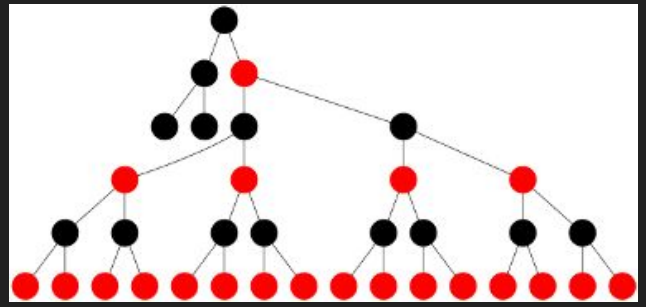
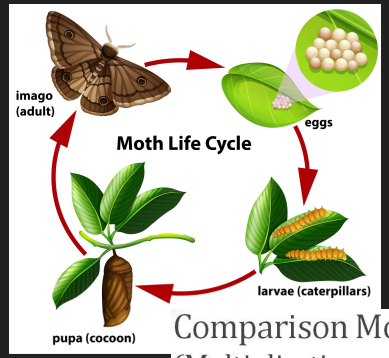
The Role of Spatial Orientation in Diagram Design for Computational Thinking Development in K-8 Teachers

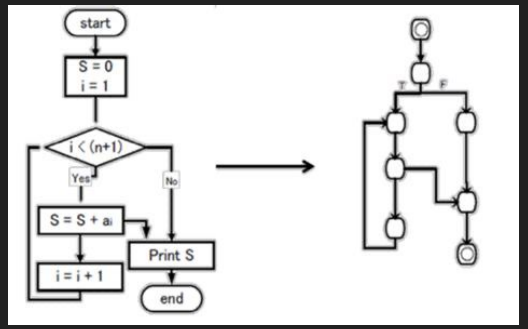
Jean Salac, Donna Eatinger, & Diana Franklin
University of Washington & University of Chicago
@SaladwithaC
salac@uw.edu

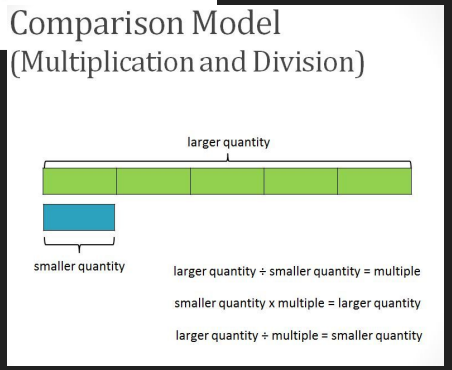
Have you encountered a diagram at any point in your education?

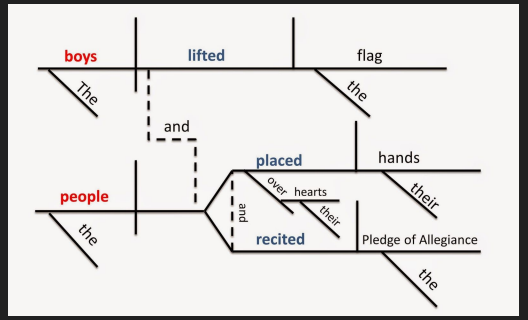
This includes any visual representations that support learning





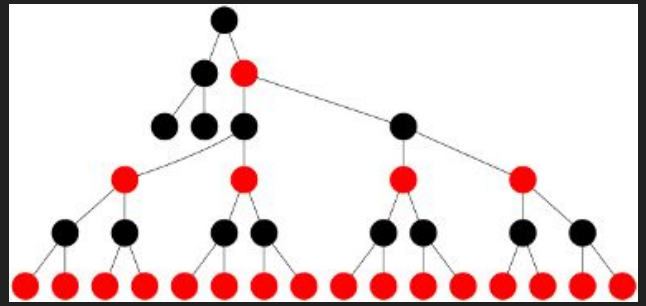


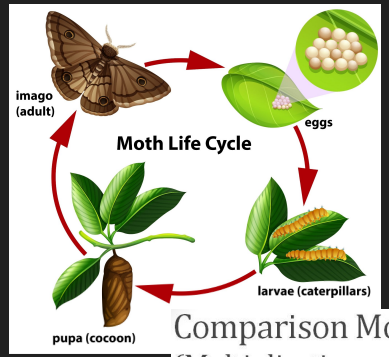


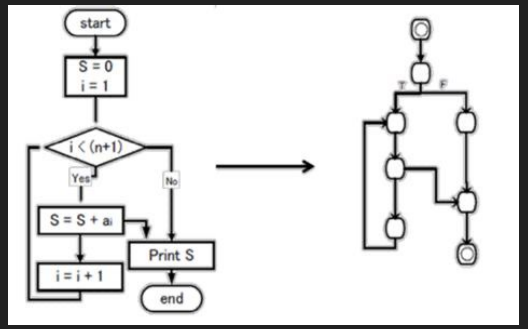


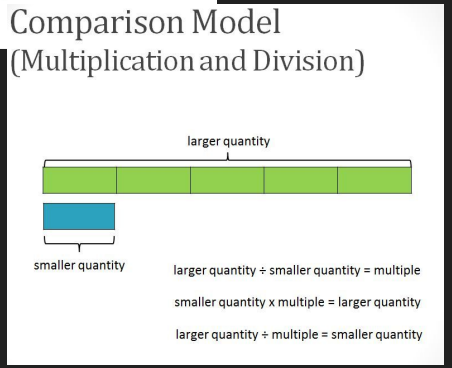
Diagrams are a common scaffold for many K-8 subjects & university CS

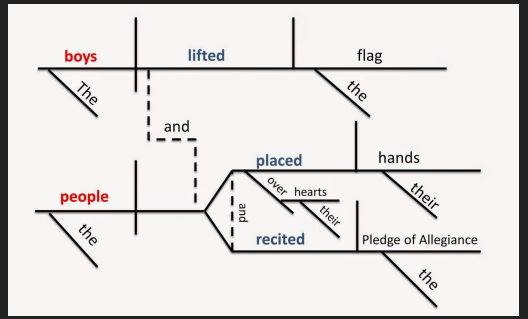
…but we don't know very much about how diagrams might scaffold ***K-8 CS instruction***











We studied diagram orientation in K-8 computing instruction

Why spatial orientation?

