Computational Thinking in Schooling: Empowering Learners

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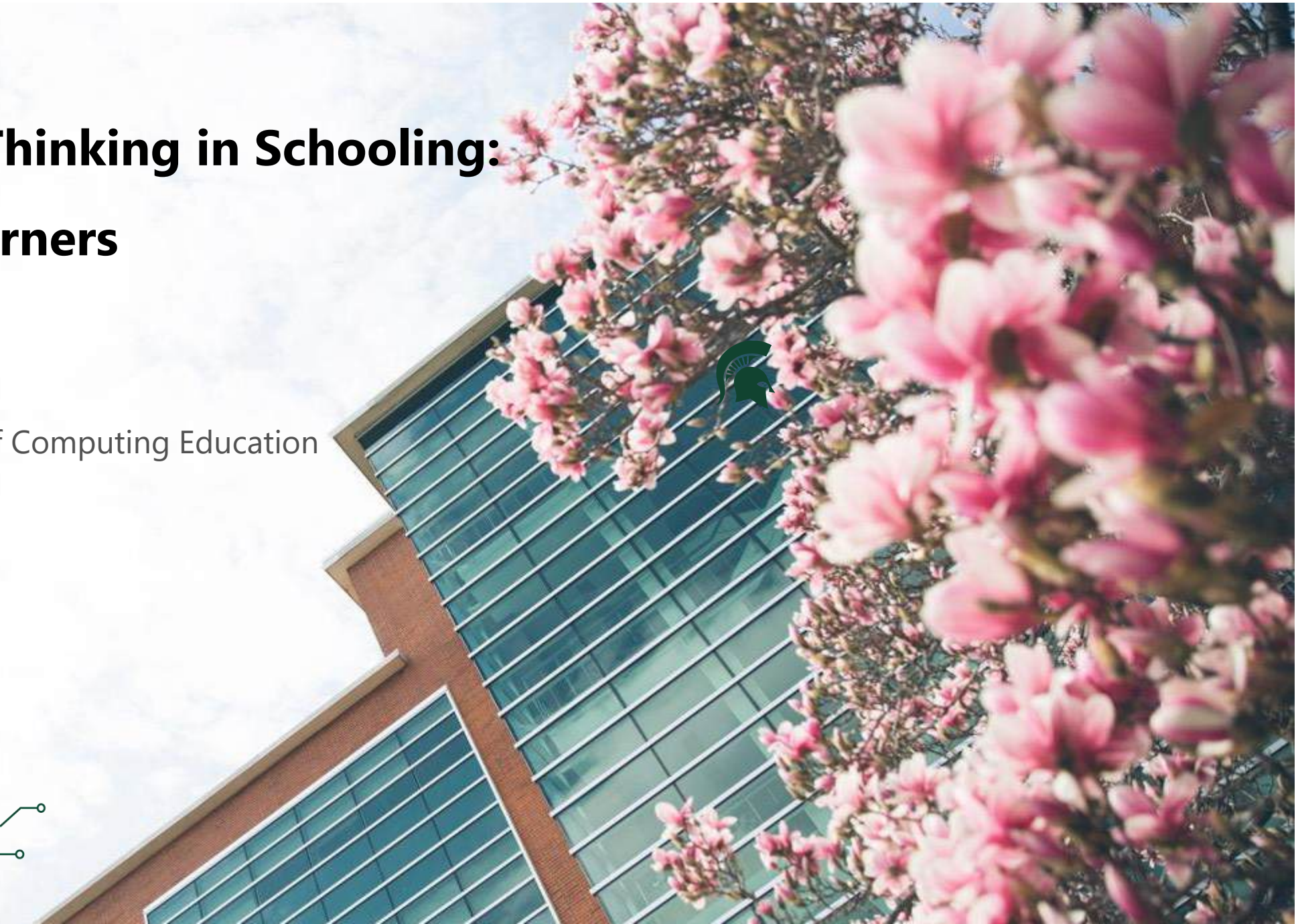
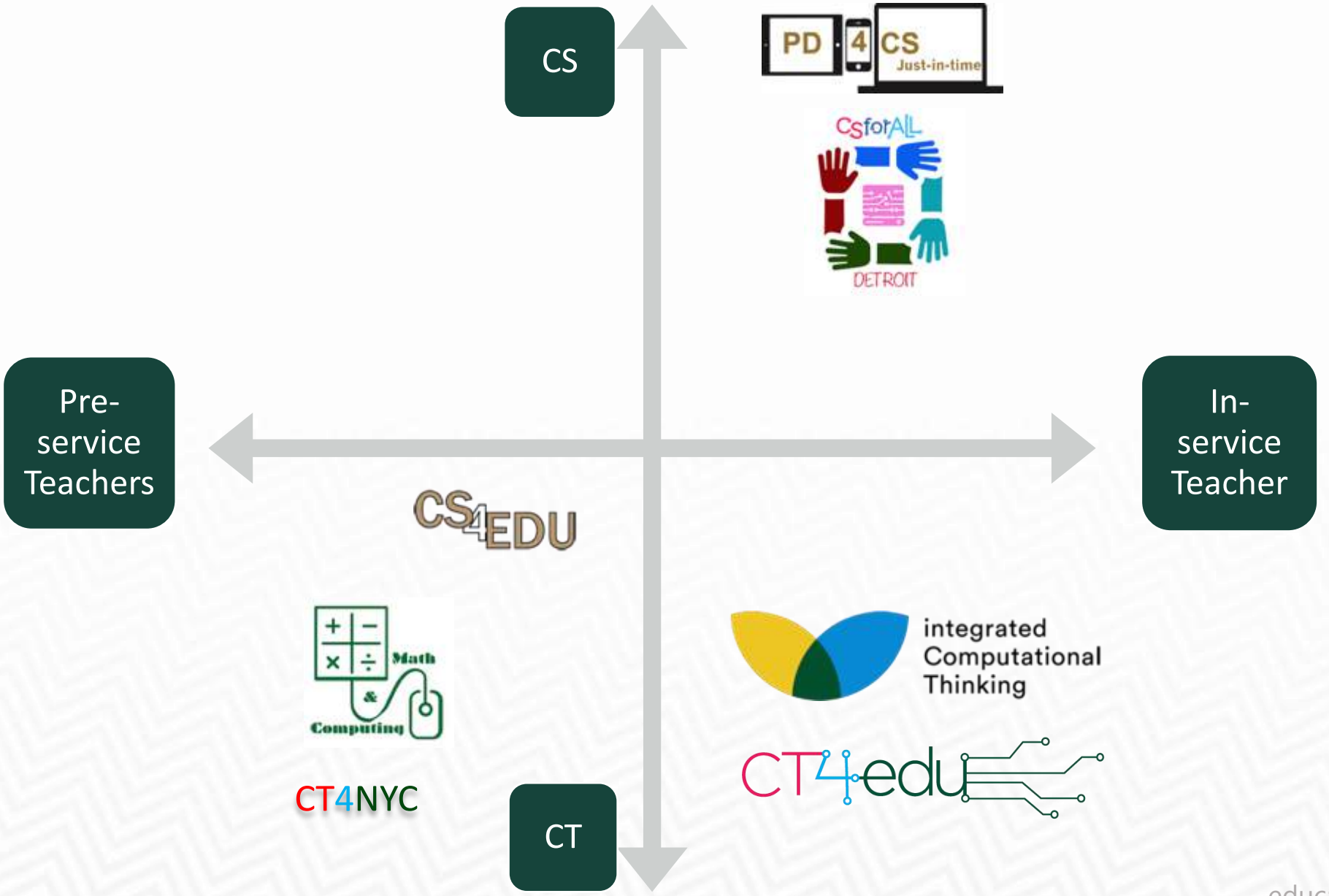


