A canticle for Euclid

John Perry

University of Southern Mississippi

March 2018

A canticle for Euclid

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You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

...but one more thing!

Overview

1. You're kidding, right?
2. A Canticle for Euclid
   - A problem
   - Towards a definition of "shiny"
   - Why Euclid?
   - What is mathematics?
   - Why aren't our students creative?
   - How do we create ideas?
   - How do we teach mathematics?
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3. Shiny math!
   - Fight the Symbolab
   - Outreach
4. Some final thoughts
5. …but one more thing!

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Outreach

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   - A problem
   - Towards a definition of "shiny"
   - Why Euclid?
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I did not expect this.

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I did not expect this.

Previous awards for teaching, if any _____

_____

_____ (Kinda pathetic-lookin', ain't it?)

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Vraiment!

[Sometime in January, 2017. Location: Bernd Schröder's office.]

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[Internal monologue: Aha! I must not have qualified.]

JP Well, there is [Worthy Nominee Redacted].

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Outreach

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In addition

- It was not a good time morale-wise (see above — or below).

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Fight the Symbolab

Outreach

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Fight the Symbolab

Outreach

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THANK YOU.

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Outreach

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To the student who feels out of place

(Possibly $\emptyset$ but probably not)

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Towards a definition of "shiny"

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Outreach

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You like math, and you you used to think you were pretty good at it until you came here. You didn't do so well in the [insert competition here].

To the student who feels out of place

(Possibly $\emptyset$ but probably not)
You like math, and you you used to think you were pretty good at it until you came here. You didn't do so well in the [insert competition here]. You don't understand the talks — and for that matter, you don't understand most of the titles!

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Outreach
Some final thoughts
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To the student who feels out of place

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You like math, and you you used to think you were pretty good at it until you came here. You didn't do so well in the [insert competition here]. You don't understand the talks — and for that matter, you don't understand most of the titles! You're thinking, "Maybe math isn't for me."

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Fight the Symbolab
Outreach
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That was me 20-30 years ago

I quit mathematics after my Master's degree because another student resembled Arago's description of Euler:

That was me 20-30 years ago

I quit mathematics after my Master's degree because another student resembled Arago's description of Euler:

He calculated effortlessly,
the way ordinary men breathe,
as eagles sustain themselves in the air.

That was me 20-30 years ago

I quit mathematics after my Master's degree because another student resembled Arago's description of Euler:

He calculated effortlessly,
the way ordinary men breathe,
as eagles sustain themselves in the air.

That, I thought, is a true mathematician. (And he is!)

But so are we!

I still feel that way (especially at conferences). I sometimes tell students:

But so are we!

I still feel that way (especially at conferences). I sometimes tell students:

> *I don't have a PhD in mathematics because I'm smart. I have a PhD in mathematics because I was too dumb to quit.*

You're kidding, right?

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Outreach

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A “familiar” example

- My brothers scored 3 or 4 on AP Calculus Exam

Alright! I won’t have to take math in college!

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Outreach

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- I scored a 2

  Yeah… I never really “got” Calculus.

A “familiar” example

- My brothers scored 3 or 4 on AP Calculus Exam

  Alright! I won’t have to take math in college!

- I scored a 2

  Yeah… I never really “got” Calculus.

- Guess who now teaches Calculus

Someone who might agree

Found online:

When we tell our students that learning should be fun, we are setting them up for failure and disappointment.

Someone who might agree

Found online:

> *When we tell our students that learning should be fun, we are setting them up for failure and disappointment. Life is simply not going to deliver them an unending stream of joyful learning experiences.*

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Outreach

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> *When we tell our students that learning should be fun, we are setting them up for failure and disappointment. Life is simply not going to deliver them an unending stream of joyful learning experiences. . . . Instead of telling our children that occasional lie, we would do better to guide them to understand that "learning is rewarding".*

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Outreach

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— Keith Devlin's Brainquake

(NPR's "Math Guy," Devlin was a previous Anderson speaker.)

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Outreach

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Bananas Foster Bread Pudding

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A Canticle for Euclid

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If you like this stuff, ***stick with it***. It is rewarding.

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Outreach

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Enough with the sappy stuff

Traditional guideline for a good talk:

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1. Curious bystanders understand first 5 minutes.

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Outreach

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Traditional guideline for a good talk:

1. Curious bystanders understand first 5 minutes.
2. People who read abstract understand the first third.
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4. The speaker understands the last third.

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Outreach

Some final thoughts

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For example

I've been to too many talks where after 50 minutes I didn't even understand what the question was.

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Outreach

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Can I give a 50-minute "Distinguished Teacher Award" talk without embarassing the committee?

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Can I give a 50-minute "Distinguished Teacher Award" talk without ~~embarrassing the committee?~~ knowing what question I'm answering?

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Outreach

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Fight the Symbolab

Outreach

Some final thoughts

...but one more thing!

Something we like to say

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A problem

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Fight the Symbolab

Outreach

Some final thoughts

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A problem

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What is mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

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But is it?

- I think so

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

...but one more thing!

Something we like to say

MATH IS BEAUTIFUL!

But is it?

- I think so
- You probably think so

You're kidding, right?

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A problem

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Outreach

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- You probably think so
- $\sim$ 90% of humanity doesn't think about the question at all

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Outreach

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But is it?

- I think so
- You probably think so
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A problem

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Outreach

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- $\sim$ 9% of humanity disagrees (sometimes intensely)
  - Of course, most of them think

$$(x+1)^2 = x^2 + 1$$

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A problem

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Fight the Symbolab

Outreach

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- $\sim$ 9% of humanity disagrees (sometimes intensely)
  - Of course, most of them think

$$(x+1)^2 = x^2 + 1$$

- **Moral of the story:** Truth is not subject to majority vote

MATH IS BEAUTIFUL! □

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A problem

Towards a definition of "shiny"

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Fight the Symbolab

Outreach

Some final thoughts

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That's kind of a cop-out

I didn't always think math was beautiful. Recall:

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

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Fight the Symbolab

Outreach

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AP Calculus score: 2

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A problem

Towards a definition of "shiny"

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What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

That's kind of a cop-out

I didn't always think math was beautiful. Recall:

AP Calculus score: 2

Math was:

- hard
- hard work
- had to be careful
- required a lot of time
- obviously important, but…

You're kidding, right?

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A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

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- hard
- hard work
- had to be careful
- required a lot of time
- obviously important, but…
- **not shiny**

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A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Fight the Symbolab

Outreach

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- hard
- hard work
- had to be careful
- required a lot of time
- obviously important, but…
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"shiny"?

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A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Towards a definition of “shiny”

A canticle for Euclid

John Perry

You’re kidding, right?

A Canticle for Euclid

A problem

Towards a definition of “shiny”

Why Euclid?

What is mathematics?

Why aren’t our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Music

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Finding your way

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Getting the news

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Getting the news

(Admit it: this is the *real* reason you subscribed.)

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

“Shiny”, ca. 1970

You’re kidding, right?

A Canticle for Euclid

A problem

Towards a definition of “shiny”

Why Euclid?

What is mathematics?

Why aren’t our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

“Shiny”, ca. 1970

(AT&T Monopoly)

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A Canticle for Euclid

A problem

Towards a definition of “shiny”

Why Euclid?

What is mathematics?

Why aren’t our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

“Shiny”, ca. 1973

A canticle for Euclid

John Perry

You’re kidding, right?

A Canticle for Euclid

A problem

Towards a definition of “shiny”

Why Euclid?

What is mathematics?

Why aren’t our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

“Shiny”, ca. 1973

(*Not* allowed on AP Calculus)

A canticle for Euclid

John Perry

You’re kidding, right?

A Canticle for Euclid

A problem

Towards a definition of “shiny”

Why Euclid?

What is mathematics?

Why aren’t our students creative?

How do we create ideas?

How do we teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

“Shiny”, ca. 1977

Apple][

TRS-80 Model I

Commodore PET

You’re kidding, right?

A Canticle for Euclid

A problem

Towards a definition of “shiny”

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What is mathematics?

Why aren’t our students creative?

How do we create ideas?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

“Shiny”, ca. 1977

Apple][
1 MHz 6502 CPU

TRS-80 Model I
1.774 MHz Z80 CPU

Commodore PET
1 MHz 6502 CPU

“Shiny”, ca. 1977

Apple][
1 MHz 6502 CPU
4 KB RAM

TRS-80 Model I
1.774 MHz Z80 CPU
4 KB RAM

Commodore PET
1 MHz 6502 CPU
4 KB RAM

A canticle for Euclid

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You’re kidding, right?

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A problem

Towards a definition of “shiny”

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How do we create ideas?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

“Shiny”, ca. 1977

Apple][
1 MHz 6502 CPU
4 KB RAM
16 (?) colors

TRS-80 Model I
1.774 MHz Z80 CPU
4 KB RAM
2 colors

Commodore PET
1 MHz 6502 CPU
4 KB RAM
2 colors

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John Perry

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A problem

Towards a definition of “shiny”

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Outreach

Some final thoughts

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“Shiny”, ca. 1977

Apple][
1 MHz 6502 CPU
4 KB RAM
16 (?) colors
TV hookup

TRS-80 Model I
1.774 MHz Z80 CPU
4 KB RAM
2 colors
modified B/W TV

Commodore PET
1 MHz 6502 CPU
4 KB RAM
2 colors
monitor

You’re kidding, right?

A Canticle for Euclid

A problem

Towards a definition of “shiny”

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

“Shiny”, ca. 1977

Apple][
1 MHz 6502 CPU
4 KB RAM
16 (?) colors
TV hookup
cassette compatible

TRS-80 Model I
1.774 MHz Z80 CPU
4 KB RAM
2 colors
modified B/W TV
cassette player

Commodore PET
1 MHz 6502 CPU
4 KB RAM
2 colors
monitor
cassette player

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A problem

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

“Shiny”, ca. 1977

Apple][
1 MHz 6502 CPU
4 KB RAM
16 (?) colors
TV hookup
cassette compatible
$1298

TRS-80 Model I
1.774 MHz Z80 CPU
4 KB RAM
2 colors
modified B/W TV
cassette player
$600

Commodore PET
1 MHz 6502 CPU
4 KB RAM
2 colors
monitor
cassette player
$795

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A Canticle for Euclid

A problem

Towards a definition of “shiny”

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

“Shiny”, ca. 1980

You’re kidding, right?

A Canticle for Euclid

- A problem
- Towards a definition of “shiny”
- Why Euclid?
- What is mathematics?
- Why aren’t our students creative?
- How do we create ideas?
- How do we teach mathematics?
- How should we not teach mathematics?

Shiny math!

- Fight the Symbolab
- Outreach

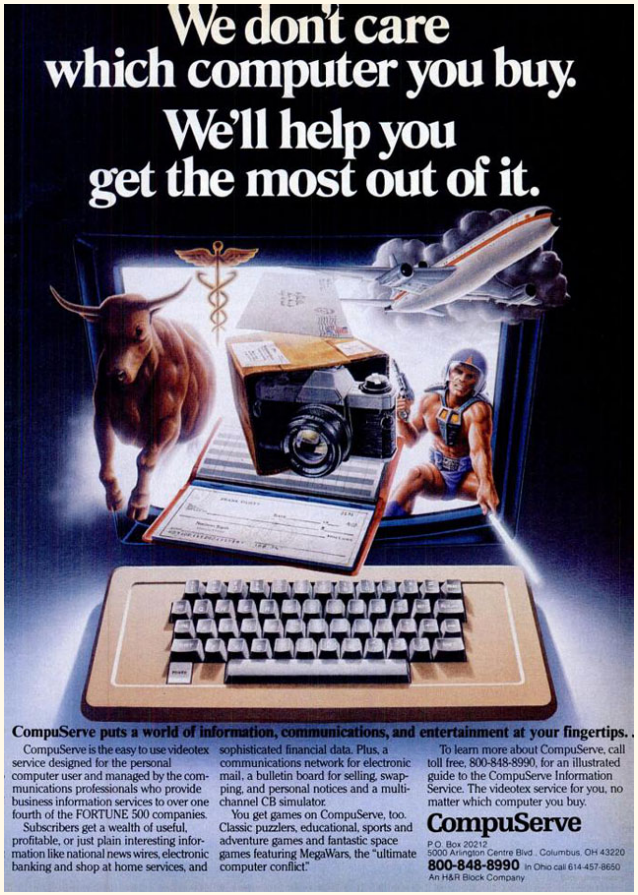
Some final thoughts

…but one more thing!

