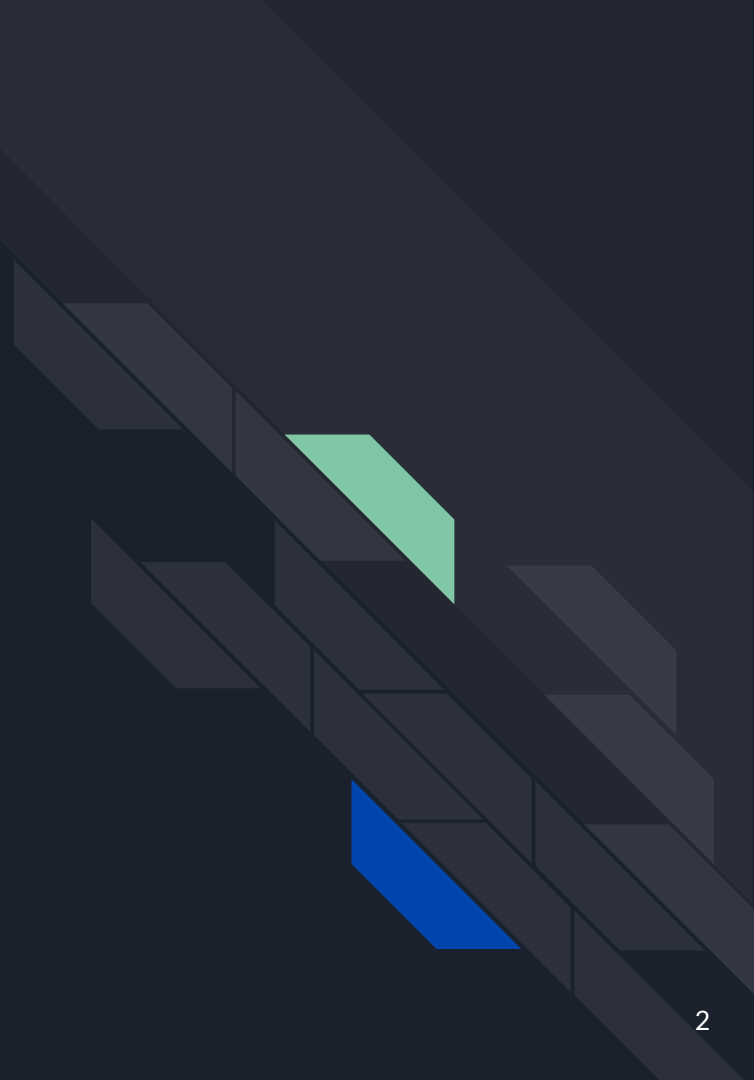




A Qualitative Exploration of Student Preconceptions of Computational Thinking

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Learning Sciences & Technologies

A plumber is fixing a pipe.
There is a hole
somewhere and he must
find it. He inspects the
pipe section by section
until he finds the hole.



Do you think the following
is an example of
computational thinking?
Why?



What is Computational Thinking?

- There is no one definitive answer!

Generally, computational thinking is the thought process used when creating problems and solving them in a similar way that a computer can.



What is Computational Thinking?

- There is no one definitive answer!

Shute (2017)	Grover & Pea (2013)	Damelin (2020)
Lens: K-16 Intervention • Iteration • Decomposition • Algorithm Design	Lens: K-12 Computing Education • Abstraction • Conditional Logic • Debugging	Lens: High School Students Learning System Modeling • Problem Decomposition • Creation of Computational Artifacts • Testing and Debugging • Iterative Refinement



What is Computational Thinking?