- Different orientations can impact reading order (Whorf, 2012)
- There is recent yet interesting research on spatial reasoning in computing
  (Check out work from Jack Parkinson, Lauren Margulieux, & Miranda Parker!)

Research Questions:

1. How does diagram orientation influence the learning of the CT concept of decomposition in teachers?
2. How does diagram orientation influence the development of technological, pedagogical, & content knowledge in teachers?

Talk Outline

Motivation:

Reading order + Spatial reasoning → Efficacy of different orientations?

Background:

Matrix Taxonomy, SOLO Taxonomy, & TPACK

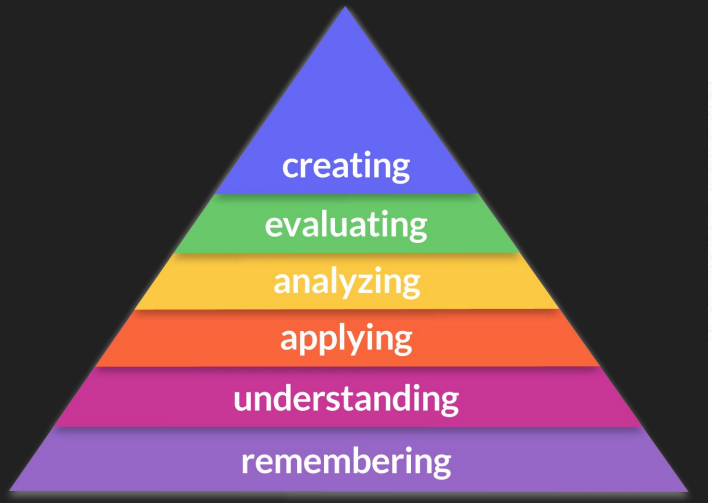
Study Context:

Teachers in Scratch Encore Virtual Professional Development

Results:

Horizontal vs Vertical Diagrams as Scaffolds

Matrix Taxonomy frames learning *goals*

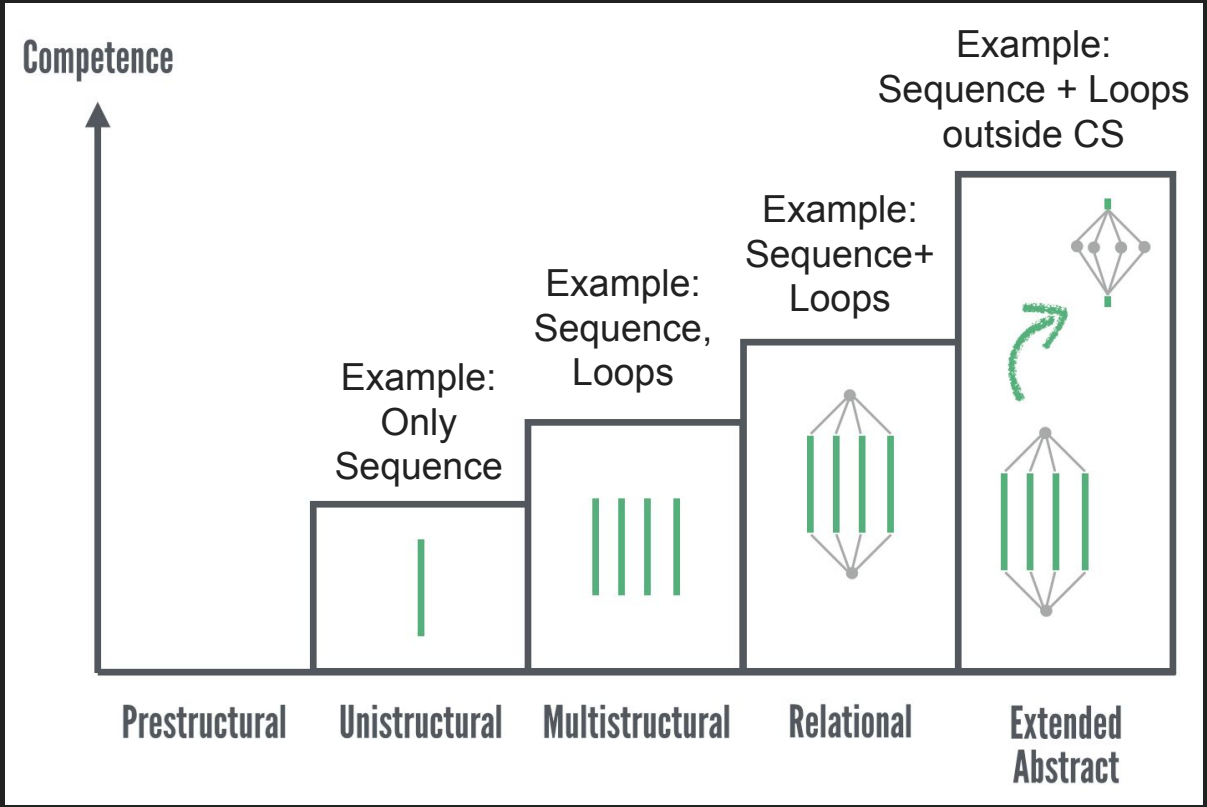


Bloom et al., 1956

PRODUCING					
	Create	Create their own code			
	Apply	Use example code	Modify example code		
	none				
		Remember	Understand	Analyse	Evaluate
		INTERPRETING			