“Shiny”, ca. 1985

Amiga 1000
7 MHz MC68000 CPU
256 KB RAM
TV or Monitor (4096 colors!)
floppy drive
$1,295

“Internet”



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Towards a definition of “shiny”

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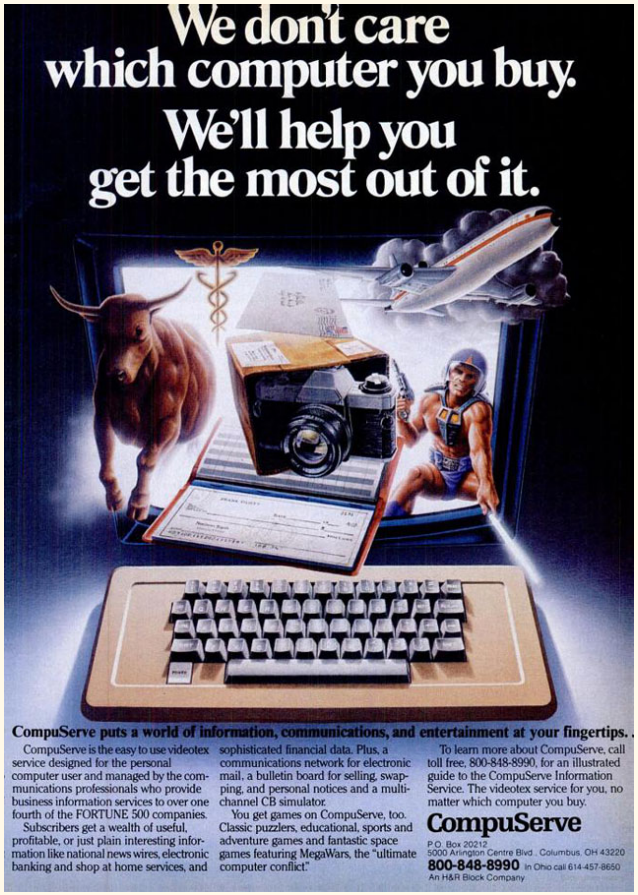
Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

“Internet”



CompuServe ⟶ AOL ⟶ AOL/Time-Warner ⟶ Verizon

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A Canticle for Euclid

A problem

Towards a definition of “shiny”

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

“Ordering online”

You’re kidding, right?

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A problem

Towards a definition of “shiny”

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

How do we accomplish all these things now?

You're kidding, right?

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A problem

Towards a definition of "shiny"

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

How do we accomplish all these things now?

"Smart" phone
$\sim$ 1.3 GHz quad-core ARM processor
1.5 GB RAM
LED capacitive touch screen (16 million colors)
smart card & wireless & Bluetooth & USB
$129

A canticle for Euclid
John Perry
You're kidding, right?
A Canticle for Euclid
A problem
Towards a definition of "shiny"
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Fight the Symbolab
Outreach
Some final thoughts
…but one more thing!

Comparison

1977	2017ish	improvement

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Comparison

1977	2017ish	improvement
~ 1.3 MHz	~ 1.3 GHz$\times 4$	$\times 10^3 \times 4$

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Fight the Symbolab

Outreach

Some final thoughts

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Comparison

1977	2017ish	improvement
~ 1.3 MHz	~ 1.3 GHz$\times 4$	$\times 10^3 \times 4$
4 KB RAM	1.5 GB RAM	$\times 10^6$

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Fight the Symbolab

Outreach

Some final thoughts

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2–16 colors	16 million colors	$\times (1-8) \times 10^6$

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Fight the Symbolab

Outreach

Some final thoughts

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Comparison

1977	2017ish	improvement
$\sim$ 1.3 MHz	$\sim$ 1.3 GHz$\times$4	$\times 10^3 \times 4$
4 KB RAM	1.5 GB RAM	$\times 10^6$
2–16 colors	16 million colors	$\times (1-8) \times 10^6$
TV hookup	touch screen	?!?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Comparison

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TV hookup	touch screen	?!?
cassette/floppy	smart card etc.	?!?

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Fight the Symbolab

Outreach

Some final thoughts

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Comparison

1977	2017ish	improvement
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2–16 colors	16 million colors	$\times (1-8) \times 10^6$
TV hookup	touch screen	?!?
cassette/floppy	smart card etc.	?!?
\$600-\$1300	\$129***	$\times (10-25)\%$

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John Perry

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A problem

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Why aren't our students creative?

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Fight the Symbolab

Outreach

Some final thoughts

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Comparison

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\$600-\$1300	\$129***	$\times (10-25)\%$

overall improvement: **a gazillion**

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A problem

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What is mathematics?

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Fight the Symbolab

Outreach

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TV hookup	touch screen	?!?
cassette/floppy	smart card etc.	?!?
\$600-\$1300	\$129***	$\times (10-25)\%$

overall improvement: **a gazillion**

***Apple still accepts \$1000+ for their latest & greatest.

A canticle for Euclid

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A problem

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Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Aside: Yes, a gazillion is a real number!

A canticle for Euclid

John Perry

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Aside: Yes, a gazillion is a real number!

$$\therefore 1 \text{ gazillion} = 10^{74}$$

A canticle for Euclid

John Perry

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Aside: Yes, a gazillion is a real number!

$$\therefore 1 \text{ gazillion} = 10^{74}$$

(They can't publish it if isn't true!)

A canticle for Euclid
John Perry
You're kidding, right?
A Canticle for Euclid
A problem
Towards a definition of "shiny"
Why Euclid?
What is mathematics?
Why aren't our students creative?
How do we create ideas?
How do we teach mathematics?
How should we not teach mathematics?
Shiny math!
Fight the Symbolab
Outreach
Some final thoughts
…but one more thing!

As I was saying. . .

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

. . . but one more thing!

Why Euclid?

A canticle for Euclid

John Perry

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

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Why aren't our students creative?

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How do we teach mathematics?

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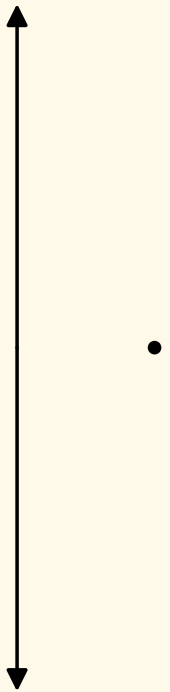
Fight the Symbolab

Outreach

Some final thoughts

...but one more thing!

Euclid (1)



Postulate. Given any line, through any point not on the line there is exactly one line parallel to the first.

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Euclid (1)

Postulate. Given any line, through any point not on the line there is exactly one line parallel to the first.

•

Proof. There ain't none. (Postulates are like that.)

You're kidding, right?

A Canticle for Euclid

A problem

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Why Euclid?

What is mathematics?

Why aren't our students creative?

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Fight the Symbolab

Outreach

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…but one more thing!

Euclid (1)

Postulate. Given any line, through any point not on the line there is exactly one line parallel to the first.

Proof. There ain't none. (Postulates are like that.)

Weird. Geometries where this is false exist. (Our universe "lives in" one of them.)

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Shiny math!

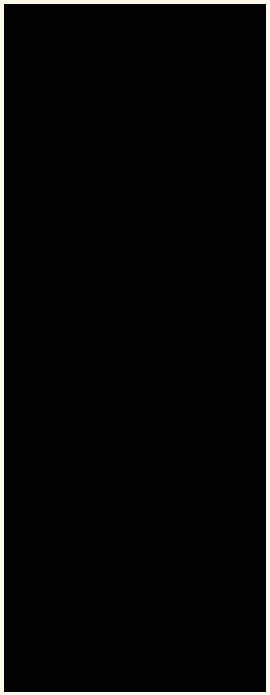
Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Euclid (2)

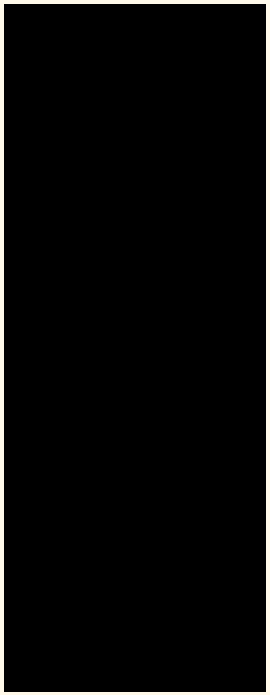


Theorem. For any nonzero $a, b \in \mathbb{Z}$:

- Let $c = \max(a, b)$, $d = \min(a, b)$
- **While** $d \neq 0$
  - Let r be remainder of $c \div d$
  - Let $c = d$, $d = r$

Then $\gcd(a, b)$ is the last c.

Euclid (2)



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Then $\gcd(a, b)$ is the last c.

Proof. I have a truly marvelous proof, but there is only enough room in the margin to animate it.

A canticle for Euclid

John Perry

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

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What is mathematics?

Why aren't our students creative?

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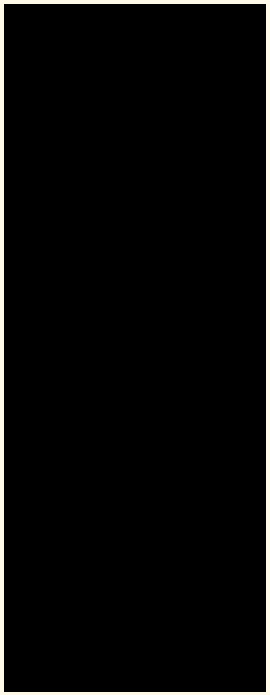

Theorem. For any nonzero $a, b \in \mathbb{Z}$:

- Let $c = \max(a, b)$, $d = \min(a, b)$
- **While** $d \neq 0$
  - Let r be remainder of $c \div d$
  - Let $c = d$, $d = r$

Then $\gcd(a, b)$ is the last c.

Proof. I have a truly marvelous proof, but there is only enough room in the margin to animate it.

Weird. 2500 years later, this is still "the" fastest method to compute a (general) gcd.

A canticle for Euclid

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A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Fight the Symbolab

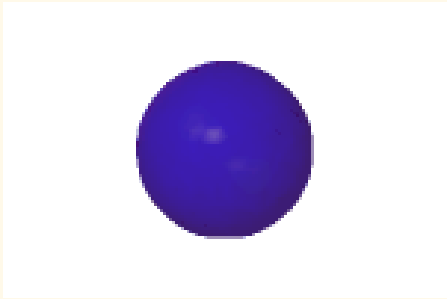
Outreach

Some final thoughts

…but one more thing!

And yet…

Axiom. Given an infinite number of buckets, you can pick an element from each bucket.



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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Shiny math!

Fight the Symbolab

Outreach

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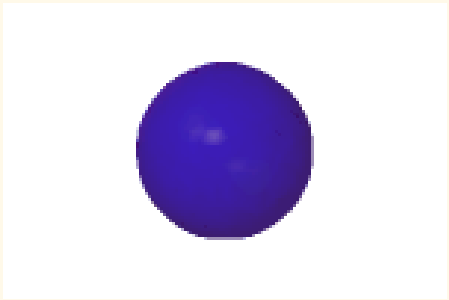

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

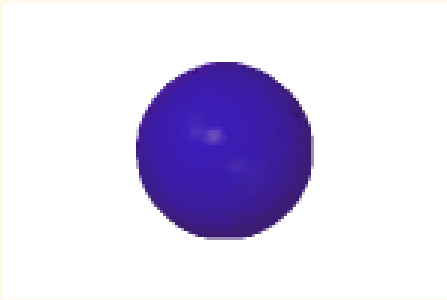
…but one more thing!

