INTEGRATED STEM & COMPUTING LEARNING IN FORMAL & INFORMAL SETTINGS FROM KINDERGARTEN TO GRADE 2

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INTRODUCTION

As people engage in real-life situations, they draw from their full knowledge base and skillset. Integrating science, engineering, mathematics, computational thinking, and literacy within educational experiences for pre-college students can better prepare them for real-world situations, while allowing teachers to add engineering and computing to the school day without diminishing their focus on mathematics and literacy. At the same time, we know children only spend about 18% of their waking hours in formal school environments - thus we can promote learning by capitalizing on time spent in out-of-school settings and making connections across school and out-of-school settings.

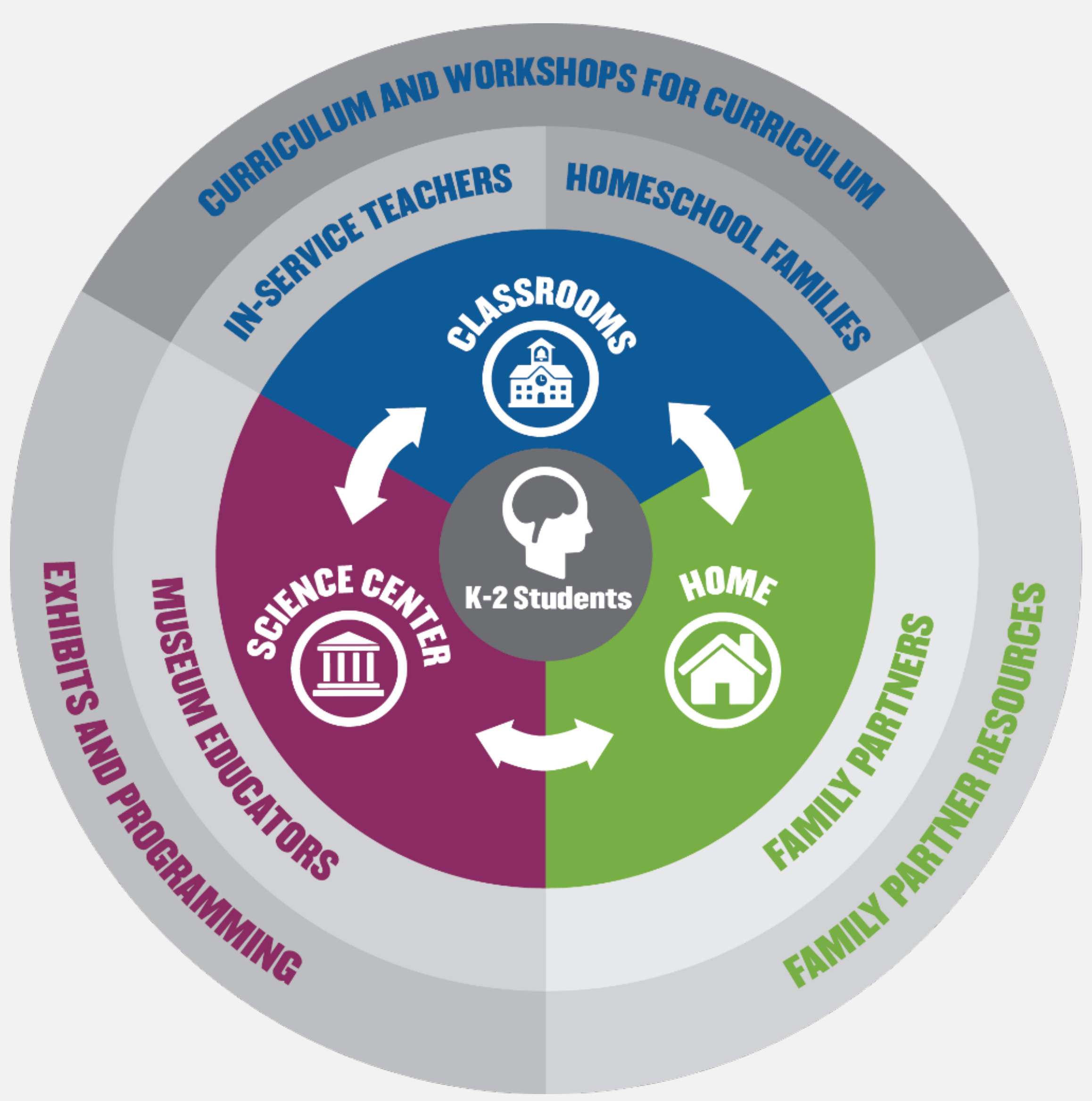
PROJECT OVERVIEW

Resources

- Computational thinking was integrated into the PictureSTEM curriculum (a research-based integrated STEM curriculum that makes extensive, authentic connections across STEM subjects while also connecting language arts).
- In development are extension activities to further support computing learning, science center exhibits for learning in informal settings, and resources for parents to help K-2nd grade students learn engineering design and computational thinking skills while also developing proficiency in mathematics, science, and literacy.

