

Concord-Carlisle
Opening Day

Merging the Disciplines (STEAM and more)

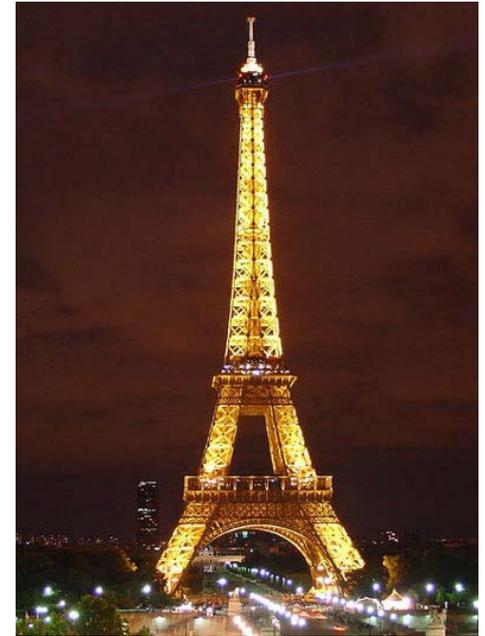
August 29, 2016

Arthur Eisenkraft



A story

- Information challenge
 - \$50 vs \$10
 - What is the height of Eiffel Tower?
 - What is both a mammal and a virus?





Where is the knowledge
we have lost in
information...

T.S. Eliot

Open book vs Closed book tests

- Open book → open internet
 - Instant access to internet at anytime and anyplace
- How do tests change when they are open internet tests?



Where is the knowledge
we have lost in
information...

T.S. Eliot

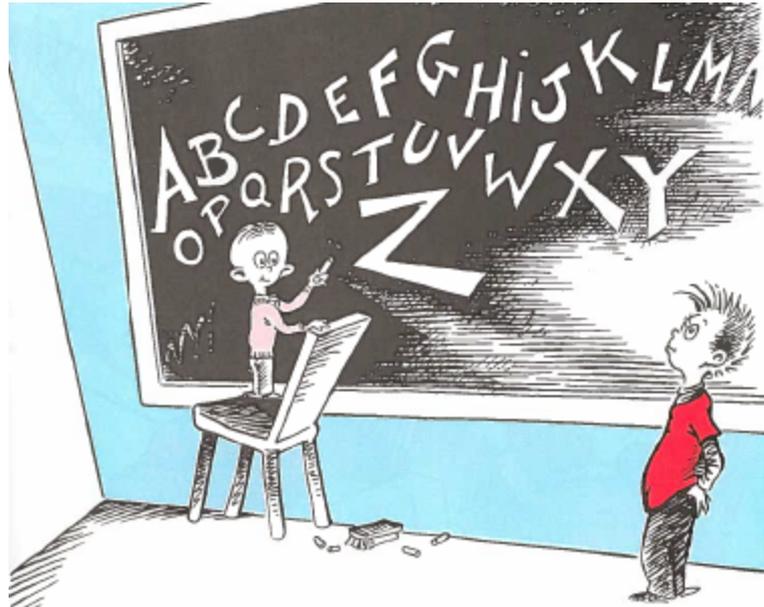
What is the knowledge to share?

Let's turn to one of the great
communicators of the 20th century.



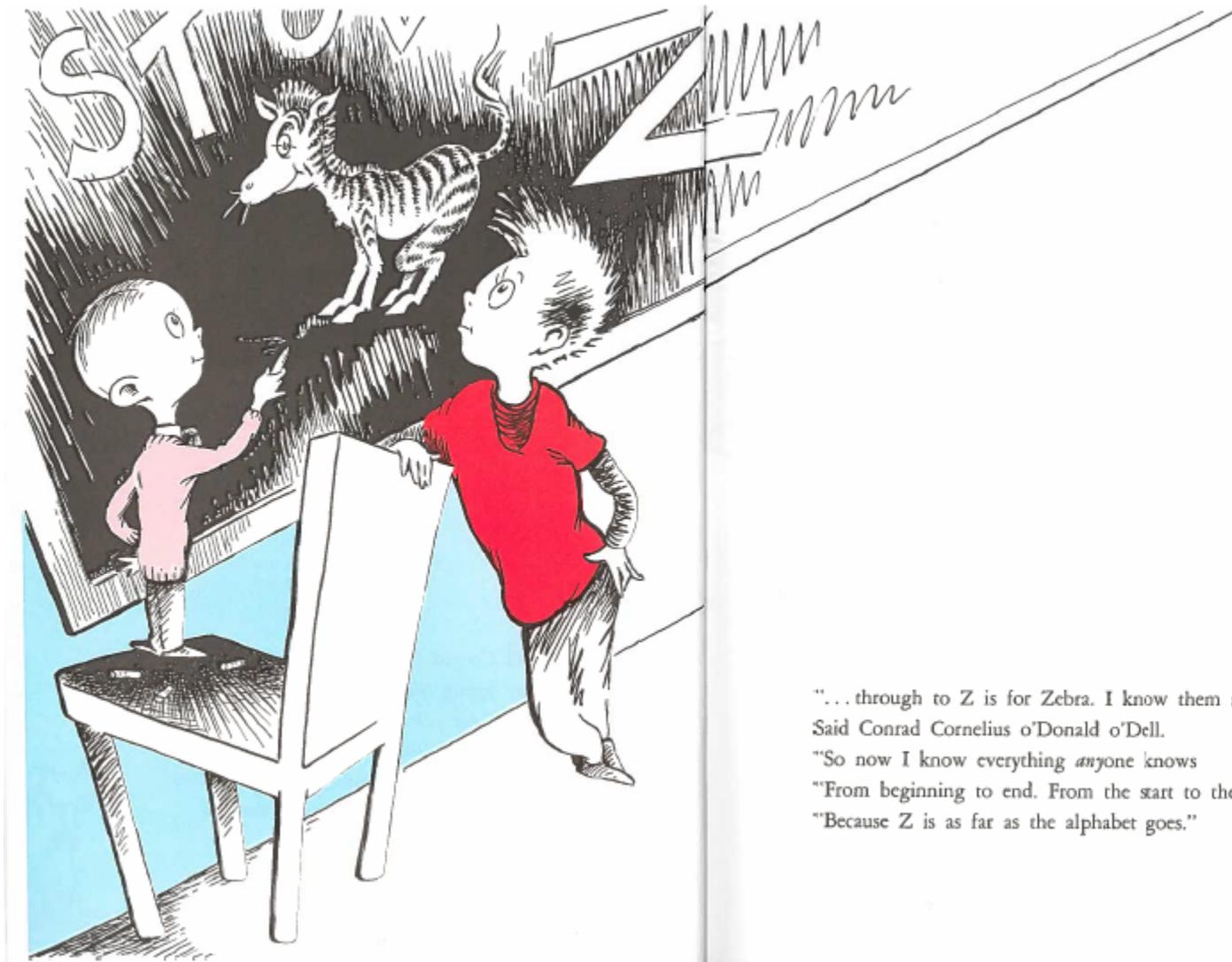
**ON
BEYOND
ZEBRA!**

By Dr. Seuss....



Said Conrad Cornelius o'Donald o'Dell,
My very young friend who is learning to spell:
"The A is for Ape. And the B is for Bear.
"The C is for Camel. The H is for Hare.
"The M is for Mouse. And the R is for Rat.
"I know *all* the twenty-six letters like that . . .





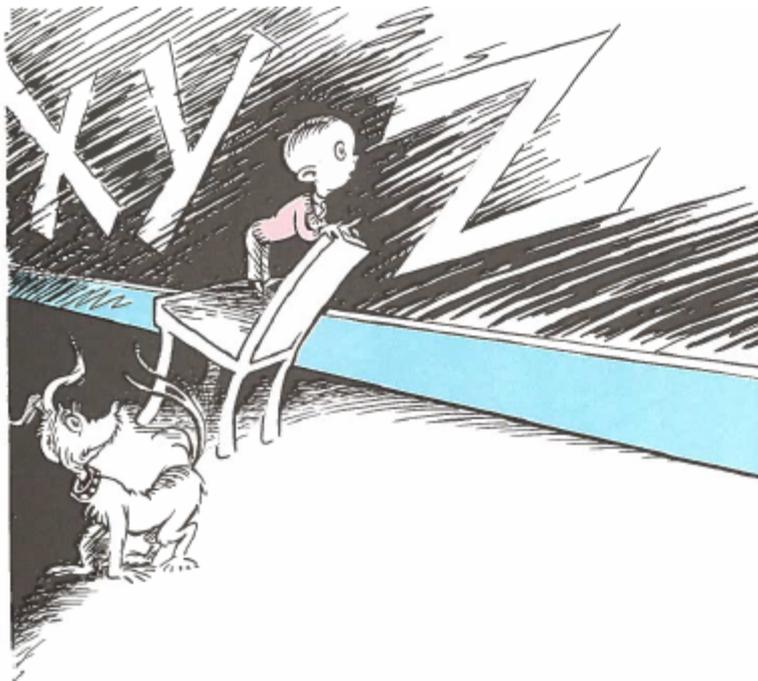
"...through to Z is for Zebra. I know them all well."

Said Conrad Cornelius o'Donald o'Dell.

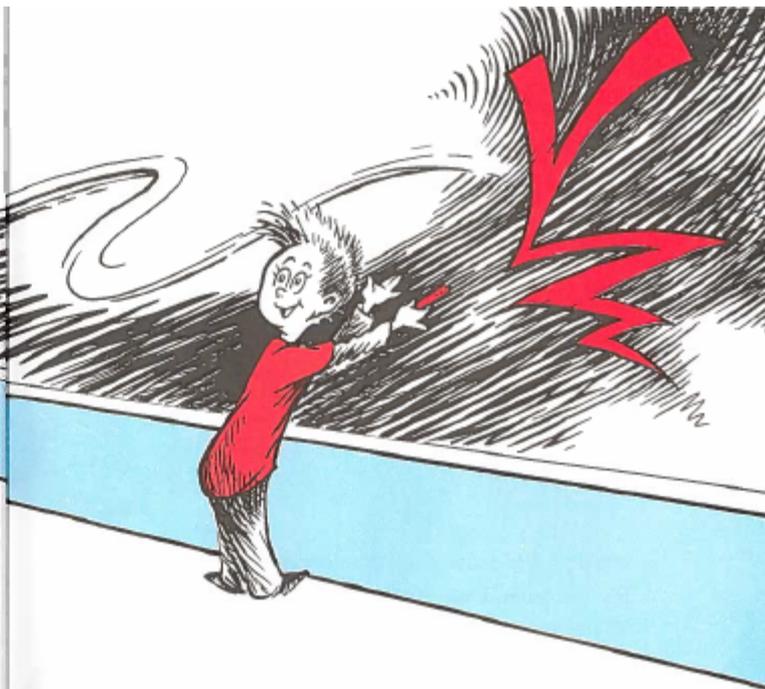
"So now I know everything *anyone* knows

"From beginning to end. From the start to the close.

