Informal STEM Teaching and Learning Through Infusing Computational Thinking into Science Learning (Connecting the STEM+C Dots: Infusing Computational Thinking in Informal STEM Learning)

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Project Goals

- ✓ Design and implement a Community Center Afterschool Program (CCAP) model for integrating computational thinking (CT) in K-12 STEM learning
- ✓ Explore how to integrate CT in hands-on, project-based, integrated STEM (STEM+ CT) inquiry/projects for 4th-6th grade students in community center afterschool programs
- ✓ Evaluate the impact of the curriculum implementation on students, teachers and community centers' staff

Research Question

How can computational thinking be effectively integrated into PBL STEM inquiry projects (activities) for an afterschool program?

Methods

- ✓ Design and develop of a STEM+CT curriculum (4 PBL STEM+CT projects)
- ✓ Implement the curriculum in community centers' afterschool programs
- ✓ Implementation was led by in- and pre-service teachers/ Provided PD prior and during the implementation
- ✓ 4^{th} to 6^{th} grade school students in small group of 4 to 6
- ✓ Two 90-minute sessions (twice per week) for 8 weeks
- ✓ Revise and reimplement the curriculum

Methods

Evaluate the impact on students, teachers & community centers' staff:

- ✓ Video-tapes of students working with peers, teachers & researchers
- ✓ Students' pre- and post- survey (S-STEM Survey (Friday Institute for Educational Innovation, 2012))
- ✓ Student artifacts produced during the implementation
- ✓ Student focus group interview
- ✓ Teacher pre- and post-survey on CT before and after PD
- ✓ Teachers' weekly or by-weekly reflection during the implementation
- ✓ Teacher interview
- ✓ Community centers' staff interview

Intended Outcomes

- ✓ A community partnership model
- ✓ A project-based, integrated STEM+CT curriculum
- ✓ CT growth and development in students and teachers
- ✓ Students' learning of STEM knowledge
- ✓ Participating teachers' adaption of the STEM+CT curriculum in a formal classroom setting

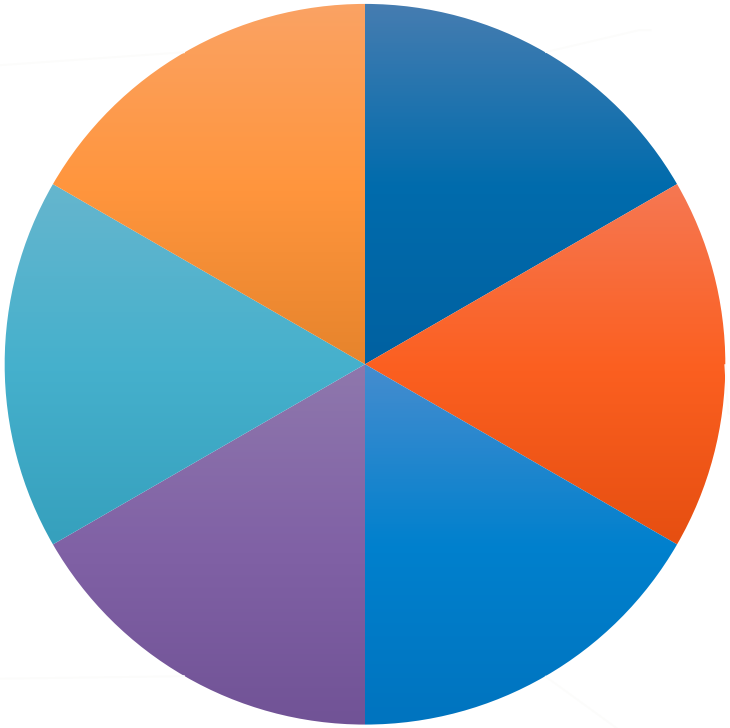
Overview of Outcomes

- ✓ Designed and developed four PBL integrated STEM+CT projects
- ✓ Implemented the curriculum (facilitated by in- and pre-service teachers) at six community centers/Title I schools over four semesters
- ✓ Worked with 24 in-service teachers, 18 pre-service teachers, and more than 140 Tittle I school students
- ✓ 10 teachers adapted the STEM+CT curriculum in formal classrooms

A Community Partnership Model

STEM Researchers

Title I Schools



School District

Parks & Recreation Dept.

