peer-reviewed lessons to prepare for the experience as well as an overview of the laboratory procedures. During the experience, students participated in the same role as their potential students would at the secondary level. After completion of each laboratory experiment (approximately 45 minutes), a debriefing session ensued that focused on the key concepts experienced along with the process of implementing it in the future as a SBAE teacher.

After completing the five bioenergy laboratories on campus, pre-service teachers will have the opportunity to implement the sustainable bioenergy curriculum to SBAE students during their

student teaching internship. Pre-service teachers will be provided a complete sustainable bioenergy laboratory kit to use during their internship. The kit includes all curriculum used, a chemistry glassware set, petri dishes, rubber gloves, PH meter, spring scale, pipettes, digital scale, caliper, timer, tape measure, filtration system, filter paper, tea candles, string, bromothymol blue, yeast, pens, centrifuge tubes, tape, thermometer, goggles, laboratory coats, matches, hot plate/stirrer, hand operated vacuum pump, grow system, coffee grinder glycerin, balloons, corn starch, vegetable oil, canola oil, growing containers, planters, soil brick, methanol, ethanol, separatory funnel, fertilizer, potassium hydroxide, and nine seed varieties.

Results to Date

The first implementation of this STEM-based curriculum was during the Fall 2019 semester at OSU. The teaching methods course consisted of 35 students preparing to student teach in the Spring 2020 semester. A total of 4 days were devoted to pre-service teachers experiencing the sustainable bioenergy curriculum resources. Laboratory assistants in the Teaching Methods course facilitated the process and assisted pre-service teachers in thinking through the delivery of the curriculum to their future students. In the main, the time devoted to the sustainable bioenergy laboratory activities were successful, as all 35 students participated and are prepared to deliver the curriculum during their SBAE student teaching experience.

Future Plans

Research will be conducted on the impact of the curriculum on SBAE students' knowledge of and interest in biofuels prior to and at the end of the unit's duration (~5 days). Additionally, cooperating teachers will be evaluated to determine their perceptions and knowledge related to the STEM integration in the SBAE classroom and to determine the extent that they intend to adopt the curriculum for future use based on its delivery by their student teaching interns. Based on the study's findings, the curriculum will be tweaked for delivery to future cohorts of student teaching interns at OSU.

Costs/Resources Needed

The costs associated with the integration of STEM curriculum at OSU include two areas: the fiscal cost of the sustainable bioenergy laboratory kits and its resources, and the time associated with training student teaching interns and delivering the content. The complete kits are distributed in a large rolling tote with all the supplies described above, costing an estimated \$1,200 per kit. The kits were funded through a large NSF grant designed to equip teachers and students with pertinent laboratory equipment and supplies necessary to conduct biofuels-related science fair projects. Based on the cost of the kits, student teaching centers hosting multiple interns received only one kit. The cost of laboratory kits will have to be considered and addressed for future cohorts. The second major resource is the time associated with the delivery of the content. In total, approximately four hours of course time were dedicated to the five sustainable bioenergy activities. Dedicating that much time during a semester-long teaching methods course can be difficult. Future considerations will need to evaluate the ideal timing and delivery of STEM integration in the SBAE teacher preparation program at OSU.

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