"Because Z is as far as the alphabet goes."



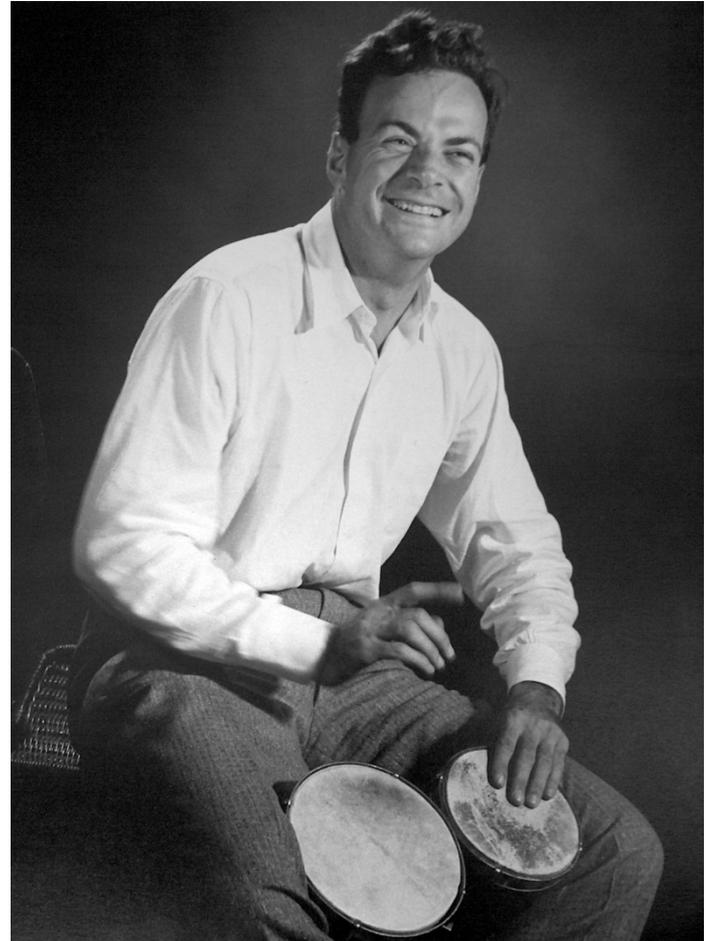
Then he almost fell flat on his face on the floor
When I picked up the chalk and drew one letter more!
A letter he never had dreamed of before!
And I said, "You can stop, if you want, with the Z
"Because most people stop with the Z
"But not me!



"In the places I go there are things that I see
"That I *never* could spell if I stopped with the Z.
"I'm telling you this 'cause you're one of my friends.
"My alphabet starts where *your* alphabet ends!

Feynman and math

- $3x + 2 = 14$



Feynman and math

- $3x + 2 = 14$

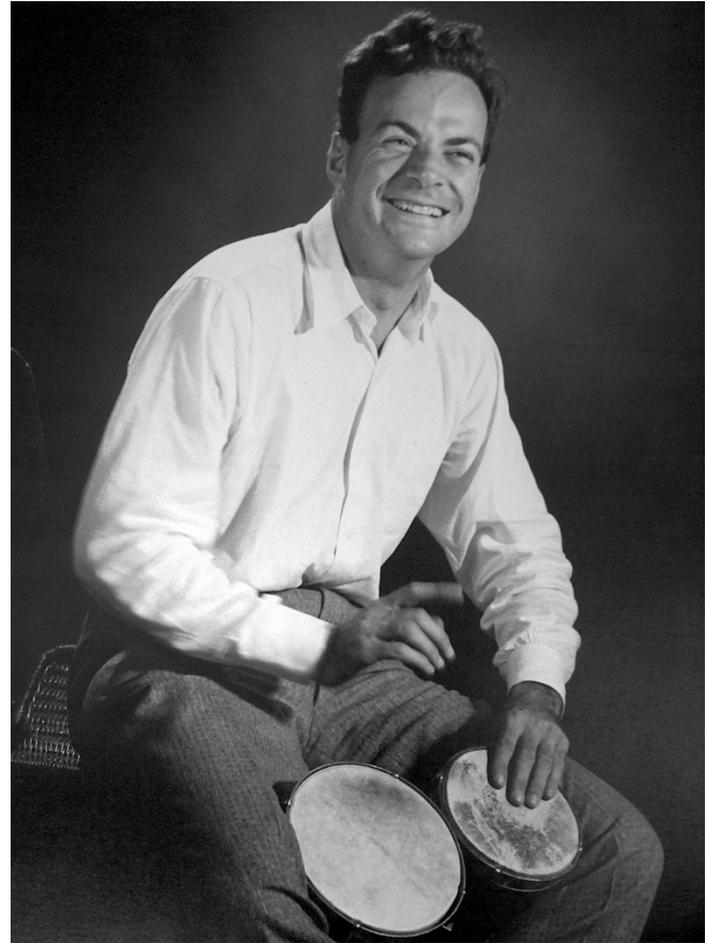
Subtract 2 from each side

$$3x = 12$$

Divide each side by 3

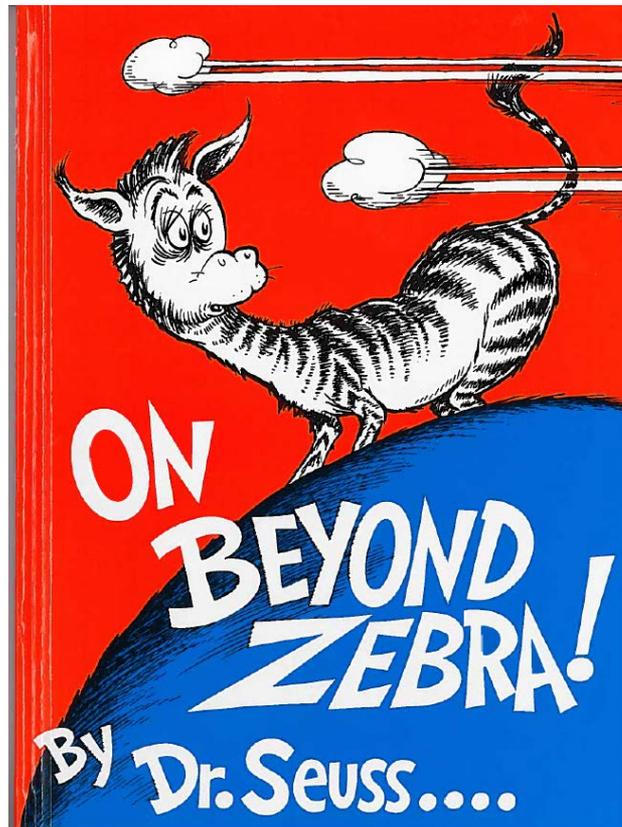
$$x = 4$$

An algorithm which bypasses
understanding



Math is not algorithms

- Math is humankind's desire to go:



What is math?

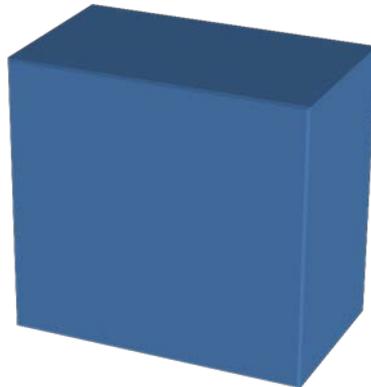
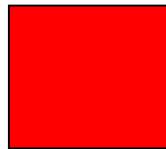
- Subtraction: 12-3; 9-4; 17-9
 - What about 3-15?
- Square roots:

$$\sqrt{9} \quad \sqrt{16}$$

- What about $\sqrt{-25}$

What is math?

- Line segment, square, cube
- 1 dimension, 2 dimensions, 3 dimensions

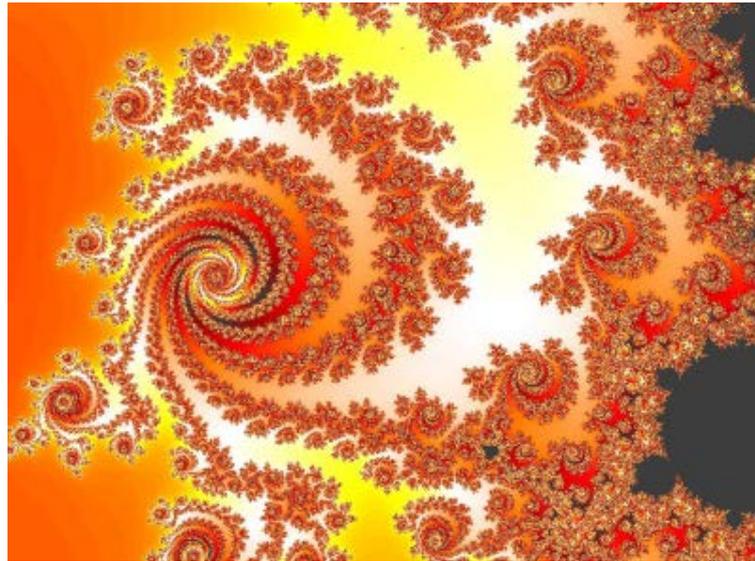


What is math?

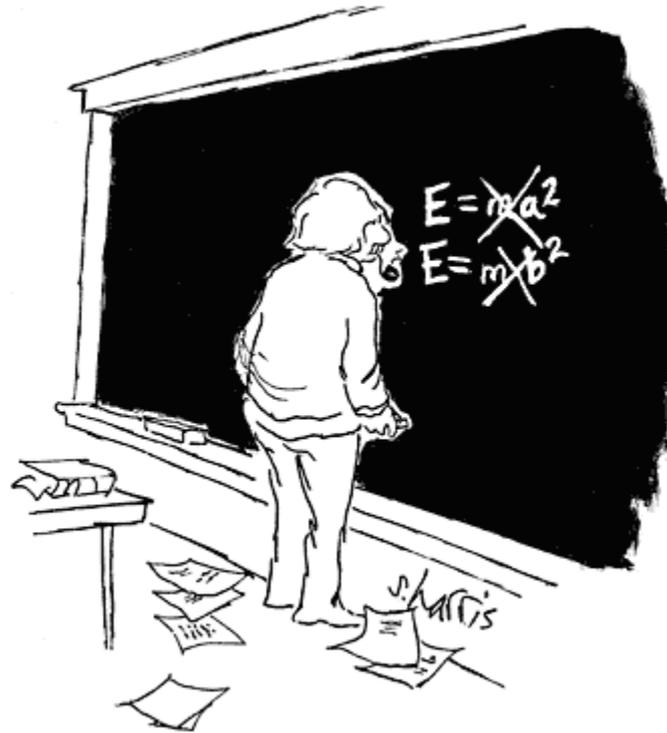
- Line segment, square, cube
- 1 dimension, 2 dimensions, 3 dimensions
- What about 1.46 dimensions?

