NSF STEM+C Program
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Agricultural Applications of Computer Science

CS & CT in Rural Schools through Physical Programming

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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?

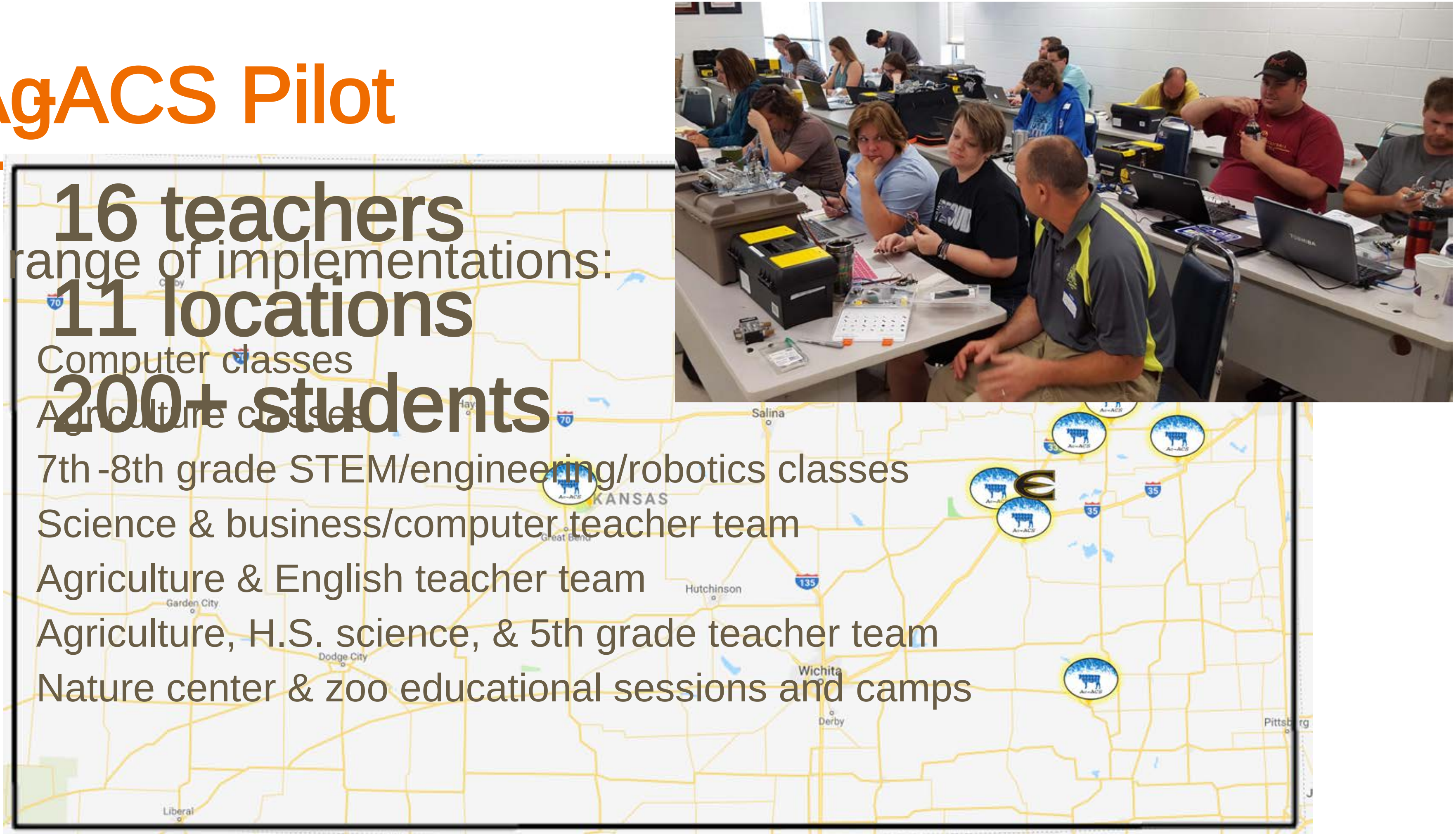
AgACS Research Questions

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 T



16 teachers

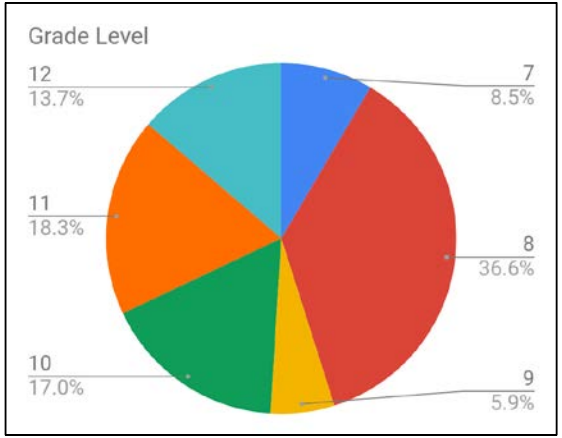