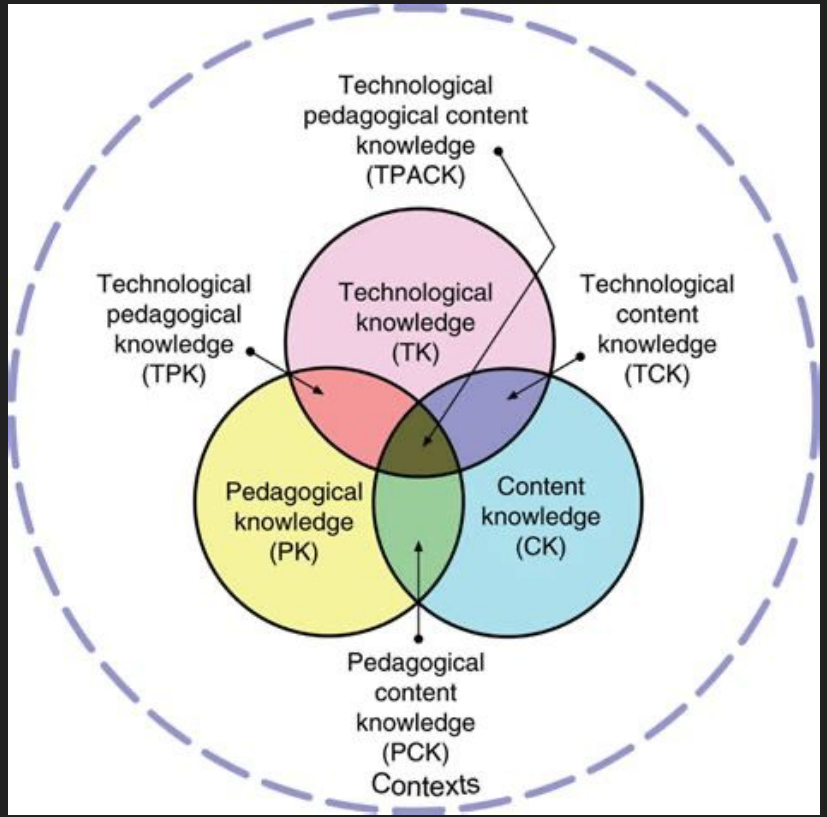
Fuller et al., 2007

SOLO Taxonomy frames learning *outcomes*



Biggs & Collis, 1982

TPACK frames teacher knowledge for technology integration



Koehler & Mishra, 2009

Talk Outline

Motivation:

Reading order + Spatial reasoning → Efficacy of different orientations?

Background:

Matrix Taxonomy, SOLO Taxonomy, & TPACK

Study Context:

Teachers in Scratch Encore Virtual Professional Development

Results:

Horizontal vs Vertical Diagrams as Scaffolds

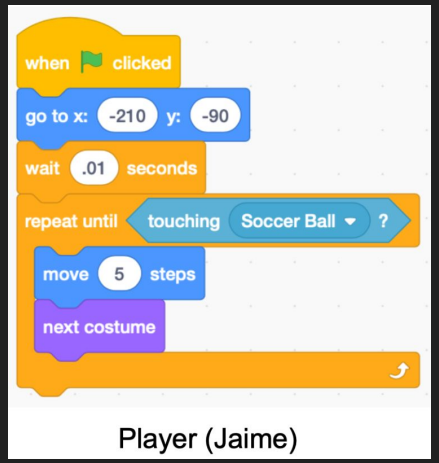
Study Context: Scratch Encore Professional Development

- 45 K-8 teachers enrolled in Scratch Encore virtual professional development
- Scratch Encore is an intermediate Scratch curriculum
- We focused on one module called *Decomposition by Sequence* because decomposition is a more advanced concept
- Learning goal was to decompose a sequence of events across multiple sprites
- In Scratch, a sequence of interactions between sprites (aka “events”) can trigger different actions

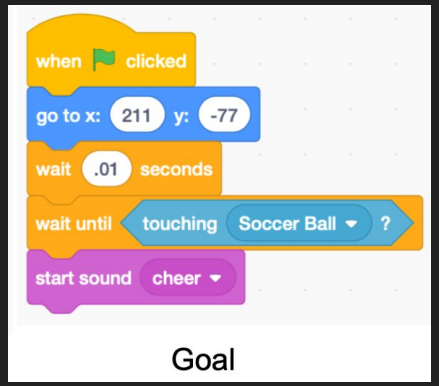
Example Decomposition of a Sequence of Events

1. When the Green Flag is clicked, the Player starts running towards the Ball.
2. When the Player touches the Ball, the Player stops running & the Ball starts rolling.
3. When the Ball touches the Goal, the Goal plays cheering sounds.

Example Vertical Diagram to help with decomposition

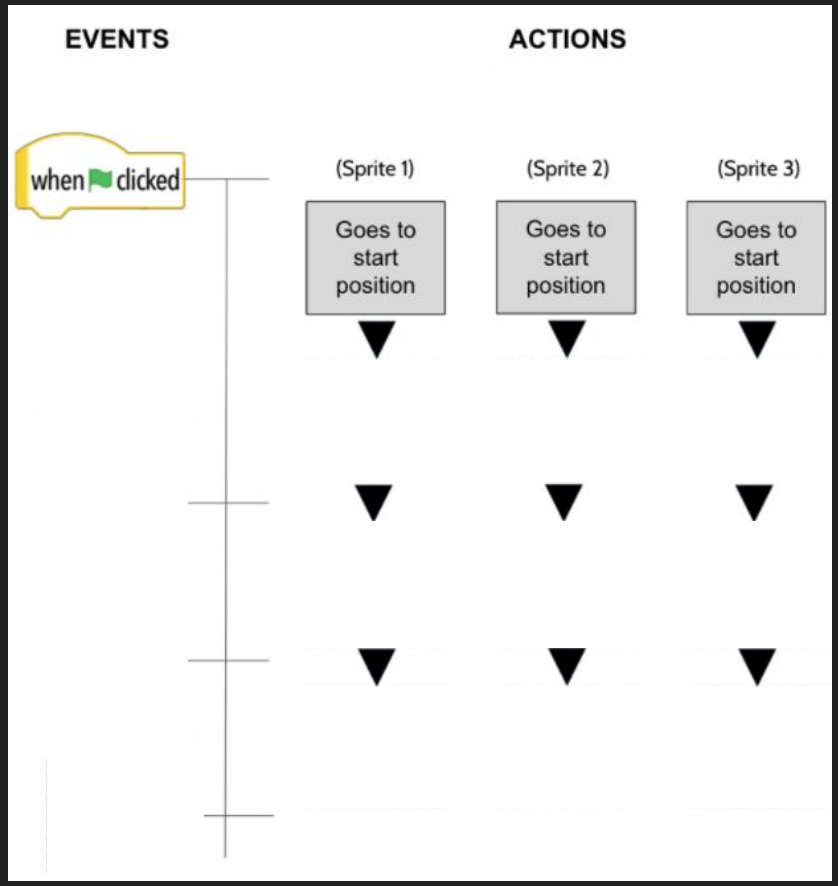


Player (Jaime)