- Weintrop (2016)
 - Data Practices
 - Modeling
 - Systems Thinking
 - Computational Problem Solving

Data Practices	Modeling	Systems Thinking	Computational Problem Solving
• Collecting, creating, and analyzing data	• Designing, assessing, and creating models	• Decomposition • Abstraction • Viewing systems as a whole along with its relationships	• Programming • Assessing solutions to problems • Debugging • Iteration



Vignettes

- Need to define computational thinking and set clear guidelines on how it can be implemented in classrooms to help educators (Weintrop et al., 2016)
- 12 Vignettes
 - 4 researcher-intended non-computational thinking vignettes
 - 8 researcher-intended computational thinking vignettes
 - 1 technology related + 1 non-technology related for 4 concepts related to computational thinking
 - Data Practices
 - Modeling
 - Systems Thinking
 - Computational Problem Solving



Vignettes

- Luisa just finished her senior capstone project in psychology. As part of the project, she watched online interviews and typed up transcriptions from 50 participants' interviews.
 - Not computational thinking
- Cole takes a walk at the park each day at 8 am. He walks exactly 2 miles and it takes him exactly 30 minutes to finish his walk. He observes the same golden retriever each day by the water fountain at 8:15 and observes the same man turning off the park lights each day at 8:05.
 - Also not computational thinking!
- The local coffee shop owner wants to know how many customers she has on each day of the week to help her plan staffing. She graphs the daily cash register purchases in a histogram on excel and uses this to conclude that she has the most customers on Wednesdays. She decided to add an extra barista on Wednesdays to cover the busy crowd.
 - Computational thinking with technology

Research Questions

- 1) Do student answers largely match researcher designed intentions?
- 2) Which themes emerge among student responses on the items with the most and least agreement?



Procedure + Participants

- Early 2021 for 7 weeks
 - 12 vignettes presented in Qualtrics over SONA
 - Participants selected “yes” or “no”
 - Prompted to write a brief description explaining their answer
-
- 37 participants collected
 - No demographics information was collected

Qualitative Analysis



Timeline

Designed Vignettes in Spring 2020

Piloted in Fall 2020

Ran Study in Spring 2021



Timeline

Began coding Fall 2021

- Met over a period of 5 months 2-3 times a week beyond individual coding
- Came up with a list of 58 codes, across 3 people
- Narrowed down to 44 final codes
- Individually re-coded each response based on final list
- Met to reach a consensus on each code
- Again narrowed down to 38 final codes to be used in analysis



Qualitative Analysis

A plumber is fixing a pipe. There is a hole somewhere and he must find it. He inspects the pipe section by section until he finds the hole.

“Yes this demonstrates Computational Thinking because inspecting the pipe might include being able to test out, tweak and identify the problem in order to develop a solution.”



Qualitative Analysis

Iteration 1

“Yes this demonstrates **Computational Thinking** because inspecting the pipe might include being able to **test** out, tweak and identify the **problem** in order to develop a **solution**.”

Computational Thinking

Solution

Problem

Test



Qualitative Analysis

Iteration 2

“Yes this demonstrates Computational Thinking because inspecting the pipe might include being able to test out, tweak and identify the problem in order to develop a solution.”

Thinking

Identify Problem

Debugging

Solution

Problem Solving

Iteration



Bringing Back the Plumber!

Iteration 3

“Yes this demonstrates Computational Thinking because inspecting the pipe might include being able to test out, tweak and identify the problem in order to develop a solution.”

Thinking

Identify Problem

Debugging

Solution

Problem Solving

Iteration



Qualitative Coding Results

Code	Instances	Code	Instances	Code	Instances	Code	Instances
Abstraction	15	Difficulty	61	Observation	35	Thinking	56
Algorithm	8	Documentation	29	Order	5	Trial and Error	16
Analyzing Information	78	Doesn't Understand	7	Organization	28	Unsure	8
Coding	17	Efficiency	20	Pattern Recognition	23		
Comparison	15	Experiment	4	Plan	29		
Computation	33	Feedback	23	Problem Solving	66		
Computer	25	Following Steps	29	Programming	13		
Creating Steps	2	Iteration	49	Qual/Quant Reasoning	8		
Data	29	List	10	Rating	13		
Debugging	31	Logic	30	Solution	21		
Decomposition	46	Math	42	Subjective	13		