11 locations

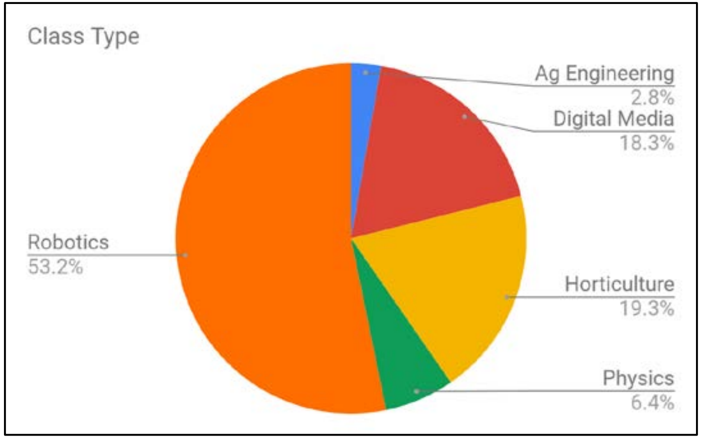
200+ students

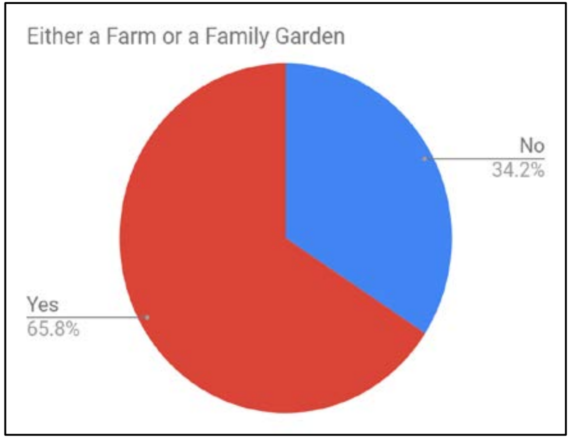
A range of implementations:

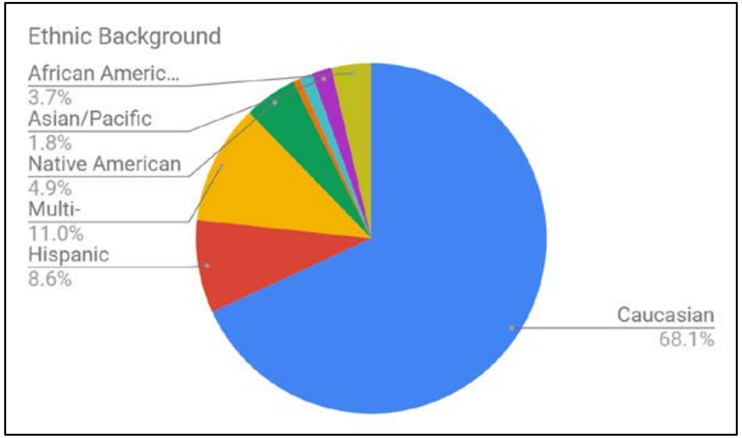
- Computer classes
- Agriculture classes
- 7th-8th grade STEM/engineering/robotics classes
- Science & business/computer teacher team
- Agriculture & English teacher team
- Agriculture, H.S. science, & 5th grade teacher team
- Nature center & zoo educational sessions and camps