CS10K to CSforALL

- 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.

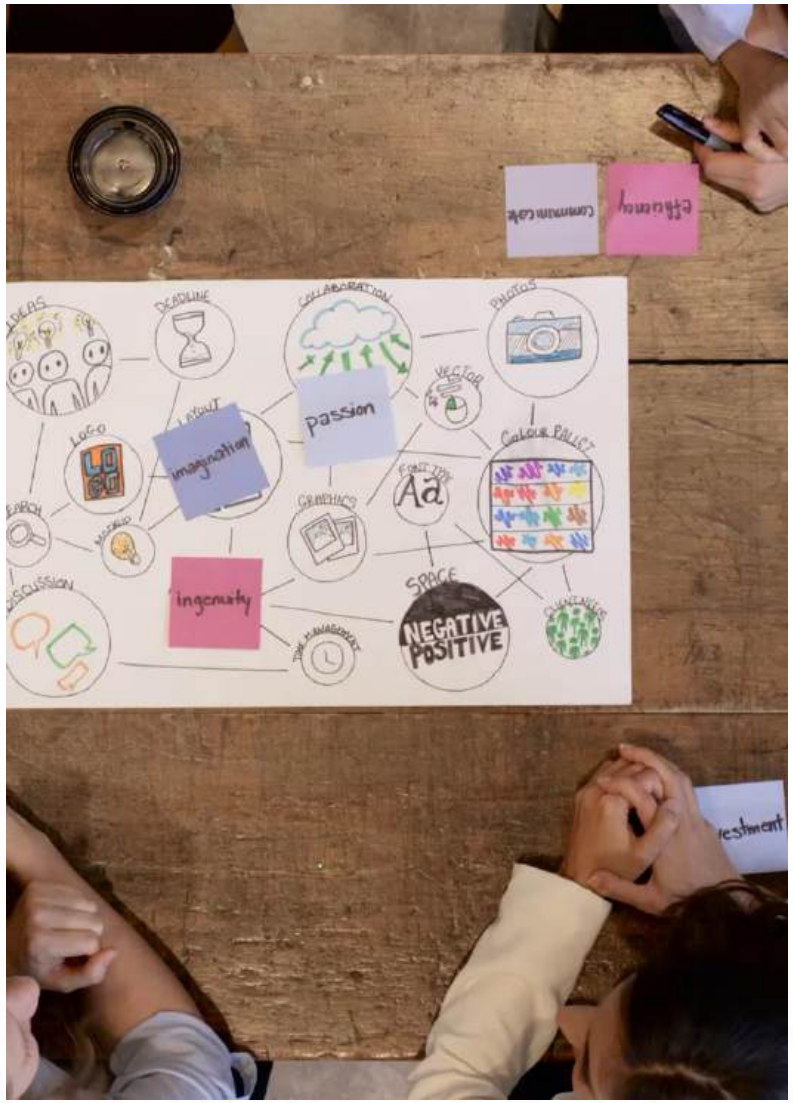

CS
PD 4 CS
Just-in-time
CsforALL
DETROIT
Pre-service Teachers
In-service Teacher
CS4EDU
Math & Computing
integrated Computational Thinking
CT4NYC
CT4edu
CT

Computational Thinking

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

Thinking Deeply and Flexibly

- Students **learn how to learn**, building metacognition.
- CT encourages students to think **iteratively and reflectively**, trying out multiple approaches and learning from mistakes.



Creative Problem Solving

- CT fosters **creativity and curiosity**, and not just correctness.
- It helps students become **more analytical and innovative** when tackling challenges.

Civic & Ethical Development

- CT provides an avenue to explore **digital ethics, fairness, and societal impact**.
- Encourages students to ask:
  - How does technology shape the world?
  - What is my responsibility as a digital citizen?