And yet…

Axiom. Given an infinite number of buckets, you can pick an element from each bucket.

Proof. There ain't none. (Axioms are like that.)

Weird. We need it for a lot of mathematics, but it leads to the Banach-Tarski Paradox.



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A Canticle for Euclid

A problem

Towards a definition of "shiny"

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What is mathematics?

Why aren't our students creative?

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How do we teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

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A canticle for Euclid

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

...but one more thing!

What is mathematics?

If we plan to show it's "shiny", we need to understand what it is.

You're kidding, right?

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A problem

Towards a definition of "shiny"

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What is mathematics?

Why aren't our students creative?

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Fight the Symbolab

Outreach

Some final thoughts

...but one more thing!

A common definition

Definition (Mathematics)

Pattern recognition! — or — The science of patterns.

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A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

A common definition

Definition (Mathematics)

Pattern recognition! — or — The science of patterns.

Common, but I never liked it.

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A problem

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Outreach

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Definition (“Mathematics”, 27 Feb 2018)

It has no generally accepted definition.

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Outreach

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Outreach

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> *Illustrious scholars have debated this matter until they were blue in the face, and yet no consensus has been reached about whether mathematics is a natural science, a branch of the humanities, or an art form.*
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> *— [authors redacted to protect the guilty]*

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A problem

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Outreach

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A problem

Towards a definition of “shiny”

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

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Outreach

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Definition ("College Admissions and the Stability of Marriage", *American Mathematical Monthly*, vol. 69, no. 1 (1962))

[A]ny argument . . . carried out with sufficient precision is mathematical,

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

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A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

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[A]ny argument . . . carried out with sufficient precision is mathematical, and the reason your friends and ours cannot understand mathematics is not because they have no head for figures, but because they are unable to achieve the degree of concentration required to follow a moderately involved sequence of inferences.

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

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[A]ny argument . . . carried out with sufficient precision is mathematical, and the reason your friends and ours cannot understand mathematics is not because they have no head for figures, but because they are unable to achieve the degree of concentration required to follow a moderately involved sequence of inferences. This observation will hardly be news to those engaged in the teaching of mathematics. . .

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

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Shiny math!

Fight the Symbolab

Outreach

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[A]ny argument . . . carried out with sufficient precision is mathematical, and the reason your friends and ours cannot understand mathematics is not because they have no head for figures, but because they are unable to achieve the degree of concentration required to follow a moderately involved sequence of inferences.

They can't print it if it ain't true, right?

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A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

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David Gale (2)

Definition (Mathematical Intelligencer, 1996)

What Is Mathematics Anyway?

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

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Definition (Mathematical Intelligencer, 1996)

What Is Mathematics Anyway? After much rumination I've reached the conclusion that there's no such thing. . . .

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

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Fight the Symbolab

Outreach

Some final thoughts

. . . but one more thing!

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Definition (Mathematical Intelligencer, 1996)

What Is Mathematics Anyway? After much rumination I've reached the conclusion that there's no such thing. … For some things… it is crucial to have definitions. For others, like mathematics, searching for a definition becomes mere wordplay. Let's not waste time on it.

Definition (“Mathematics”, 27 Feb 2018)

[T]he science of structure, order, and relation that has evolved from elemental practices of counting, measuring, and describing the shapes of objects.

You’re kidding, right?

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A problem

Towards a definition of “shiny”

Why Euclid?

What is mathematics?

Why aren’t our students creative?

How do we create ideas?

How do we teach mathematics?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

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A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Definition ("Mathematics", 27 Feb 2018)

[T]he science of structure, order, and relation that has evolved from elemental practices of counting, measuring, and describing the shapes of objects.

I like it, but we can do better.

A Hungarian mathematician

Everyone thinks mathematicians like hard work. Nothing could be further from the truth! Mathematicians are lazy! We try to avoid work!

You're kidding, right?

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Towards a definition of "shiny"

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Outreach

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That made no sense to me at the time, but…

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Fight the Symbolab

Outreach

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Example (1)

$$\int_a^b f(x)\,dx = \lim_{n\to\infty}\left[\Delta x \sum_{i=1}^{n} f(x_i)\right]$$

You're kidding, right?

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Towards a definition of "shiny"

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Outreach

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Example (1)

$$\int_a^b f(x)\,dx = \lim_{n\to\infty}\left[\Delta x\sum_{i=1}^{n} f(x_i)\right]$$

So

$$\begin{aligned}
\int_0^1 x^2\,dx &= \lim_{n\to\infty}\left[\frac{1}{n}\sum_{i=1}^{n}\left(0+\frac{i}{n}\right)^2\right] \\
&= \lim_{n\to\infty}\frac{1}{n^3}\sum_{i=1}^{n} i^2 \\
&= \lim_{n\to\infty}\frac{1}{n^3}\cdot\frac{n(n+1)(2n+1)}{6} \\
&\underset{\text{L'H}}{=} \frac{1}{3}.
\end{aligned}$$

A canticle for Euclid

John Perry

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Outreach

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So

$$\int_0^1 x^2\,dx = \lim_{n\to\infty}\left[\frac{1}{n}\sum_{i=1}^{n}\left(\frac{i}{n}\right)^2\right]$$

Oggi

$$= \lim_{n\to\infty}\frac{1}{n^3}\sum_{i=1}^{n} i^2$$

$$= \lim_{n\to\infty}\frac{1}{n^3}\cdot\frac{n(n+1)(2n+1)}{6}$$

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Outreach

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oggi

non

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$$\int_0^1 x^2\,dx = \lim_{n\to\infty}\left[\frac{1}{n}\sum_{i=1}^{n}\left(\frac{i}{n}\right)^2\right]$$

$$= \lim_{n\to\infty}\frac{1}{n^3}\sum_{i=1}^{n} i^2$$

$$= \lim_{n\to\infty}\frac{(n+1)}{n^3}$$

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oggi non mi va

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A problem

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oggi

$$= \lim_{n\to\infty}\frac{1}{n^3}\sum_{i=1}^{n} i^2$$

non

$$= \lim_{n\to\infty}\frac{(n+1)}{n^3}$$

mi va

$$\underset{\text{L'H}}{=} \frac{1}{3}.$$

(That's Italian for, "I'm smarter than this.")

A canticle for Euclid

John Perry

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Example (2)

Who wants to do all that?

$$\int_0^1 x^2\,dx \underset{\text{FTC}}{=} \frac{1^3}{3} - \frac{0^3}{3} = \frac{1}{3}.$$

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A Canticle for Euclid

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Outreach

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Example (2)

Who wants to do all that?

$$\int_0^1 x^2\,dx \underset{\text{FTC}}{=} \frac{1^3}{3} - \frac{0^3}{3} = \frac{1}{3} .$$

Definition (Hungarian mathematician, ca. 1988)

Mathematics is the art of avoiding hard work.

You're kidding, right?

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Outreach

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Example (2)

Who wants to do all that?

$$\int_0^1 x^2\,dx \underset{\text{FTC}}{=} \frac{1^3}{3} - \frac{0^3}{3} = \frac{1}{3} .$$

Definition (Hungarian mathematician, ca. 1988)

Mathematics is the art of avoiding hard work.

PS: She was speaking to a Governors' School at Virginia Tech.

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Why aren't our students creative?

A canticle for Euclid

John Perry

You're kidding, right?

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Problem from a computer science course

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Outreach

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Problem from a computer science course

Don't protest!

- Problem is mathematical, honest!

You're kidding, right?

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Outreach

Some final thoughts

…but one more thing!

Problem from a computer science course

Don't protest!

- Problem is mathematical, honest!
- CS is daughter of mathematics.

You're kidding, right?

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Outreach

Some final thoughts

…but one more thing!

Problem from a computer science course

Don't protest!

- Problem is mathematical, honest!
- CS is daughter of mathematics.
- Appeared on a Soviet Mathematical Olympiad.

You're kidding, right?

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Outreach

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...but one more thing!

Problem from a computer science course

I have 16 coins.

You're kidding, right?

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Outreach

Some final thoughts

…but one more thing!

Problem from a computer science course

I have 16 coins.

- I know one of them is counterfeit *and weighs less*.

You're kidding, right?

A Canticle for Euclid

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Problem from a computer science course

I have 16 coins.

- I know one of them is counterfeit *and weighs less*.
- I have a scale which can weigh any two piles.

You're kidding, right?

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Fight the Symbolab

Outreach

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…but one more thing!

Problem from a computer science course

I have 16 coins.

- I know one of them is counterfeit *and weighs less*.
- I have a scale which can weigh any two piles.
- What's the minimum number of weighings?

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A problem

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

...but one more thing!

Problem from a computer science course

I have 16 coins.

- I know one of them is counterfeit *and weighs less*.
- I have a scale which can weigh any two piles.
- What's the minimum number of weighings?
- Take a moment to think about it.

You're kidding, right?

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Outreach

Some final thoughts

…but one more thing!

“Naïve” solution

1. Measure 1 v. 1
   Balance? move on
   Else found fake

You’re kidding, right?

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Outreach

Some final thoughts

…but one more thing!

“Naïve” solution

1. Measure 1 v. 1
   Balance? move on
   Else found fake
2. Measure 1 v. 1
   Balance? move on
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Outreach

Some final thoughts

…but one more thing!

“Naïve” solution

1. Measure 1 v. 1
   Balance? move on
   Else found fake
2. Measure 1 v. 1
   Balance? move on
   Else found fake
3. . . .

You’re kidding, right?

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Outreach

Some final thoughts

. . . but one more thing!

“Naïve” solution

1. Measure 1 v. 1
   Balance? move on
   Else found fake
2. Measure 1 v. 1
   Balance? move on
   Else found fake
3. . . .

Worst case?

You’re kidding, right?

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A problem

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Outreach

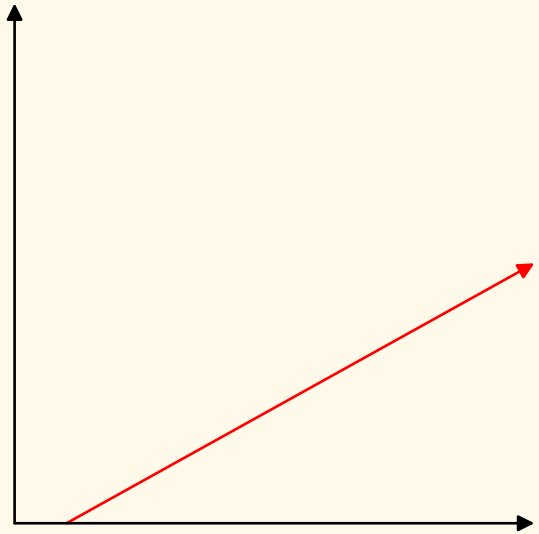
Some final thoughts

. . . but one more thing!

“Naïve” solution

1. Measure 1 v. 1
   Balance? move on
   Else found fake
2. Measure 1 v. 1
   Balance? move on
   Else found fake
3. …

Worst case? $n/2$ measures



“Best” solution

1. Measure 6 v. 6
   Balance? found fake’s pile
   Else found fake’s pile

You’re kidding, right?

A Canticle for Euclid

A problem

Towards a definition of “shiny”

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

“Best” solution

1. Measure 6 v. 6
   Balance? found fake’s pile
   Else found fake’s pile
2. Measure 2 v. 2
   Balance? found fake’s pile
   Else found fake’s pile

You’re kidding, right?

A Canticle for Euclid

A problem

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Outreach

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…but one more thing!

“Best” solution

1. Measure 6 v. 6
   Balance? found fake’s pile
   Else found fake’s pile
2. Measure 2 v. 2
   Balance? found fake’s pile
   Else found fake’s pile
3. Measure 1 v. 1

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Outreach

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…but one more thing!

