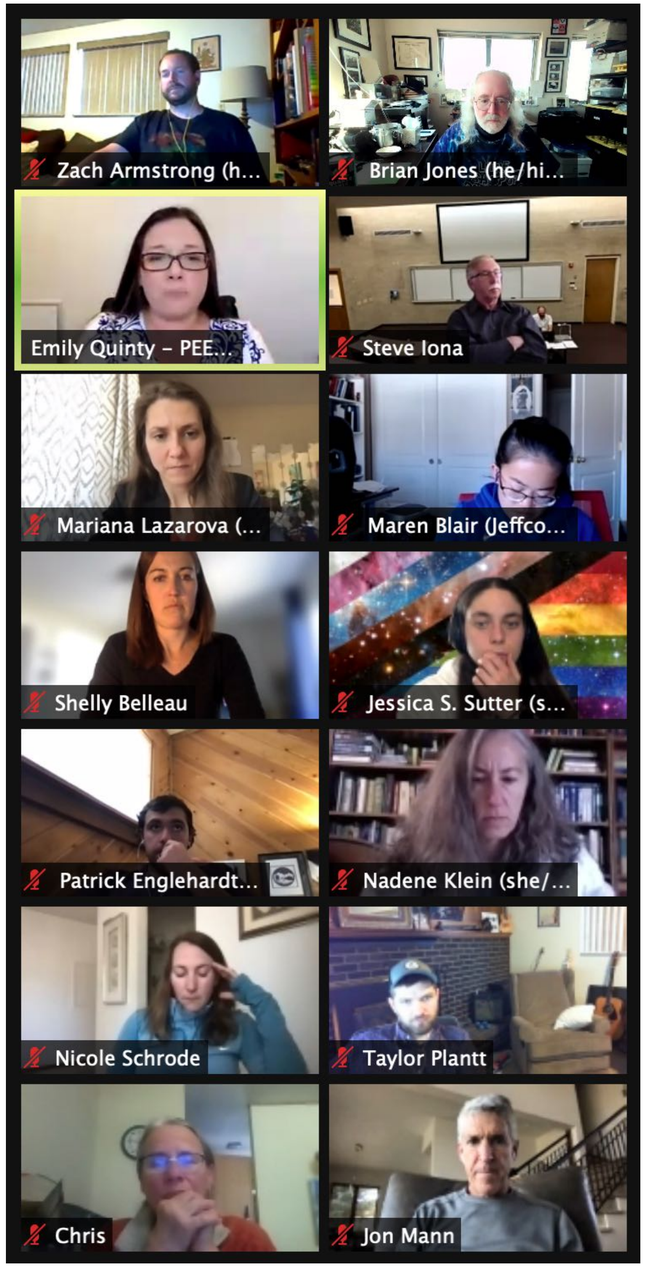
Effective Traditional and Virtual Education Outreach

Brian Jones & LSOP
Physics Department

COLLEGE OF NATURAL SCIENCES
COLORADO STATE UNIVERSITY

LITTLE SHOP OF PHYSICS

http://lsop.colostate.edu

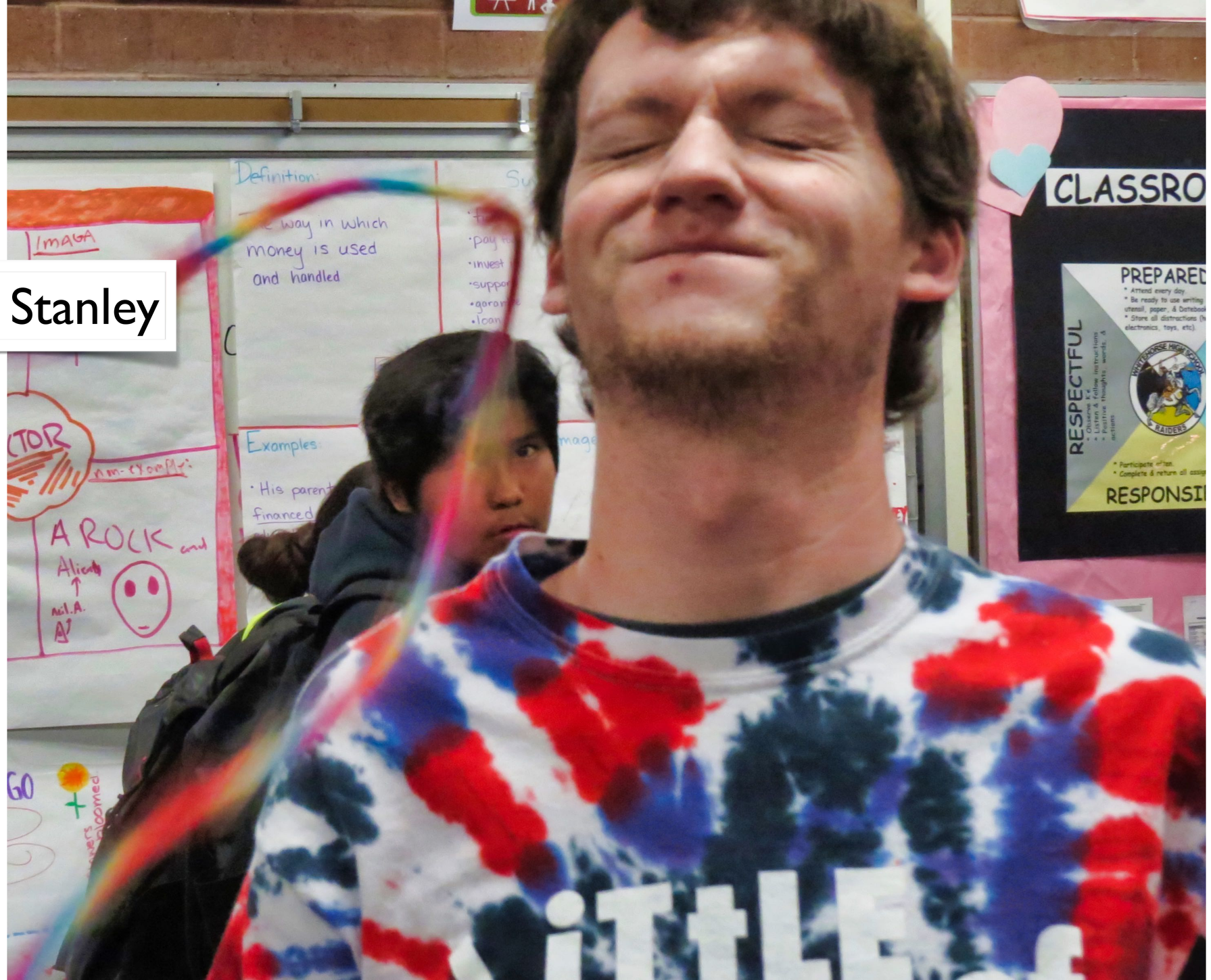


It's been really great to interact with other adults.