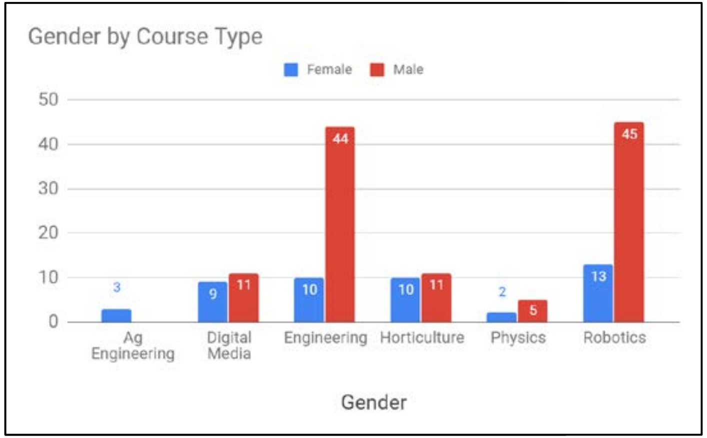
Student Demographics





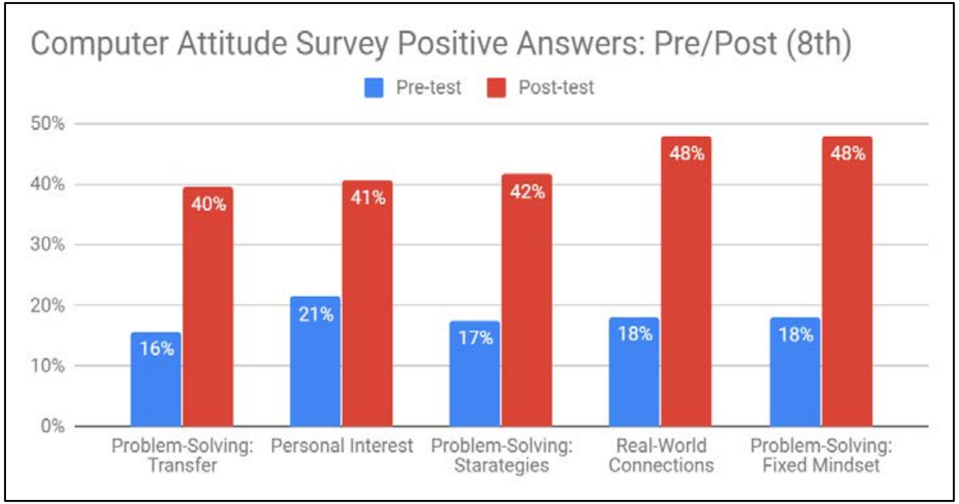






Computer Attitude Survey Data

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



Dorn, B., & Tew, A.E. (2015). Empirical validation and application of the computing attitudes survey. *Computer Science Education, 25*(1). https://www.tandfonline.com/doi/full/10.1080/08993408.2015.1014142