“Best” solution

1. Measure 6 v. 6
   Balance? found fake’s pile
   Else found fake’s pile
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Outreach

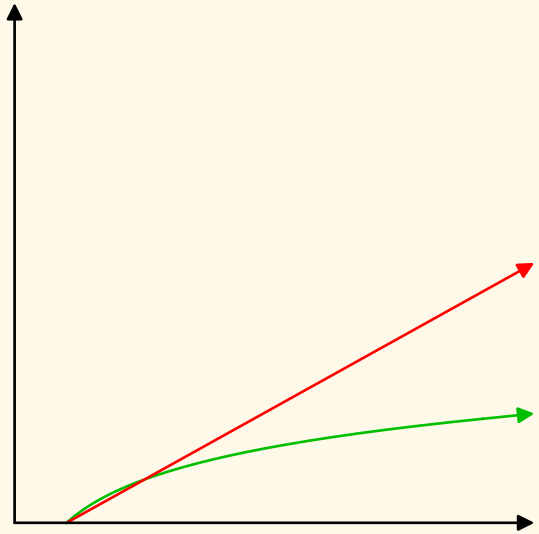
Some final thoughts

…but one more thing!

"Best" solution

1. Measure 6 v. 6
   Balance? found fake's pile
   Else found fake's pile
2. Measure 2 v. 2
   Balance? found fake's pile
   Else found fake's pile
3. Measure 1 v. 1

Worst case? $\log_3 n$ measures



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A Canticle for Euclid

A problem

Towards a definition of "shiny"

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Shiny math!

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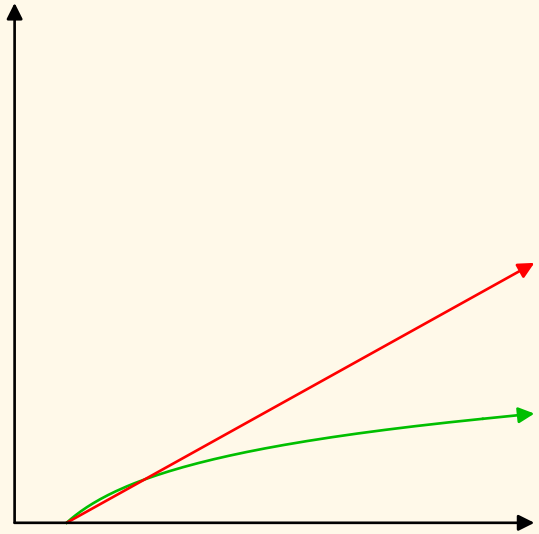
Outreach

Some final thoughts

…but one more thing!

"Best" solution

1. Measure 6 v. 6
   Balance? found fake's pile
   Else found fake's pile
2. Measure 2 v. 2
   Balance? found fake's pile
   Else found fake's pile
3. Measure 1 v. 1



Worst case? $\log_3 n$ measures
students who found this solution: 0

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Common solution

1. Measure 8 v. 8

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Common solution

1. Measure 8 v. 8
2. Measure 4 v. 4

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

...but one more thing!

Common solution

1. Measure 8 v. 8
2. Measure 4 v. 4
3. Measure 2 v. 2

You're kidding, right?

A Canticle for Euclid

A problem

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

...but one more thing!

Common solution

1. Measure 8 v. 8
2. Measure 4 v. 4
3. Measure 2 v. 2
4. Measure 1 v. 1

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Outreach

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...but one more thing!

Common solution

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Common solution

1. Measure 8 v. 8
2. Measure 4 v. 4
3. Measure 2 v. 2
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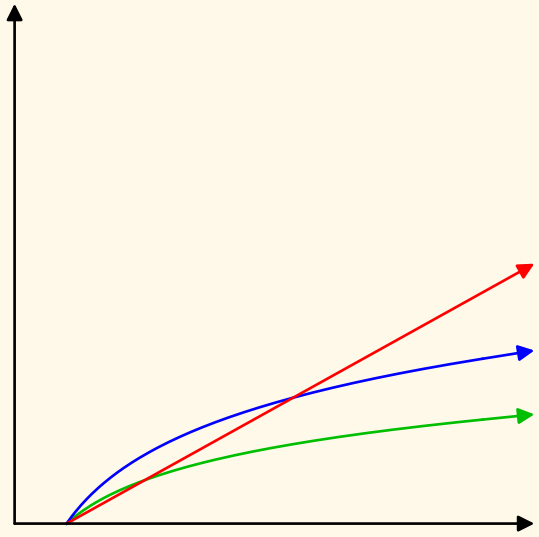
Worst case? $\log_2 n$ measures



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A Canticle for Euclid

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Towards a definition of "shiny"

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Shiny math!

Fight the Symbolab

Outreach

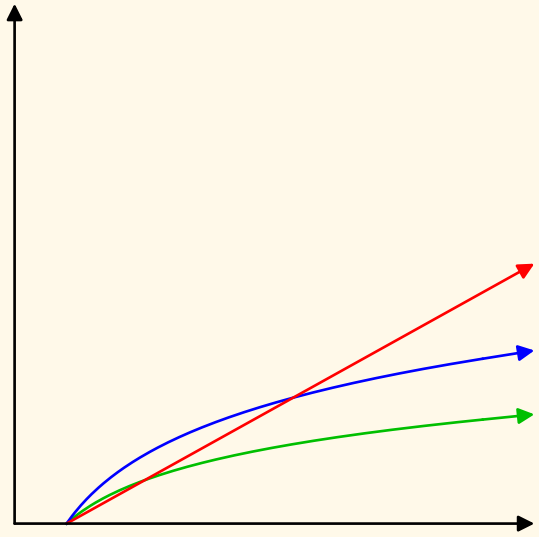
Some final thoughts

…but one more thing!

Common solution

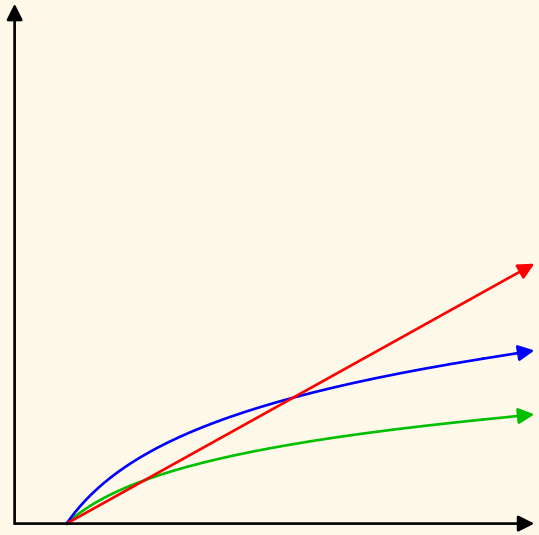
1. Measure 8 v. 8
2. Measure 4 v. 4
3. Measure 2 v. 2
4. Measure 1 v. 1

Worst case? $\log_2 n$ measures
Wrong answer!



Common solution

1. Measure 8 v. 8
2. Measure 4 v. 4
3. Measure 2 v. 2
4. Measure 1 v. 1



Worst case? $\log_2 n$ measures
Wrong answer!

Teacher's comment:

> *"We spend so much time teaching you binary search that you want to do that all the time. It's an example of how our education system beats the creativity out of you."*

You're kidding, right?

A Canticle for Euclid

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Fight the Symbolab

Outreach

Some final thoughts

...but one more thing!

Hold on a moment

"We spend so much time teaching you binary search that you want to do that all the time. It's an example of how our education system beats the creativity out of you."

You're kidding, right?

A Canticle for Euclid

A problem

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

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A problem

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

> *"We spend so much time teaching you binary search that you want to do that all the time. It's an example of how our education system beats the creativity out of you."*

Students *used what they had learned* to come up with a non-naïve solution to a problem they had never seen before.

Hold on a moment

You're kidding, right?

A Canticle for Euclid

A problem

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Fight the Symbolab

Outreach

Some final thoughts

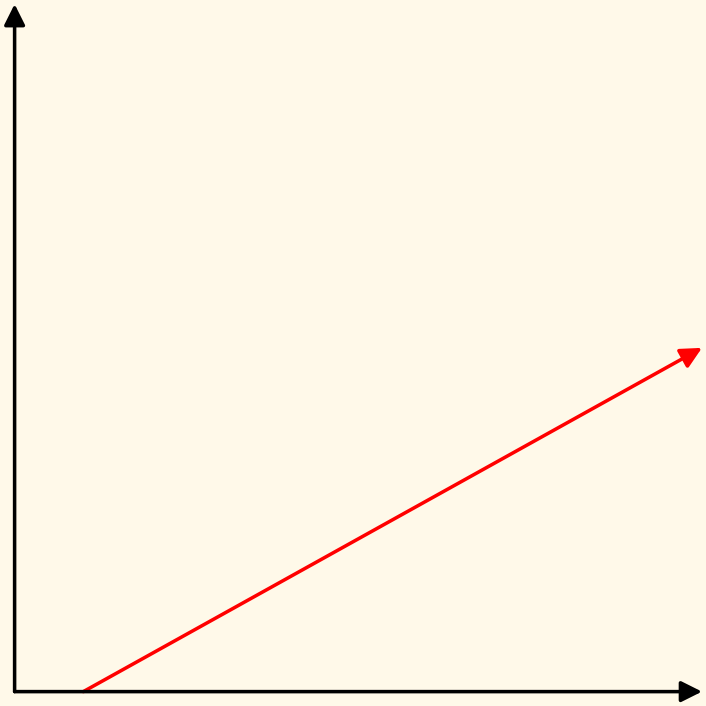
…but one more thing!

> *"We spend so much time teaching you binary search that you want to do that all the time. It's an example of how our education system beats the creativity out of you."*

Students *used what they had learned* to come up with a non-naïve solution to a problem they had never seen before.

How is this not creative?

To recap



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Outreach

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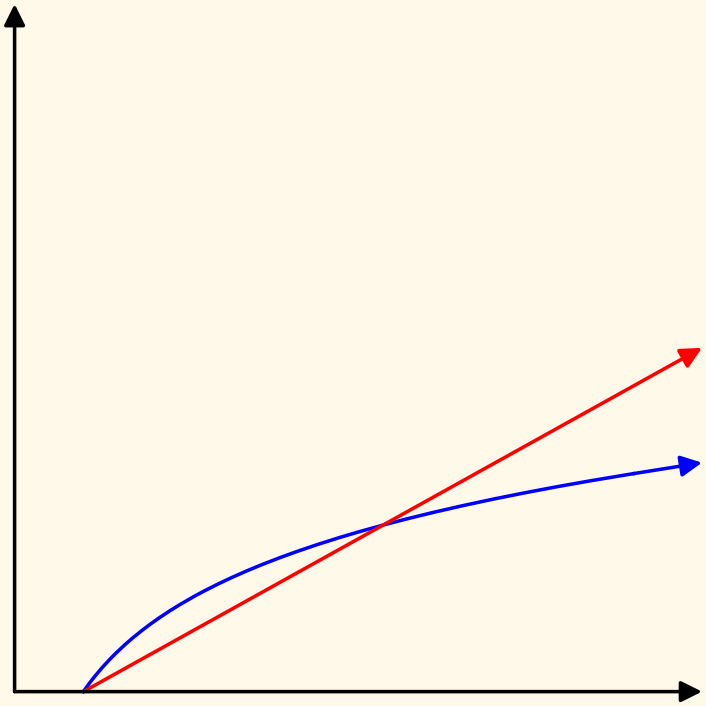
To recap



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Outreach

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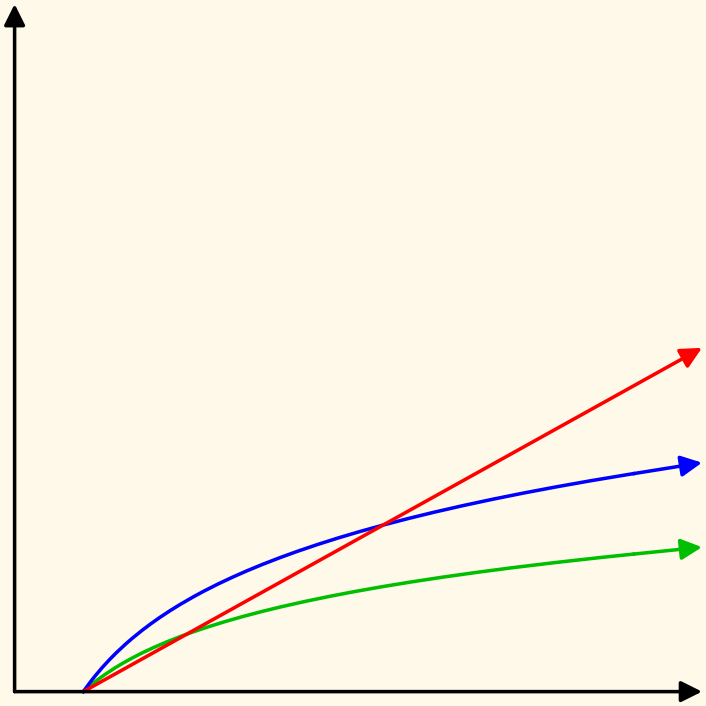
To recap



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A problem

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Still not convinced?