Results: *Do student answers largely match researcher designed intentions?*

Vignette	Anticipated Response	Student Agreement	
		Agree	Disagree
Cole	No	51.4%	48.6%
Matt	No	58.8%	41.2%
Lily	No	58.8%	41.2%
Luisa	No	85.7%	14.3%
Plumber	Yes	67.6%	32.4%
Francis	Yes	70.6%	29.4%
Preschoolers	Yes	73.5%	26.5%
Hannah	Yes	83.3%	16.7%
Olivia	Yes	82.4%	17.6%
Grace	Yes	85.3%	14.7%
Rich	Yes	88.9%	11.1%
Coffee	Yes	100%	0%



Results: *Do student answers largely match researcher designed intentions?*

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Hannah	Yes	83.3%	16.7%
Olivia	Yes	82.4%	17.6%
Grace	Yes	85.3%	14.7%
Rich	Yes	88.9%	11.1%
Coffee	Yes	100%	0%



Common Themes and Codes

- **Abstraction:** Discussion of reducing complexity by removing unnecessary information or focusing only on relevant information or explicitly using the term abstraction.
- **Difficulty:** Anything that mentions the difficulty or simplicity of a task.
- **Problem Solving:** When the participant mentions any aspect of the problem solving process, including “solving”, “fixing”, “figuring out”, “problem solving”, “solve a problem”, or comments on any attempt to solve a problem.
- **Data:** When the word “data” is explicitly mentioned.
- **Analyzing Information:** When the participant mentions using, processing, analyzing or assessing information or mentioning coming to an informed decision.
- **Iteration:** Changing based on prior information to make better or implement a solution, but not necessarily to reach a “solution”



Common Themes and Codes

- **Math:** Anytime the participant uses mathematical terms as rational or when the participant references the use of mathematical methods to approach a problem.
- **Solution:** When the participants mention a solution or a problem that is solved or a decision being made.
- **Debugging:** Mention of the process of detecting, locating, and fixing problems or finding errors, by testing or checking, going line by line or section by section, assessing code
- **Decomposition:** When the participant mentions breaking a problem down or thinking of a solution into simpler or smaller parts or mentions decomposition explicitly.
- **Pattern Recognition:** Any mention of patterns, noticing a pattern, or repetition.



Results: *Which themes emerge among student responses on the items with the most and least agreement?*

Luisa just finished her senior capstone project in psychology. As part of the project, she watched online interviews and typed up transcriptions from 50 participants' interviews.

- Luisa vignette
 - Abstraction
 - Difficulty
 - Problem Solving



Results: *Which themes emerge among student responses on the items with the most and least agreement?*

The local coffee shop owner wants to know how many customers she has on each day of the week to help her plan staffing. She graphs the daily cash register purchases in a histogram on excel and uses this to conclude that she has the most customers on Wednesdays. She decided to add an extra barista on Wednesdays to cover the busy crowd.

- Coffee vignette
 - Abstraction
 - Data
 - Analyzing Information
 - Problem Solving
 - Math
 - Solution



Results: *Which themes emerge among student responses on the items with the most and least agreement?*

Cole takes a walk at the park each day at 8 am. He walks exactly 2 miles and it takes him exactly 30 minutes to finish his walk. He observes the same golden retriever each day by the water fountain at 8:15 and observes the same man turning off the park lights each day at 8:05.

- Cole vignette
 - Decomposition
 - Observation
 - Pattern Recognition
 - Math



Discussion + Conclusion

- Computational thinking has been widely recognized by educators, business leaders, and researchers as a set of skills that can improve access to STEM careers (Smith, 2016; Weintrop et al., 2016; Adams & Pruijm, 2012; Wing, 2006).
- Students should have the opportunity to practice computational thinking in K-12 education because such skills are facets of higher-level thinking and problem solving that are applicable across a wide variety of contexts.
- Future Directions
 - Do students associate technology with computational thinking?
 - Do students' ideas of computational thinking connect with established taxonomies of computational thinking concepts?
 - Do students cite computational thinking concepts to explain why they think an example is not CT?
 - Do students cite CT concepts to explain why they think an example is CT?



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Thank you!

Questions?

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