Research

- Assessment frameworks, tools, and approaches are being developed, while research is conducted on student learning that takes place in school, home and science center settings.



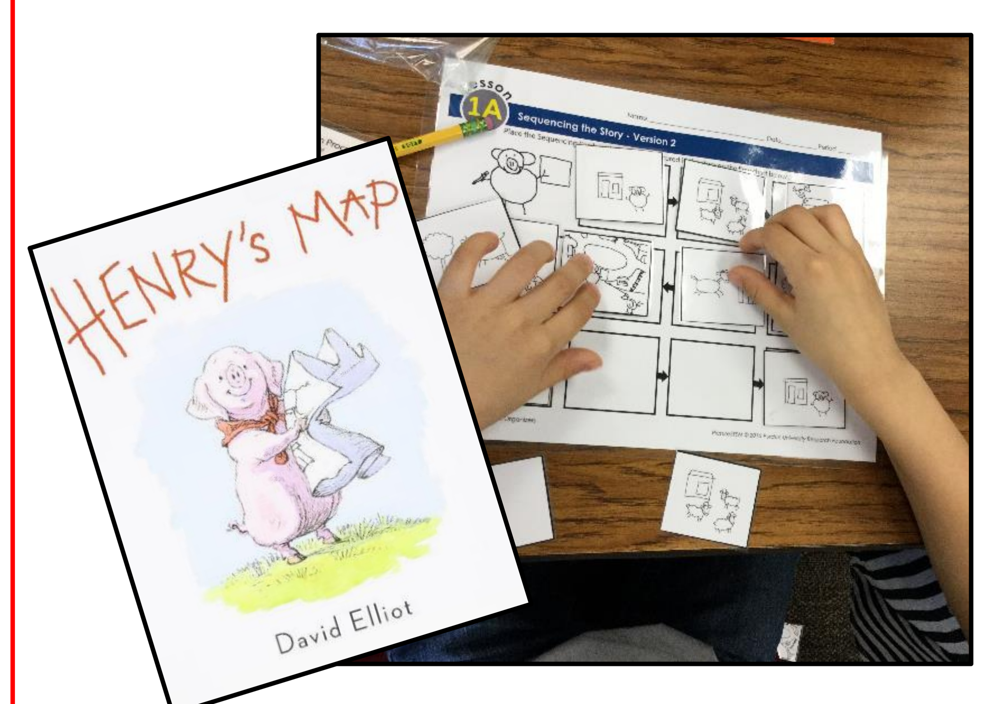
RESEARCH QUESTIONS

- What does student learning look like in an integrated STEM+C school-based environment?
- What does student learning look like in an integrated STEM+C informal learning environment?
- In what ways (if at all) do students make connections across school and science center(and potentially other) settings?

	Lesson 1:	Lesson 2:	Lesson 3:	Lesson 4:	Lesson 5:	Lesson 6:
Literacy Connections	**Book:** Henry's Map **Strategy:** Story sequencing	**Book:** How Big is a Foot? **Strategy:** Story structure	**Book:** Measuring Penny **Strategy:** Compare & contrast	**Book:** Living Color **Strategy:** Questioning	**Book:** Rosie Revere, Engineer **Strategy:** Sequencing to lead to summarizing	**Book:** Too Many Toys **Strategy:** Summarizing narrative text
STEM+C Connections	Design a map for a robot mouse	Design a set of instructions for a treasure hunt	Design your own class "standard" of measurement	Sort and describe materials by physical properties	Test the properties of materials, plan initial design for toy box organizer	Create, test, and redesign toy box organizer
	• Newly added computational thinking lessons	• Problem decomposition • Simulation • Algorithms and procedures	• Data collection • Data analysis • Data representation	• Abstraction • Algorithms and procedures	• Data collection • Data analysis • Problem decomposition	• Data analysis • Algorithms and procedures • Simulation

Lessons 1A Henry's Map & 1B Robot Mouse

Students learn how to use flowcharts and mapping to help solve problems and illustrate their ideas in a step-by-step manner.