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

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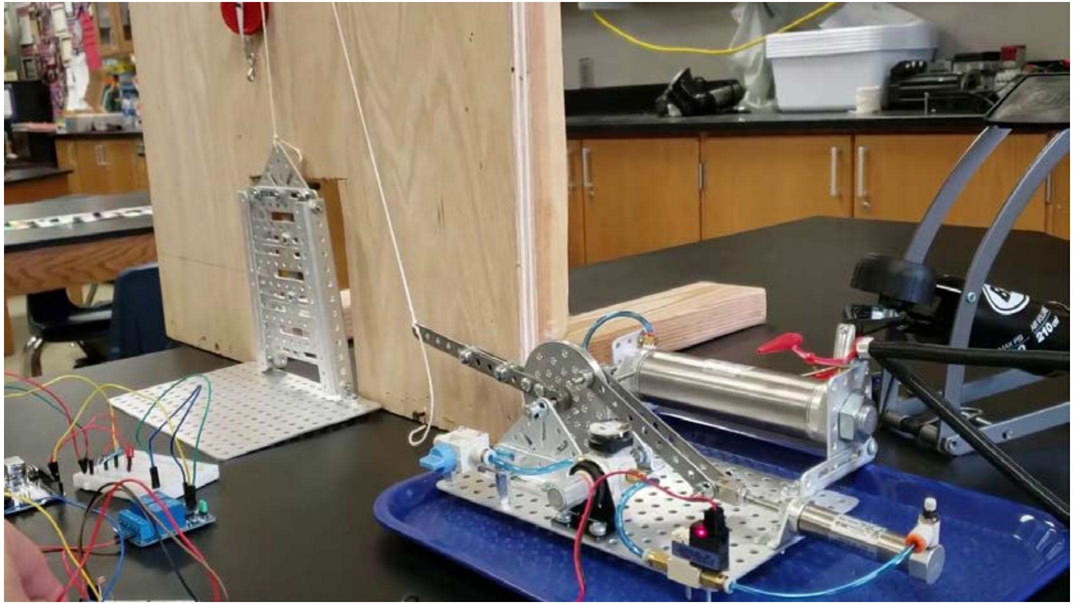
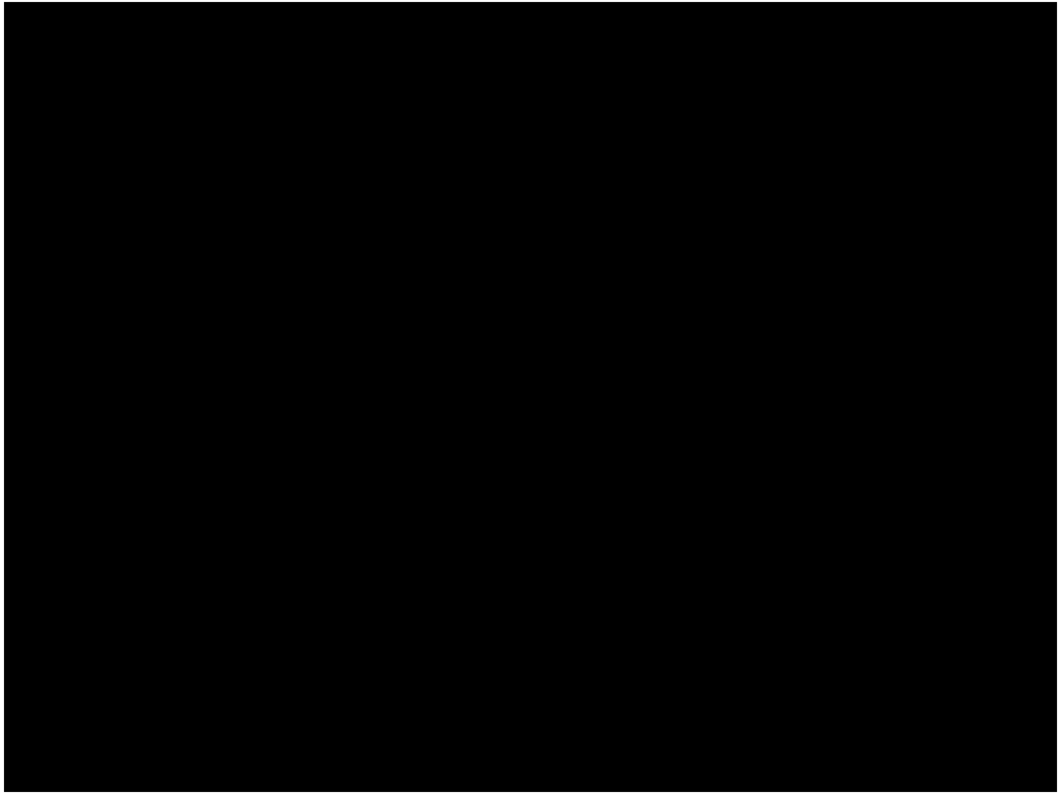


