Building Computational Thinking through Integrated Curriculum
What is Computational Thinking?

A Thought Process to Formulate Problems and Solutions

- Decomposition
- Abstraction
- Pattern Recognition
- Algorithms
Where Does Computational Thinking Fit?

Computational Thinking

Ubiquitous

Reading
Writing
Arithmetic
Where Does Computational Thinking Fit?

Computational Thinking

Ubiquitous
How is Computational Thinking Important?

“Computational thinking is a fundamental skill for everyone, not just for computer scientists.”

Dr. Jeannette Wing, Vice President of Microsoft Research
Former Department Head of CS at Carnegie Mellon University

“Coding teaches me to think in a logical way”

Trinity School high school student
Accepted at MIT
How Can We Teach Computational Thinking?

Computational Thinking vs Math Skills

Do students just “pick up” computational thinking?

Isn’t math taught systematically and reinforced throughout the curriculum?
Consider an Electrical Engineering Curriculum

Year 1
- Humanities
- General Chemistry
- Intro to Engineering
- Calculus I

Year 2
- Humanities
- Circuits
- Physics I
- Programming
- Calculus II

Year 3
- Humanities
- Algorithms
- Physics II
- Linear Algebra
- Calculus III

Master
- Micro-electronics
- Semiconductors
- Controls
- Energy & Power

- Technical Elective
- RF & Optics
- Embedded Systems
- Technical Elective

- Technical Elective
- Comm
- Statistics
- Technical Elective

- Technical Elective
- Capstone Design I
- Numerical Methods
- Capstone Design II

- Technical Elective
- Signals & Systems
- Electromagnetics
- Technical Elective

- Technical Elective
- Differential Equations
- Statistical Methods
- Technical Elective
How Math is Introduced in the Curriculum?

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- Calculus I

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- Differential Equations

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- Algorithms
- Digital Systems
- Signals & Systems
- Semi- Conductors
- Electronics
- Electro- magnetics
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Core Math Courses
How Math is Introduced in the Curriculum?

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Core Math Courses

Courses applying Math
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Core Math Courses
Courses applying Math
Students’ cumulative Math proficiency
### How is Computational Thinking Introduced?

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Forgetting Curve:

- Students' cumulative Computational proficiency
- Computational Courses
Imagine, you are in charge of revamping a program

Could **Computational Thinking** be built up like we introduce Math?
Imagine, you are in charge of revamping a program
Introduce engineering through Problem-Based Learning @UPMC

Mohamed Ben Chouikha
UPMC, France

Year 1
Intro to Engineering

Physics of image sensors
Histograms of image color pixels

Decomposition
Pattern Recognition
Algorithms
Abstraction
Blend Math, Physics and Computing

**Physics**

\[ m \frac{d^2 x}{dt^2} = -c v v_x, \quad x(0) = 0, \quad v_x(0) = v_0 \cos(\alpha_0) \]

\[ m \frac{d^2 z}{dt^2} = -mg - c v v_z, \quad z(0) = 0, \quad v_z(0) = v_0 \sin(\alpha_0) \]

\[ z(t = T) = \delta x(t = T)^2, \quad \delta \geq 0 \]

\[ T = \frac{g + 2\delta v_0^2 \cos^2 \alpha_0}{g} \]
Educate future engineers: breadth and depth

Year 3+

Signals & Systems
Physics
Embedded Systems
Numerical methods
Programming

Prototyping educational

Modeling and simulation

Prototyping industrial

Decomposition
Abstraction
Algorithms
Build Computational Thinking through integrated curriculum
Build **Computational Thinking** through integrated curriculum

Why are professors using MATLAB and Simulink?