(And with other physics educators, of course.)

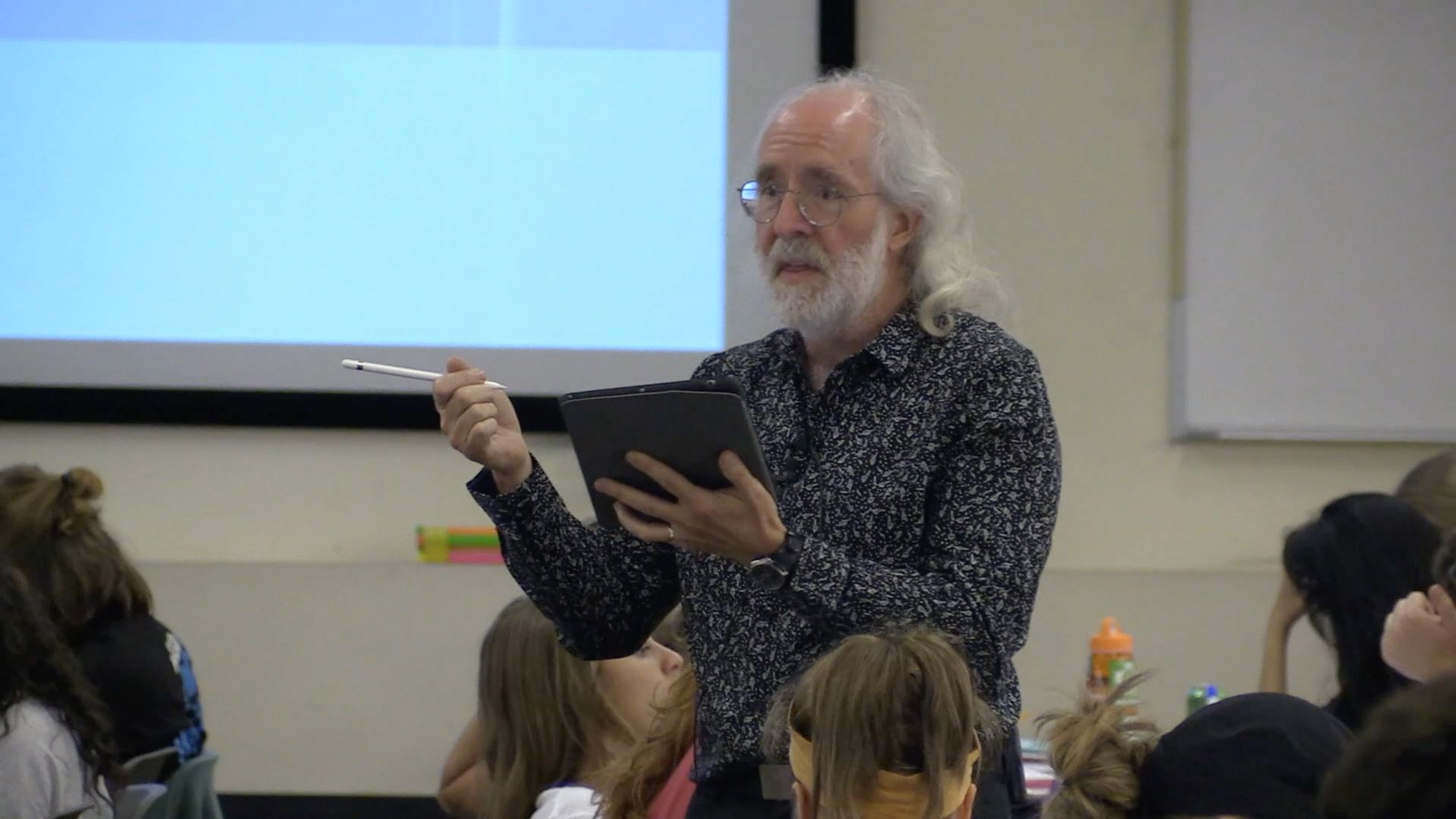
Team Effort


Heather Michalak
Adam Pearlstein



Bryan Stanley


Warming Up:
Four springs each have an unstretched length of 10 cm. When the masses are hung from the springs, they stretch as shown.
• Which spring has the largest spring constant? The smallest?
• If the masses are each subsequently raised a short distance and then released, which mass will oscillate with the highest frequency?
A.
B.
D.
Day Job



Little Shop of Physics

Little Shop in action at a school


LiTtLE SHOP of PhYSiCS
Annual Open House

Experiment Stations Built By Undergraduate Students

International Efforts


- ENERGY
ELASTIC BANDS
ENERGY TOYS
(HEAT PACKS)
GRASHOPPERS
LENSES
CHARGERS
CUBES
eembundufukwa
eendomba
-TALKING TURTLE
Adam


LiTtLE
SHOP of
PhYSiCS

“Franchises”


Videos


Why do we do outreach?
Who are the beneficiaries?
Breakout Rooms


A bit of history

Not intelligent design.
Evolution.

“Building the Brand”

Wonder
Science Is Social
Student-Centered
Undergraduate Engagement
Community

Questions

1) Is informal education effective?
2) How can we make our efforts inclusive and equitable?
3) Who are the beneficiaries?
4) What is the difference between outreach and engagement?

Target Audience #1: K-12 Students

Early Efforts.

Can we show any effect, at all?