Asymptotic complexity:

naïve $O(n)$ steps

You're kidding, right?

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A problem

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Fight the Symbolab

Outreach

Some final thoughts

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Asymptotic complexity:

naïve $O(n)$ steps

common $O(\log n)$

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A problem

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Fight the Symbolab

Outreach

Some final thoughts

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Still not convinced?

Asymptotic complexity:

naïve	$O(n)$ steps
common	$O(\log n)$
best	$O(\log n)$

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A problem

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Fight the Symbolab

Outreach

Some final thoughts

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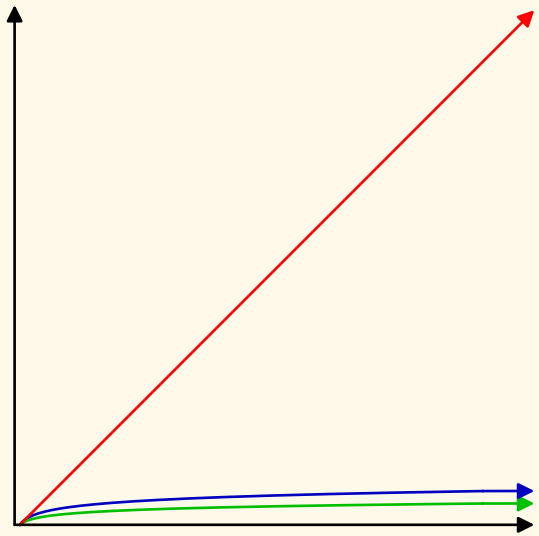
Still not convinced?

Asymptotic complexity:

naïve $O(n)$ steps

common $O(\log n)$

best $O(\log n)$



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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Our students *are* creative.

A canticle for Euclid

John Perry

You're kidding, right?

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A problem

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Thesis

Our students *are* creative.
Not recognizing it doesn't mean it ain't there.

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Our students *are* creative.
Not recognizing it doesn't mean it ain't there.
The problem is that the educational system has beat into us [faculty!] that if you don't find ***the one correct answer in 30 seconds*** then you aren't creative.

A canticle for Euclid
John Perry
You're kidding, right?
A Canticle for Euclid
A problem
Towards a definition of "shiny"
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Shiny math!
Fight the Symbolab
Outreach
Some final thoughts
…but one more thing!

How do we create ideas?

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Fight the Symbolab

Outreach

Some final thoughts

...but one more thing!

Erich Kaltofen saves my PhD

- ACM Fellow
- gcd computation
- polynomial factorization
- primality testing
- polynomial interpolation
- black box computation
- symbolic-numeric computation

You're kidding, right?

A Canticle for Euclid

A problem

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Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Erich Kaltofen saves my PhD

- ACM Fellow
- gcd computation
- polynomial factorization
- primality testing
- polynomial interpolation
- black box computation
- symbolic-numeric computation

You ask a very good question: How do we create ideas? In my entire career, I've had only 4 truly original ideas.

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

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Outreach

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Over 200 publications. Highly cited. I *respect* this guy. Only 4 ideas? Maybe I *can* do this.

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A problem

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Outreach

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A problem

Towards a definition of "shiny"

Why Euclid?

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Why aren't our students creative?

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Fight the Symbolab

Outreach

Some final thoughts

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Bertrand Meyer

- ACM Fellow
- Design by Contract
- Eiffel programming language

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A problem

Towards a definition of "shiny"

Why Euclid?

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Outreach

Some final thoughts

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99.97% of all research . . . is incremental.

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A problem

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How do we teach mathematics?

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Fight the Symbolab

Outreach

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A problem

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Outreach

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A Canticle for Euclid

A problem

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Why Euclid?

What is mathematics?

Why aren't our students creative?

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Fight the Symbolab

Outreach

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. . . but one more thing!

Bertrand Meyer

99.97% of all research . . . is incremental. [W]hen a "breakthrough" does happen — the remaining 0.03% — it was often not planned as a breakthrough. . . . You read someone else's solution to a problem, and you improve on it. Any history of science will tell you that for every teenager who from getting hit by a falling apple intuits the structure of the universe there are hundreds of great researchers who look at the state of the art and decide they can do a trifle better.

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

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Fight the Symbolab

Outreach

Some final thoughts

. . . but one more thing!

So how do we create ideas?

1. I don't know, but…

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

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Fight the Symbolab

Outreach

Some final thoughts

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1. I don't know, but…
2. Small results are good results

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

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1. I don't know, but…
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3. We stand on the shoulders of giants

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A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Fight the Symbolab

Outreach

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…but one more thing!

So how do we create ideas?

1. I don't know, but…
2. Small results are good results
3. We stand on the shoulders of giants
4. Learn from what is good about the past

You're kidding, right?

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A problem

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Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

So how do we create ideas?

1. I don't know, but…
2. Small results are good results
3. We stand on the shoulders of giants
4. Learn from what is good about the past
5. Be humble about your results

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A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

How do we teach mathematics?

A canticle for Euclid

John Perry

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A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

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Fight the Symbolab

Outreach

Some final thoughts

...but one more thing!

Start early

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

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How do we create ideas?

How do we teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

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Ehi, professore!

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

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Start early

Ehi, professore!

A quei tempi, era difficile prendere il 9!

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A Canticle for Euclid

A problem

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Why Euclid?

What is mathematics?

Why aren't our students creative?

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How do we teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Translations for those not at the talk

1. *Ehi, professore!* (Hello, professor!)
   Tell the soft-spoken, bookish weirdos that there's a place for them in the world.

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Translations for those not at the talk

1. *Ehi, professore!* (Hello, professor!)
   Tell the soft-spoken, bookish weirdos that there's a place for them in the world.
2. *A quei tempi, era difficile prendere il 9!* (In those days, it was hard to earn an A!)
   Working hard for a good grade gives an objective reason for pride.

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

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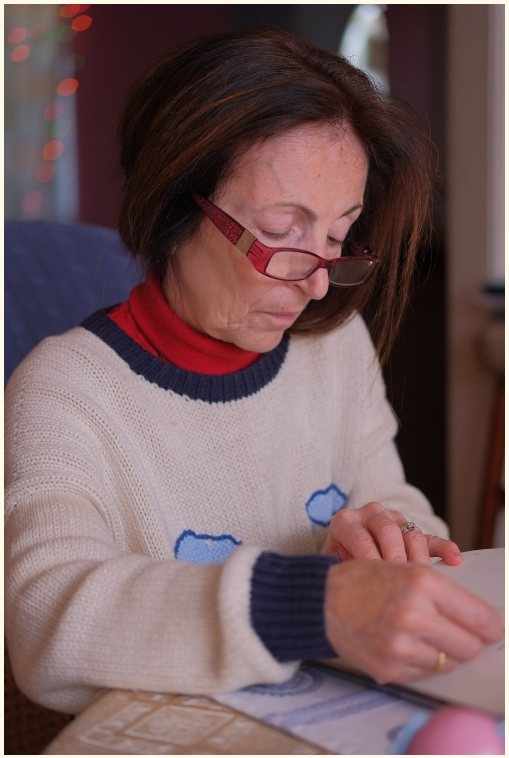
Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Do your homework



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A problem

Towards a definition of "shiny"

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What is mathematics?

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Outreach

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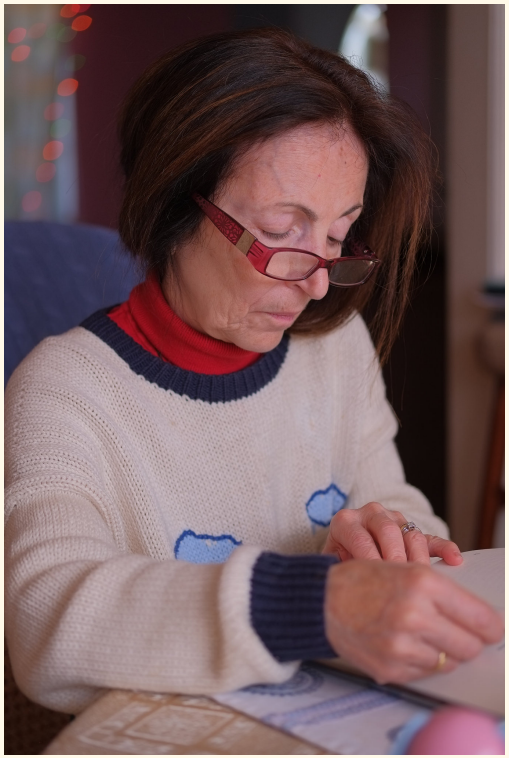

Past retirement age.
Grading papers & preparing lessons on Christmas Break.
Typical Southern Italian, right?

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

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What is mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

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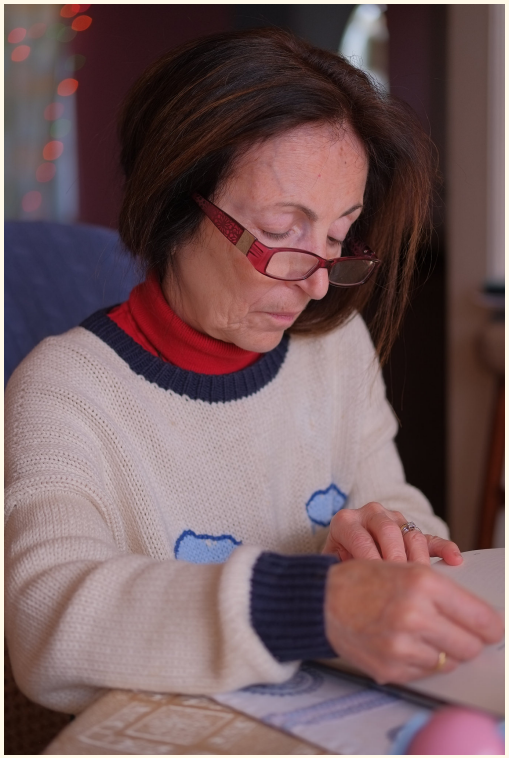

Past retirement age.
Grading papers & preparing lessons on Christmas Break.
Typical Southern Italian, right?

(Her students do well on the statewide tests.)

