Computational Thinking in Primary Schooling: Thinking Beyond Computer Science

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CS10K to CSforALL

- To meet the growing demand/need for computing, we need:
  - Training new teachers in the teaching of computer science
  - Creating in-service opportunities for current teachers
  - Increasing education research in computer science.

Computer Science in US Schools

57.5% of U.S. high schools offer foundational computer science

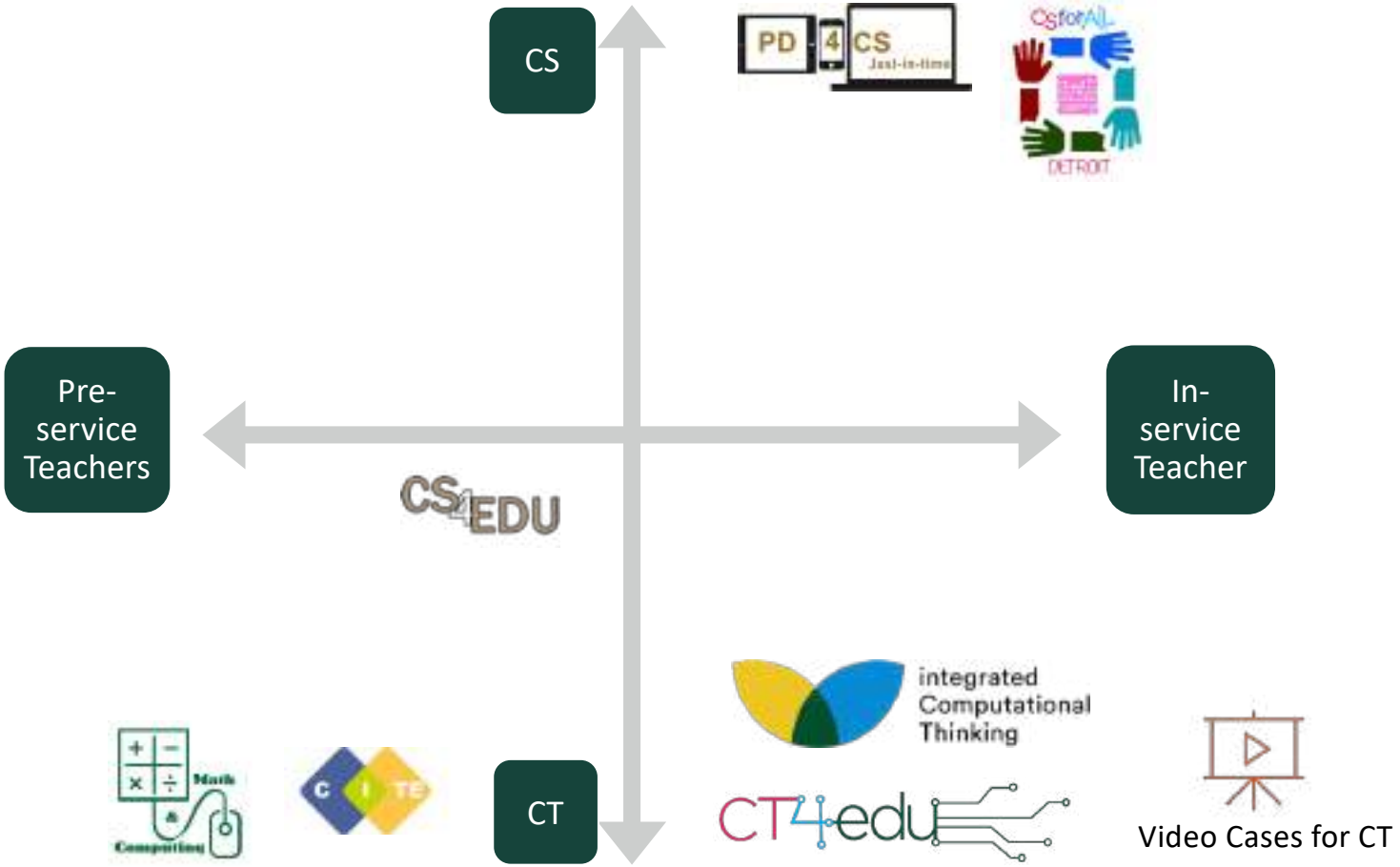
Across 35 states, 5.8% of high school students are enrolled in foundational computer science

Just 31% of students in high school foundational computer science are young women

What kinds of experiences do students need to learn computing concepts, to be confident to pursue computing?

What kinds of knowledge do teachers need to have to facilitate these learning experiences?

What kinds of experiences do teachers need to develop these kinds of knowledge?


CS
Pre-service Teachers
In-service Teacher
CT
CS4EDU
PD 4 CS
integrated Computational Thinking
CT4edu
Video Cases for CT

Integration

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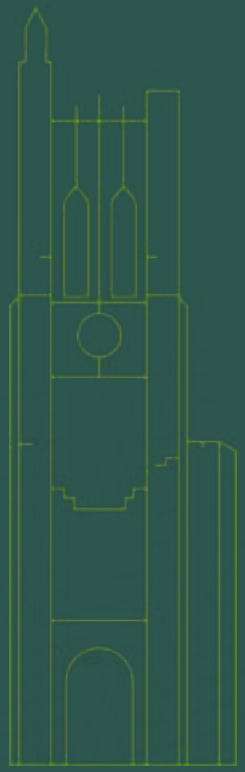

Computational Thinking

"encompassing approach that exposes students to "computing" ideas and principles in the context of the subject areas they are already learning."