Draw a picture of air pressure in action.


How do you measure engagement?
Observation study of about 1000 kids

Does the student read the sign?
[0] Not at all [1] Briefly [2] Completely

How long does the student spend trying to figure out the purpose of the exhibit?
(in seconds)

Does the student use the exhibit in the correct manner (as implied by directions)? **Y =1/N=0**

How long does the student stay at the exhibit after figuring out the purpose?
(in seconds)

Does the student use the exhibit at all as though it were a physical object? **Y=1/N=0**

On balance, characterize student's use of the exhibit:

0 – **Completely** (or nearly so) as **physical** object
1 – Clearly **more** as **physical** object than for inquiry
2 – **About equally** as physical object and for inquiry
3 – Clearly **more** for **inquiry** than as a physical object
4 – **Completely** (or nearly so) for **inquiry**

Which of the following statements best describes how the student interacts with the exhibit?

0– The student cannot immediately see how the exhibit works, so the student moves on to the next exhibit
1– The student seems interested by the exhibit, but doesn't understand how it is supposed to work, so student moves on to next exhibit
2– The student plays with the object in their own way, not trying to figure out the purpose of the exhibit/how it should work.
3—Student works at figuring out how the exhibit should be used, but neve figures it out and moves on to next exhibit
4– The student works at figuring out how the exhibit should be used and then once discovering this moves on to the next exhibit
5– The student figures out how exhibit should be used and then becomes more intrigued and continues to play with it in this manner

If the student played with the object in their own way was it:
[0] NA [1] Non-meaningful manner [2] Meaningful/investigative

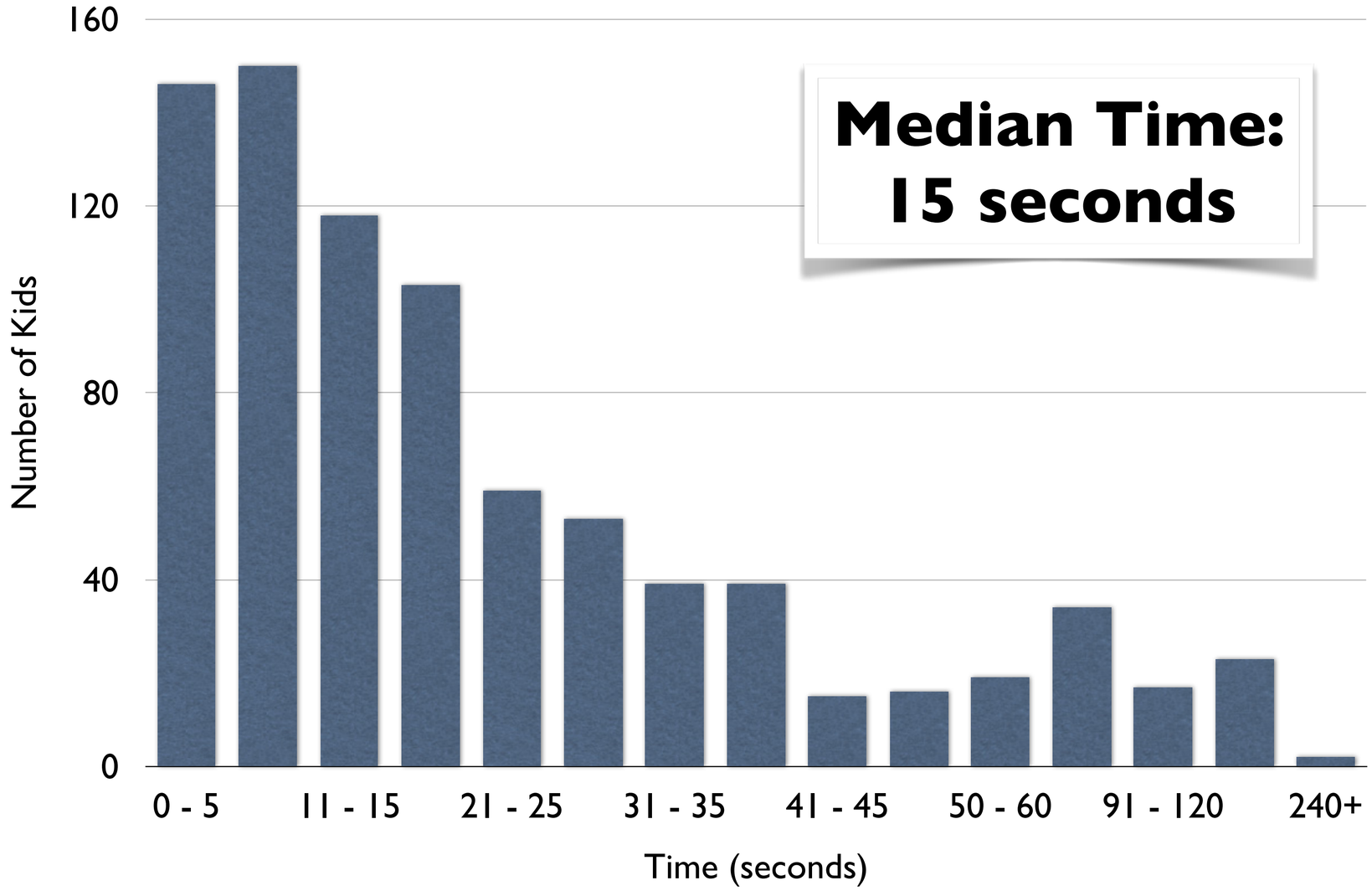
Does the student describe to another how the exhibit works?
Y=1/N=0

How does the student mostly use the exhibit?
[0] Individually [1] With Peers [2] With Adults

Does the student ask for assistance about how to do something?
Y=1/N=0

Inter-rater reliability was very high.

Time at a station.



Seconds per station, by grade level.

3 - 5 grades	15 s	±5 s
6 - 7 grades	18 s	±2 s
8 -9 grades	13 s	±2 s

Reading?