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A problem

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Outreach

Some final thoughts

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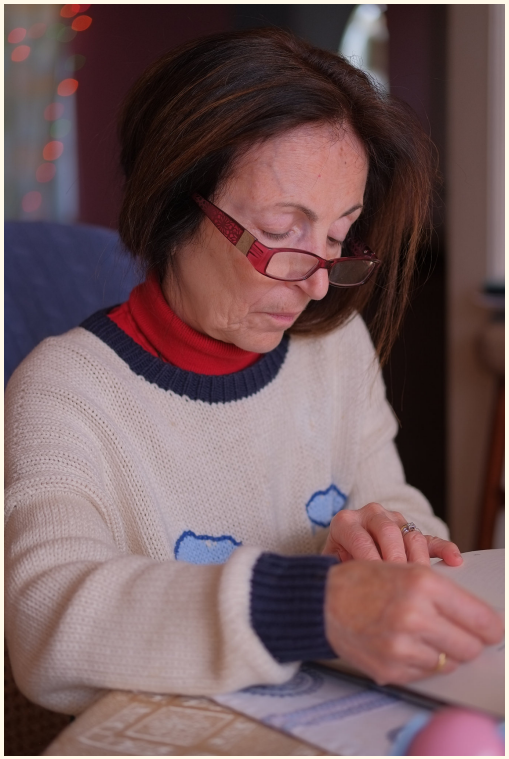

"I love math, but no matter how hard I work at it,
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Fight the Symbolab

Outreach

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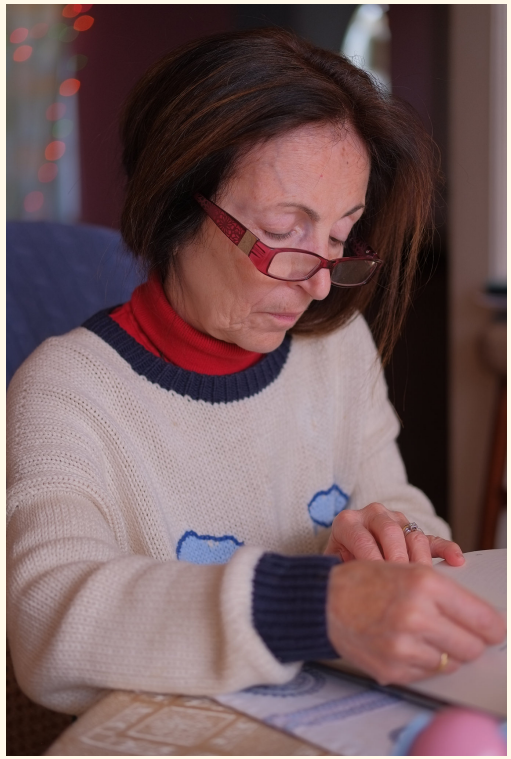

"I love math, but no matter how hard I work at it,
I just don't get it."

I didn't earn a PhD because I'm good at math,
but because I was too dumb to quit.

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A problem

Towards a definition of "shiny"

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Fight the Symbolab

Outreach

Some final thoughts

...but one more thing!

Along those lines: Don Music

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Along those lines: Don Music

Oh, I'll never do it!
Never, oh!

(links to a video, click it!)

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

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How do we teach mathematics?

How should we not teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Mathematics should make sense

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

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Mathematics should make sense

Too often, math teachers present mathematics as a bunch of unrelated tricks.

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

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Fight the Symbolab

Outreach

Some final thoughts

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Towards a definition of "shiny"

Why Euclid?

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Fight the Symbolab

Outreach

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Mathematics should make sense

Too often, math teachers present mathematics as a bunch of unrelated tricks. I never knew that math was supposed to make sense until I got to college and had a professor who told us that he would grade every part of the test *except* the answer. You could have every answer wrong and still earn 100% because you had done the problems correctly.

A canticle for Euclid

John Perry

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

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How do we create ideas?

How do we teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Mathematics should make sense

also, Even if the teacher teaches only "to the test", at least the teacher teaches *something*.

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

also, Even if the teacher teaches only "to the test", at least the teacher teaches *something*. Back in the 70s things were so bad that high school graduates started suing their schools because they couldn't find jobs because they couldn't even read the diploma the school had given them!

How about some PhDs?

- Vanessa Job, Marymount University

I apologize for my mistakes.
Your brain stops working when you're at the board.

You're kidding, right?

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A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

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Fight the Symbolab

Outreach

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…but one more thing!

How about some PhDs?

- Vanessa Job, Marymount University

  I apologize for my mistakes.
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- Adrian Riskin, Northern Arizona University

  A good mathematics teacher should tell the truth and nothing but the truth, but never ever ever the whole truth.

(also)

If there's any justice at all, and in algebra there usually is, [insert theorem here].

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A problem

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Fight the Symbolab

Outreach

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(also)

If there's any justice at all, and in algebra there usually is, [insert theorem here].

- Hoon Hong, North Carolina State University

Never introduce an idea until you need it.

(also)

Every now and then you have to stop and engage in meta-thinking: that is, thinking about your thinking.

You're kidding, right?
A Canticle for Euclid
A problem
Towards a definition of "shiny"
Why Euclid?
What is mathematics?
Why aren't our students creative?
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Shiny math!
Fight the Symbolab
Outreach
Some final thoughts
…but one more thing!

Michael Starbird: practice the basics

You're kidding, right?

A Canticle for Euclid

- A problem
- Towards a definition of "shiny"
- Why Euclid?
- What is mathematics?
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Shiny math!

- Fight the Symbolab
- Outreach

Some final thoughts

…but one more thing!

How should we not teach mathematics?

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

...but one more thing!

Don’t get the wrong idea here

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A Canticle for Euclid

A problem

Towards a definition of “shiny”

Why Euclid?

What is mathematics?

Why aren’t our students creative?

How do we create ideas?

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Fight the Symbolab

Outreach

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Yes, the selfsame Michael Starbird.
But really, don’t get the wrong idea!

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Fight the Symbolab

Outreach

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His liberal arts class proved countability of $\mathbb{Q}$

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A problem

Towards a definition of “shiny”

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Fight the Symbolab

Outreach

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Calculus in 15 minutes: Zeno the traffic patrol

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A problem

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Outreach

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Calculus in 15 minutes: Zeno the traffic patrol

Good teaching looks easy and fun!

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Outreach

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…but one more thing!

What's the opposite of an epiphany?

I'm sitting there the whole time thinking,

You're kidding, right?

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Towards a definition of "shiny"

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Outreach

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Outreach

Some final thoughts

…but one more thing!

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- Yes!
- This is awesome!

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Outreach

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…but one more thing!

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I'm sitting there the whole time thinking,

- Yes!
- This is awesome!
- I do that, too! Almost the same story!

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

What's the opposite of an epiphany?

I'm sitting there the whole time thinking,

- Yes!
- This is awesome!
- I do that, too! Almost the same story!
- I do exactly as an MAA-award winner recommends!

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A problem

Towards a definition of "shiny"

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Shiny math!

Fight the Symbolab

Outreach

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…but one more thing!

What's the opposite of an epiphany?

I'm sitting there the whole time thinking,

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Outreach

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…but one more thing!

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A problem

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…but one more thing!

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A canticle for Euclid
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You're kidding, right?
A Canticle for Euclid
A problem
Towards a definition of "shiny"
Why Euclid?
What is mathematics?
Why aren't our students creative?
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How should we not teach mathematics?
Shiny math!
Fight the Symbolab
Outreach
Some final thoughts
…but one more thing!

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They don't do anything different from me.

I wanted to leave teaching.

A canticle for Euclid
John Perry
You're kidding, right?
A Canticle for Euclid
A problem
Towards a definition of "shiny"
Why Euclid?
What is mathematics?
Why aren't our students creative?
How do we create ideas?
How do we teach mathematics?
How should we not teach mathematics?
Shiny math!
Fight the Symbolab
Outreach
Some final thoughts
…but one more thing!

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Conjecture: John Perry $\not\cong$ Michael Starbird

A canticle for Euclid

John Perry

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

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A canticle for Euclid
John Perry
You're kidding, right?
A Canticle for Euclid
A problem
Towards a definition of "shiny"
Why Euclid?
What is mathematics?
Why aren't our students creative?
How do we create ideas?
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Shiny math!
Fight the Symbolab
Outreach
Some final thoughts
…but one more thing!

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A canticle for Euclid
John Perry
You're kidding, right?
A Canticle for Euclid
A problem
Towards a definition of "shiny"
Why Euclid?
What is mathematics?
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Fight the Symbolab
Outreach
Some final thoughts
…but one more thing!

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Likelihood: There is no "magic bullet."

A canticle for Euclid
John Perry
You're kidding, right?
A Canticle for Euclid
A problem
Towards a definition of "shiny"
Why Euclid?
What is mathematics?
Why aren't our students creative?
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Shiny math!
Fight the Symbolab
Outreach
Some final thoughts
…but one more thing!

What do I blame?

Students receive grades they don't deserve.

- curves
- "40 is the new 0"
- lack of homework, non-challenging tests
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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

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Shiny math!

Fight the Symbolab

Outreach

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Email excerpt

I just spent 2 hours helping an Honors College Calc II student with roughly 5 problems.

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

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Fight the Symbolab

Outreach

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

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A canticle for Euclid

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You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

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Task	Student's approach
$(mg)^2 = m^2g^2$	$(mg)^2 = mg^2$
$\sec(\pi/4) = 2/\sqrt{2}$	look it up at mathway.com
$\frac{d}{dm}(gm) = g$	"isn't the derivative of a constant 0?"
the chain rule	didn't understand it well last semester & just sort of guessed her way through

A canticle for Euclid

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

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the young lady earned an A in Calc I from one of our classes last spring.

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

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Outreach

Some final thoughts

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A problem

Towards a definition of "shiny"

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Fight the Symbolab

Outreach

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

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Fight the Symbolab

Outreach

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A problem

Towards a definition of "shiny"

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Fight the Symbolab

Outreach

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Fight the Symbolab

Outreach

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A problem

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Outreach

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A problem

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Outreach

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It is a setup for literal failure.

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Towards a definition of "shiny"

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

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How should we not teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

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How do we create ideas?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

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How do we create ideas?

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How should we not teach mathematics?

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Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

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A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

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A problem

Towards a definition of "shiny"

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Through the grapevine

This year a major employer in north MS is training workers over a 2-day period at $26/hr to:

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

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You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

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Fight the Symbolab

Outreach

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

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How do we teach mathematics?

How should we not teach mathematics?

Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

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Some of us aren't *paid* that much to *teach* that! (ca. $52,000/year)

Outline

1. You're kidding, right?
2. A Canticle for Euclid
   - A problem
   - Towards a definition of "shiny"
   - Why Euclid?
   - What is mathematics?
   - Why aren't our students creative?
   - How do we create ideas?
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   - How should we not teach mathematics?
3. Shiny math!
   - Fight the Symbolab
   - Outreach
4. Some final thoughts
5. …but one more thing!

Fight the Symbolab

A canticle for Euclid

John Perry

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

...but one more thing!

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

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A problem

Towards a definition of "shiny"

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What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

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A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

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How do we teach mathematics?

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Fight the Symbolab

Outreach

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JP Symbolab?

ST It's an online homework system. It even shows you how to do each step.

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

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What is mathematics?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

An aside

I actually like this student. Can you guess why?

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A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

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Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

...but one more thing!

An aside

I actually like this student. Can you guess why?

I want to understand how to do it.

You're kidding, right?