Elementary
+
CT

- Debugging
- Abstraction
- Decomposition
- Patterns

CT4edu

Developing Teacher Knowledge

COLLEGE OF EDUCATION

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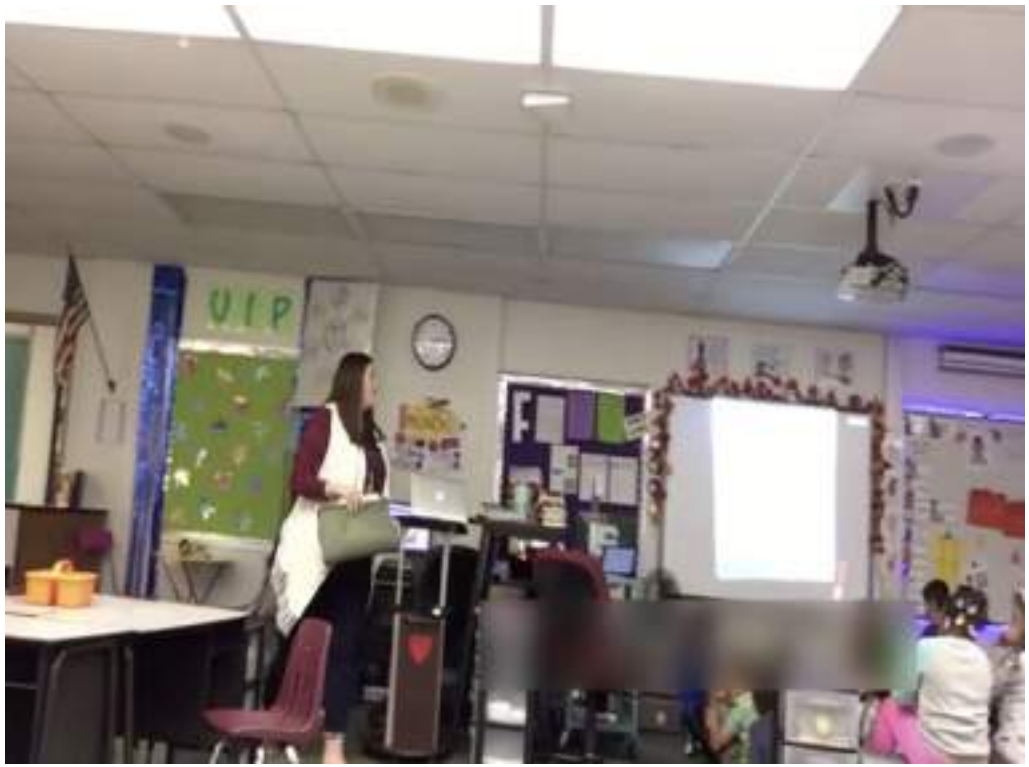
Plan a
CT lesson
OR
draw
25


I am once again asking
to try something new in your classroom

Using CT to structure lessons



Rich, Yadav, & Larimore (2020)

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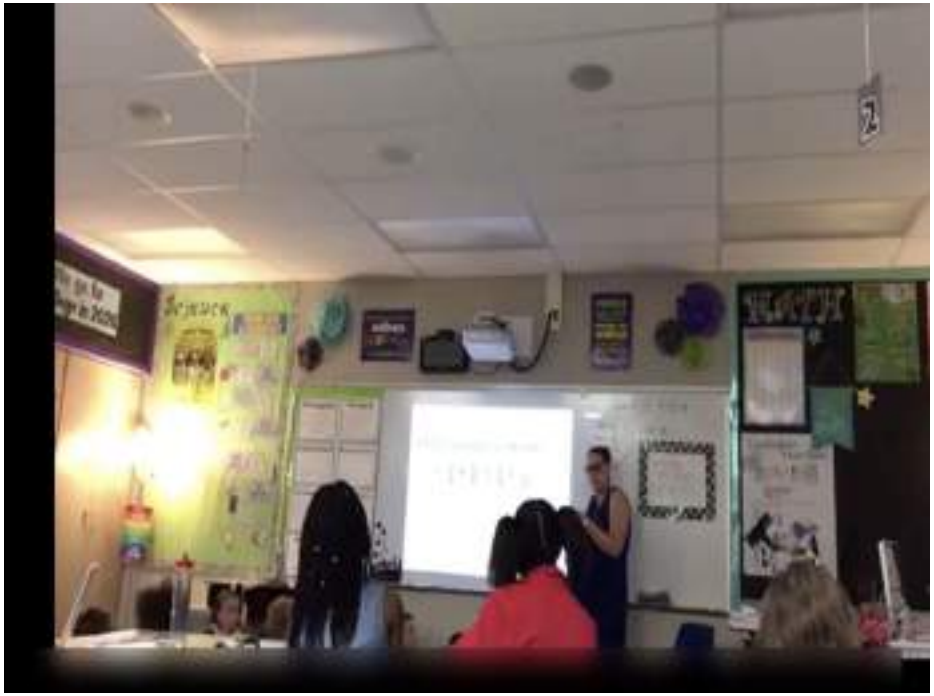
Using CT to guide teacher planning

From lesson plan: *Students will engage in abstraction when they "Look at visual representations of mixed numbers, identifying the whole and the extra."*

$$\frac{1}{3} + \frac{1}{3} + \frac{1}{3} + \frac{1}{3} + \frac{1}{3}$$



Rich, Yadav, & Larimore (2020)

CT and Meta-cognition: A Plugged Example

Name:_____
Date:_____
Partner(s):_____

Dash wants to go on a special trip. Here are the details:

1. He wants to travel a total distance of 600 cm.
2. He wants to travel in a square.
3. He wants to end the trip facing the same direction he started.

How can you program Dash for this special trip?

Predict the Path (Draw It)	Write the Code Here	Reflect
		What worked? What information did you need? What debugging did you have to do?

What could change if Dash wanted to travel in a rectangle?