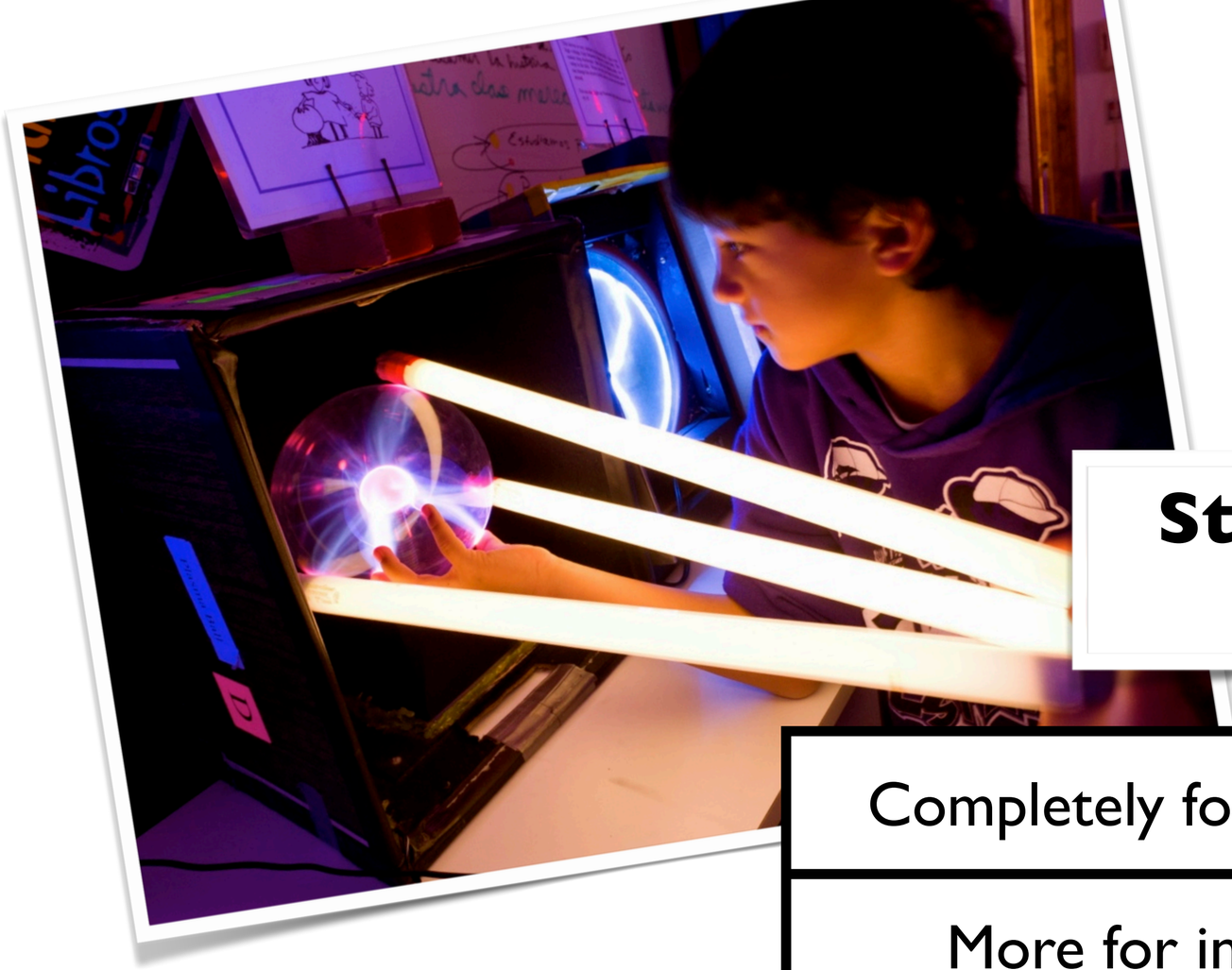
Reads Sign?	3rd-5th	6th-7th	8-9th
Completely Reads	17.5%	26.1%	23.9%
Briefly Reads	16.9%	23.2%	31.7%
Doesn't Read	65.6%	50.7%	44.4%

Used the equipment correctly?

Yes.	88.4%
No.	11.6%

Of the students who used the equipment correctly...

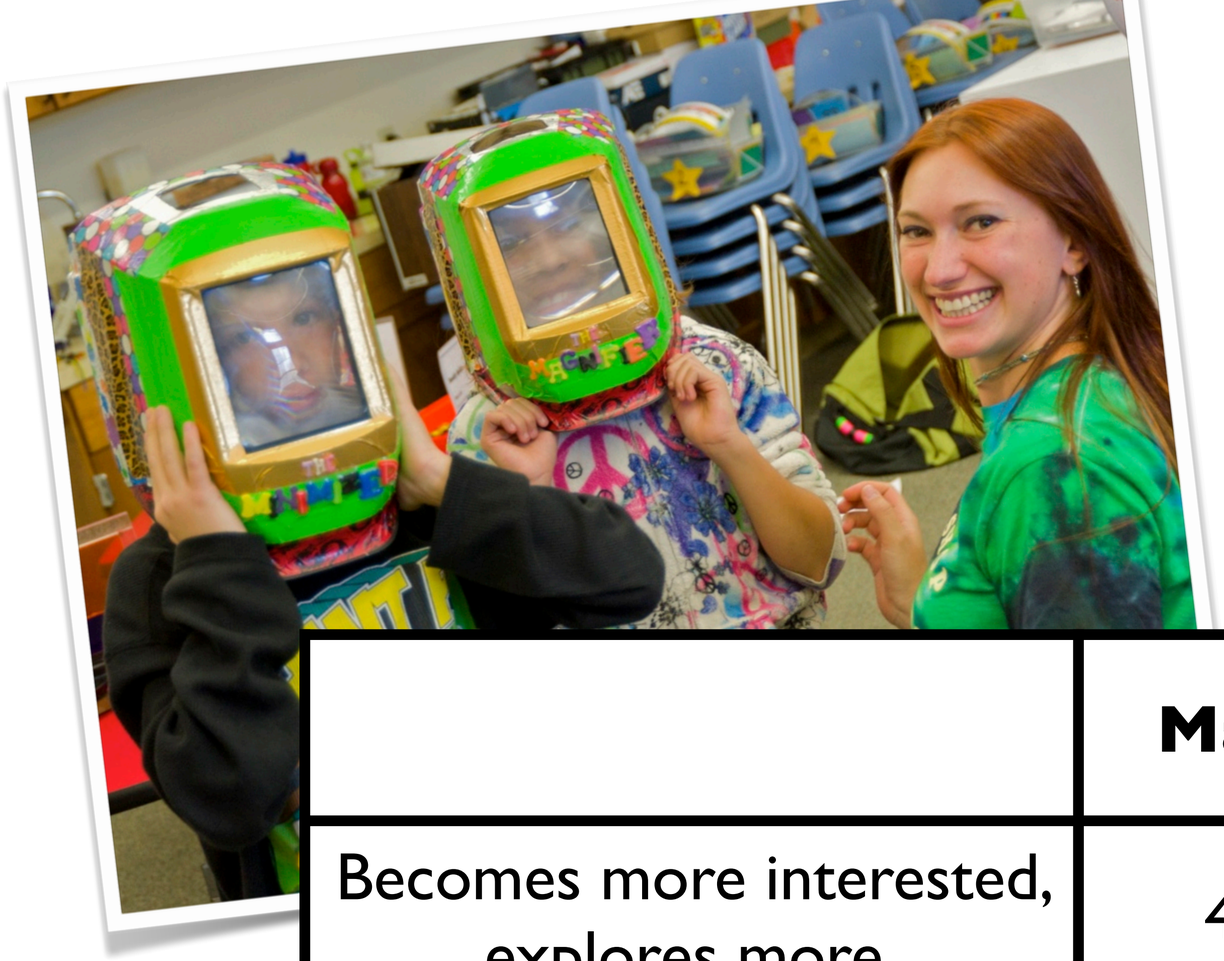
Became more interested, explored more.	50.7%
Moved on.	49.3%



