A Cross-disciplinary Approach to Agricultural Literacy at the Middle School Level: "Growing" Interest in Social Studies & Science Students

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Introduction/Need for Innovation

There are more than 98,000 public schools nationwide, serving students from pre-kindergarten through high school (NCES, 2022). Of those, only 8,817 offer school-based agricultural education (SBAE) programs (National FFA Organization, 2023), causing an insufficient number of youths seeking careers in food and agricultural sciences (USDA, 2022). Therefore, it is essential to develop creative means to reach additional students and increase the diversity of those seeking agricultural careers at the same time. One option is focusing on agricultural literacy tools with non-ag students, such as the National Agricultural Literacy Outcomes (NALO; Spielmaker & Leising, 2013). Additionally, the majority of SBAE programs are at the secondary level, creating a large need for middle school students to be exposed to agriculture. Moreover, three of the five themes in the NALO align with South Carolina's middle school curricula across science and social studies.

A cross-disciplinary approach in middle schools, linking science, social studies, and agricultural programs, is suggested to increase students' agricultural literacy. As our world continues to grow more complex and multidimensional, educators must look to an increase in collaboration amongst disciplines to move toward a more sustainable future (Galvão et al., 2021). When teachers integrate curriculum and collaborate, students are more successful. Due to positive implications of collaboration across disciplines and curriculum, programs need to be developed to facilitate and provide the necessary affective support (Nguyen & Nguyen, 2020) for professional collaboration and increased student learning. Studies of Occupations, Culture, and Innovations toward Agricultural Literacy (SOCIAL): Professional Development for Integrating Agriculture and History Curricula is a program funded by USDA-NIFA, from which one of the fellows returned home and engaged his science teacher to create *Big Water*, a cross-disciplinary program at Dutchman Creek Middle School in South Carolina that was partially funded by the SOCIAL project.

Program Phases/Steps

Big Water was conceived and implemented by three teachers, representing science, social studies, and agriculture. *Big Water* engages students in a multi-phase project that has the objective of initiating students' interest in agricultural careers. In phase 1 of *Big Water,* the students built and programmed multiple Arduino-controlled watering systems. Each system contained sensors that detect soil moisture levels, which then activated the Arduino system to automatically pump water to the pots with milkweed seeds provided by the SBAE teacher.

Phase 2 included a variety of experiments planned by the students under the direction of the science teacher. Students recorded their findings in Google Sheets/Docs. Phase 3 included a visit to a local technology center, where the middle school students learned about various careers in agriculture and natural resources from an SBAE teacher and FFA members.

In phase 4, students constructed raised-bed keyhole gardens in pre-determined locations around the school. For phase 5, milkweed plants were grown to the appropriate size and then planted into the keyhole gardens. Throughout the school year, publicity efforts were coordinated with school officials, English teachers, and career center personnel.

Throughout the phases of the project, the social studies teacher engaged the students in three topics related to the research: 1) *Economic Development*, where students explored the impact of water conservation on economic development in South Carolina; 2) *Technological Innovation*, where students investigated the role of technological innovation in transforming South Carolina's economy, from the Great Depression to the present day, and 3) *Economic Diversification*, where students explored how water conservation and sustainable practices can promote economic diversification in South Carolina.

Results to Date

The self-watering systems are in place and fully operational. Students from the science and social studies classes are involved in a variety of tasks supporting the *Big Water* project on a daily basis. They are conducting various experiments on the system, and some students are assigned to maintain the system's water levels and collect data, too.

When visited by faculty from Clemson University, a variety of those students were available to explain their engagement and share records they've collected in Google Sheets/Docs. To gain widespread interest from the students throughout the school, volunteer teachers across all disciplines were secured to serve as fosters for the plants/watering systems. Students constructed the keyhole gardens in pre-planned locations around the middle school and milkweed plants were transferred to the pollinator keyhole gardens.

Future Plans/Advice to Others

In the upcoming year, students will continue maintenance of the milkweed plants in the keyhole raised bed gardens. Under the guidance of the science teachers, they will monitor and record pollinator attraction and tag Monarch butterflies for research purposes. Also, the teachers in this project are looking into ways of generating revenue to make *Big Water* a district-wide activity. An evaluation is underway to understand how perceptions of food and agricultural careers may have changed due to this effort.

Advice for others wishing to replicate this project include organizing a committee of leaders at the beginning of the school year and assigning specific tasks to each member. It is imperative that the local SBAE teacher and principal are engaged at the onset of the planning. It is also recommended that plans accommodate the students' submission of their work for local science fairs. Since SBAE programs are not available in every school, other content area teachers could work collaboratively to integrate such a project, but it is recommended that guidance from an SBAE teacher or industry professional is sought out to help provide the appropriate connections.

Costs/Resources Needed

The supply costs per each unit for the *Big Water* project includes: WayinTop Automatic Irrigation DIY Kit Self Watering System - $30.59; water and related containers, and pots for plants - $10; a BBC keyhole garden - $169.95; a USB power adapter to support the Arduino controller and water pumps - $5, and ½ pack of milkweed seeds - $2.50/pack. It is recommended that two teachers work together on this project. Each teacher will spend three hours per week throughout the school year in planning and engaging staff and students. This is in addition to the estimated time to build one self-watering station, which is six hours.

A Windows computer is also required to code the Arduino chip for each of the systems. Although a guide for programming is included with the kit, it is recommended that someone with programming skills be available for consulting purposes. Students maintain their *Big Water* scientific observations in Google Sheets and Google Docs, so they will need access to Chromebooks or a computer with Internet access.

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