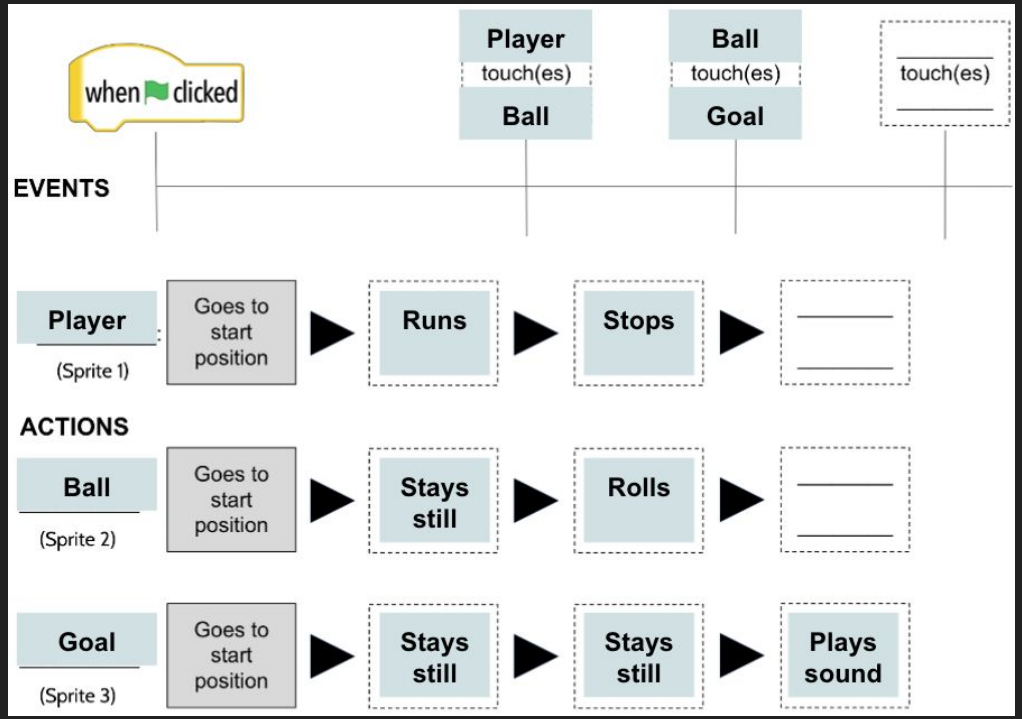


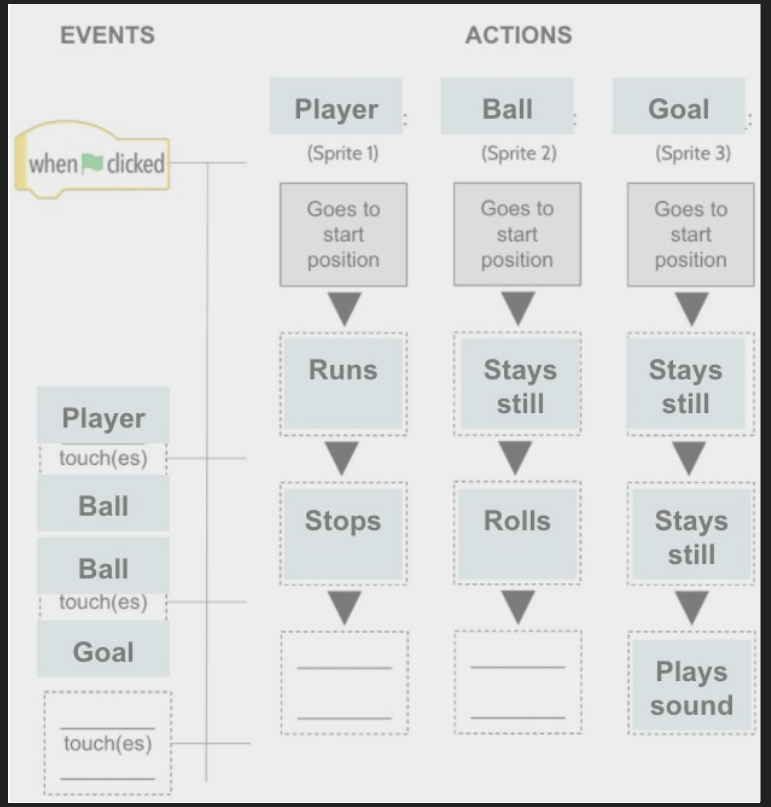
Goal

Soccer Ball



Example Horizontal Diagram

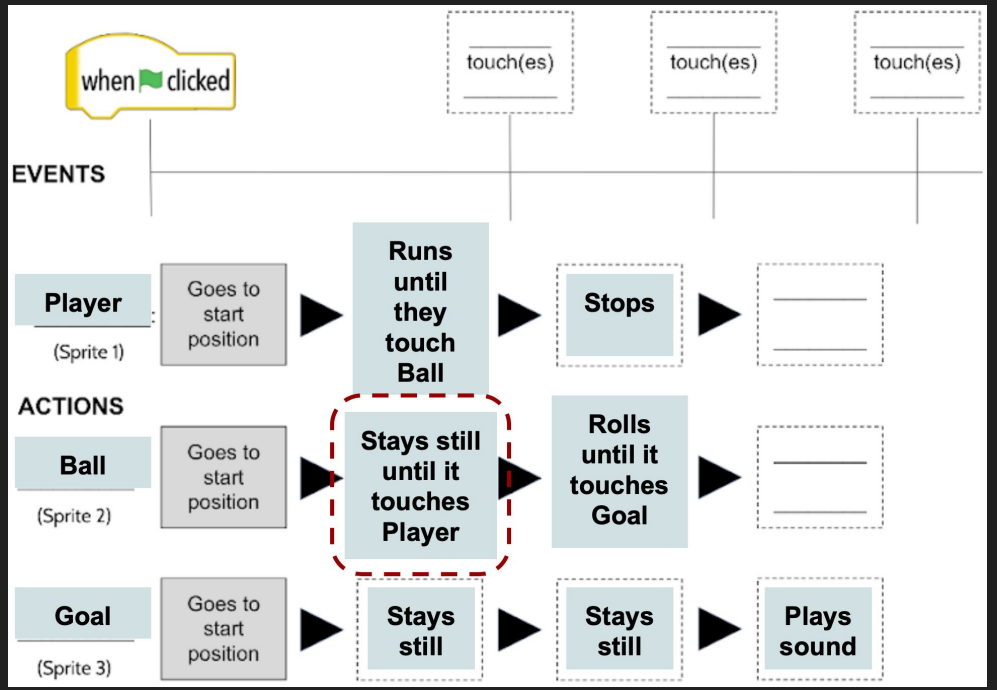




We compared horizontal vs vertical diagrams with teachers

We analyzed:

- diagrams for evidence of decomposition
- Scratch projects for requirement completion