Teacher Voices


A

CT Practices

- Algorithms and Debugging
- Abstraction
- Decomposition
- Patterns

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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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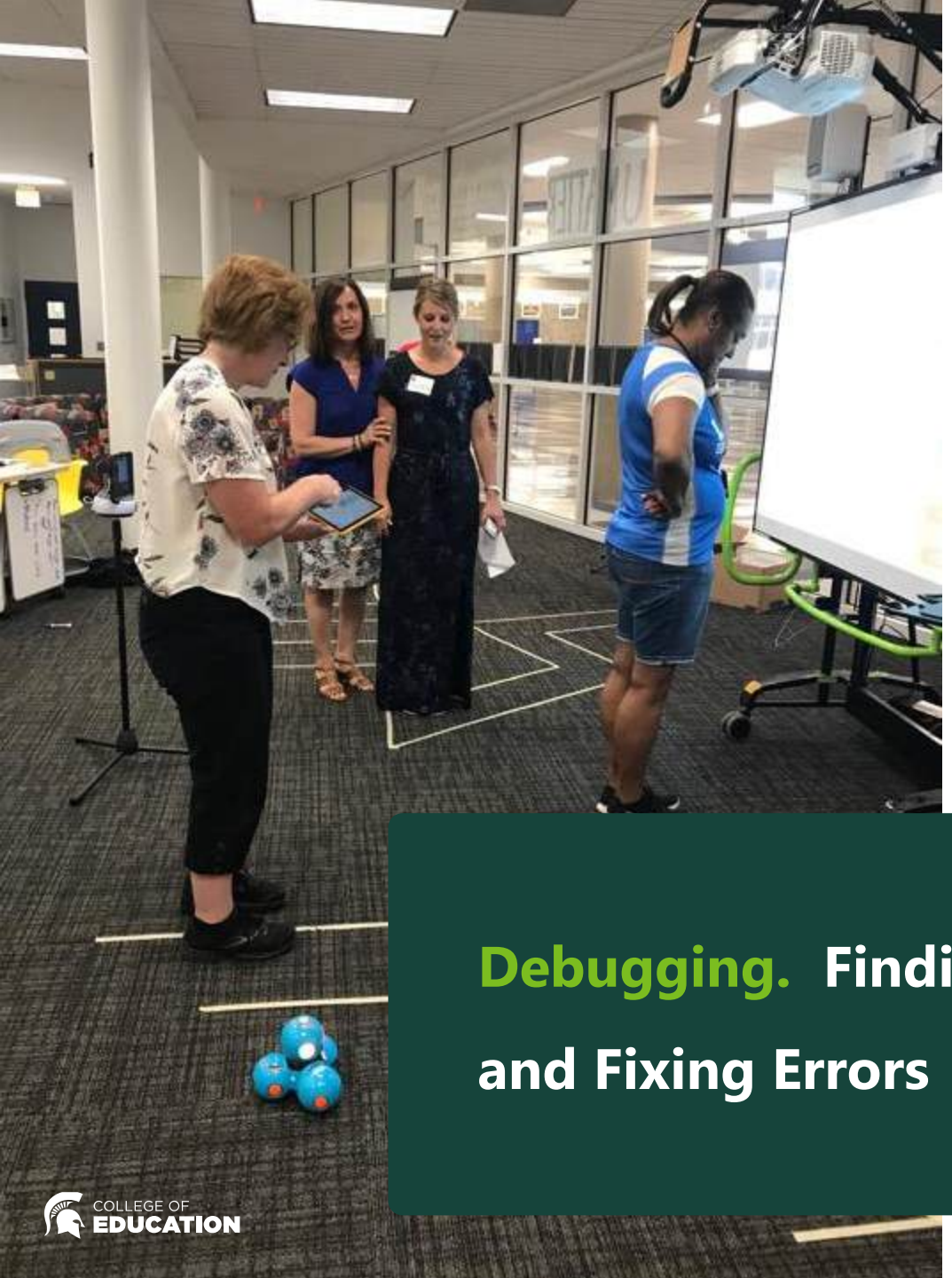


Debugging. **Finding and Fixing Errors**

Associated Metacognitive Processes

Monitoring the solution.

Assessing the solution.

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

Yadav, Ocak, & Oliver (2022)

Abstraction.

Focusing on most essential details

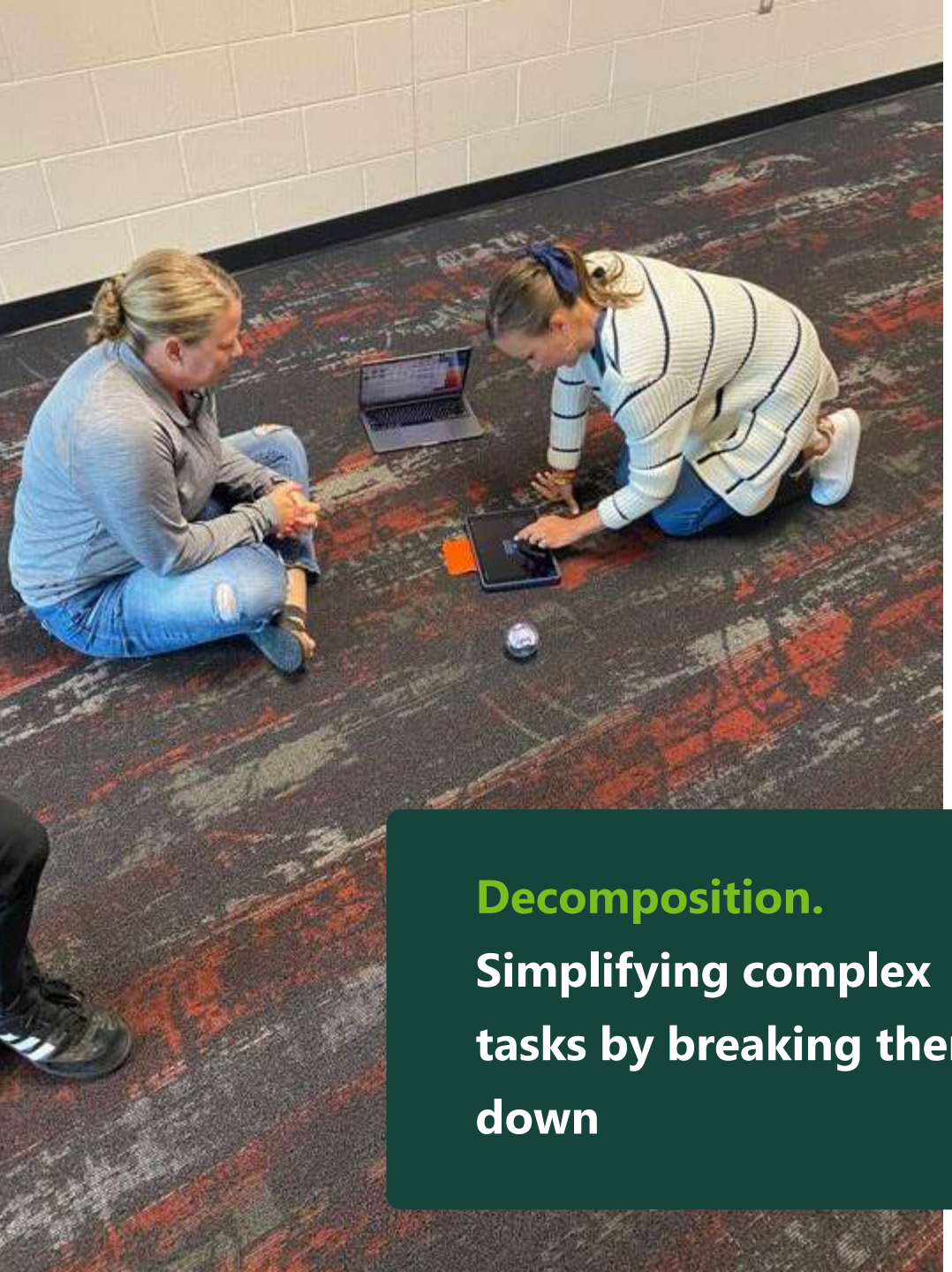
Associated Metacognitive Processes

Defining a problem.

Selecting the relevant elements from the problem to be addressed.

Attending critical features of a problem.

Yadav, Ocak, & Oliver (2022)



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)

Computational Thinking to support disciplinary learning

integrated Computational Thinking

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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**

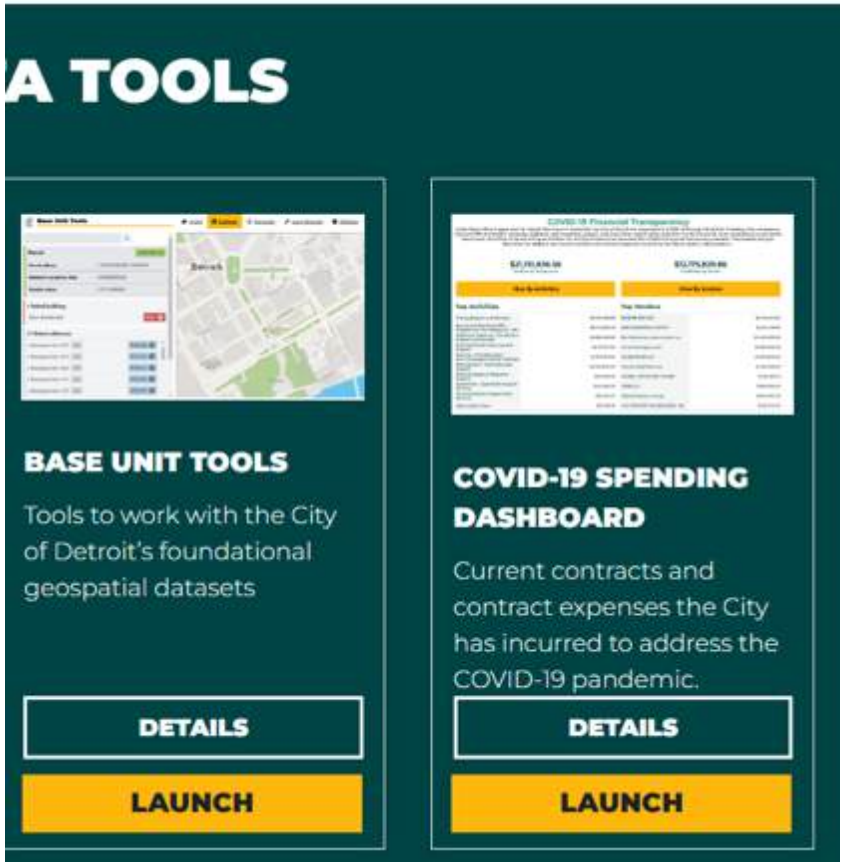
Pathway

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.

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**

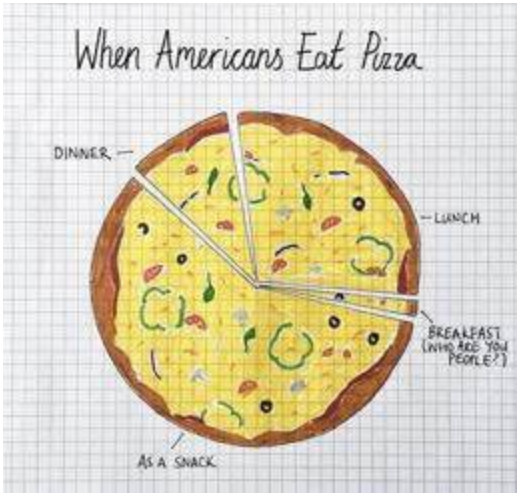
As students try understanding art and creating their own art, they need opportunities to grasp complex artistic techniques. Computational thinking can help students explore, appreciate, and analyze artistic processes and products in new ways .

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.

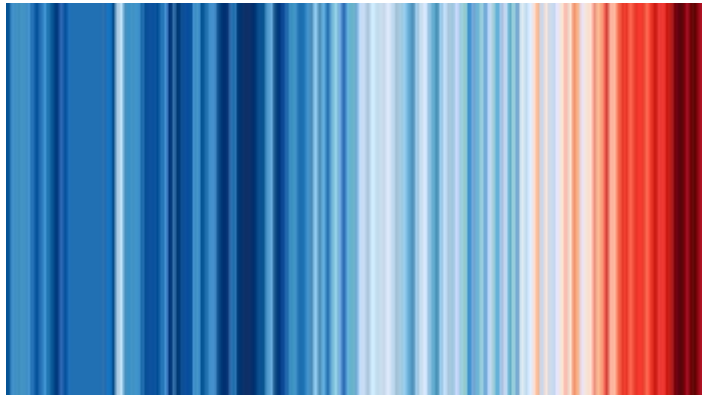
Support students to **See Data in Art & Make Data as Art**

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.