A Canticle for Euclid

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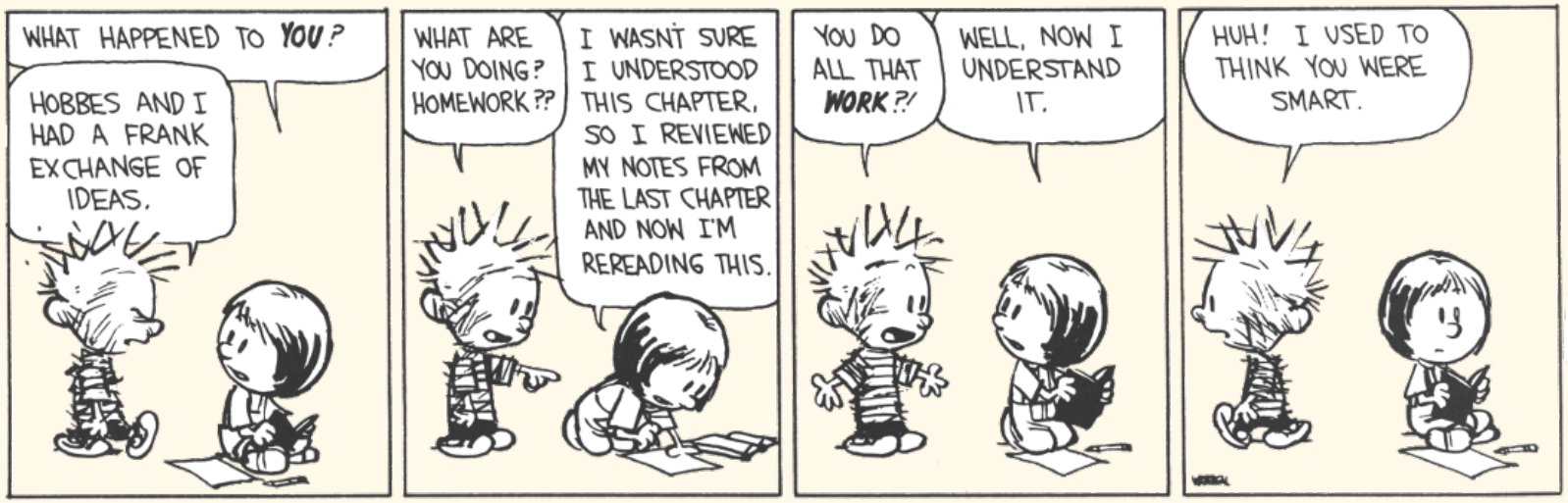

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Outreach

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New-timey calculators!

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Outreach

Some final thoughts

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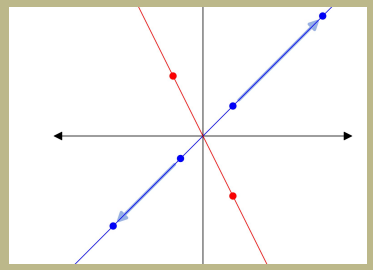
Free textbook for a free system!

www.math.usm.edu/dont_panic

Peering into Mathematics through Sage-colored Glasses



John Harris · Karen Kohl · John Perry

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Outreach

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Outreach

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Outreach

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Populations are declining

Attract — or inspire — better students!

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Outreach

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They will pay cold, hard cash.

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Leaving a good impression on a student will bring cold, hard cash in the future!

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Outreach

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- Visit schools
- Games and competitions
  - MappMath.org
  - American Mathematics Competition

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Outreach

Some final thoughts

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Wuzzit Trouble

— from Brainquake

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Outreach

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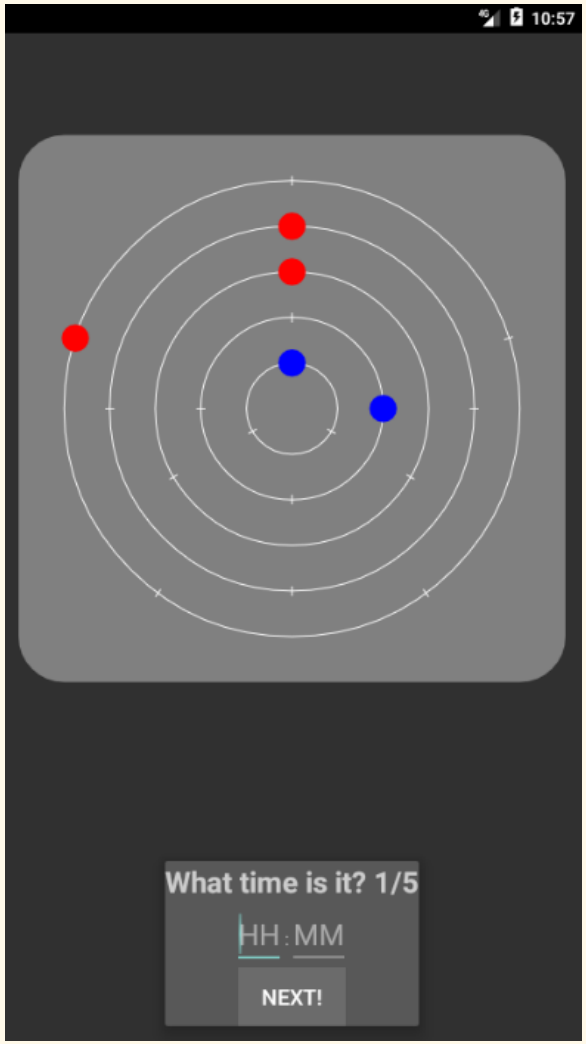
The Perucca Clock



App at Google Play Store

Antonella Perucca

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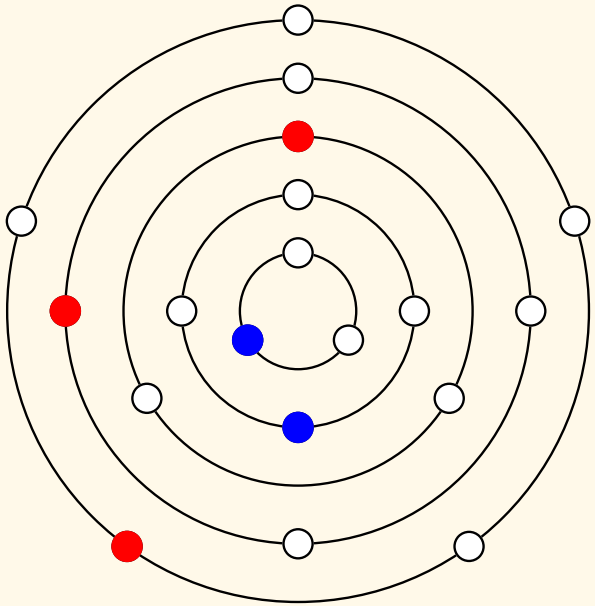

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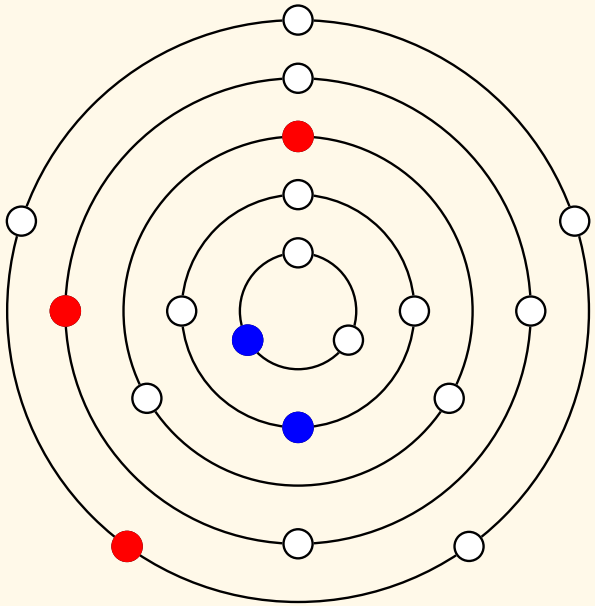

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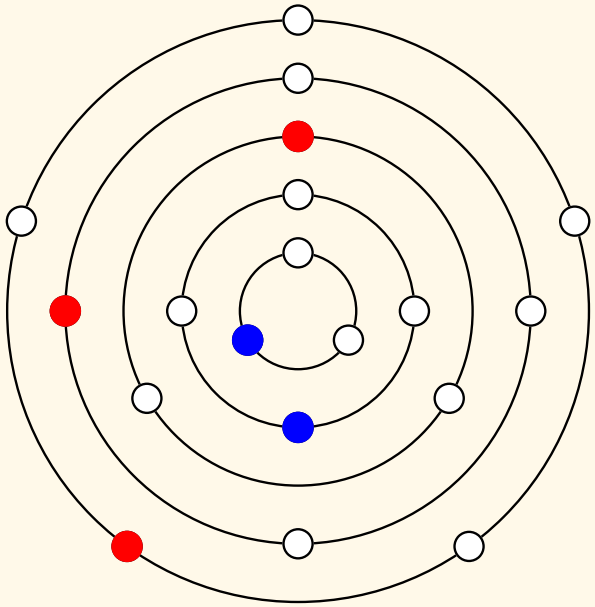
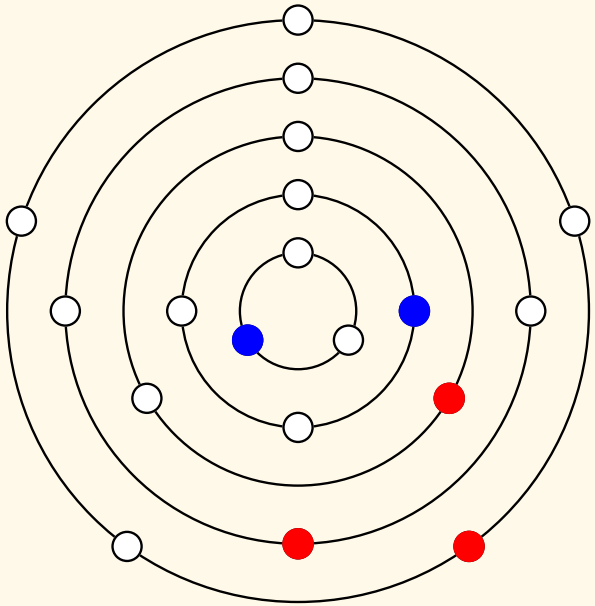


- The hour
  - when dividing by 3, the remainder is 2
  - when dividing by 4, the remainder is 2
- The minute
  - when dividing by 3, the remainder is 0
  - when dividing by 4, the remainder is 3
  - when dividing by 5, the remainder is 3

What time is it?



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Outreach

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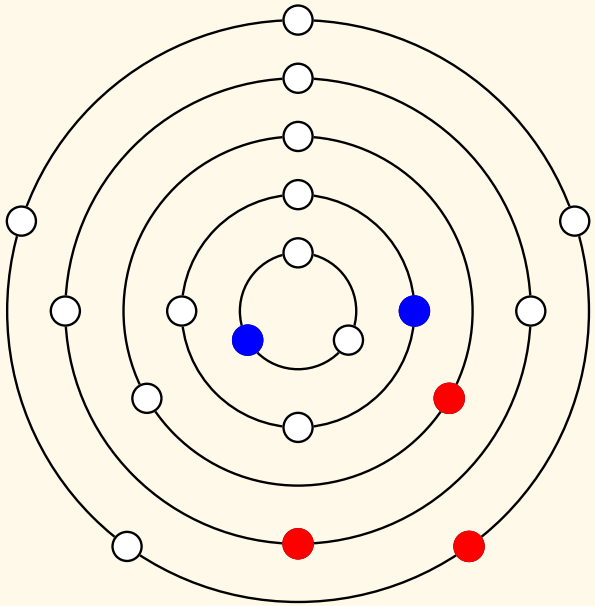

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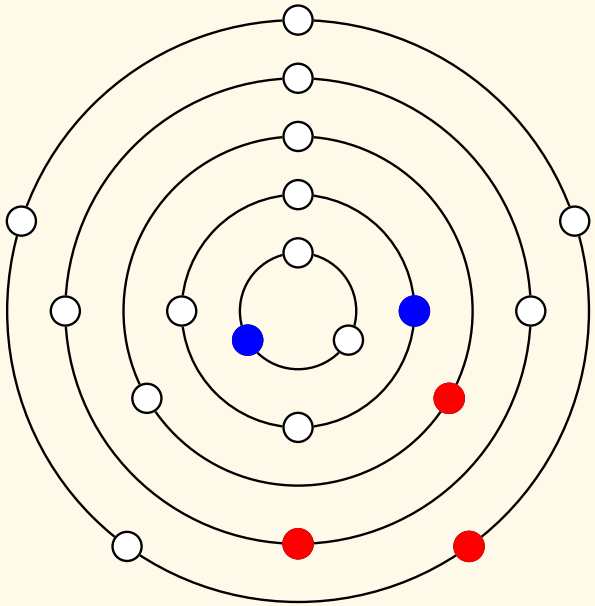