What is math?

- Line segment, square, cube
- 1 dimension, 2 dimensions, 3 dimensions
- What about 1.46 dimensions?



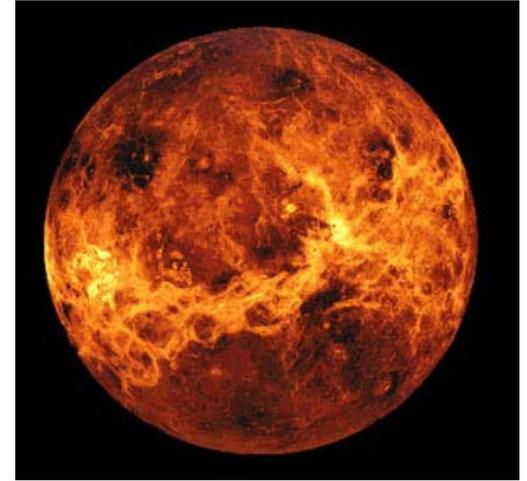
And what is science?



Artifacts of Science

- A conversation with a principal
 - Order of the planets
- “Science is a way of thinking much more than it is a body of knowledge.”

- Carl Sagan



- The science questions:
 - What does it mean* to say that Venus is closer to the Sun?
 - How do we know* that Venus is closer to the Sun?

What is science?

- Just try lots of equations.
- The order of the planets
- William Bragg: “The important thing in science is not so much to obtain new facts as to discover new ways of thinking about them.”
- Weyl: My work has always tried to unite the true with the beautiful and when I had to choose one or the other, I usually chose the _____.

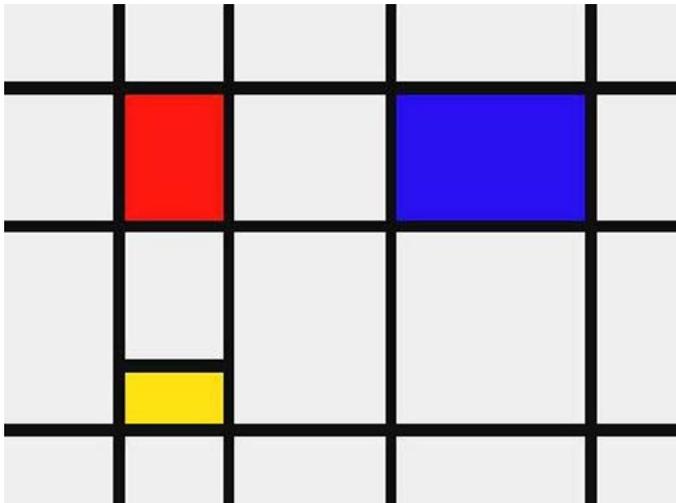
What is art?

- Mastering perspective



What is art?

- Mondrian



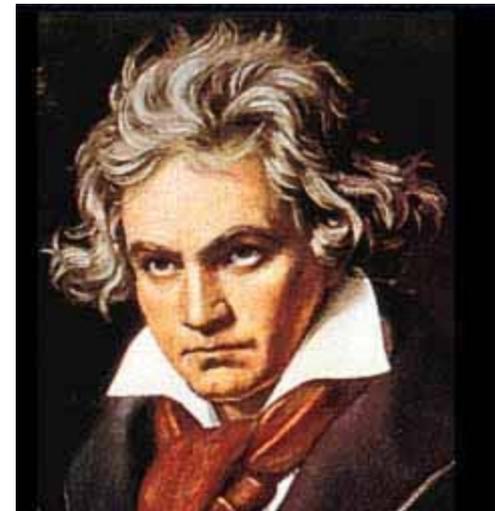
- Pollack



• Sol
Lewitt

In Retrospect

- It's all so easy AFTER someone goes On Beyond Zebra
 - Earth is round
 - The germ theory of disease
 - Art can be abstract
 - Beethoven's 5th symphony



On Beyond Zebra

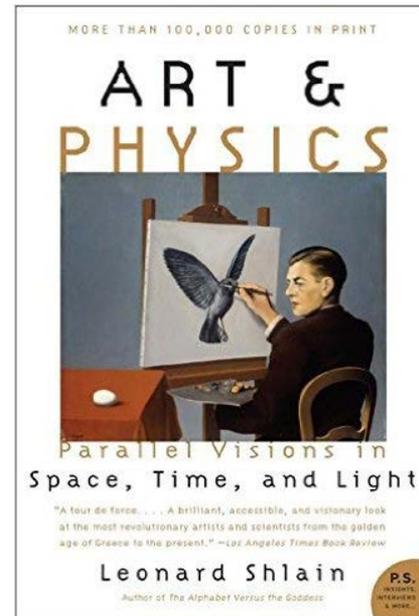
- We must see all of our content as On Beyond Zebra
 - It's all new to our students
 - It was once new to everyone
 - It took great minds many years of effort
 - It is not common sense

Your Content Area

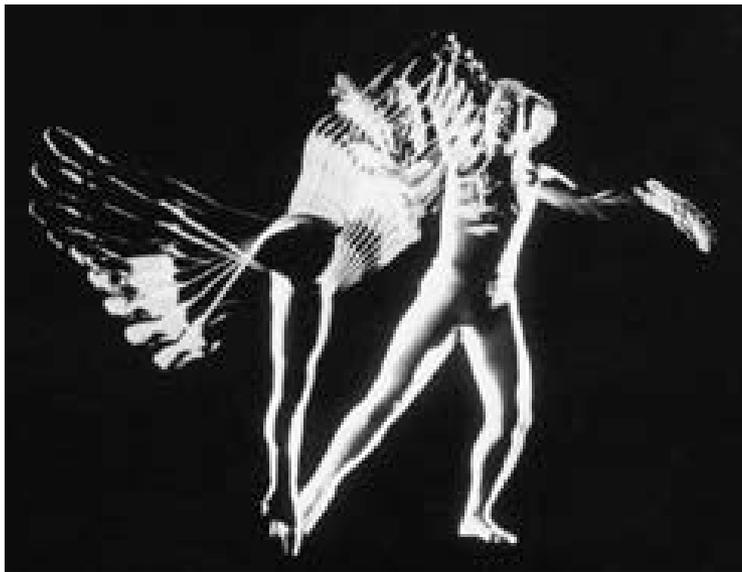
- Where have people gone beyond zebra?
- What intellectual, artistic, physical strides have been made?

Similar Problems

- Just as we “invented” algebra, we “invented” disciplines.
- Where has art and science tried to solve similar problems?



Pas de Deux
by Normal McLaren



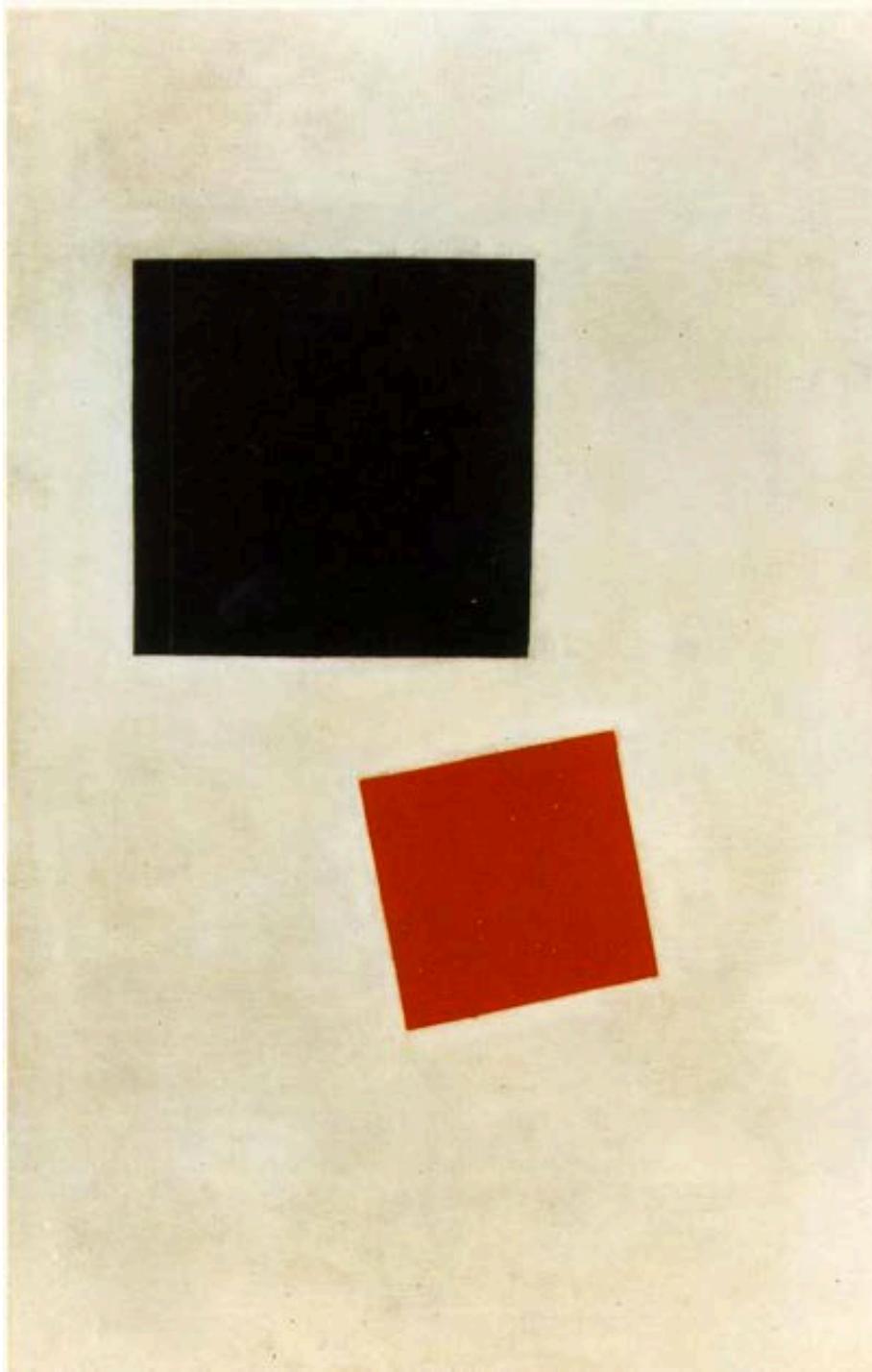


Nude
Descending a
Staircase, No. 2

By Marcel
Duchamp

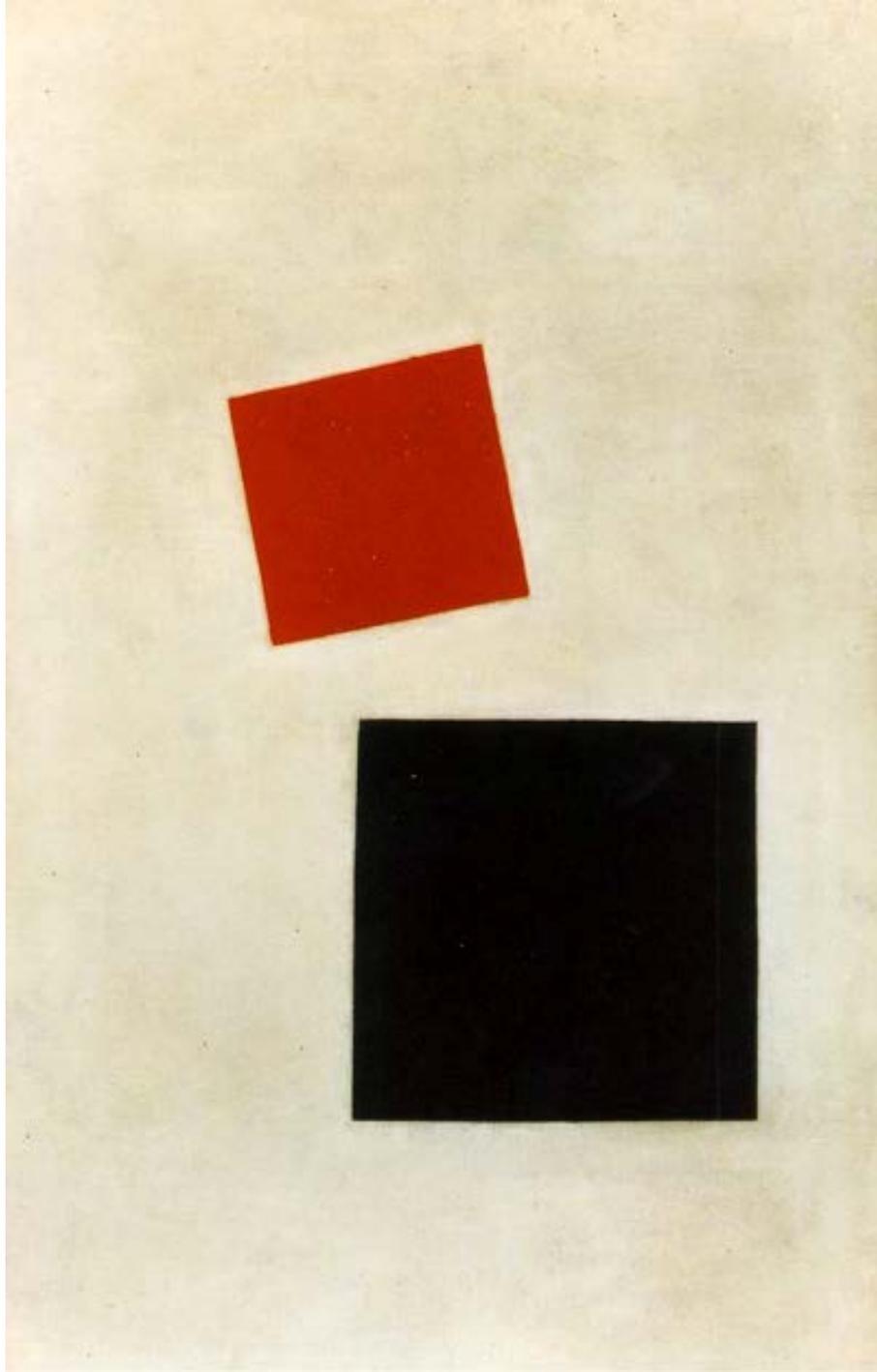


A Sunday on La Grande Jatte by Georges Seurat



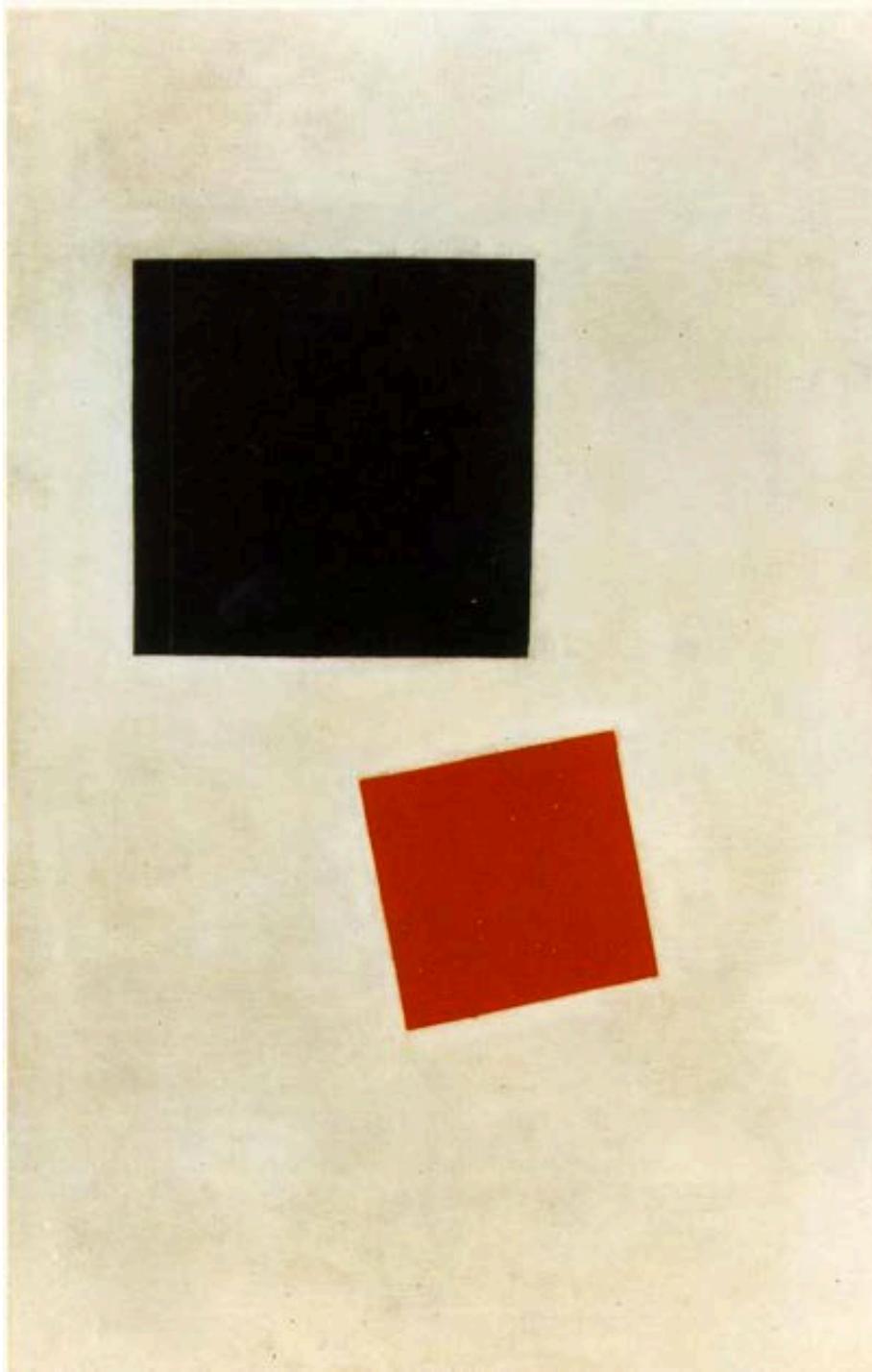
Black Square
and Red
Square

By Kasimir
Malevich



Black Square
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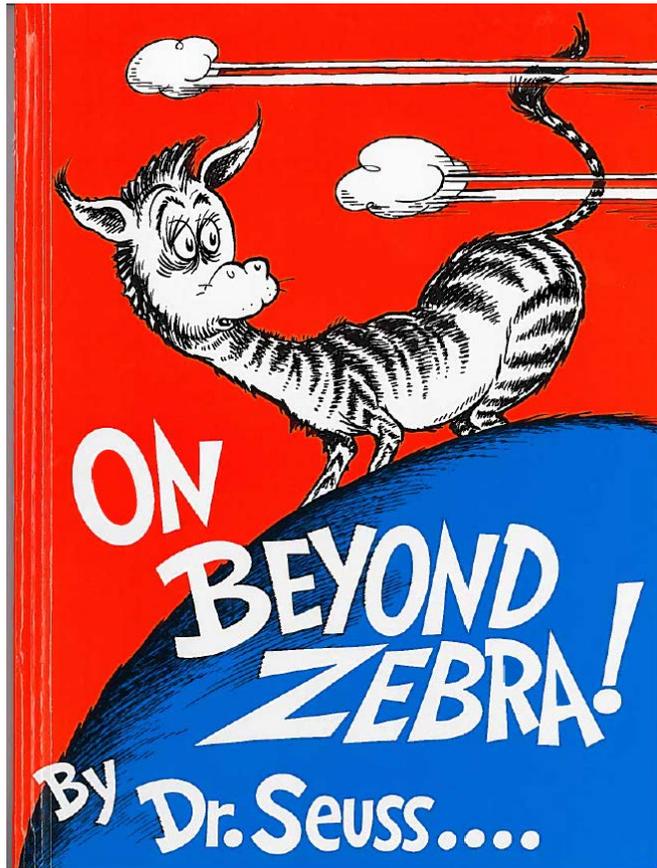


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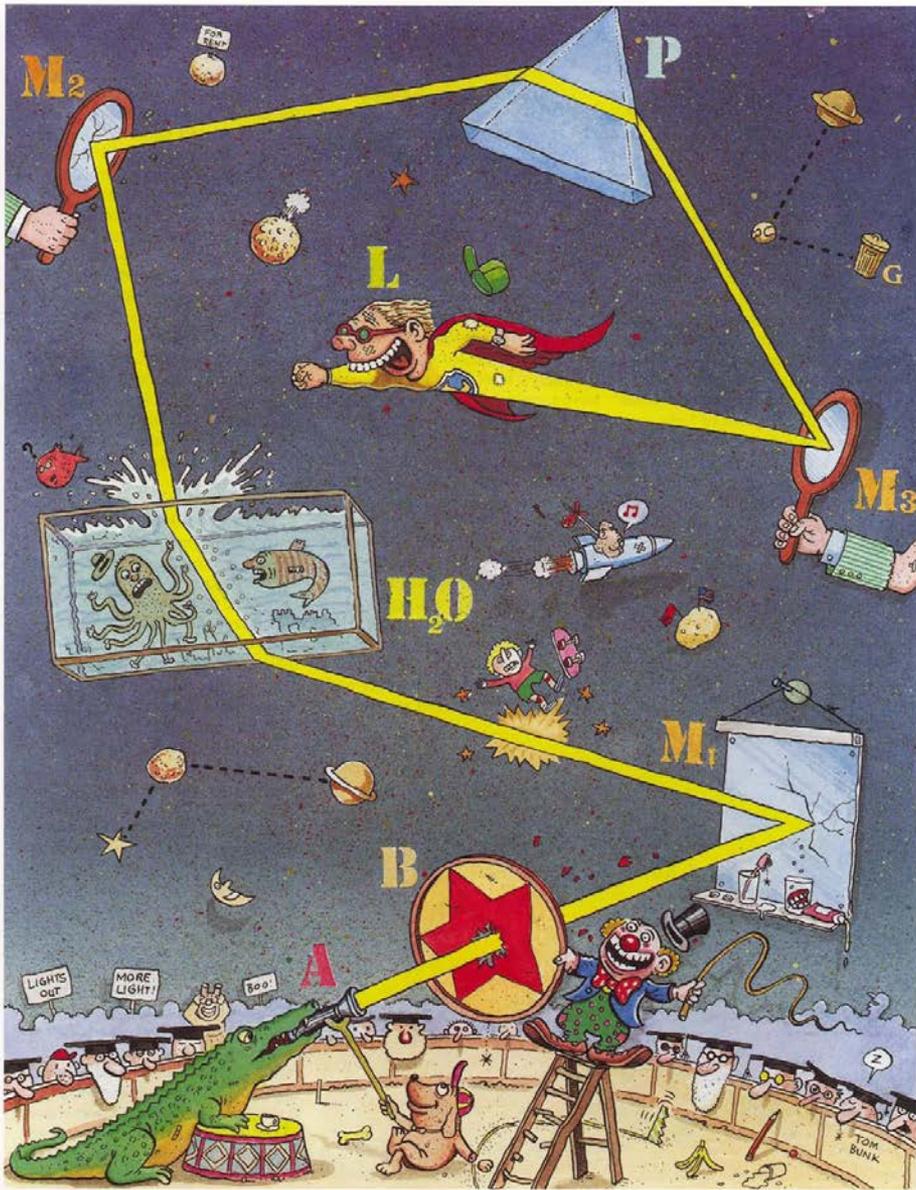
STEM to STEAM

- Purpose of infusing the arts and science and literature and ...
 - to better engage the students OR
 - to increase understanding of science OR
 - to increase understanding of art OR
 - to increase understanding of the world OR
 - to make the content (science or art) relevant



A project to blend disciplines

Quantoons



Light is bending the rules a bit here. (Can you see where?)

The cause is hidden but the effect is known.
- Ovid

1st Quanton

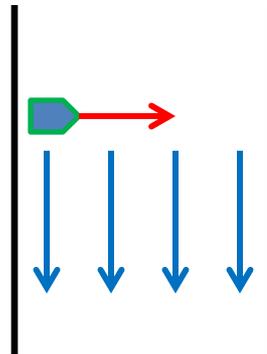
Fermat – light
Snail on wall

Quantoons

- Literature
- Physics
- Art

Quantoons

- Before lessons
 - Crossing a river

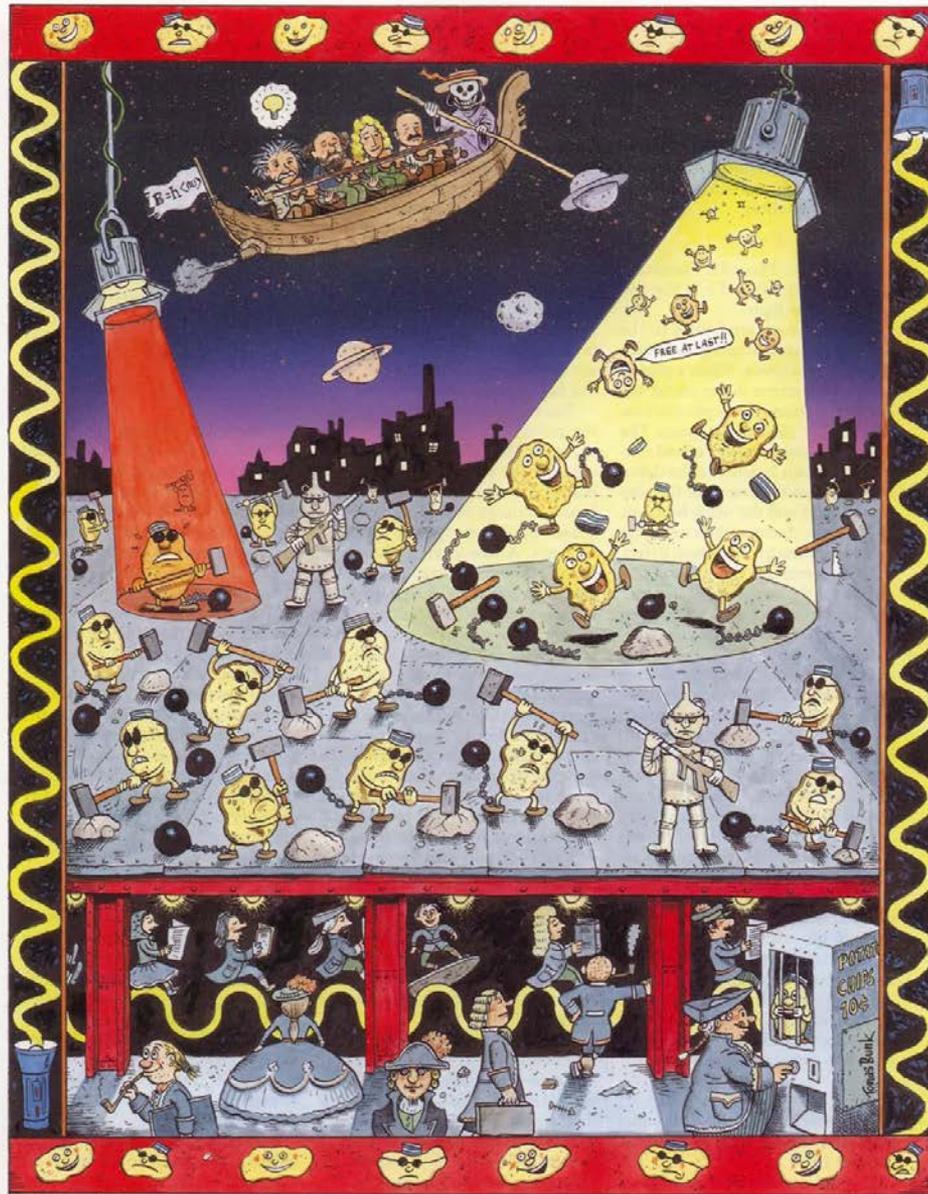


It is not possible to step into the same river twice.

- Heraclitus

Quantoons

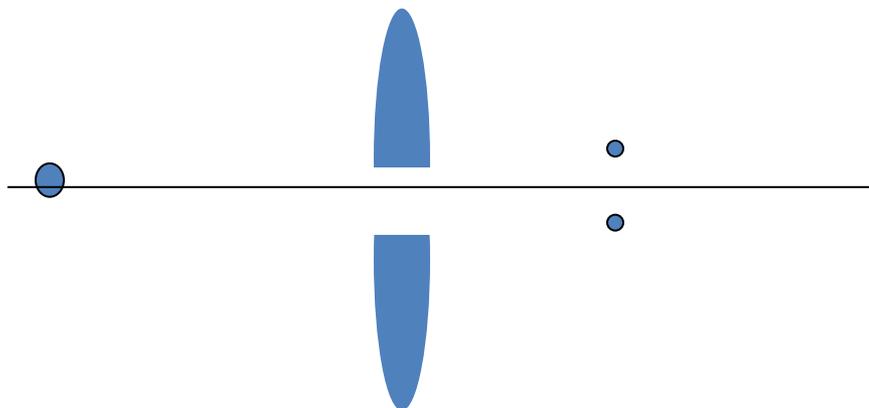
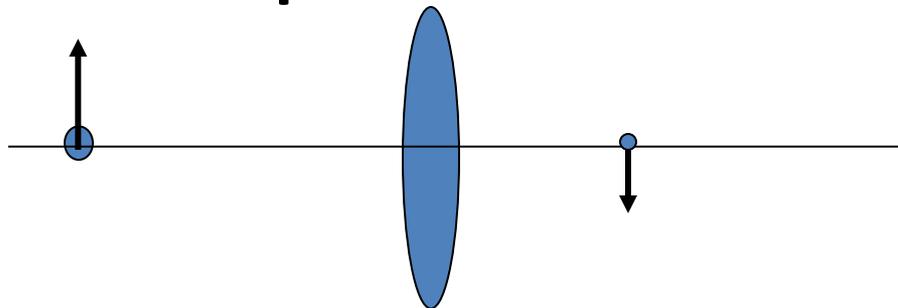
- After lesson on the photoelectric effect:
 - Photo (light) electric (electron)
 - Light frees an electron from a metal
 - Energy of electron = energy of light – work to free
 - $KE = hv - w_0$
 - Potato chip analogy
 - Change from vending machine = coin value - cost

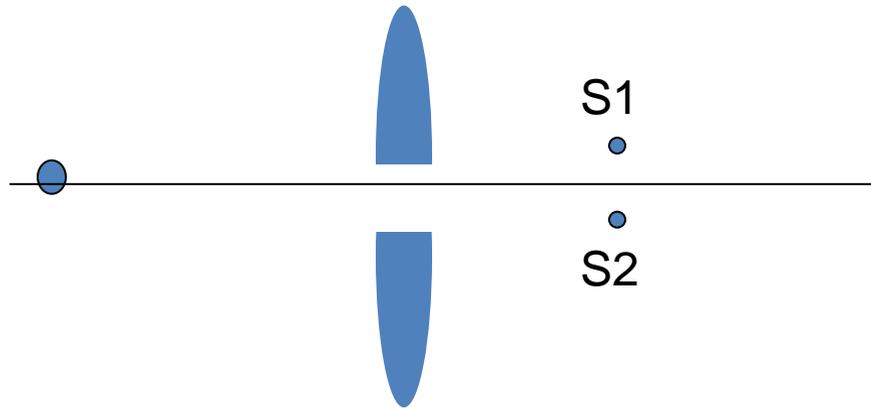
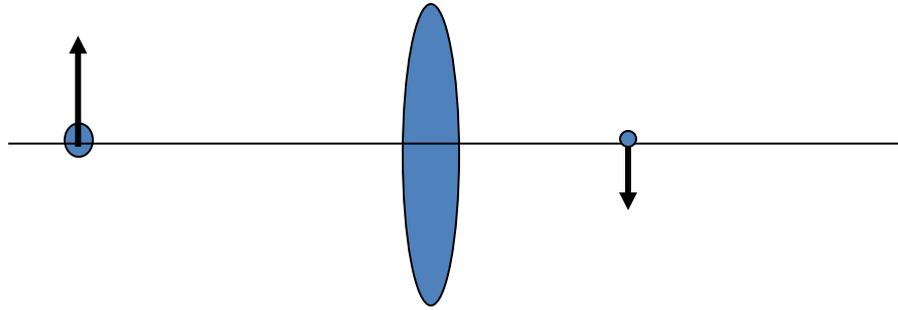


Have other eyes,
new light!
And look!
This is my glory,
unveiled to mortal
sight.

- Bhagavad Gita

Split Lens







SPLIT IS A BEAUTIFUL OLD TOWN ON THE ADRIATIC COAST IN DALMATIA, WHERE THE ARTIST WAS BORN.

Tomas p.100

Quantoons

- How a non-physics person can make physics personal





Revolutions are celebrated when
they are no longer dangerous.
-Pierre Boulez

The path On Beyond Zebra
Is not an easy one.

Ask Beethoven
Ask Stravinsky
Ask Ray Charles



Oh, crucified Jove
do you turn your just eyes
away from us
or is there here prepared a
purpose secret and beyond
our comprehension.
- Dante

Tomas p.196

Quantoons

- 3 windows to engage students in physics
 - Art
 - Physics
 - Literature
- Before, during and after lessons

PBL: Light and Sound Show

Active Physics



Chapter Challenge

Let Us Entertain You

Scenario

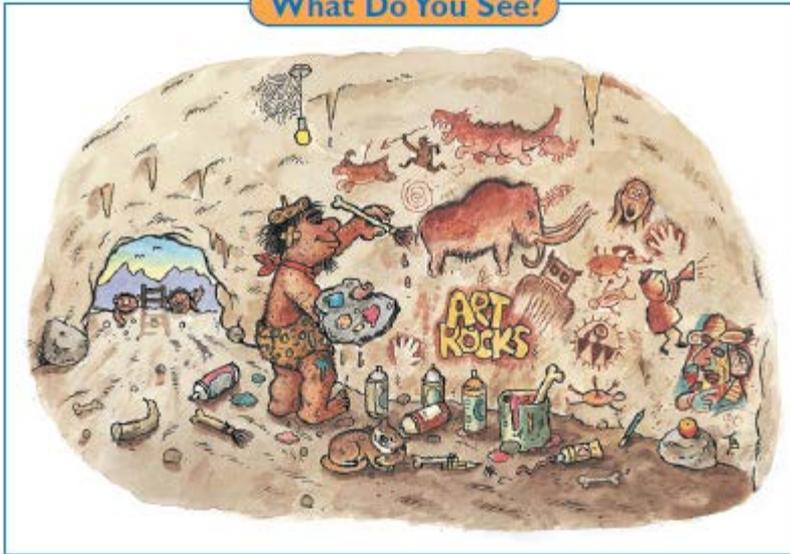
Most entertainment today, such as movies, television and video games, all involve the communication of sound and light signals. The sound signals that entertain you usually come from voices or musical instruments. Light signals make the images you see on TV or in the movies, and specially designed light patterns add to the effect of an event.



PBL: Artist as Chemist

What Makes Something Art?

What Do You See?



Active Chemistry

What Do You Think?

"The art of a people is a true mirror of their minds."

Jawaharlal Nehru

"Every child is an artist. The problem is how to remain an artist once he grows up."

Pablo Picasso

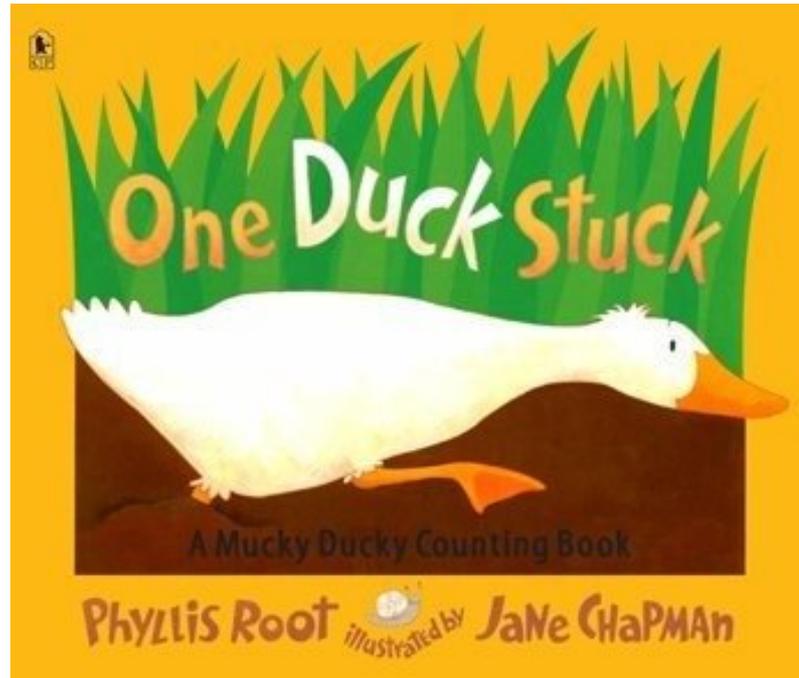
"Art is either plagiarism or revolution."

Paul Gauguin

"We must never forget that art is not a form of propaganda; it is a form of truth."

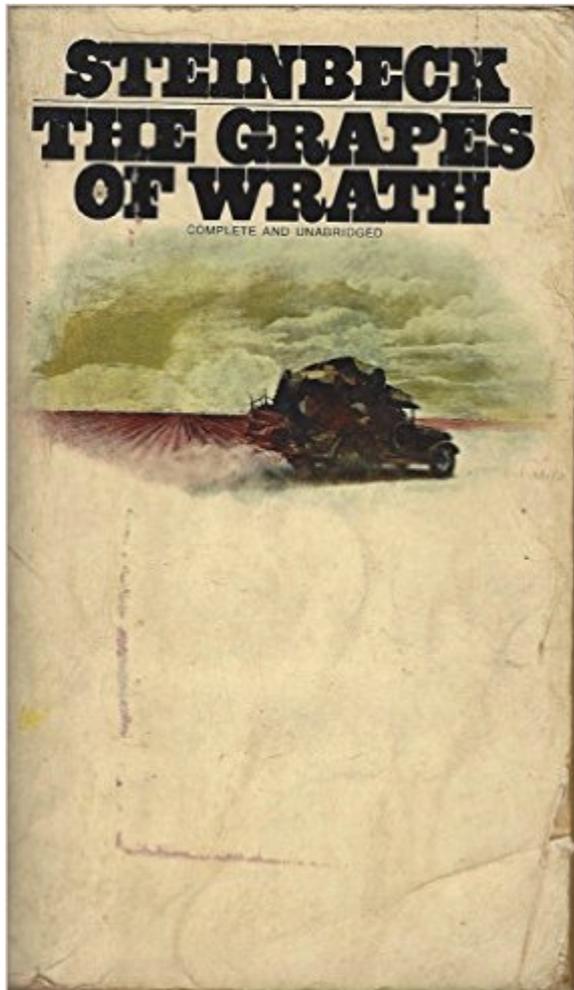
John F. Kennedy

Infusing engineering and literature



Not all problems have tech solutions





Read books that students read.

Different perspective than English teacher.

Why will you not pursue physics in college?

Thermometer Wine

- Robert Morgan

Always hung on its plaque
on the porch like a mounted
icicle, but was so old
already the painted numbers
were peeling and hard to read.
Only Daddy could tell
the measurements – he'd known
the instrument since a boy.
At ten below it really
meant twenty, being slow
with age he said. At
ten above it was roughly
accurate, but on a hot day
he added twenty to its reading.
I watched the red needle
rise in the dog days and
marveled how the tiny
hair was both sensitive and significant.
The blood rose in that stem
just a capillary of
bright, as though the day
were sipping through its ice
straw that special wine
and about to taste the
color from the drop at the bottom that never clotted
or dulled no matter how
far up or down it wrote,
always chilled as snake or worm.

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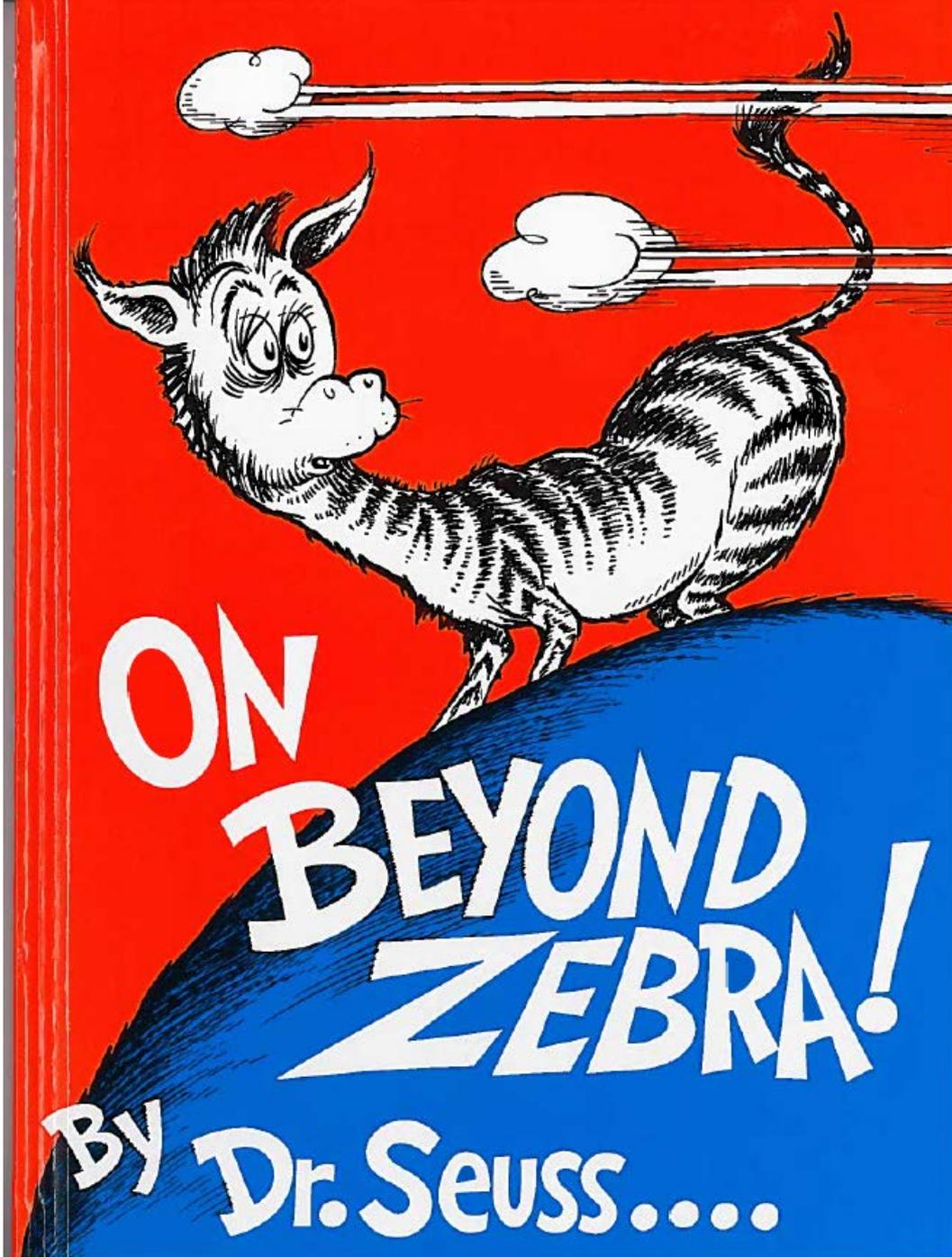
Thermometer Wine Analysis

*At ten below it really
meant twenty, being slow
with age he said. At
ten above it was roughly
accurate, but on a hot day
he added twenty to its reading.*

What is the meaning???

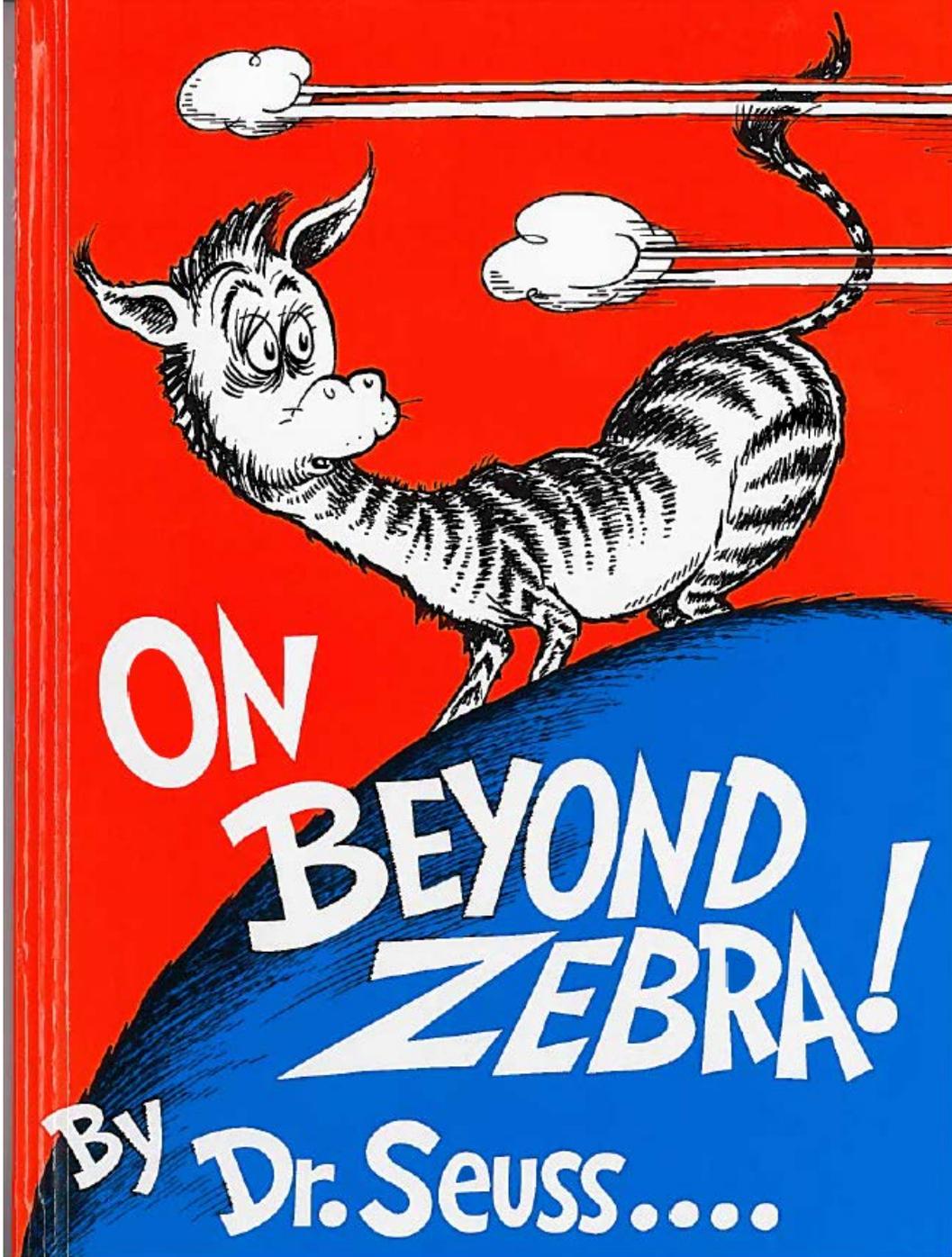
Thermometer Wine (student responses)

- Distrust of science.
- The father is needed to help the son interpret the world.
- The father remembers when he was younger and everything was more extreme than it is now.
- The thermometer is inaccurate.



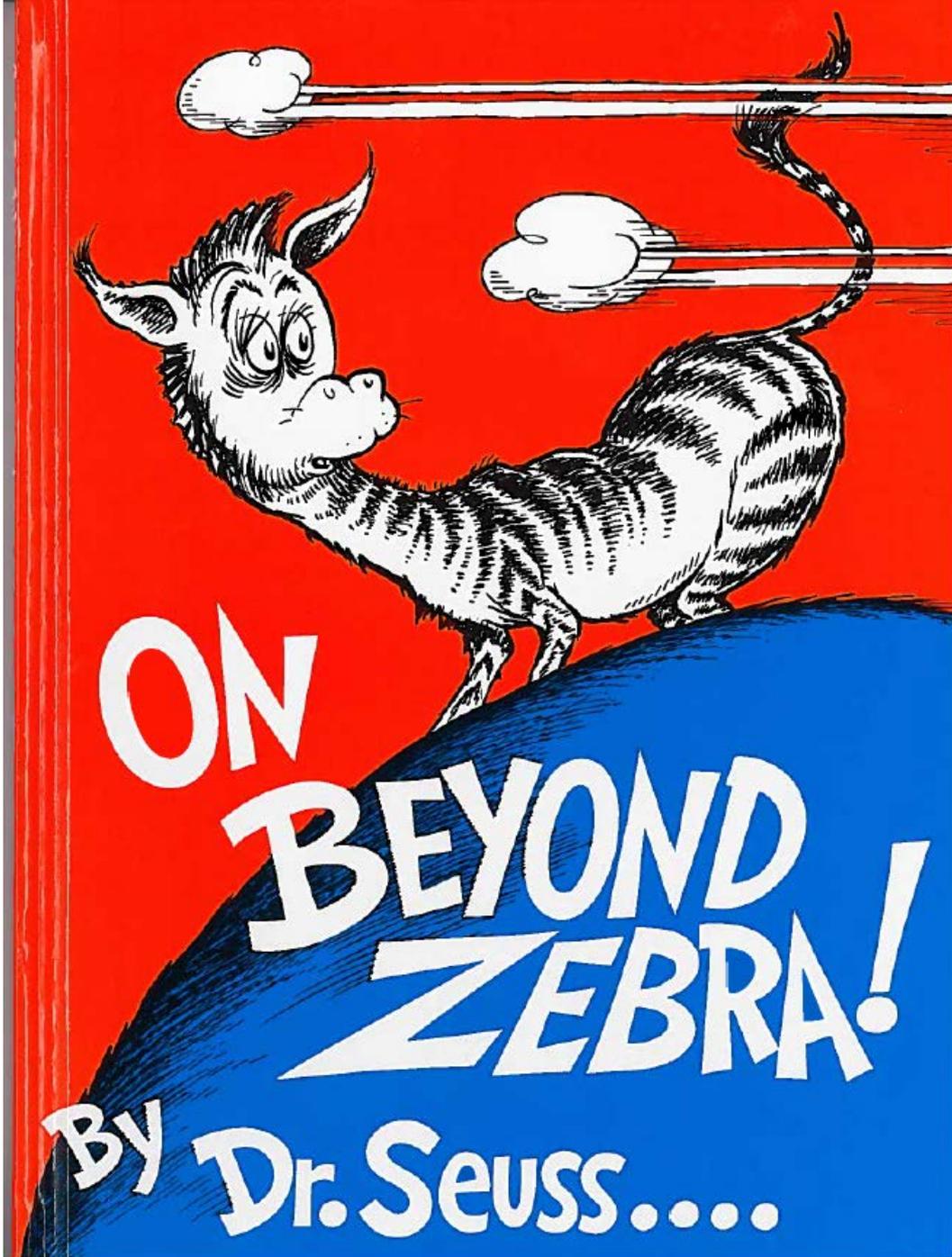
On Beyond Zebra
for

content



On Beyond Zebra
for
content

On Beyond Zebra
for
**Interdisciplinary
work**

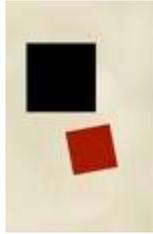


On Beyond Zebra
for
content

On Beyond Zebra
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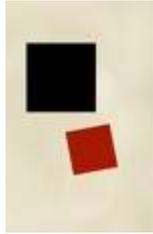
On Beyond Zebra
for
teaching

The complexity of teaching



We would like Malevich

The complexity of teaching

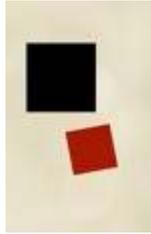


We would like Malevich



We can handle Mondrian

The complexity of teaching



We would like Malevich



We can handle Mondrian



We are faced with Pollack

How do we make sense of the complexity w/t pd



Content knowledge

Pedagogical knowledge

Pedagogical content knowledge

How do we teach?

- We teach the way we were taught.
- And, why not?
- “We learned that way. And we are good, responsible adults.”

Our students

- They are not us
- They did not grow up in our world
- Most were born after 9/11
- What are we going to do?