Ocak, Yadav, & Macann (2023)

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CT and Meta-cognition: A Plugged Example

Michael: So, with the people sitting next to you, I want you to turn and talk about <u>what are some things that you need to think about with these directions</u> [e.g., the total distance and shape of the path that robot must follow]

Developing an understanding of the critical features of a problem

Ocak, Yadav, & Macann (2023)

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CT and Meta-cognition: A Plugged Example

Michael: Some of the groups are finding out that they made a plan that involves their robot traveling in certain directions.... o, there are really some things that you need to think about ... that are a little bit different ... So, if your planning involved just moving and sliding around, you might have to add in different things and try that out.

Algorithmic Thinking

Ocak, Yadav, & Macann (2023)

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Algorithmic Thinking.
Step-by step solutions to a problem

Associated Metacognitive Processes

Planning how to proceed

Identifying steps needed to solve the problem

Executing the steps serially or in parallel

Yadav, Ocak, & Oliver (2022)

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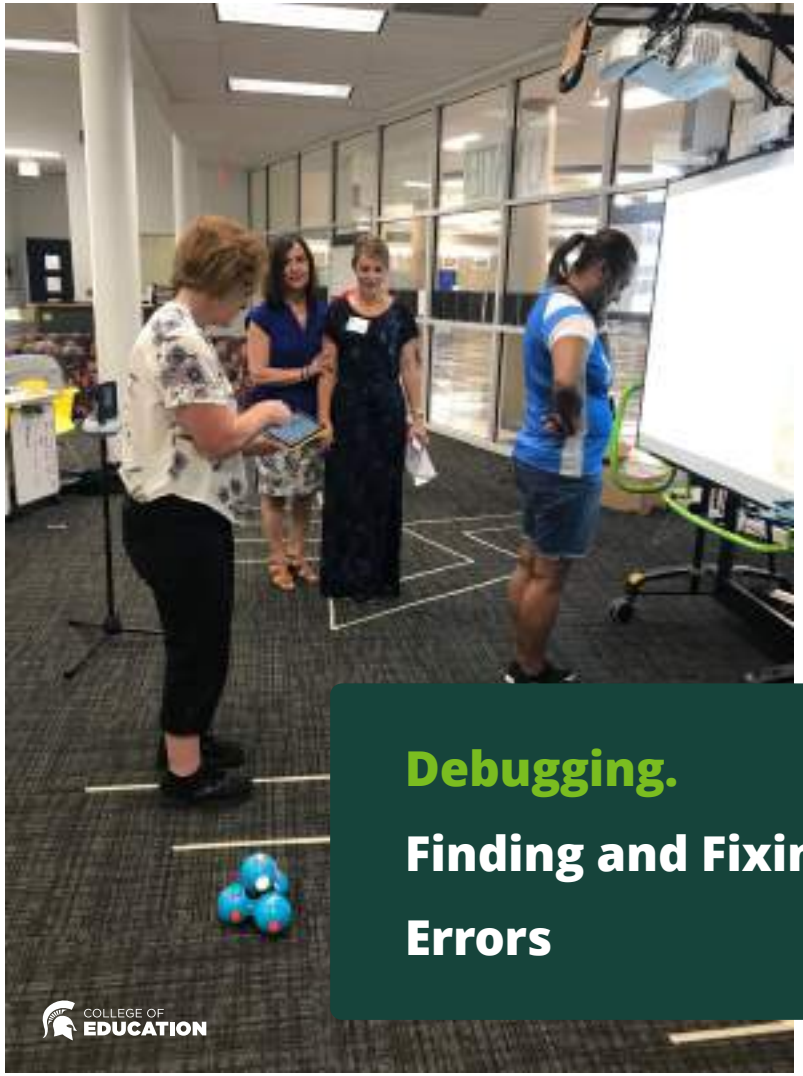

Debugging.

Finding and Fixing Errors

Associated Metacognitive Processes

Monitoring the solution.

Assessing the solution.

Trying new strategies when the former one doesn't work.

Yadav, Ocak, & Oliver (2022)

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Abstraction.

Focusing on most essential details

Associated Metacognitive Processes

Defining a problem.

Selecting the relevant elements from the problem to be addressed.

Attending critical features of a problem.

Yadav, Ocak, & Oliver (2022)

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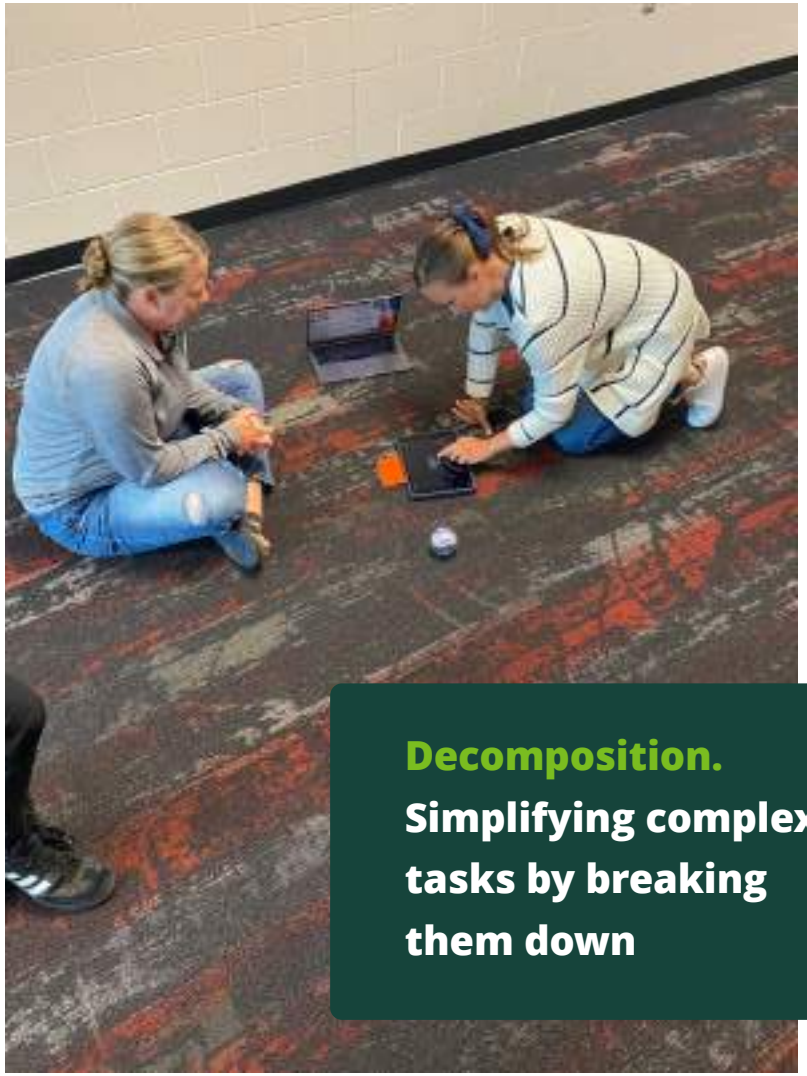

Decomposition.
Simplifying complex tasks by breaking them down

Associated Metacognitive Processes

Decomposing a task into sub-problems that are well-structured to decrease task complexity.

Yadav, Ocak, & Oliver (2022)

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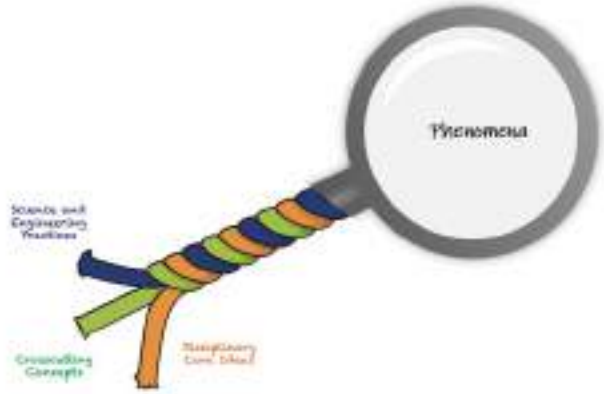
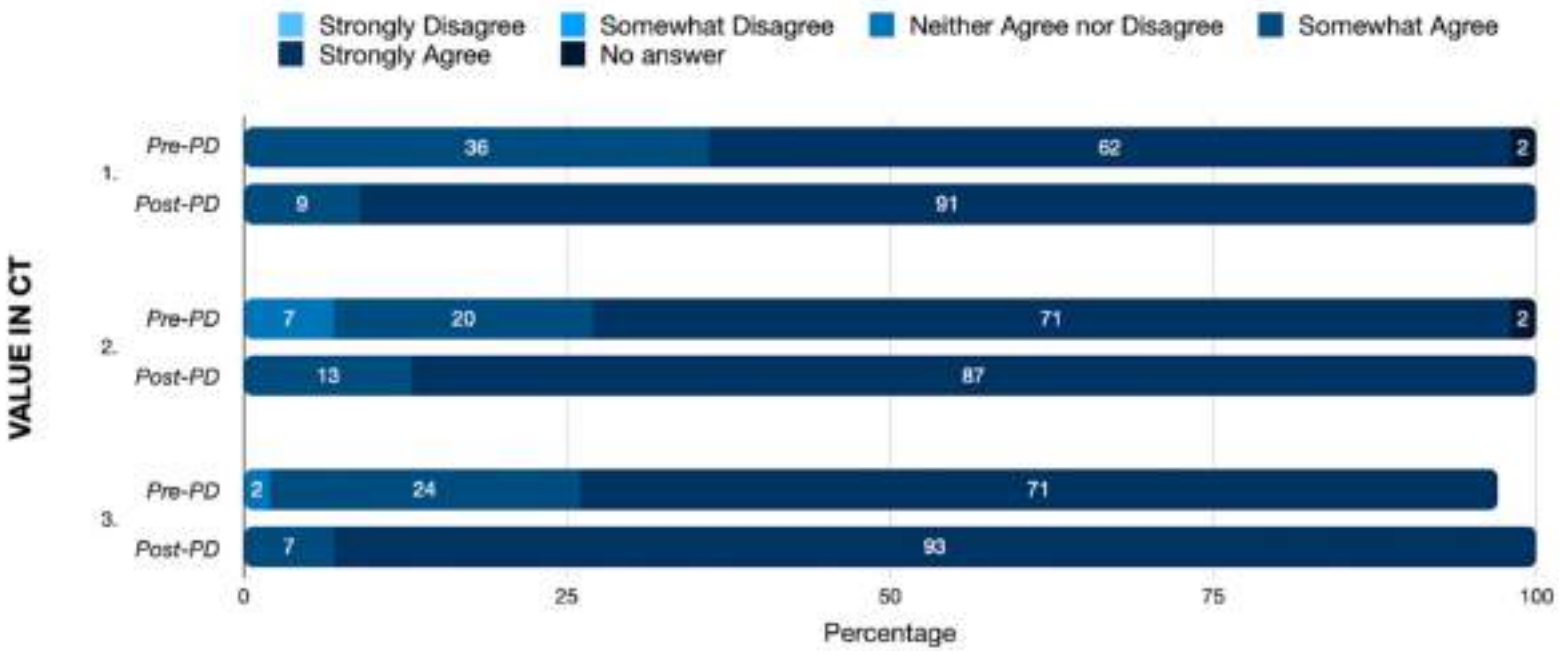
Smithsonian | SCIENCE for Computational Thinking

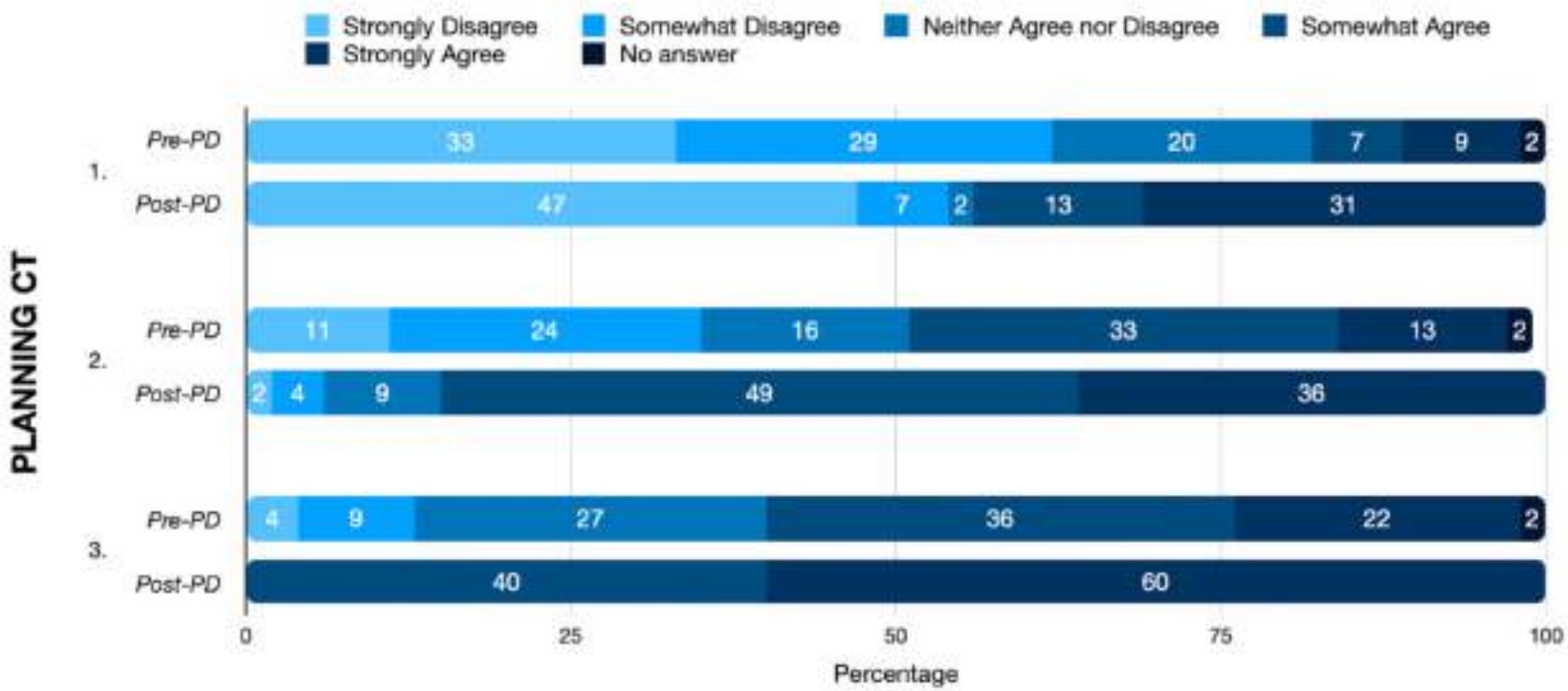




1. I see value in using computational thinking broadly across the curriculum
2. The use of computational thinking principles will allow me to better teach my subject
3. The use of computational thinking principles will engage my students in higher order thinking skills

Way to make cross curricular [links] to bring science into math and math into science and reading and make it all encircling. So it's not just one subject here, one subject there, they get to see how it impacts all the different subject areas, how it can be used in all the different content areas. And it [CT] just gives it more of a holistic approach or whole world approach.

Value in CT

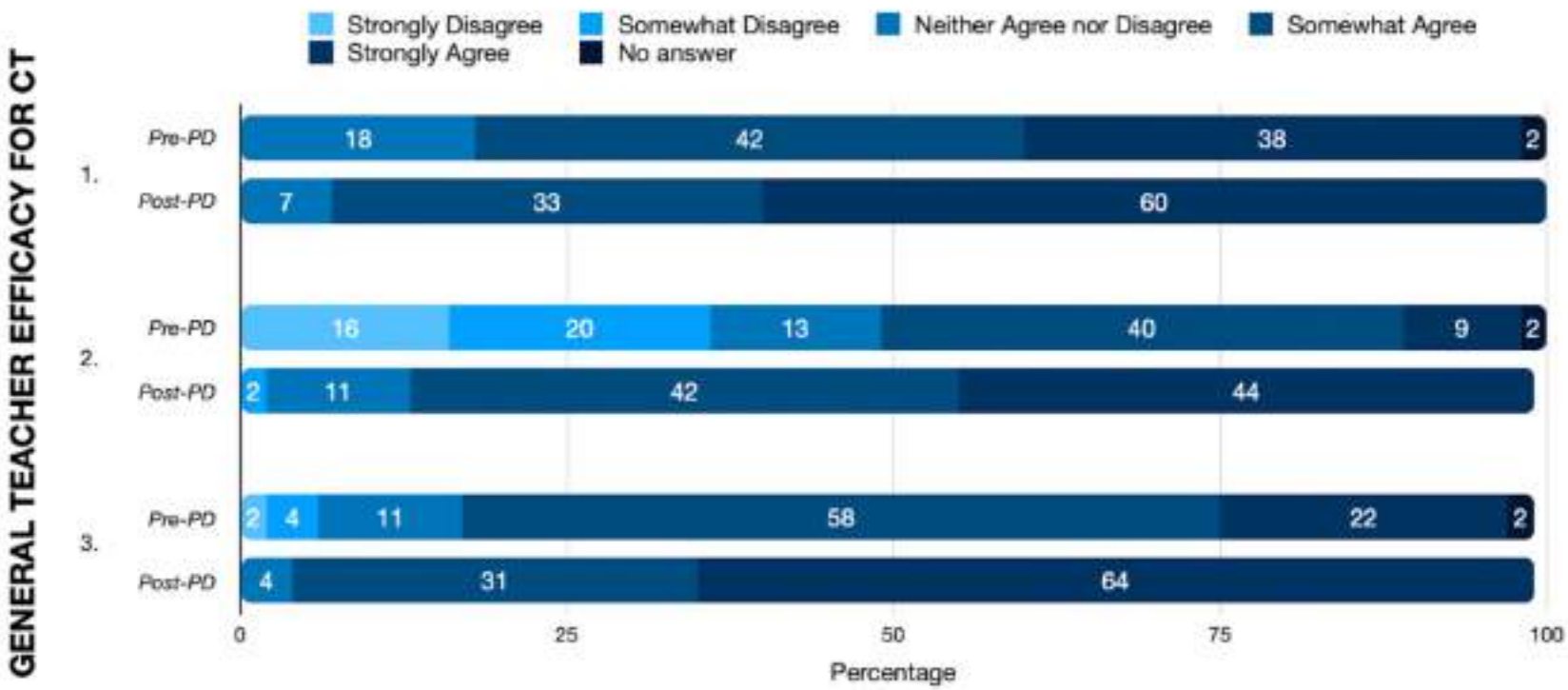


1. I think the use of computational thinking principles will constrain my teaching
2. I know how to bring coding into my classroom
3. I can integrate these computational thinking concepts (problem decomposition, abstraction, algorithm design, and debugging) into my classroom

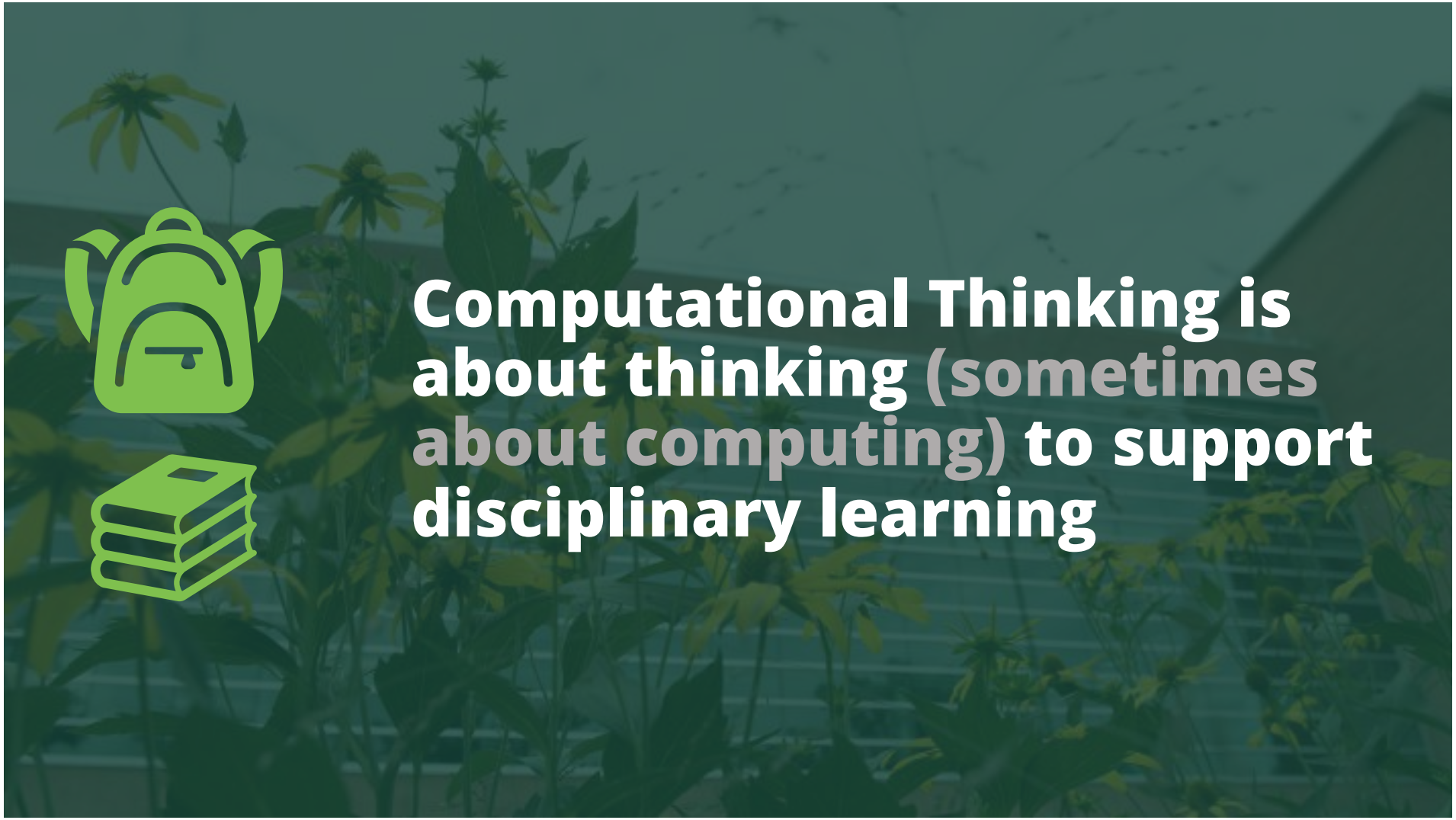
“I see the kids really once or twice a week, [and] *it's really hard for me to get into all of these things. So, I feel like I rush”.*

some things I really think that're harder for us to do, [is] *come* [up] *with computer-based coding and things like that”*

“the two things [CT and coding] t*hat I keep on trying to put together, which I know it's not only that, but that's just what I keep on going back to - I don't know how to do that”*



1. I can help students develop a deep understanding of foundational computer science ideas
2. I know how to help my students find information related to CT or CS tasks when I don't know the answer myself
3. I know how to encourage my students to make an initial plan, work through setbacks, and transform feedback from these attempts into a revised plan


Computational Thinking is about thinking (sometimes about computing) to support disciplinary learning

integrated Computational Thinking

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mouse_

Telos Learning

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Learning
Pathways

CT Integration Pathways in Social Studies

Support students to **Create Models and Representations in Social Studies**

CT focuses on creating models or representations—maps, simulations, flow charts, timelines, and more—that can highlight complex dynamics of the kinds of social and political topics addressed in social studies classrooms.

Support students to **Engage in Data Practices for Social Studies Inquiry**

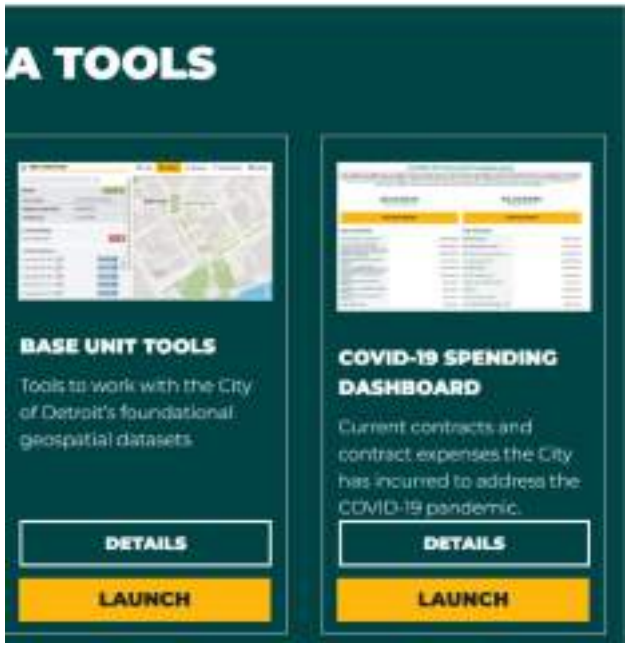
Data is increasingly critical to understanding our world, and being fluent in data practices is a key element of being an informed and engaged citizen. Data and data science can help students understand social, political, historical, and economic phenomena.

Support students to **Understand Computing's Impact on Society**

Computing is everywhere, impacting all facets of our social, economic, and political life. CT in the social studies classrooms helps students see computing's social and political dimensions to understand, rethink, and take action on an increasing range of social issues.

Support students to **Engage in Data Practices for Social Studies Inquiry**

- **Map**
- **Data**
- **Civics**



City of Detroit, Open Data Tools, 2019

Building Caring Communities, Community Asset Mapping, 2016

CT Integration Pathways in Arts

Support students to **Create Computational Art**

Art is taking new forms through computing. CT can help students use computational tools and practices to express themselves and extend their creativity in new and dynamic ways.

Support students to **Explore Art Through Computational Thinking**

As students try understanding art and creating their own art, they need opportunities to grasp complex artistic techniques. Computational thinking can help students explore, appreciate, and analyze artistic processes and products in new ways .

Support students to **See Data in Art & Make Data as Art**

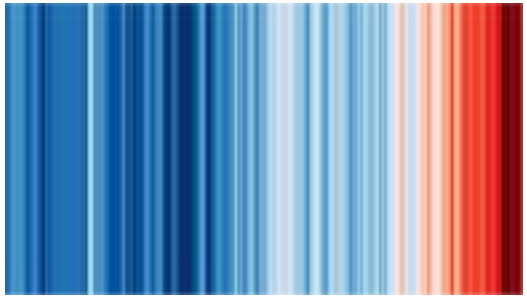
While art and data might seem like they're in different worlds, bringing them together can be powerful. Students can both understand art through data, and use data to create new and unique kinds of art.

Support students
to
See Data in Art &
Make Data as Art

Giorgia Lupi & Stefanie Posavec, Observe, Collect, Draw!,, 2018

Mona Chalabi, When Americans Eat Pizza, 2017

Jill Pelto, Decrease in Glacier Mass Balance, 2015



Ed Hawkins, Warming Stripes, 2018

CT Integration Pathways in Language Arts

Support students to **Analyze Text through Computational Methods**

Media and technology expose students to countless data in the form of viral figures, trends, and visualizations. Identifying patterns in textual data can enhance essential reading skills and deepen critical analysis of texts in language arts classrooms.

Support students to **Enhance Writing Through Computational Practices**

Many students struggle with writing, and techniques inspired by computing—flow charts, graphic organizers, pattern recognition in mentor texts, and more—can support students with new entry points into the writing process.

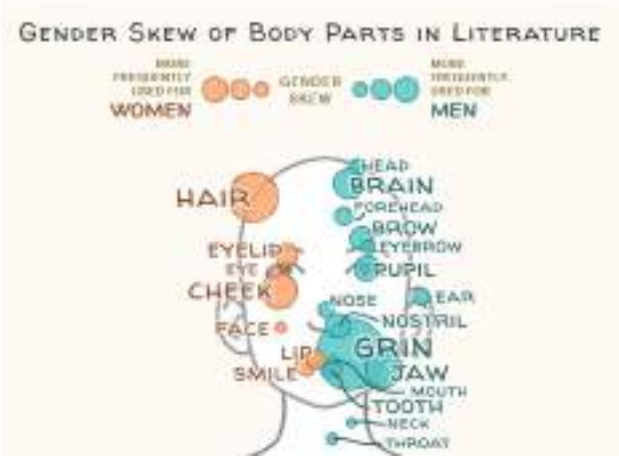
Support students to **Compose Interactive Computational Texts**

In the 21st century, texts are no longer just static words on a page. Computing can support students to create interactive texts that utilize sound, imagery, animation, and more in ways that promote multimodal writing literacies.

Support students to **Critically Analyze Computational Texts and Practices**

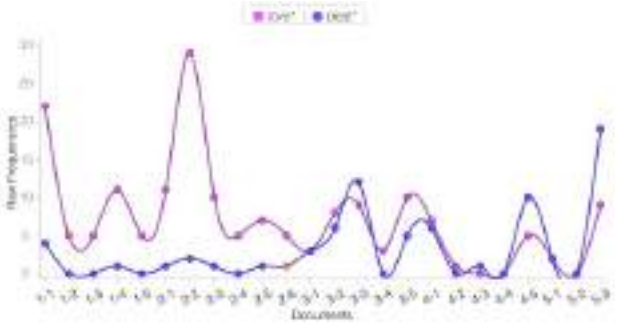
The social platforms and media tools students use everyday are, just like traditional texts, full of authorial intent and values. It's critical for students to understand how computing tools shape meaning and change our broader communication culture.

Support students to **Analyze Text through Computational Methods**



Erin Davis, The physical traits that define men and women in literature, 2020

Leonardo Nicoletti & Sahiti Sarva, When Women Make Headlines, 2022



Tom Lynch, Plotting Plots

Support students to **Engage in Data Practices for Social Studies Inquiry**

Pathway

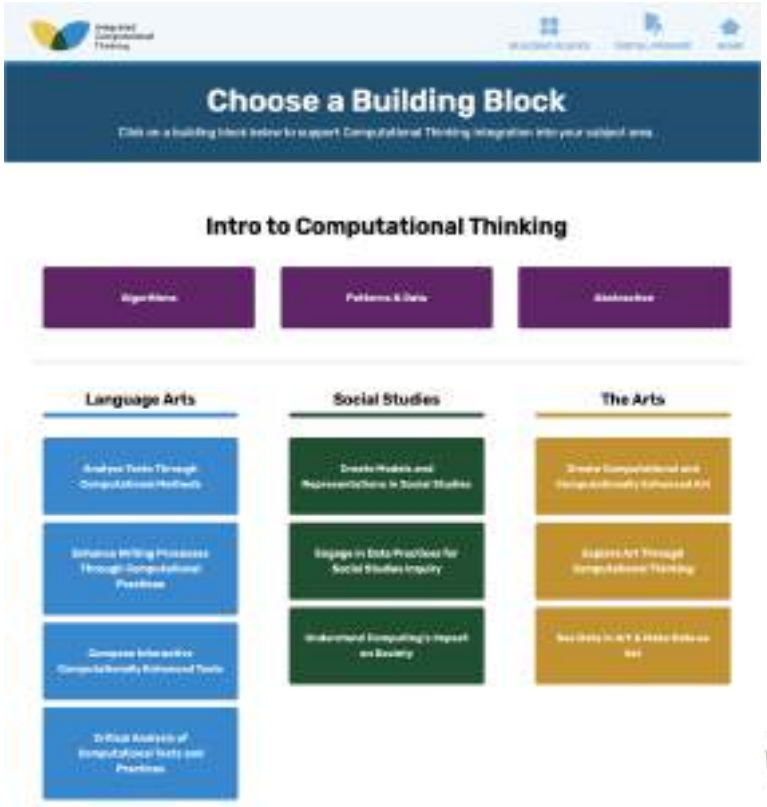
Practices

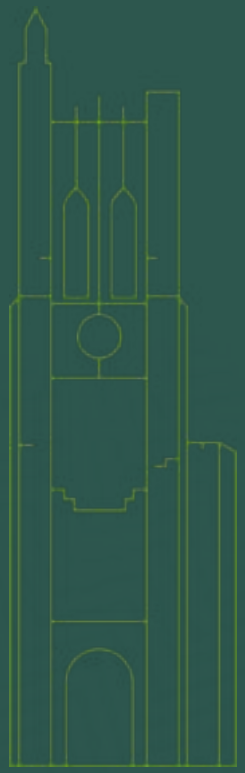
Critically engage with data visualizations related to social issues	• Explore data visualizations to come to conclusions, generate new questions and/or make predictions about social, historical, political, economic, or geographic phenomena. • Assess the perspective of and potential biases present in data visualizations to understand the viewpoint of their creators.
Critically engage with data sets related to social issues	• Explore existing data sets to draw conclusions, generate new questions, and/or make predictions about social, historical, political, economic, or geographic phenomena. • Determine what questions a data set related to a social, historical, political, or economic phenomena may or may not be able to answer. • Assess the perspective and potential biases present in data sets to understand the viewpoint of their creators.
Engage in data-based inquiry around social issues	• Generate questions related to social, historical, political, economic, or geographic phenomena and determine what kind of data would need to be collected in order to answer these questions. • Collect relevant data in order to answer questions related to social, historical, political, economic, or geographic phenomena. • Analyze data to come to conclusions, generate new questions and/or make predictions about social, historical, political, economic, or geographic phenomena. • Create data representations and visualizations in order to highlight trends within social, political, historical, economic, or geographic phenomena.

Pathways and Practices in Building Blocks

iCT Pathways and Practices are at the core of Building Block activities

projects.ctintegration.org





THANK YOU

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