Inquiry

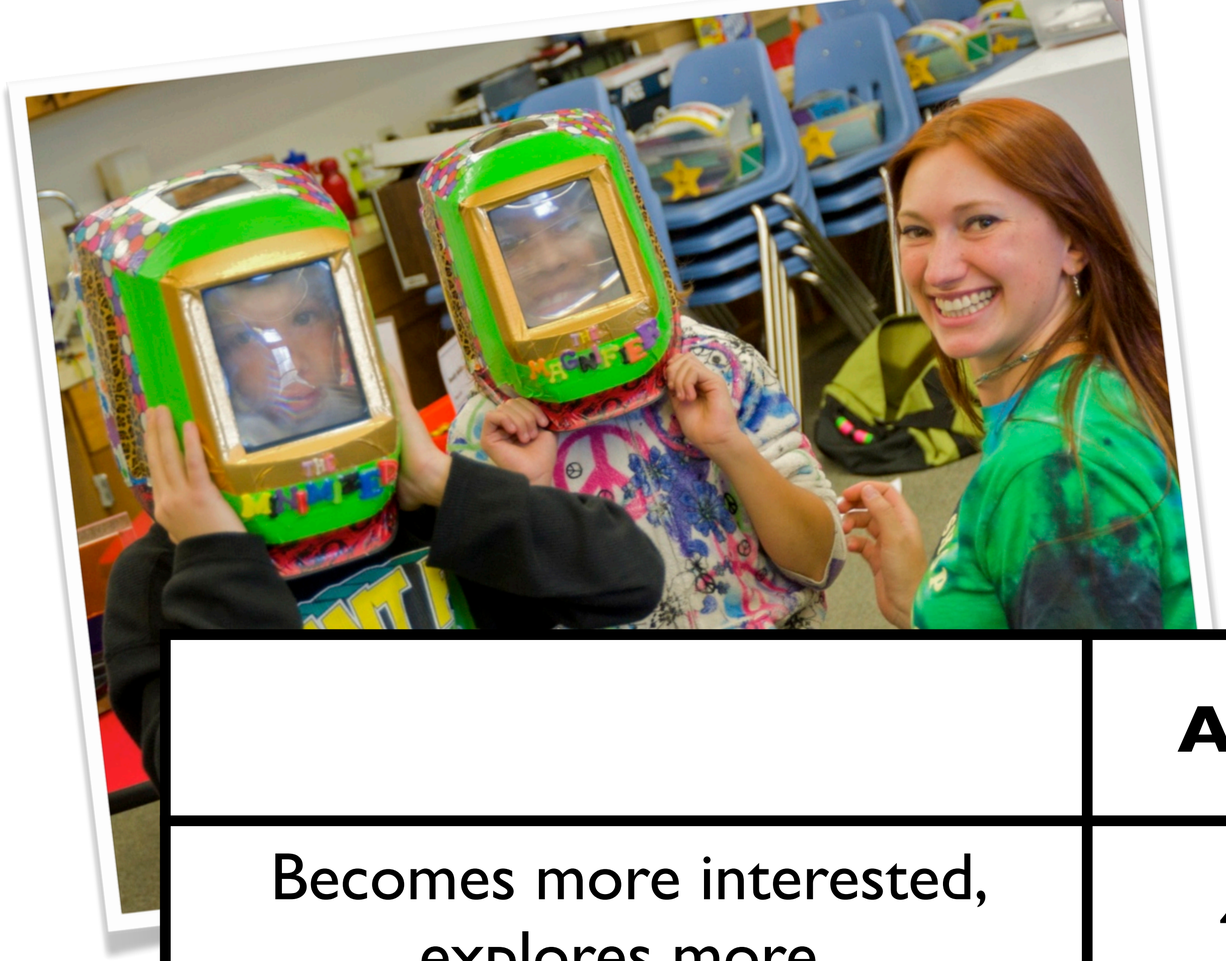
Student used the equipment:

Completely for inquiry	36.3%
More for inquiry	58.2%
About equally	5%
More as physical object	0.5%



Gender effects?

	Male	Female
Becomes more interested, explores more.	42	43.1
Moves on.	44.7	44.6
Doesn't use equipment correctly.	13.3	12.3



Ethnicity differences?

