Agricultural Applications of Computer Science

CS & CT in Rural Schools through Physical Programming

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NSF STEM+C Program
Grant #1742519
What is AgCS? The Need

- 50% of U.S. schools & 20% of students are rural
- Few certified CS teachers or developed CS pathways
- Future rural industry leaders are consumers of technology, not producers
- If we can’t get CS & CT to students through traditional CS courses that don’t exist in rural schools, can we leverage existing agriculture and science course content to include CS & CT tasks?
AgACS Research Questions

1. Under what conditions and implementation models does integrating CS competencies as a tool to solve agricultural problems increase student interest, motivation, and performance in CS courses, independent projects, and careers?

2. How do students of different demographic, personal, and academic backgrounds interact with the Ag-ACS curriculum? Do these students have similar engagement patterns, performance, interest, and attitude changes?
AgACS Curriculum Modules

- Module 0 - Intro content  (Programming & Electronics)
- Module 1 - Chicken coop door controlled by daylight
- Module 2 - Moisture-sensitive irrigation system
- Module 3 - Greenhouse heating and cooling system
- Module 4 - Android app for tracking natural resources
- Module 5 - Raspberry Pi camera  (Timelapse, Livestream)
- Module 6 - R-Pi data online  (Temp to a Google Sheet)
AgACS Pilot

16 teachers
11 locations
200+ students

A range of implementations:

- Computer classes
- Agriculture classes
- 7th-8th grade STEM/engineering/robotics classes
- Science & business/computer teacher team
- Agriculture & English teacher team
- Agriculture, H.S. science, & 5th grade teacher team
- Nature center & zoo educational sessions and camps
Student Demographics

**Grade Level**
- 12: 13.7%, 7
- 11: 18.3%, 8
- 10: 17.0%, 9

**Class Type**
- Ag Engineering: 2.8%, 10
- Digital Media: 18.3%, 10
- Robotics: 53.2%, 11
- Horticulture: 19.3%
- Physics: 6.4%

**Either a Farm or a Family Garden**
- Yes: 65.8%
- No: 34.2%

**Ethnic Background**
- African American: 3.7%
- Asian/Pacific: 1.8%
- Native American: 4.9%
- Multi: 11.0%
- Hispanic: 8.6%

**Gender by Course Type**
- Ag Engineering: Female: 3, Male: 9
- Digital Media: Female: 11, Male: 11
- Engineering: Female: 19, Male: 44
- Horticulture: Female: 10, Male: 11
- Physics: Female: 2, Male: 5
- Robotics: Female: 13, Male: 45

**Caucasian**: 68.1%
### Computer Attitude Survey Data

<table>
<thead>
<tr>
<th>CAS Factor:</th>
<th>Pre-</th>
<th>Post-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Solving – Transfer: Ability to see and/or apply connections between concepts and ideas in order to solve problems.</td>
<td>16%</td>
<td>40%</td>
</tr>
<tr>
<td>Personal Interest and Enjoyment: Personal interest, motivation, and engagement with computer science.</td>
<td>21%</td>
<td>41%</td>
</tr>
<tr>
<td>Problem Solving – Strategies: Classic problem-solving strategies in computer science, including topics of practice, problem decomposition, and planning prior to writing code.</td>
<td>17%</td>
<td>42%</td>
</tr>
<tr>
<td>Real-World Connections: Relationship between the “real world” and the computer science discipline.</td>
<td>18%</td>
<td>48%</td>
</tr>
<tr>
<td>Problem Solving – Fixed Mindset: Belief of predetermined fate or learned helplessness within the discipline.</td>
<td>18%</td>
<td>48%</td>
</tr>
</tbody>
</table>

Piloting Impacts

- Ag engineering: “Empty hopper” planter alert with light sensor and LED
- Fishing line alert with motion sensor and buzzer
- Automatic classroom pet feeder
- 1-week middle school zoo program: Autonomous enrichment activities for the animals

***Only limited by available sensors and code libraries***
Piloting Impacts

$30,000 STEM investment by one school, after one pilot semester
Piloting Impacts

$30,000 STEM investment by one school, after one pilot semester
Piloting Impacts

Muscle-controlled robot arm
Piloting Impacts

Timer/Servo - controlled dog feeder
Piloting Impacts
Piloting Impacts
Piloting Impacts

How can we use urban gardening to connect our community with healthy foods?
Key Insights

- Yes, it’s feasible, flexible, and a low-barrier, open-ended entry point, but it requires a minimum level of teacher readiness.
  - Can’t already be starting too many other new things

- Teachers are self-critical about knowing enough to get out of the weeds when students take them somewhere unexpected.
  - “I want my students to be able to do their own projects, but I don’t always know where to fix things that are wrong in their code.” ~Teacher
    - Peer support required
    - Curriculum emphasis on computational thinking skills and the use of online resources
  - Lots of apologies to me about implementation, data collection, etc.
    - “We don’t know if this will work as well as we hope. The answer may be that it doesn’t work for you, but your feedback can help us figure out why.” ~Me

- Students like the activities. Uncertain about translation to career interest.
  - Still a mixed understanding of what a “computer science career” is
NSF Acknowledgement

This material is based upon work supported by the National Science Foundation (STEM+C program) under Grant #1742519.

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

National Science Foundation
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