- semi-structured interviews to understand their mental models of their projects & diagrams



Talk Outline

Motivation:

Reading order + Spatial reasoning → Efficacy of different orientations?

Background:

Matrix Taxonomy, SOLO Taxonomy, & TPACK

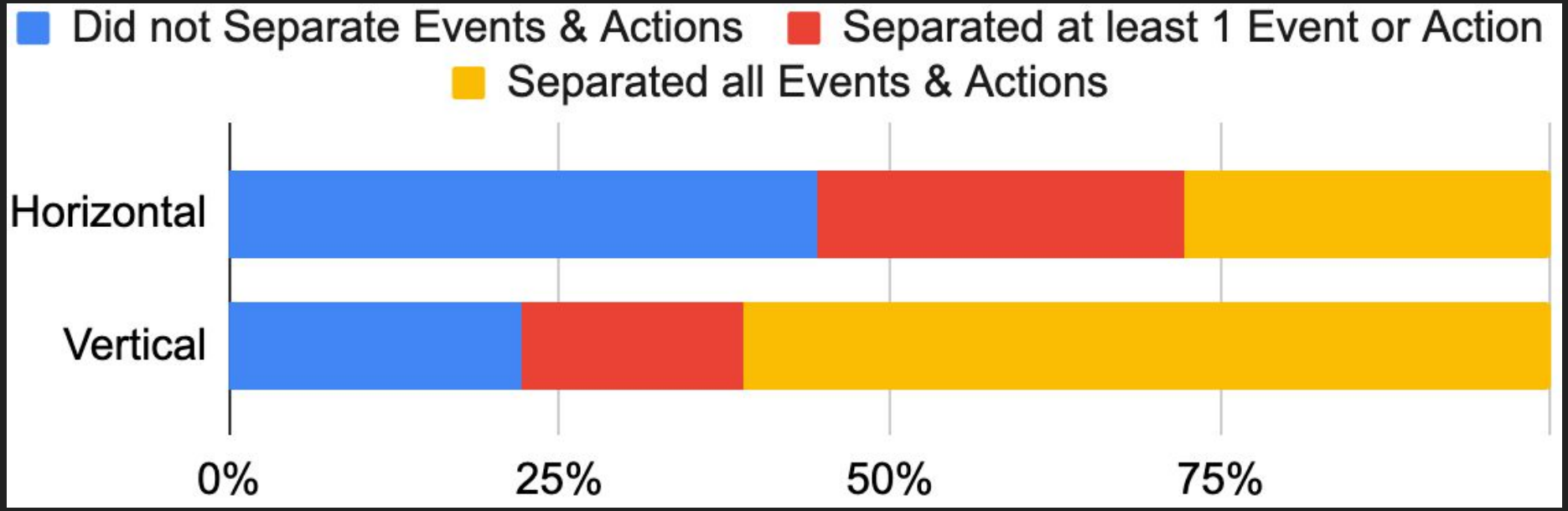
Study Context:

Teachers in Scratch Encore Virtual Professional Development

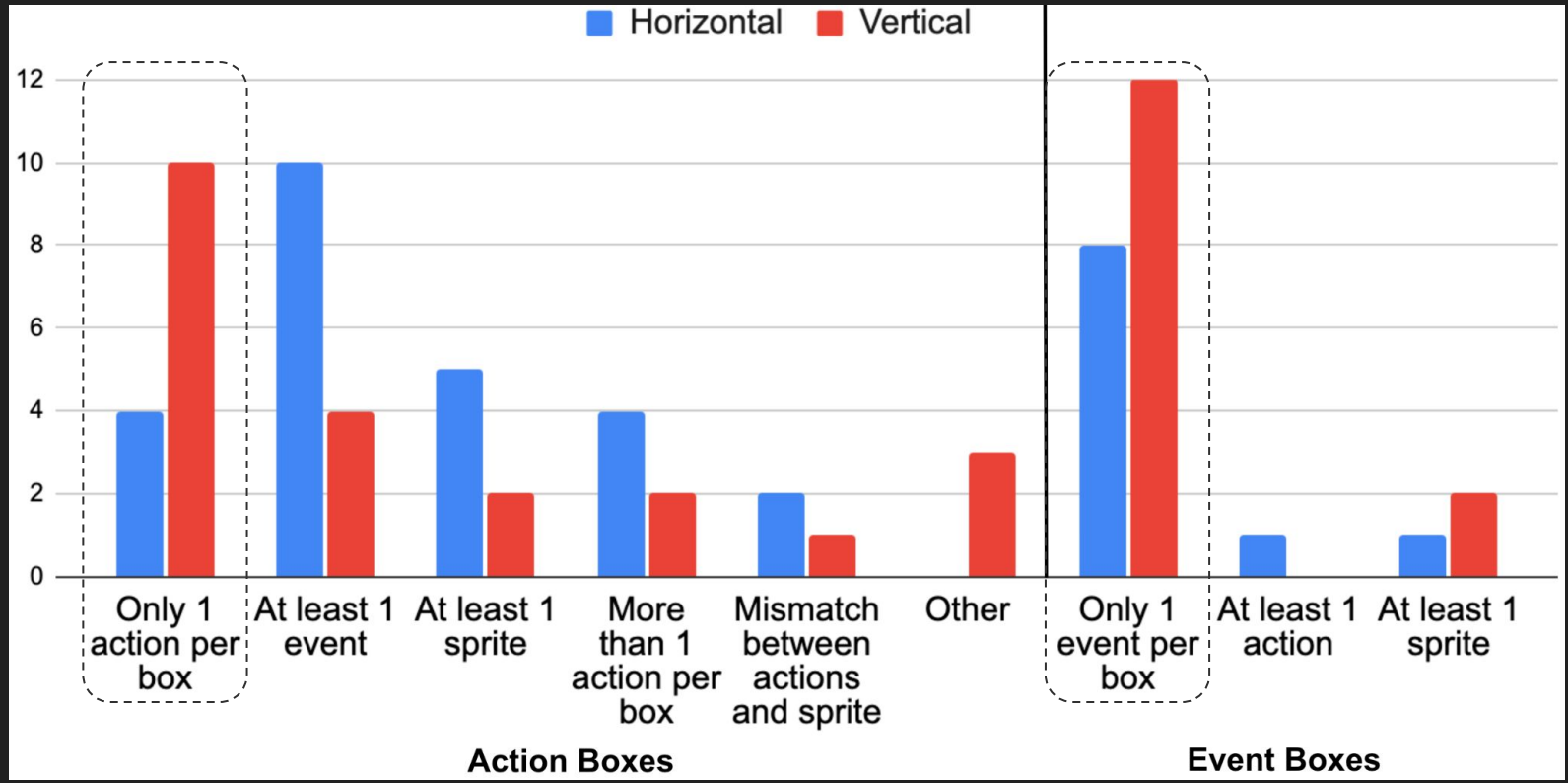
Results:

Horizontal vs Vertical Diagrams as Scaffolds

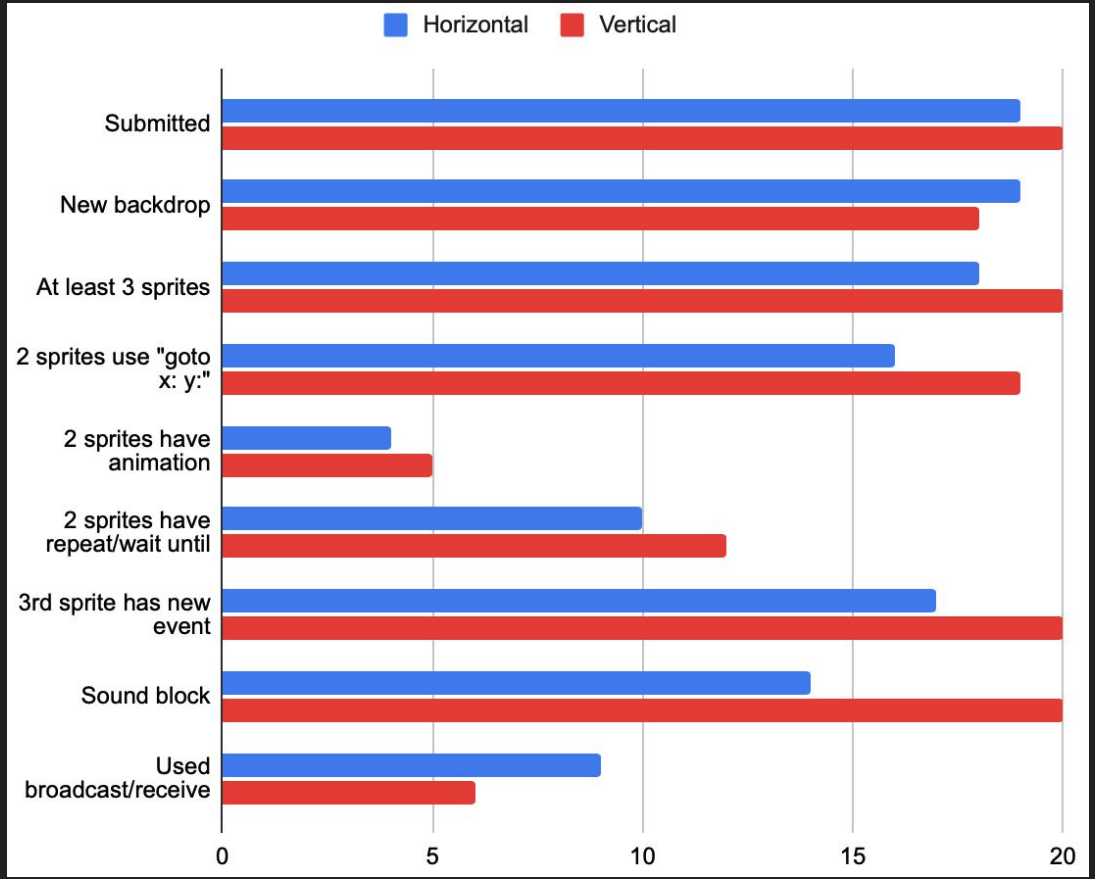
Most teachers using the vertical diagram fully or partially decomposed the sequence of events