	Anglo	Non-Anglo
Becomes more interested, explores more.	44.3	42.2
Moves on.	45.5	45.4
Doesn't use equipment correctly.	10.2	12.4

There does not seem to be a significant difference in engagement between different kinds of students.

Content

Normalized learning gain

$$g = \frac{\text{post - pre}}{\text{100- pre}}$$

Pre-test vs. post-test

Before visit / after visit
Time varies, but results do not seem to

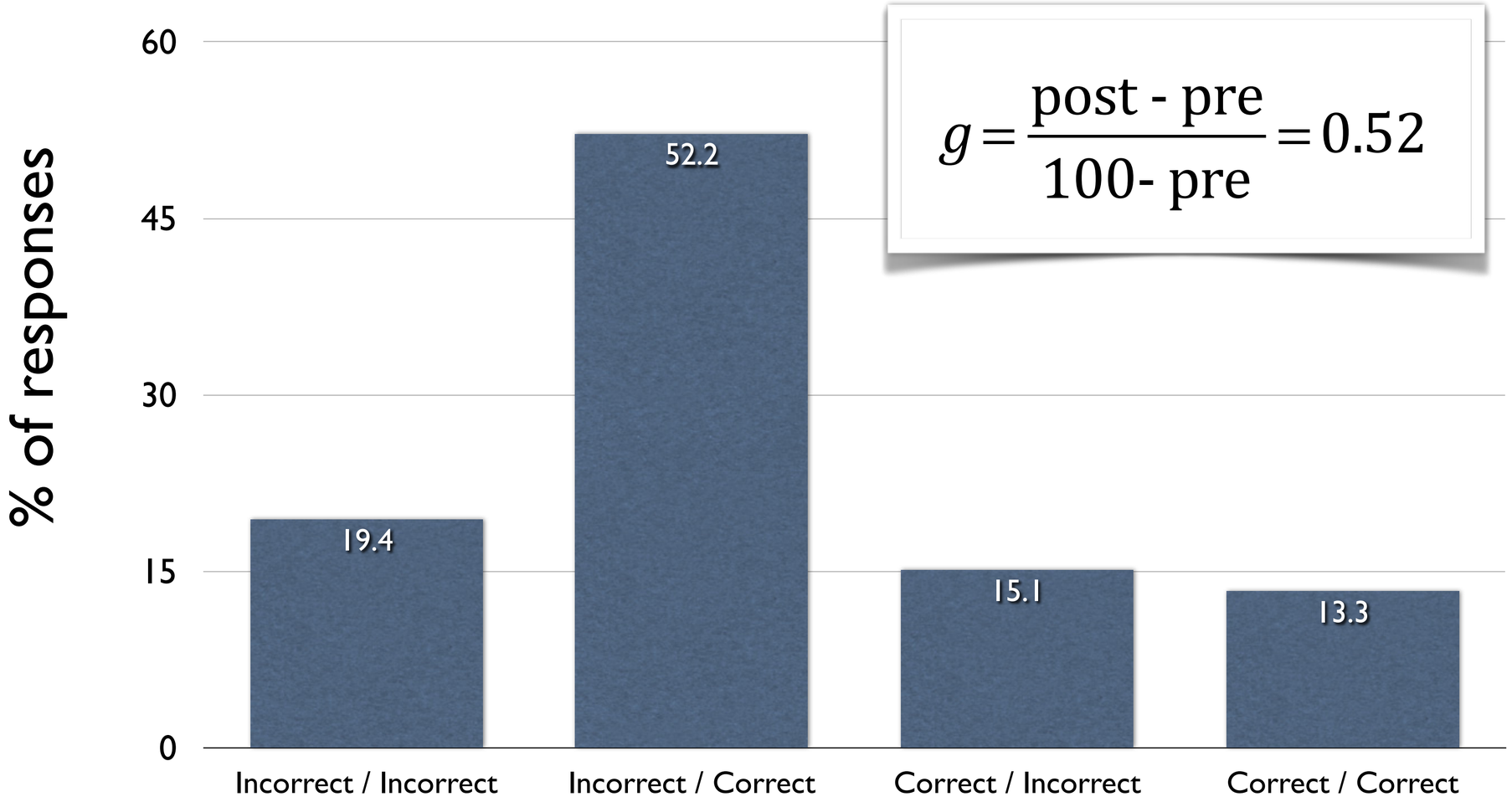
The Way the Wind Blows

In Colorado, sometimes the wind blows from high elevations and low pressures in the mountains to low elevations and high pressures on the plains.

As the air does this, it:

A. cools down.
B. warms up.

Comparing pre-test / post-test data



Data from Columbia Middle School
17 Feb 2011

Changes in self-efficacy

Target audience #2: Undergraduate students

Volunteers and Interns

Intern interviews

- All surveyed students noted lessons and specific skills that they had learned, regardless of their eventual career path.

  I learned to imagine more and instruct less. The kids always had interesting ideas with the projects I had never even considered.

- All surveyed students reported gains in communication skills.

  I found that learning science is a very individualistic thing. Something that made one person understand might not work on another. The important thing was always to just keep trying.

- Nearly all students reported clarification of career goals.

  LSOP was the first step for me to change from a research focus to an education focus.The knowledge that I enjoy teaching has impacted many of my career decisions since.

