Fixing maths education for 21st century.

The real-world changed.
How should education react?
Effects of AI on Subjects:

Change what humans need to learn
...including what’s for computer
...what’s for the human

Guide: What happened in the real-world?
How is Ubiquitous Computation changing real-world STEM...?
Maths newly applied everywhere, e.g.:

- Virtual prototyping
- Linguistic interpretation
- Medical imaging
- Algorithmic trading
- Archaeological surveying
- Computational biology
Key today: Data Science

In[]: `GenomeLookup["CTCTCTAACTAAACT"]`

Out[]: `{{{Chromosome1, 1}, {108 939 073, 108 939 087}}, {{Chromosome1, -1}, {138 309 610, 138 309 624}}, {{Chromosome5, -1}, {139 640 264, 139 640 278}}, {{Chromosome8, 1}, {72 019 948, 72 019 962}}, {{Chromosome9, 1}, {110 092 060, 110 092 074}}}`
Key challenge for Society:
Citizen Data Analysts
Today’s Survival Skills?
Tomorrow's Top value-add?
Core human skill: Computational Thinking

Manifested by maths education...?
Maths education crisis: 80% wrong subject?
Key difference: Computers
Why learn maths?
What is maths?

1. DEFINE QUESTIONS
2. TRANSLATE TO MATH (real world → maths)
3. COMPUTE ANSWERS
4. INTERPRET RESULTS (maths → real world)
Use computers for...

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Use humans for...

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Maths: problem-solving process
Solve[{x + 2 = 2 y, y – x = 5}, {x, y}]
Today’s mechanics-centred schooling

Similar triangles
Calculate this long division
Completing the square
Inverting matrices
Simplifying Surds and Recurring Decimals
Solving simultaneous equations
The chain rule
Today’s problem-centric maths need

What’s the perfect password for your login?
Am I normal?
Should I insure?
How do I design controls for my game?
Are our incentives working?
How do we evaluate our social media effectiveness?
Is a fraud occurring?
How much can you compress photos, video or music before you notice?
By how many levels of friends are we separated on Facebook?
What’s a beautiful shape?
Remove the computer...
⇒ remove the context
Remove the computer...
⇒ different computational toolset

(4-steps’ cost-benefit analysis)
cf. photography
Example problem: can I spot a cheat?

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th
Example module:
How fast can I cycle...?
Computational... 

Thinking: way to do STEM, life 

Maths: CT domain knowledge 

Coding: way to express CT, maths »
Fix Motivation

Solve real-life, messy, hard, problems.

Use abstraction to help...
...not scare students off trying.
Core Outcomes?
Build curriculum backwards

Even we can’t predict which maths you need...
Don’t write spec for curriculum first.

Start with problems
Work back to maths you need
Label with outcomes
Check coverage
Order
Reorder for conceptual not computational complexity

Eg. Calculus for 10-year-olds
3D geometry first
Machine-Learning for Primary
Fix assessment to match

Problem types that match new content
Question styles change
More open-ended (like in arts subjects)
Primary v. Secondary context
Stand on power of automation...
...now for STEM

ie. work a level up from the machines,
don’t compete...
Steve Jobs (1988):

“Mathematica will revolutionize the teaching and learning of math by focusing on the prose of mathematics without getting lost in the grammar.”
Prepared for the “Computational Knowledge Economy”? 
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computerbasedmath.org
wolframalpha.com
conradwolfram.com
wolfram.com