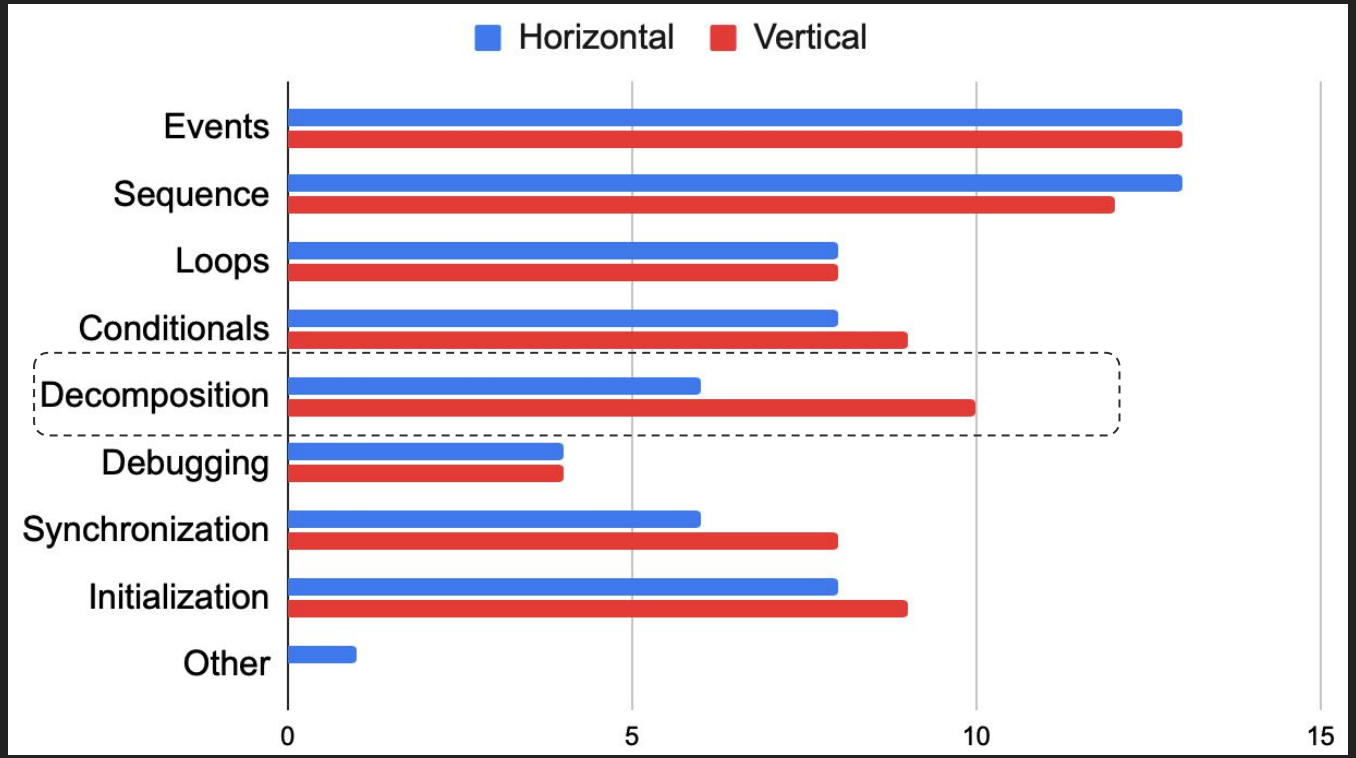
Most teachers using the vertical diagram fully or partially decomposed the sequence of events



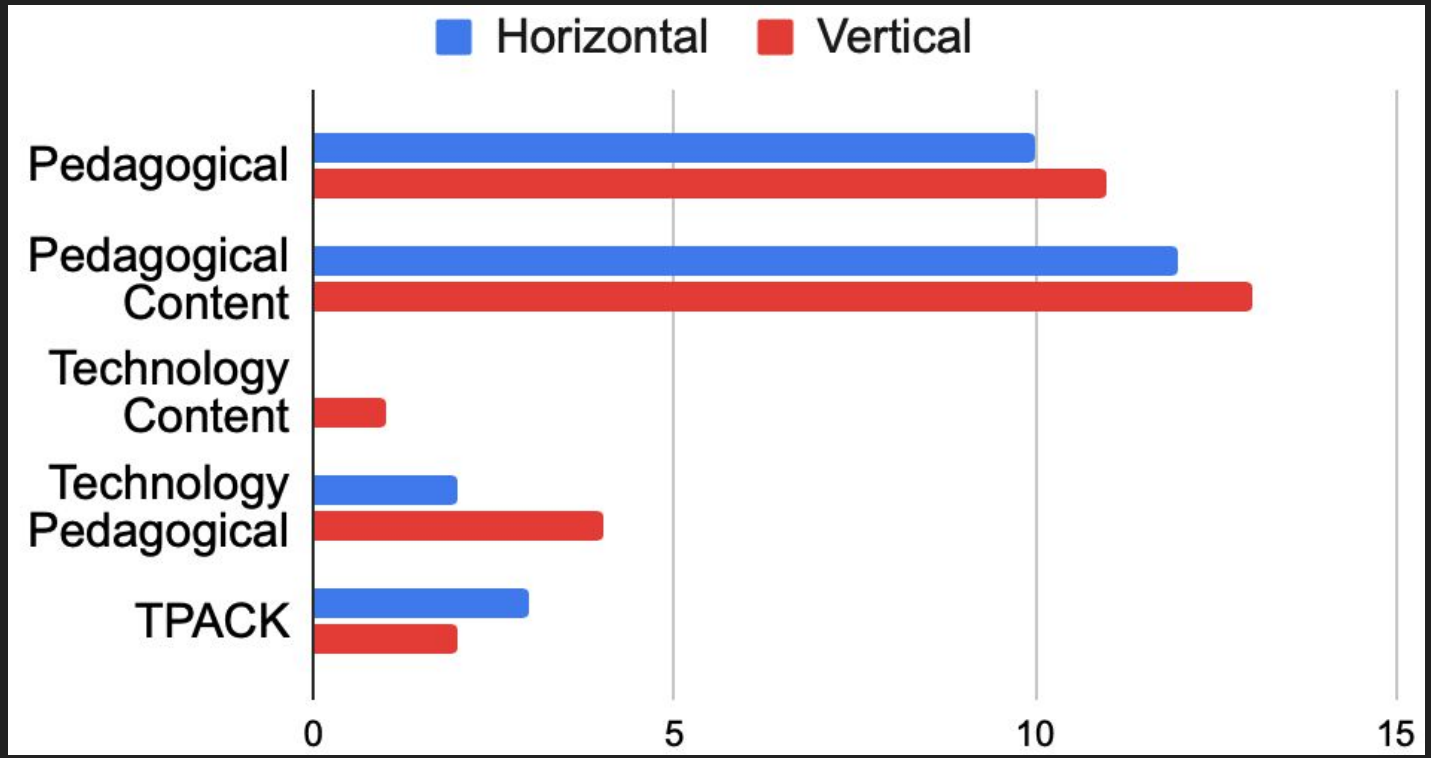
Teachers completed project requirements at similar rates