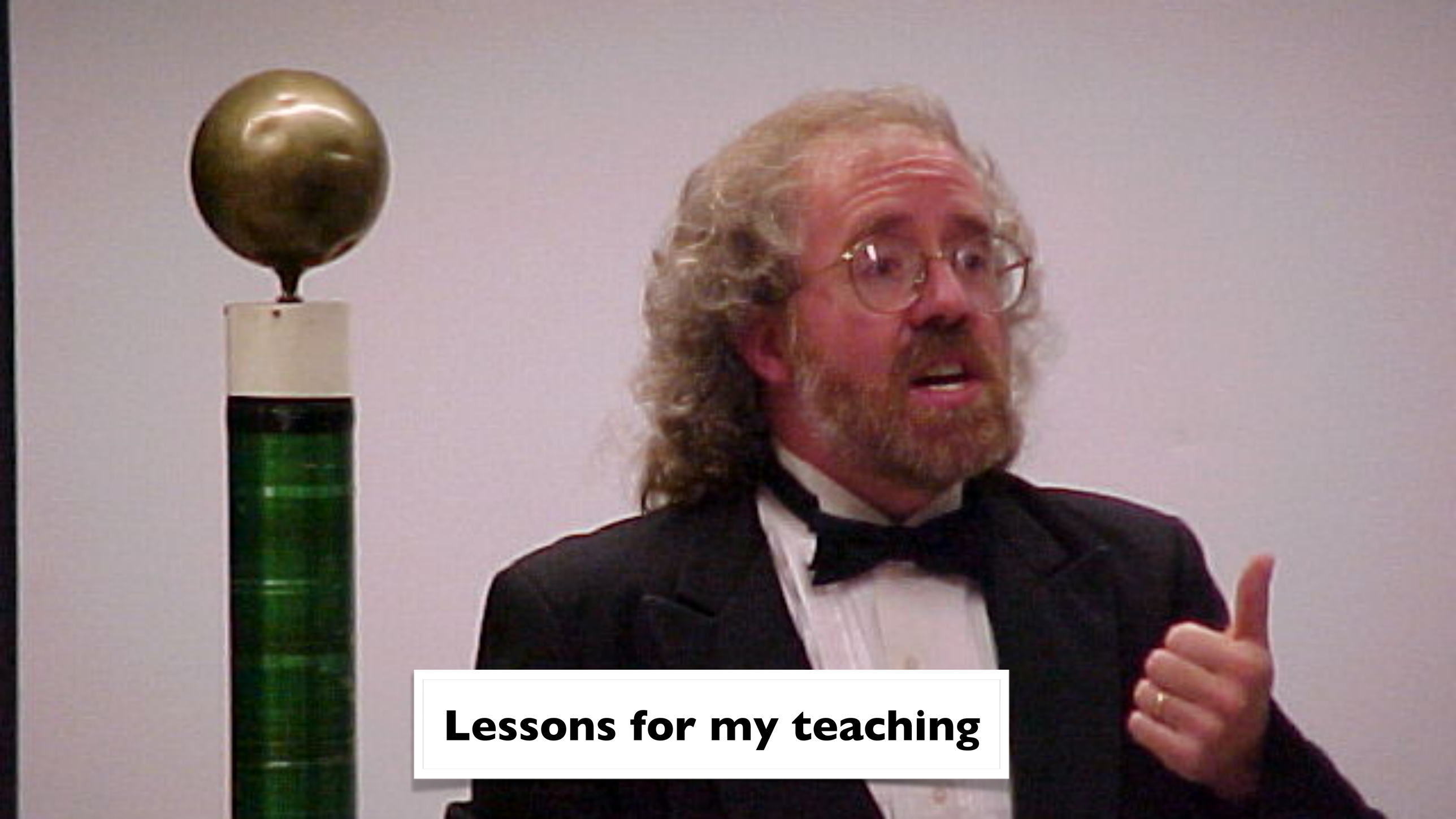
- Interns reported gains in interpersonal skills.

  Great team relationship and depending on other people to hold high expectations as well.

Target audience #3: Fellow educators

Responses from summer workshop attendees

Item	Response
I used what I learned in the workshop in my teaching.	93%
I used hands-on activities from the workshop in my teaching.	93%
I shared what I learned with other science teachers at my school.	86%
I became more confident in my ability to communicate science.	79%
I learned from the pedagogical approaches of the workshop.	57%
I used slides from the workshop in my teaching.	36%


Lessons for my teaching

Science and education are social enterprises.

We learn best when we are active.

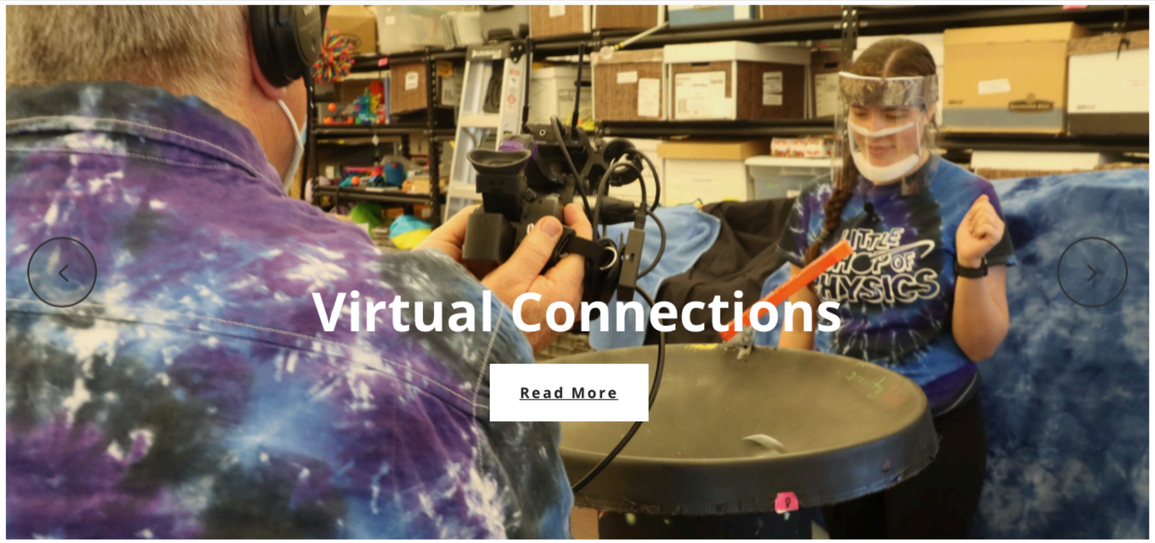
Our job as educators is to design an environment in which students can learn.


Changes in my class

Engagement vs. Outreach

It's not the having.
It's the doing.

How do we stay connected in a physically-distanced world?



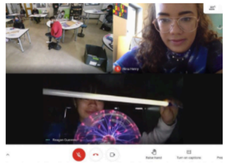
http://lsop.colostate.edu

Not intelligent design.
Evolution.