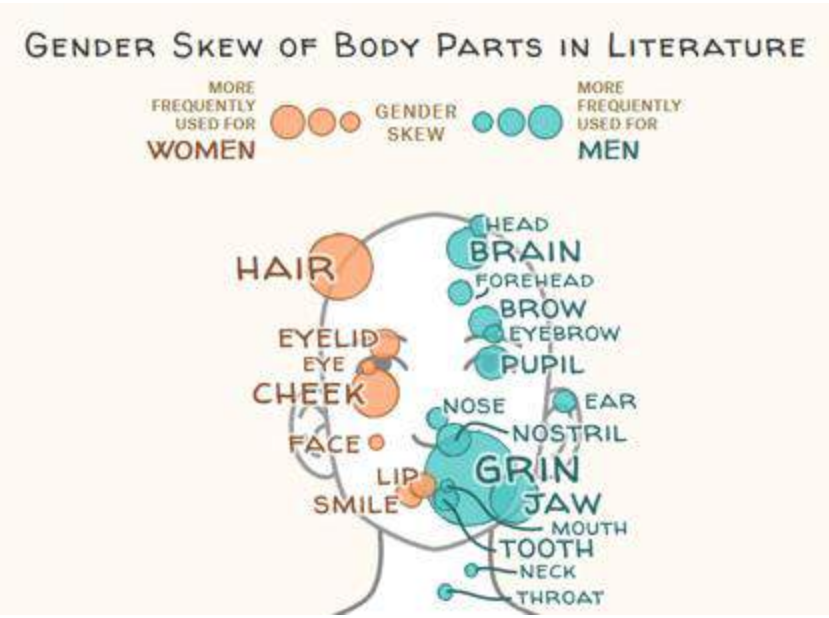
Support students to **Compose Interactive Computational Texts**

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.

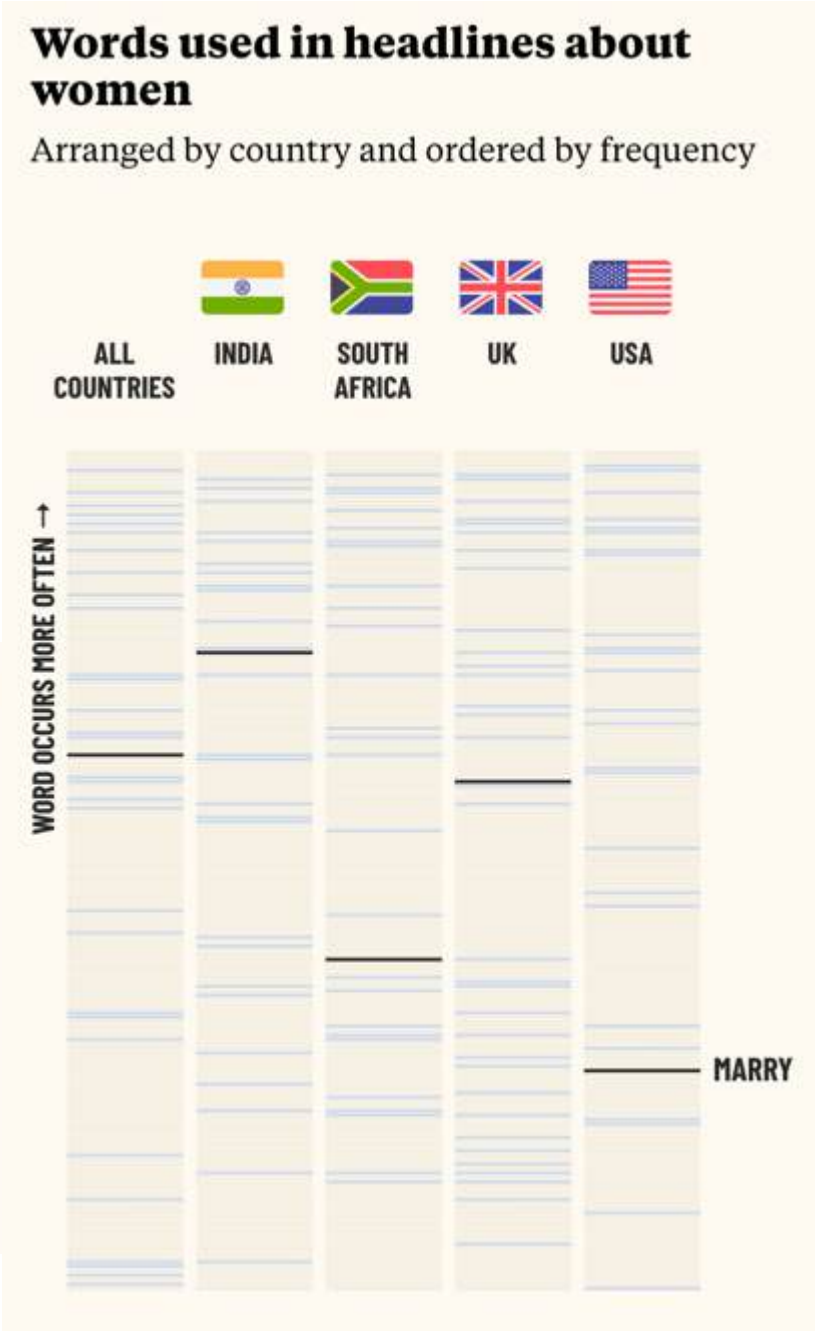
Support students to **Critically Analyze Computational Texts and Practices**

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.

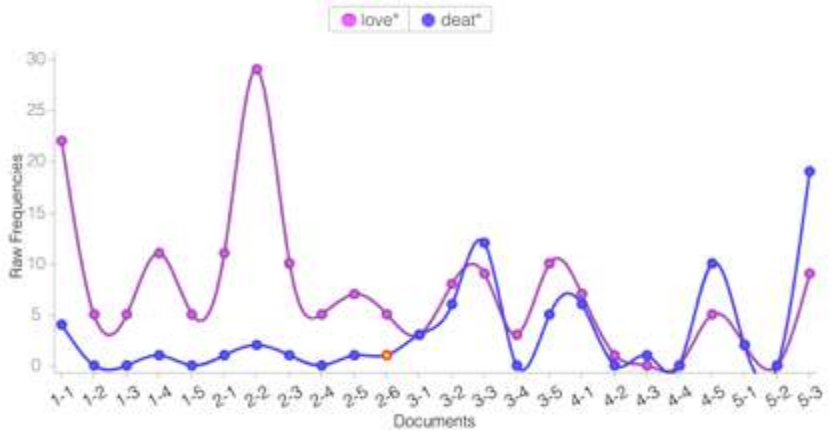
Support students to **Analyze Text through Computational Methods**



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



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

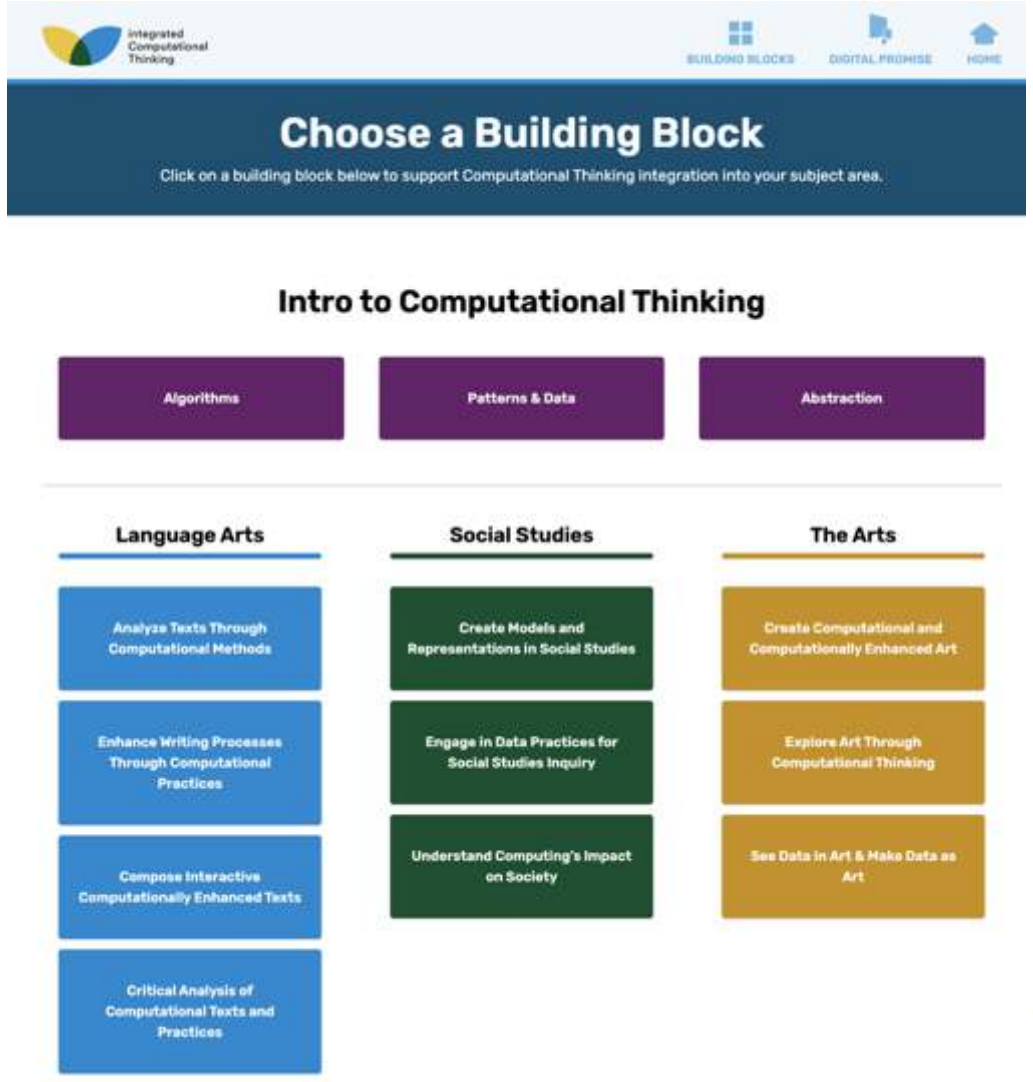


Tom Lynch, Plotting Plots

Pathways and Practices in Building Blocks

[CT Integration Library]