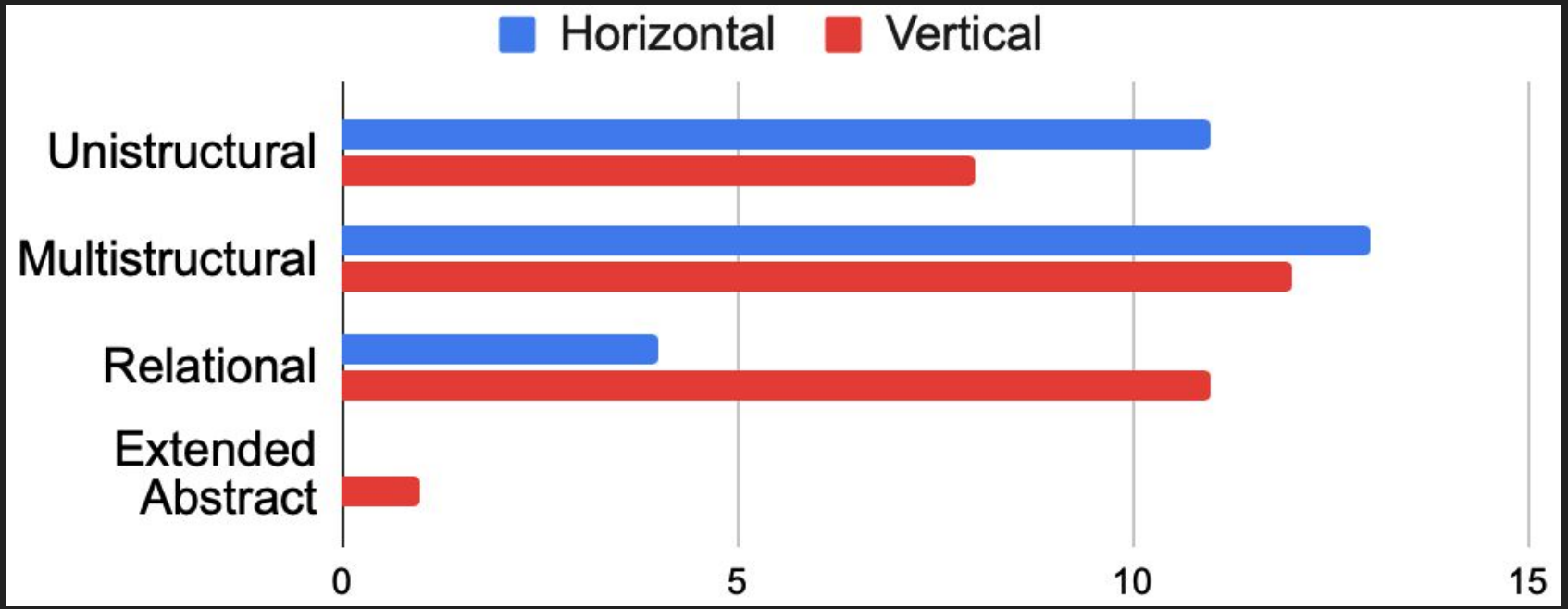
~Twice as many teachers described decomposition in interviews



Teachers were similar in the types of knowledge expressed in interviews



More teachers in the vertical condition described CT concepts at the relational level



Example of a multistructural response:

“When she touches the guitar, it would start playing[...]then it would send out a message to the target and it would repeat until the color red was touching the brown of the boy’s shoes”

Described events, sequence, and loops, but not integrated into a structure

Example of a relational response:

“Sprites are characters that you can program to interact with each other in many different ways...when a sprite reaches that position and comes in contact with another sprite,[...]there's going to be an action that occurs when two sprites come in contact with each other.”

Described events & sequence in a more general structure

RQ1: How does diagram orientation influence the learning of decomposition in teachers?

- Most teachers using the vertical diagrams partially or completely decomposed the sequence of events
- ~ Twice the number of teachers in vertical condition mentioned decomposition

RQ2: How does diagram orientation influence the development of technological, pedagogical, & content knowledge in teachers?

- Teachers exhibited similar knowledge of CT concepts
- Teachers in the vertical condition described their knowledge with more depth

Why did we observe differences across orientations?

We don’t know!

Further motivation for spatial reasoning in computing?

Active Learning Time!

Think about a diagram you've encountered in your learning or teaching.

On a piece of paper,

1. Draw or describe the diagram
2. Describe what concept or subject was covered by the diagram
3. Reflect on why you think the diagram was effective (or not!) in your learning or teaching

Don't forget to write your name!

Snowball Fight!

The Role of Spatial Orientation in Diagram Design for CT Development in K-8 Teachers

Jean Salac, Donna Eatinger, & Diana Franklin

Key Takeaways:

- More teachers decomposed a sequence of events when using a vertical diagram
- More teachers using a vertical diagram made connections between concepts, whereas more teachers using a horizontal diagram described concepts in isolation
- “Why?” may point to emerging research on spatial reasoning in computing

@SaladwithaC
salac@uw.edu

Template Outline Slide

Motivation

Background

Study Context

Results

Template Content Slide

Important things here

Template Conclusion Slide

Authors

Key Takeaways: