Integrating Automation Technology into Agriculture Sciences: Lessons Learned Across Three States

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Introduction

The rapid advancement of technology presents both opportunities and challenges for agricultural education. To equip students with relevant technical skills for the 21st century, educators must embrace new technologies in their classrooms (TEConomy Partners, 2025). One such technology that has become prevalent in all agricultural sciences is programmable automation controllers (Langemeier & Boehlje, 2021). These embedded computing systems have several applications within agricultural, food and natural resources pathways, such as, monitoring environments for plants and livestock, to precision agriculture to machinery systems (Johnson et al., 2022). With the increased use of automation technologies in agricultural sciences, there is a need for school-based agriculture education (SBAE) teacher professional development opportunities on the subject. The integration of automation technologies into SBAE programs is lacking due to a shortage of teacher expertise, instructional materials, and necessary supplies (Hainline & Wells, 2019). The purpose of this innovative idea is to describe the development of a sustainable professional development program for low-cost integration of microcontrollers within agricultural science curriculum to facilitate skill development in automation operations.

How it Works

First, curriculum was developed using a scope and sequence strategy adapted from Roehrig et al.'s (2021) integrated STEM conceptual framework for student engagement. One foundational module and four technical modules were written, tested, and reviewed by subject matter experts. The foundational module included 4 lessons on how microcontroller operated: Using basics of microcontroller; Electrical components and circuit construction; Sensors, actuators and programming; Troubleshooting. We aligned each technical module to an Agriculture, Food, and Natural Resources (AFNR) Career Pathway. Within each module included several lessons with student learning activities, rubrics, learning assessment and instructional videos. A six-hour teacher training workshop was provided at Arkansas, Pennsylvania, and Utah corresponding to the 2025 summer in-service. Twelve teachers from each state were provided with hands-on training and online access to all aspects of the curriculum. Classroom hardware kits to support instruction were provided for teachers to implement the curriculum in their classroom. This included a microcontroller, breadboard for circuit construction, digital and analog inputs and outputs, sensors, wires, and resistors. Additionally, teachers needed to download the Arduino integrated development environment (IDE). This is a free software that uses a variation of the C++ programming language, which is a widely used language in programming (Schaffer, 2022). This software is used to write the programs for the microcontrollers. Furthermore, participating teachers implementing the curriculum into their classrooms during the 2025-26 academic year are required to train four additional SBAE teachers within their state to facilitate curriculum adoption. After the professional development training, technical support and communication were maintained with the participating SBAE teachers using Zoom conferencing and site visits.

Results to Date

A total of 36 teachers from three different states were initially trained through the summer workshop and provided access to online resources. Ten videos have been produced to review all the circuits made in the curriculum and 28 learning activities have been developed for the curriculum. Feedback collected from directly following the workshop showed teachers were agreeable to the curriculum implementation, ease of use and intent to use the materials. Additionally, focus group discussions with teachers that have implemented the curriculum discussed the importance of including agricultural relevance in the learning activities.

Future Plans/Advice to Others

Future plans include refining curriculum and ease of access for instructors to better incorporate the activities into their classrooms. Additional lessons for each pathway module plan to be developed to create a deeper understanding of the role of microcontrollers in their respective industries. Also, more agricultural pathways will have modules developed for a greater diversity of instructors to implement learning activities, such as animal sciences and forestry. If planning to create a professional development for microcontrollers in SBAE, it is advised to avoid preassembled Arduino educational kits and construct your own. Many educational Arduino kits are targeted for general engineering students, whereas for agricultural sciences, specialty sensors and circuits serve a better teaching environment as it would simulate what teachers and students would experience. Additionally, feedback from focus group discussions with teachers that have implemented the curriculum noted that having a specific contact person for troubleshooting circuits was beneficial. Therefore, we recommend professional development hosts provide contact information for subject matter experts to assist teachers as they implement new curriculum. Furthermore, it is encouraged for teacher-education programs to introduce new technologies to their students, so they are more likely to seek out training and implementation in their classrooms.

Costs

The primary costs associated with the workshops include the classroom kits. Each kit costs $45 for a total of $270 per instructor. Arduino IDE software is free to download. Additionally, the cost of curriculum development was supported through a two-year [SPONSOR] award totaling $149,932. Table 1 outlines the costs and materials needed for each classroom kit.

Table 1

Classroom kit for Microcontroller Curriculum

Item	Unit Price Per Kit
Microcontroller Board	$8.98
Breadboard	$1.45
Power Supply	$1.20
Gas/O2 Sensor (MQ135)	$6.99
Temperature/Humidity Sensor (DHT22)	$2.30
Ultrasonic Sensor (HC-SR04)	$2.00
Total Dissolved Solids (TDS) Sensor	$11.99
Servo Motor	$1.56
DC Motor	$1.61
Resisters/Jumpers/Push Buttons Set	$1.67
Potentiometer	$0.50

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