http://projects.ctintegration.org/



Integration

Developing Teacher Knowledge

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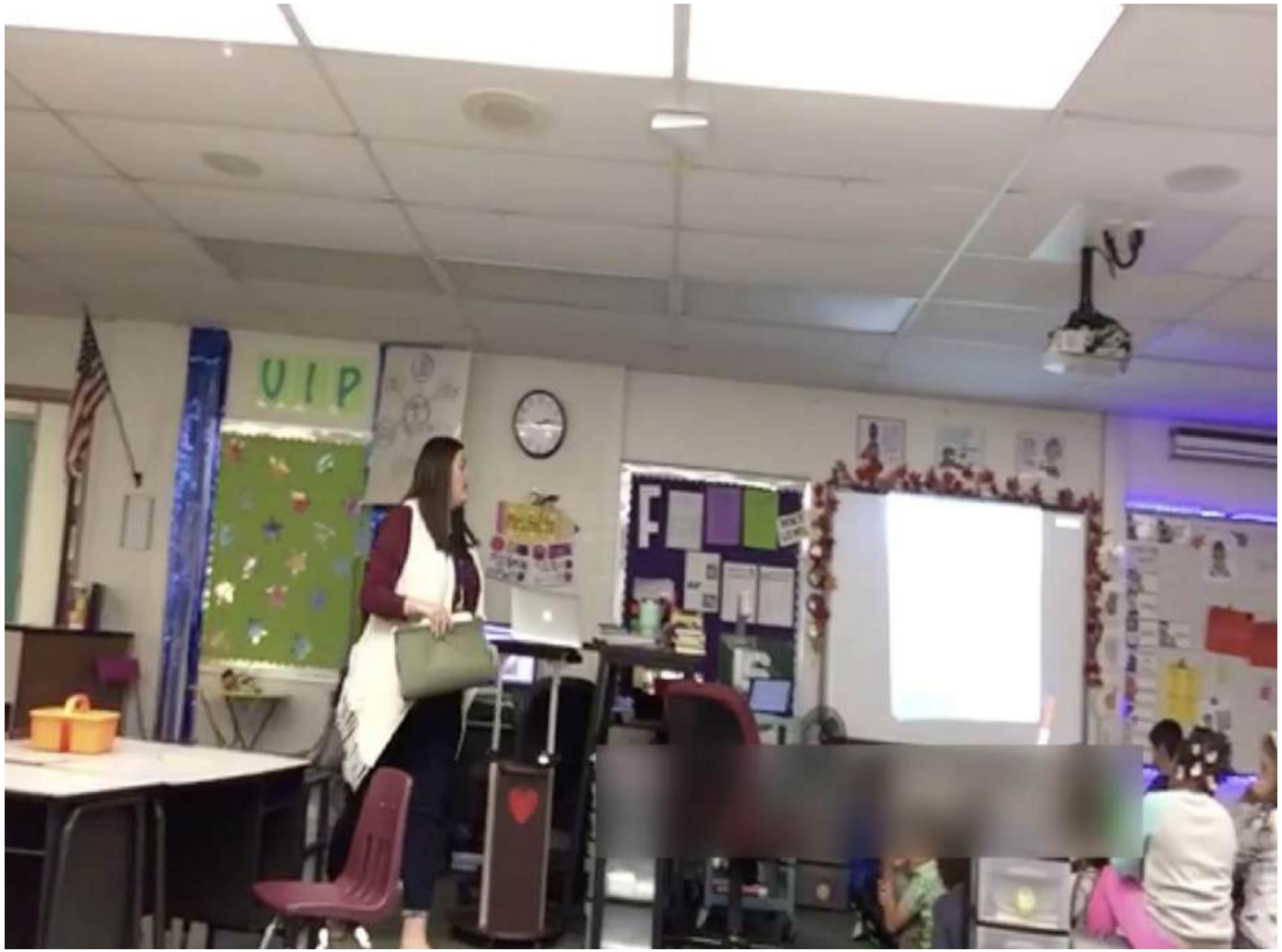
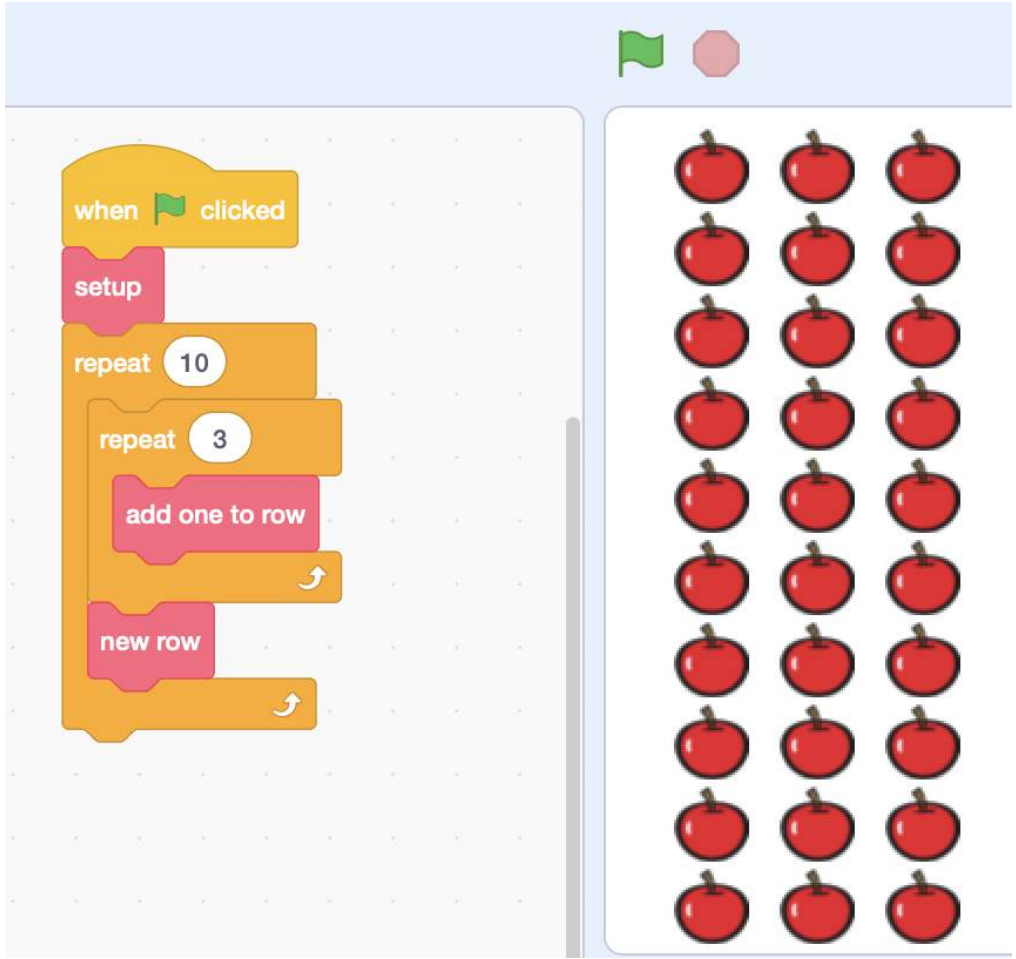
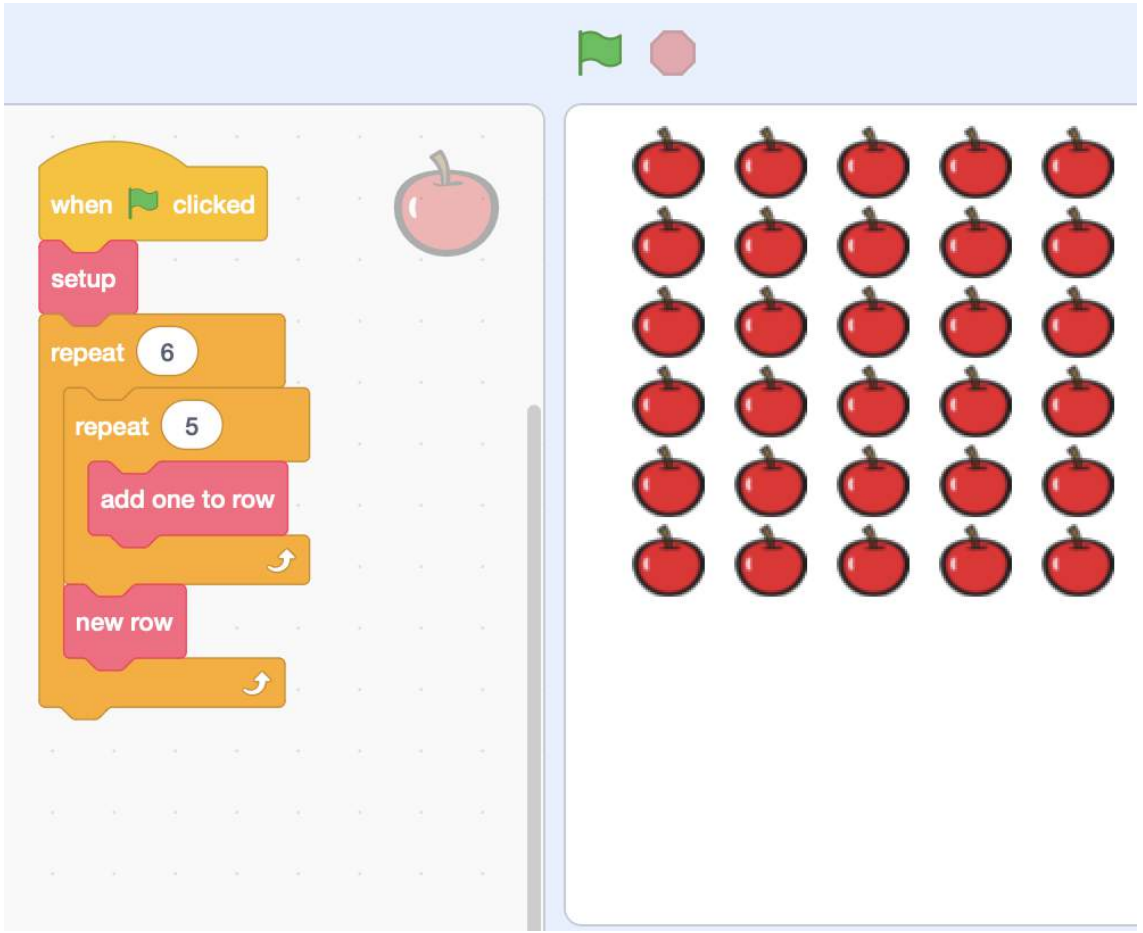
CT and Meta-cognition: An Unplugged Example



Rich, Yadav, & Larimore (2020)

From Unplugged to Plugged





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 what are some things that you need to think about with these directions [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)

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)

From the Classroom

Jenna Williams

I’m pointing out different critical thinking skills and computational thinking skills that I would have just kind of not said at all. I would have just kind of glossed over. Oh, yeah, we have steps that we're taking. But now I'm like, ‘okay, we're decomposing’. We're pulling out one step at a time.

THANK YOU

QUESTIONS

Aman **YADAV**

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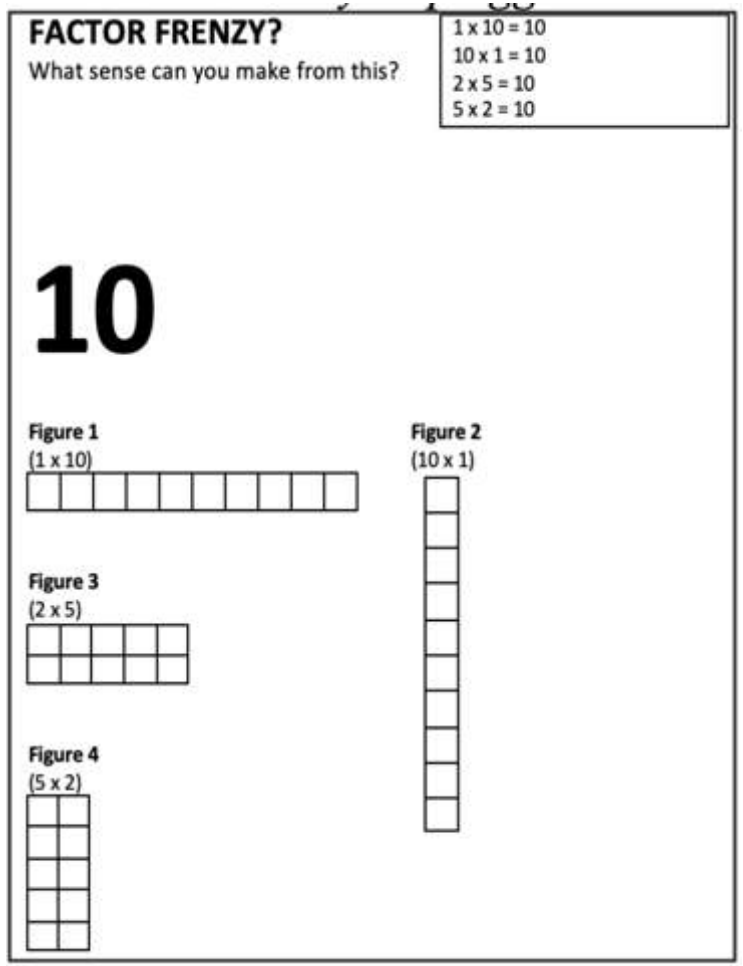
CT and Meta-cognition: An Unplugged Example

Jill: Take a look at the board. It says factor frenzy. *What sense can you make from this slide?*

Allowing students to assess problem's initial condition



Ocak, Yadav, & Macann (2023)

CT and Meta-cognition: An Unplugged Example

I'm modeling (i.e., the problem) right now because you're going to be doing this. Today, you're going to be finding as many factors as you can for a number [setting a goal]. This is our target number [pointing at the givens of a problem]. And we were trying to find all the factors we could. We use the arrays to help us find the factors [cueing about reaching the goal].

Ocak, Yadav, & Macann (2023)