Community Centers' Satellite Sites

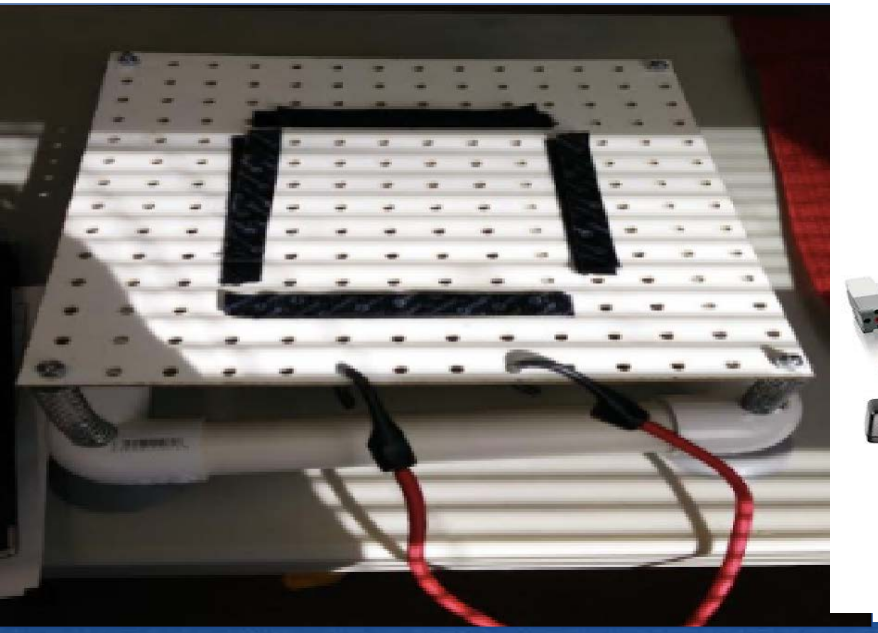
Community Centers

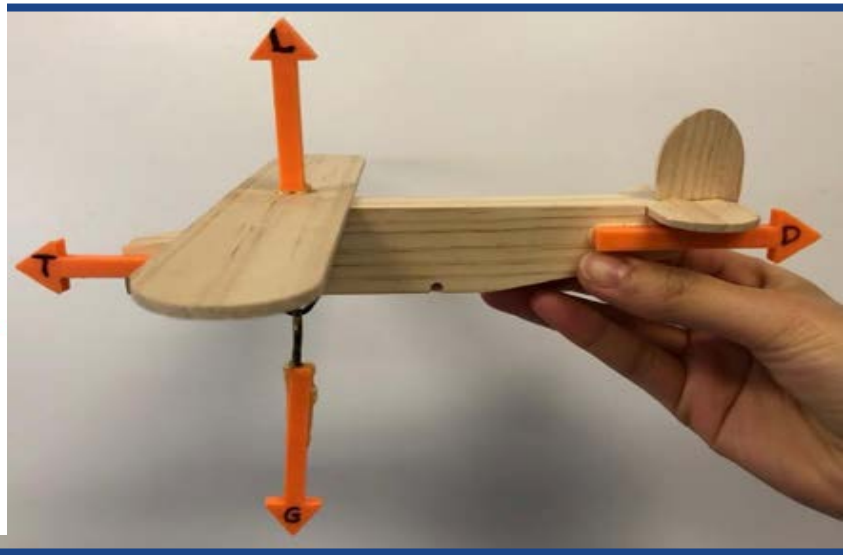
STEM+CT Curriculum

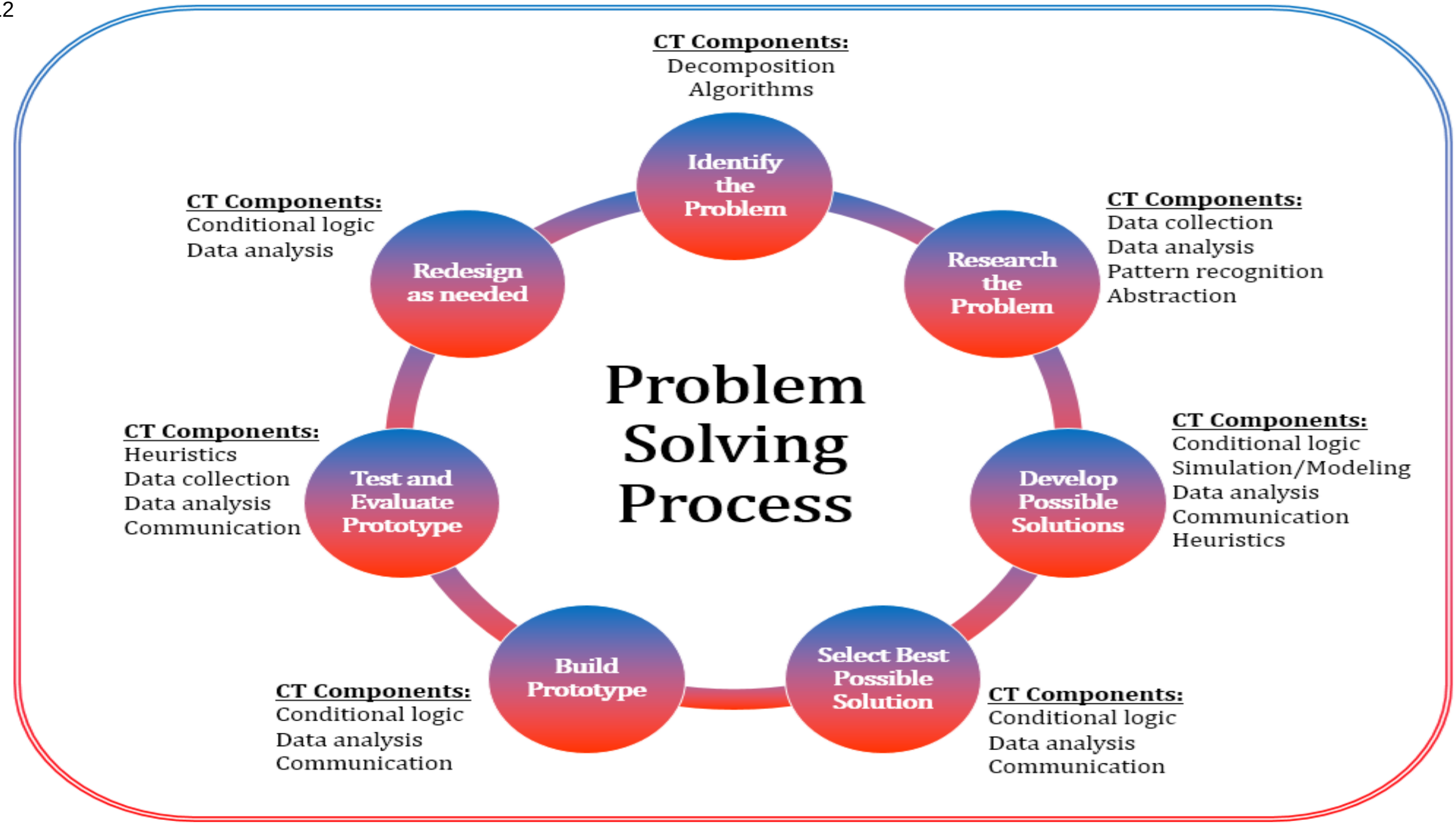
- Guided by PBL (driving questions & hands-on activities)
- Integrated STEM - required multiple subjects knowledge to solve the problem
- Mapped with K-12 engineering design process
- Aligned with content standards
- Showcased students' final products/student competitions
- Implementation of the STEM+CT curriculum led by in- and pre- service teachers

STEM+CT Curriculum

- **1.** How Can We Detect Life on Mars Using a Robot? (Engineering, Science, Math, Computer Science, & Technology) Video Clip
- **2**. How Can We Build a Bridge for the Boise River that is Strong Enough to Resist Earthquake Forces? (Engineering, Physics, Geoscience, Technology, & Math) Video Clip
- **3.** How Do Airplanes Fly? (Engineering, Science, Math, Computer Science, Technology) Video Clip
- **4.** Can We Make Sand Stand Tall? (Engineering, Science, Math, Technology) Video Clip






Problem Solving Process
Identify the Problem
CT Components:
Decomposition
Algorithms
Research the Problem
CT Components:
Data collection
Data analysis
Pattern recognition
Abstraction
Develop Possible Solutions
CT Components:
Conditional logic
Simulation/Modeling
Data analysis
Communication
Heuristics
Select Best Possible Solution
CT Components:
Conditional logic
Data analysis
Communication
Build Prototype
CT Components:
Conditional logic
Data analysis
Communication
Test and Evaluate Prototype
CT Components:
Heuristics
Data collection
Data analysis
Communication
Redesign as needed
CT Components:
Conditional logic
Data analysis

Preliminary Findings

- ✓ Teachers and students were generally positive towards the STEM+CT curriculum
- ✓ Students' improved confidence towards math
- ✓ The practice of CT is dependent upon the learning tasks (Yang, Swanson, Baek & Chittoori, 2018)
- ✓ **Challenges:** limited time; complex learning activities; students' low interest in research and reading

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