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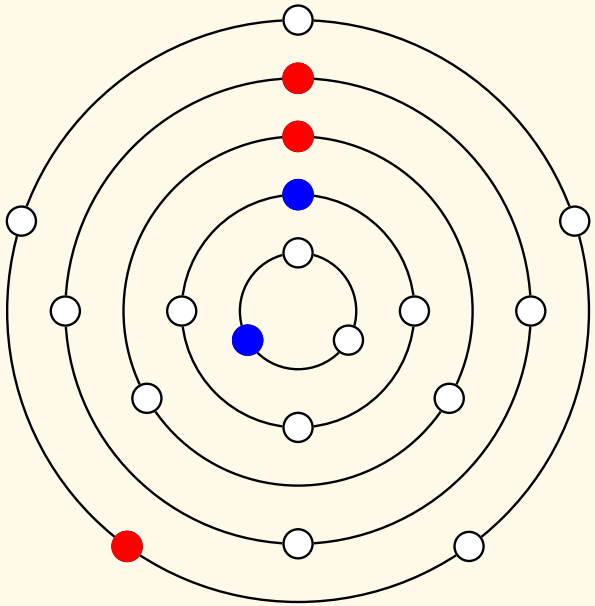

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Outreach

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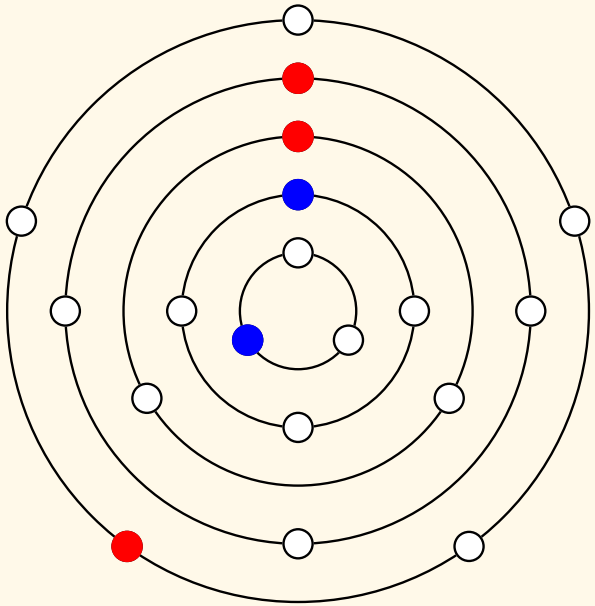

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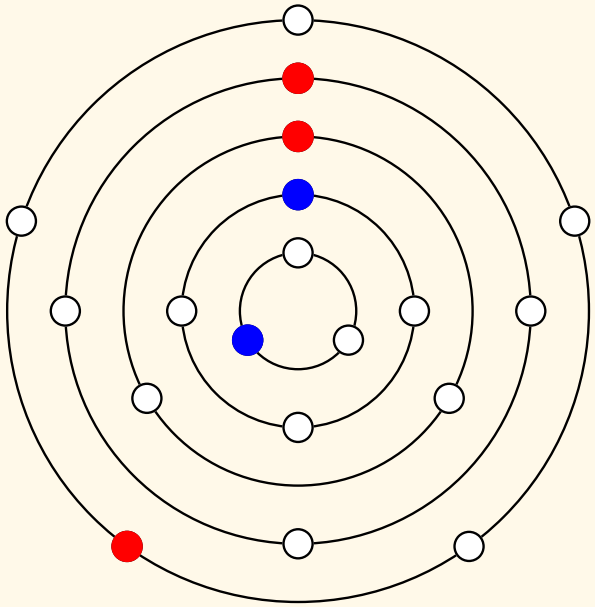

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“Chinese Remainder Clock”

Theorem (Chinese Remainder Theorem)

Given integers a and b that have no common factors, and given two numbers c and d, there is exactly one number x between 1 and ab such that the remainder of dividing x by a is c and the remainder of dividing x by b is d.

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Outreach

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Outreach

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Golden Eagle Nim

Rules

1. Two players alternate turns.
2. On each turn, the player crosses out any number of eagles in **one** row.
3. The player who takes the last eagle wins.
4. Can you find a strategy that guarantees a win?

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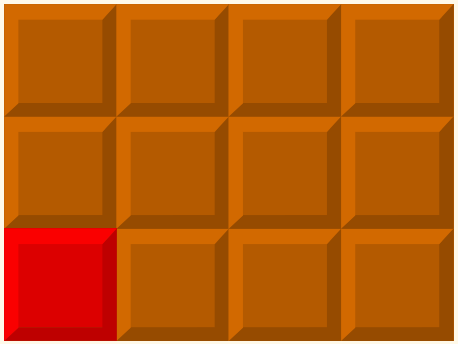
…or try Droid Nim

Chomp



Rules

1. Two players alternate turns.
2. On your turn, choose a corner and "chomp" each square northeast of it.
3. The player who chomps the poisoned red square loses!
4. Can you find a strategy that guarantees a win?

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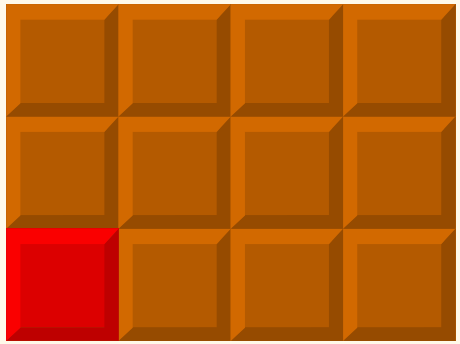

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. . . or try various Android apps

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Mathematical games (3)

Ideal Nim

Modern Algebra I, II

August 18, 2016

Ideal Nim is a game for two players. To start, choose a set of not-too-many points F. This defines the *F*orbidden *F*rontier. A point (c,d) lies in the Forbidden Frontier if

- (c,d) does not lie "northeast" of any point in F;

or, more precisely,

- for any point $(a,b) \in F$, $c \leq a$ or $d \leq b$.

Players may not choose a point in the Forbidden Frontier.

Gameplay consists of choosing points (c,d) and adding them to a set G, which defines a region *G*one from *G*ameplay. A point (m,n) is Gone from Gameplay if

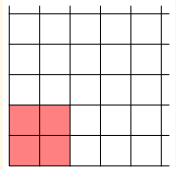
- (m,n) lies "northeast" of some point of G;

or, more precisely,

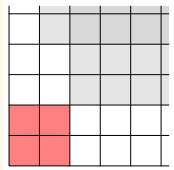
- we can find a point $(c,d) \in G$ such that $c \leq m$ and $d \leq n$.

Players may not choose a point that is Gone from Gameplay.

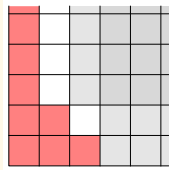
Examples



This game is defined by $F = \{(0,2),(2,0)\}$. The Forbidden Frontier consists of the four points $(0,0)$, $(0,1)$, $(1,0)$, and $(1,1)$. No moves have been made, so no points are Gone from Gameplay.



This game is defined by $F = \{(0,2),(2,0)\}$. The Forbidden Frontier consists of the four points $(0,0)$, $(0,1)$, $(1,0)$, and $(1,1)$. At least two moves have been made, to $(2,2)$ and $(1,4)$. Any point *inside* or *bordering* the gray region is Gone from Gameplay.



This game is defined by $F = \{(1,2),(2,1),(3,0)\}$. The Forbidden Frontier consists of the points that lie *inside* the red region. At least two moves have been made, to $(2,2)$ and $(3,0)$. The only playable points remaining are $(2,1)$ and $(1,y)$, for any $y \geq 2$.

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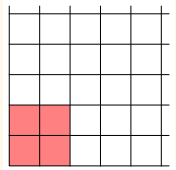
or, more precisely,

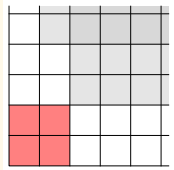
- we can find a point $(c,d)\in G$ such that $c\leq m$ and $d\leq n$.

Players may not choose a point that is Gone from Gameplay.

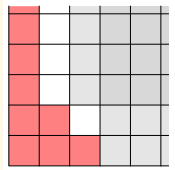
Examples



This game is defined by $F=\{(0,2),(2,0)\}$. The Forbidden Frontier consists of the four points $(0,0)$, $(0,1)$, $(1,0)$, and $(1,1)$. No moves have been made, so no points are Gone from Gameplay.



This game is defined by $F=\{(0,2),(2,0)\}$. The Forbidden Frontier consists of the four points $(0,0)$, $(0,1)$, $(1,0)$, and $(1,1)$. At least two moves have been made, to $(2,2)$ and $(1,4)$. Any point *inside* or *bordering* the gray region is Gone from Gameplay.



This game is defined by $F=\{(1,2),(2,1),(3,0)\}$. The Forbidden Frontier consists of the points that lie *inside* the red region. At least two moves have been made, to $(2,2)$ and $(3,0)$. The only playable points remaining are $(2,1)$ and $(1,y)$, for any $y\geq 2$.

…or try Android app

You're kidding, right?

A Canticle for Euclid

A problem

Towards a definition of "shiny"

Why Euclid?

What is mathematics?

Why aren't our students creative?

How do we create ideas?

How do we teach mathematics?

How should we not teach mathematics?

Shiny math!

Fight the Symbolab

Outreach

Some final thoughts

…but one more thing!

Math is “shiny”, but…

De gustibus non disputandum.

You’re kidding, right?

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Math is “shiny”, but…

De gustibus non disputandum.

[Translation 1: It’s a mental kind of shiny.]

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Math is “shiny”, but…

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[Translation 1: It’s a mental kind of shiny.]

[Translation 2: I’m mental.]

But really,

You’re kidding, right?

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…but one more thing!

Math is “shiny”, but…

De gustibus non disputandum.

[Translation 1: It’s a mental kind of shiny.]

[Translation 2: I’m mental.]

But really,
There’s no magic bullet for every situation.

You’re kidding, right?

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…but one more thing!

Outline

1. You're kidding, right?
2. A Canticle for Euclid
   - A problem
   - Towards a definition of "shiny"
   - Why Euclid?
   - What is mathematics?
   - Why aren't our students creative?
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3. Shiny math!
   - Fight the Symbolab
   - Outreach
4. Some final thoughts
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Some final thoughts

…but one more thing!

What is mathematics?

When I meditate on the unchangeable truth of number, and, so to speak, its home or sanctuary, or whatever word is suitable to describe the place where number resides, I am carried far away from the body.

You're kidding, right?

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What is mathematics?

When I meditate on the unchangeable truth of number, and, so to speak, its home or sanctuary, or whatever word is suitable to describe the place where number resides, I am carried far away from the body. Finding, it may be, something which I can think of, but not finding anything I can express in words, I return, worn out, to familiar things in order to speak, and I express in ordinary language what lies before my eyes.

A canticle for Euclid

John Perry

You're kidding, right?

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— St. Augustine

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— St. Augustine

Definition (Mathematics)

The art of expressing the unchangeable truth of number in words.

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The end

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- Fight the Symbolab
- Outreach

Some final thoughts

. . . but one more thing!

The end

. . . my favorite people are waiting for me.

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You have homework

Every year we choose someone new

- Nominate someone worthy!
- Nominate someone again!
  - update the application
  - consider saying more
- Many good candidates; we can only choose one (I think)

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This year's awardee

- At least 30 years of service

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- Received national recognition for work funded by an Eisenhower grant

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Congratulations to…

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Congratulations to…

George Mead
McNeese State University

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