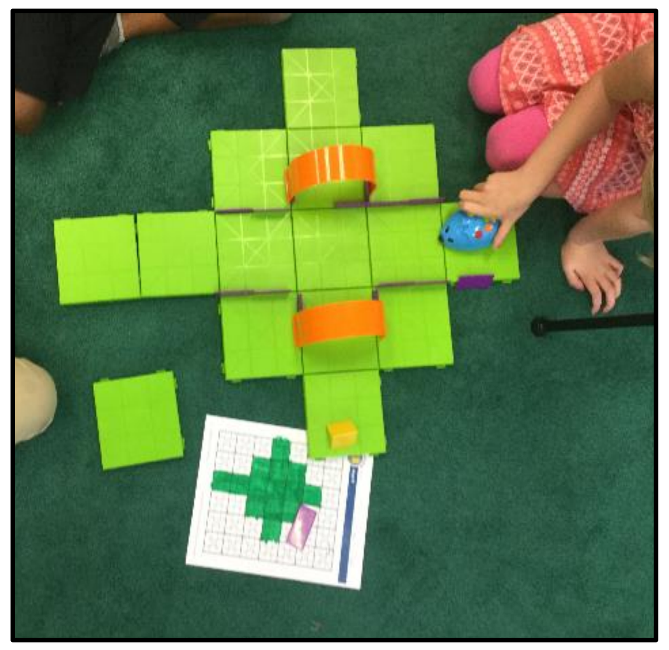


Exhibit Development & Research

- Conducted a pilot study with existing foam blocks & a CT task at local science center
- Developed a new exhibit in collaboration with Purdue Exhibit Design Center
- Recruited families from partner schools (children experienced curriculum) and from the science center (children did not experience the curriculum)


Build a Safe, Puppy Play Space!

Can you help Eva and her Puppy?

Eva is a kindergarten student. She has a puppy. She wants to send him to play outside in the yard.

Oh no! The yard is not ready for the puppy to go and play.

Eva needs your help. She wants a space for the puppy that:
- keeps him from running away from the yard.
- has toys to help him play and get exercise.
- includes patterns to look nice.

Use the big blocks to build a safe play space for her puppy. We will send a photo of what you build to Eva.

Curriculum Revision

- Reviewed PictureSTEM curriculum to identify existing computational thinking
  - Content analysis of two PictureSTEM units
  - Coded for computational thinking
- Analyzed classroom video observation data to identify students engaged in computational thinking
  - Interaction analysis
  - Case studies
- Identified an area in each unit that could be strengthened by a lesson focused on a computational thinking competency
  - Wrote a new literacy and STEM+C lesson for each unit
- Developed new introductory lessons that allowed students to do age appropriate problem scoping

Educator Workshops

- Twenty-eight educators were trained in Year 1
- Sixty-three educators were trained in Year 2

Student Learning Research

- Year 1:Twenty-two educators from seven elementary schools across four school corporations participated in data collection
- Year 2: Twenty-six educators from seven schools & 2 homeschooling families

COMPUTATIONAL THINKING

Computational thinking (CT) is a systematic problem-solving process that involves identifying, formulating, and solving problems in a way that enables us to use tools such as computers to more efficiently address complex, real-world situations. Computational thinking can be used across disciplines (e.g., mathematics, science, engineering, and literacy).

The CT core competencies the project is focusing on are:

- **Abstraction** - Identifying and utilizing the structure of concepts/main ideas
- **Algorithms & procedures** - following, identifying, using, and creating an ordered set of instructions (i.e., through selection, iteration and recursion)
- **Problem decomposition** - Breaking down data, processes or problems into smaller and more manageable components to solve a problem
- **Debugging/Troubleshooting** – Identifying and addressing problems that inhibit progress towards task completion

DATA SOURCES

Research data used to understand student learning

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Our definitions of computational thinking are based on: Barendsen & Stoker (2013), Barr & Stephenson (2011), ISTE & CSTA (2011), The College Board (2012), The Australian Curriculum Technologies (2015), Google's Computational Thinking Concepts Guide, & SRI Education (2015)

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