Where is the knowledge
we have lost in
information...

T.S. Eliot

They live
(and have always lived)
in the world
of the internet

Four Essential Questions

- What does it mean?
- How do we know?
- Why do we believe?
- Why should we care?

The Essential Questions

- What does it mean?
 - » Newton's 2nd Law: $F = ma$
 - » Energy is conserved
 - » The Earth goes around the Sun
 - » The atom has a nucleus
 - » Mitochondria are the power house of the cell
 - » H₂O is a polar molecule (angle of 105)
- Textbooks and classrooms are dominated by this question.

Artifacts of Science

- A conversation with a principal
 - Order of the planets
- “Science is a way of thinking much more than it is a body of knowledge.”

- Carl Sagan



- The science questions:
 - What does it mean* to say that Venus is closer to the Sun?
 - How do we know* that Venus is closer to the Sun?

The Four Essential Questions

- What does it mean?
- How do we know?
 - » Newton's 2nd Law: $F = ma$
 - » Energy is conserved
 - » The Earth goes around the Sun
 - 80% know this
 - 49% know how long it takes
 - We have evidence for Venus being between us and the Sun; what about Earth going around the Sun?
 - » The atom has a nucleus
 - » Mitochondria are the power house of the cell
 - » H₂O is a polar molecule (angle of 105)

How do we know?

- In science, we accept carefully controlled experiments (or careful observations) as evidence of our understanding
- “How do we know” unacceptable responses:
 - It is in the book
 - The teacher told us

How do we know?

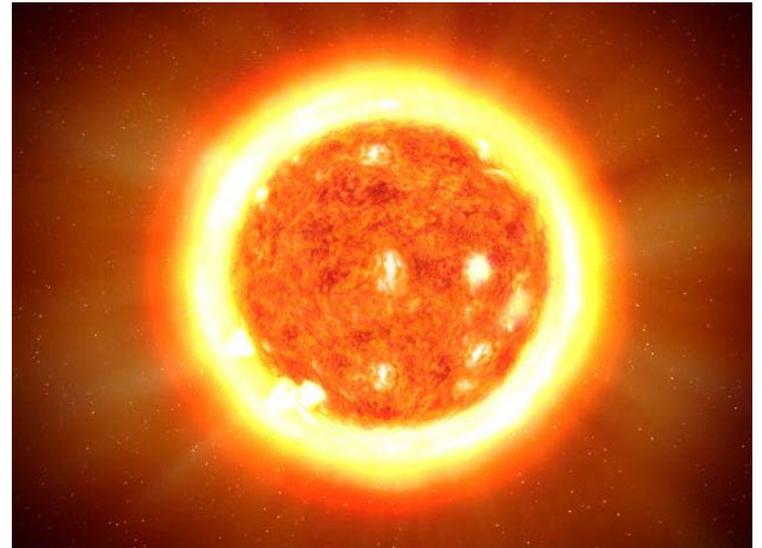
- In YOUR discipline?
- How do we know in history?
- What do we accept as evidence in literature?
- What makes your discipline different?

I need your help

- Believe
 - accept something as true
 - have trust
 - have religious faith
- How would you phrase the question
 - “Why do we believe?”
where
- It captures the meanings that I will outline
- It is not misinterpreted to imply religious faith

Why do we believe?

- The Nature of Science
 - Seat belts in the laboratory and seat belts in cars.
 - Mixing liquids today and mixing them tomorrow.
 - Cell structure in San Francisco and cell structure in Auckland.
- The spectra of the Sun



Why do we “not” believe

- We believe some things and don't believe others.
- We have well developed crap detectors.
 - CRITICAL Analysis of Physics (CRAP)
- If there is one quality needed , above all others, to be a good writer, Ernest Hemingway replied, “Yes, a built-in, shock-proof, crap detector.”

Why do we “not” believe

- We believe some things and don't believe others.
 - People magazine
 - Woman giving birth
 - Umbrella
- We have constructed filter systems after many years
- This filter system is rarely articulated
- We may not be able to communicate it
 - Polanyi -tacit knowledge



Why do we “not” believe

- The best things schools can do for kids is to help them learn how to distinguish useful talk from crap.
 - Neil Postman (1969)
- And, more important today than in 1969, given new forms of communication with no filters.

Why do we believe?

1. Does this content fit with other content in science?
 - Each discipline has a set of traditional topics that helps us organize the discipline
 - Physics
 - Movement of the line during fly fishing – yes
 - Cezanne's influence on Picasso - no



Science vs Pseudo-science

- Fields in physics vs auras
- Predicting the future in science vs astrologers
- Falsifiability

The first three questions are good for academics:

BUT this is not enough

The Essential Questions

- What does it mean?
- How do we know?
- Why should I believe?
- **Why should I care?**
 - » Newton's 2nd Law: $F = ma$
 - » Energy is conserved
 - » The Earth goes around the Sun
 - » The atom has a nucleus
 - » Mitochondria are the power house of the cell
 - » H₂O is a polar molecule (angle of 105)

Why should I care?

- Motivated students have higher achievement
- Relevance to their lives now.
- Why are we learning this?
 - This is chapter 14.
 - One day this will be useful
 - Not about “now” and therefore not about me
 - Not even true!



$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Why should I care?

“Education is not a preparation for life;
education is life itself.”

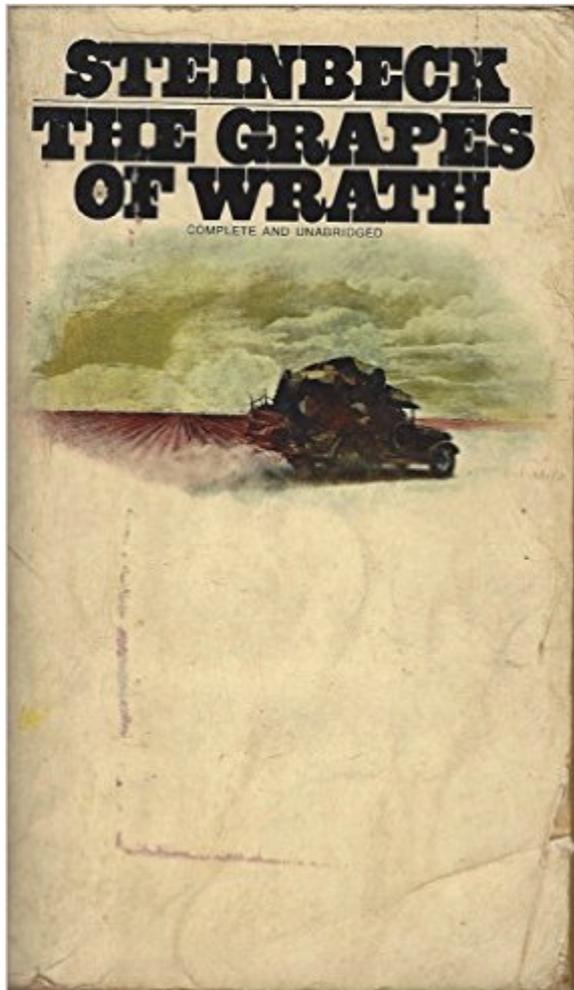
John Dewey





Oh, crucified Jove
do you turn your just eyes
away from us
or is there here prepared a
purpose secret and beyond
our comprehension.
- Dante

Tomas p.196



Read books that students read.

Different perspective than English teacher.

Why will you not pursue physics in college?

PBL: Light and Sound Show

Active Physics



Chapter Challenge

Let Us Entertain You

Scenario

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You are the experts

- You are the ones that can find out what works
- You can test it in the classroom because you are in the classroom.
- You can stimulate the research community with your findings

You are the experts

- You are the ones that can find out what works
- You can test it in the classroom because you are in the classroom.
- You can stimulate the research community with your findings
- You are the leaders of the educational community.

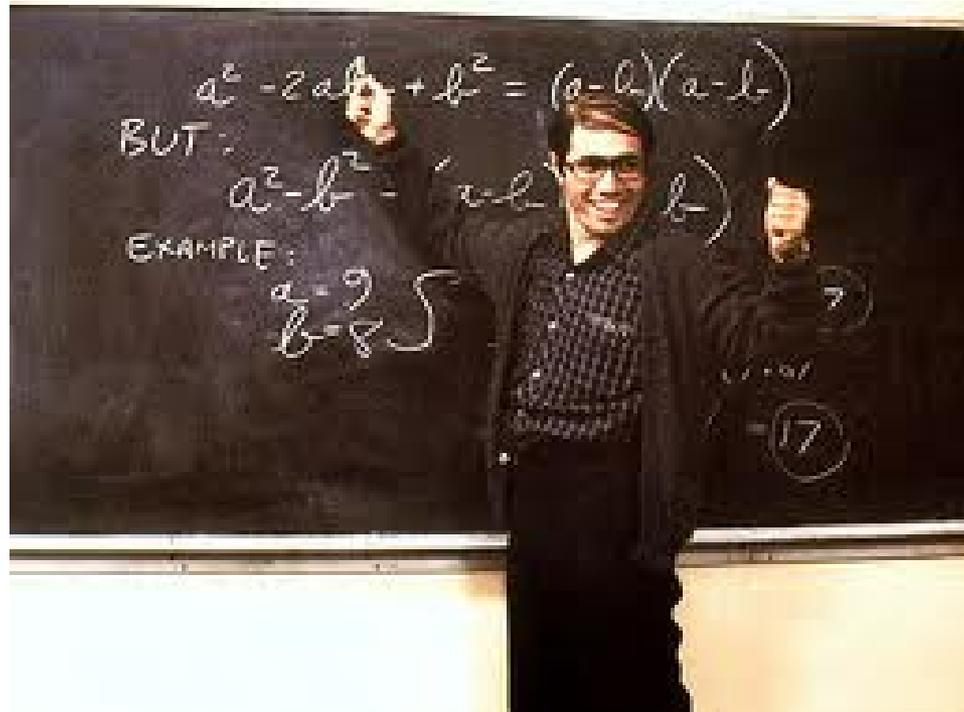
Teachers as Leaders

We change people's lives



Teachers as Leaders

We communicate the beauty in the world



Teachers as Leaders

We help students reach their potential.



We are changing the world
and
making it a better place.



And unlike most people who leave the theater inspired
after seeing these 'teacher movies'

....you get to teach tomorrow

- Today you have the pleasure of getting to see your colleagues after the summer.
- Tomorrow you will meet 25-150 students.
 - You want to put your best foot forward
 - You want to make a good impression
 - You want the students to be excited enough to come back the next day
- Tomorrow you get to take them....



**ON
BEYOND
ZEBRA!**

By Dr. Seuss....

Thank You

Arthur Eisenkraft@umb.edu
www.COSMIC.umb.edu