Piloting Impacts

Muscle-controlled robot arm

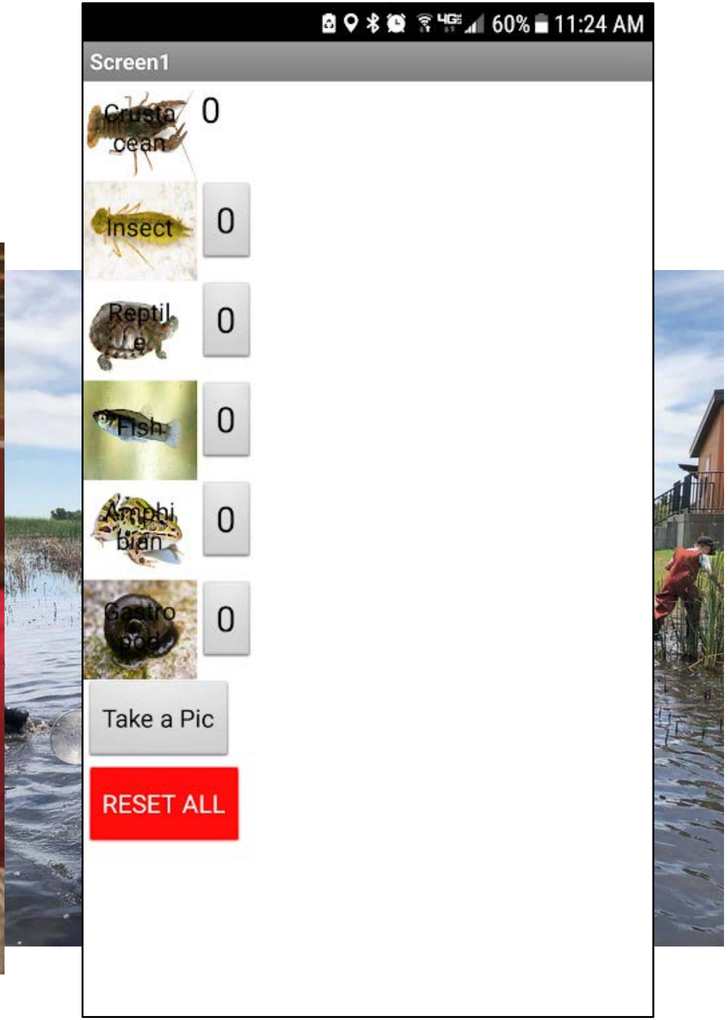


Piloting Impacts

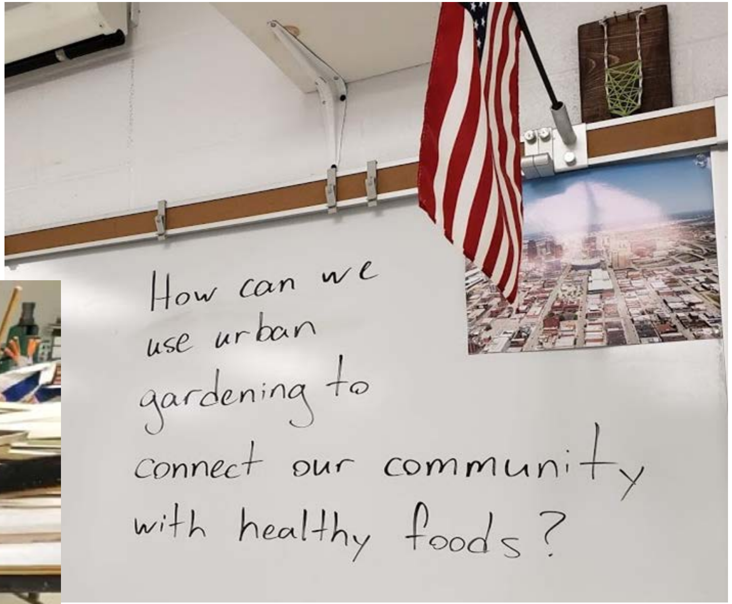
Timer/Servo - controlled dog feeder

Piloting Impacts

Piloting Impacts



Piloting Impacts



Key Insights *(with 1 tentative year down, one confident year to*

- **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

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