LSOP LIVE

Every Friday at 11am MST we bring you a new episode of LSOP Live. Curious about how magnets work? Wonder why the sky is blue? Looking for some cool science experiments you can try with materials you already have at home? Tune in live on Zoom to ask questions or you can view it later on our website.

For more information, to participate live, or see past episodes, please visit https://www.lsop.colostate.edu/lsop-live/



CLASSROOM CONNECTIONS

The Little Shop of Physics is currently developing novel ways to connect with K-12 students in Poudre School District and beyond. We have materials and expertise, and we're looking for educators who are interested in inviting us into their classroom, be it virtual, hybrid, or in-person. For more information, please visit our Classroom Connections page.

ART OF SCIENCE CONTEST

Students in grades 6-12 can submit original artwork in any medium — video, music, visual art, or written composition — for a chance to win awesome prizes! Winners will be chose by the LSOP Team, and students and classrooms can virtually connect with CSU students, staff, and faculty to explore the connections between art and science.

For more information or to enter, please visit https://www.lsop.colostate.edu/artofscience/

BOYS AND GIRLS CLUB

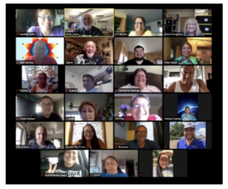
The Little Shop of Physics has teamed up with the College of Natural Sciences Learning Community Science Outreach Scholars to do some awesome high tech programs with the Fort Collins Boys and Girls Club. We were able to stay connected remotely through science! Check out photos and details about our adventures here.

SCIENCE AT HOME KITS

We have developed two science-at-home kits. These kits can be used as structured inquiry-based laboratory exploration independently at home or in a classroom. Students will also have the opportunity to virtually connect with CSU staff and students to explore these kits.

One kit is sponsored by the Halliburton Foundation and focuses on science in general: optics, motion, electricity, thermodynamics, energy, matter, sound, density and buoyancy. The other kit specifically focuses on magnetism and magnetic phenomena.

Click here to see details of our kits!



TEACHER WORKSHOPS

In July we hosted a hands-on virtual workshop for teachers and pre-service teachers on the Pine Ridge reservation. This 3-day course focused on weather and climate, and every teacher received a kit with hands-on experiments. For details about this project, please click here.

We are currently developing a kit called "Earth as a Planet" for 5th grade teachers in Poudre School District. Once completed there will be a virtual teacher training workshop, where teachers can become familiar with the kit, ask clarification questions on the content, and discuss pedagogy.

LSOP LIVE: FOOLING YOUR BRAIN, FRIDAY, APRIL 9

You know about optical illusions, where your eyes see something that isn't really there—but do you know that there are hearing illusions, touch illusions, and even taste illusions? It turns out that it's not that hard to fool your brain, and doing so teaches us a lot about how your brain works. Video Shorts

Read More

LSOP LIVE: DO THE LOCOMOTION, APRIL 2, 2021

By student request: A show about how you walk, how fish swim, how birds fly! If you want to move forward, you need to push backward—on the ground, on the water, or on the air. You want to do this efficiently, using as little energy as possible. In this show, we answer a bunch of [...]

Read More

LSOP LIVE: ROCK ON!, MARCH 16, 2021

What's so cool about rocks? A lot, as it turns out. In this episode, we show you rocks that pop like popcorn, rocks that you can use to make electrical circuits, rocks that split light in two. We also show you how to read history in rocks that you find, and even how to find [...]

Read More

LSOP LIVE: FORCE AND MOTION, MARCH 12, 2021

By request from a local school: Force and Motion! When you jump in the air, it's not your legs that push you upward—it's actually the ground! And you know you have to push something to get it movi
have to push to make it s
we make things float an

LSOP: INVISIBLE FORCES, MARCH 5, 2021

By request from a local school: Invisible Forces! You can't see gravity—but you can certainly see its effects. And it works at a distance—you don't need to be in contact with the earth to feel its pull. We say that the earth has a gravitational field around it—and if you are in the field, you [...]

Read More

LSOP LIVE: SCIENCE IT UP!, FEBRUARY 26, 2021

Last week, we asked students to share their questions with us—and did they ever! We got questions from "Why can we see clouds, since they are made of air?" to "Why do snowflakes have different designs?" On this episode, we take one question after another and Science It Up! We take each question and use [...]

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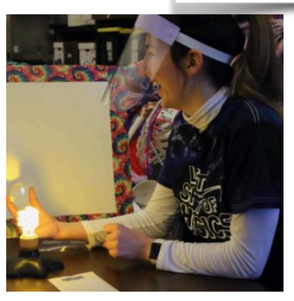


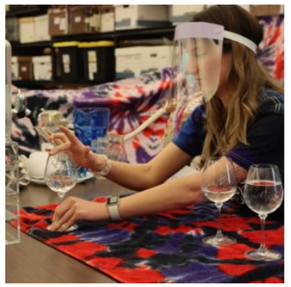
LSOP LIVE: BOUNCING, BENDING, AND TWISTING LIGHT, FEBRUARY 19, 2021

Mirrors, lenses, and polarizers, oh my! In this episode we show you some amazing effects that you can recreate at home. We make objects seem to disappear, make transparent objects develop colors, turn people upside down, make a mirror out of transparent materials, and show you how to use a mirror to make what seems [...]

Read More

LSOP LIVE: SINKING AND FLOATING, FEBRUARY 12, 2021

A bowling ball—does it sink or float? The answer might surprise you, as will dozens of the experiments we share. We float bubbles and steel balls, and make a ketchup packet go back and forth between sinking and floating. We answer the



LSOP LIVE: THE MUSIC SHOW, FEBRUARY 5, 2021

Talking about music gives us a chance to talk about forces, frequency, energy, vibrations, and states of matter. It's a rich topic, and one we had a lot of fun exploring. How many ways can you play Hot Cross Buns? We play it on glasses, bottles, sewer pipes, electrical conduit, and, of course, actual hot [...]

Read More

LSOP LIVE: IT'S ABOUT TIME, JANUARY 29, 2021

This episode is about time! We use video to slow time down, to speed time up, to make time go backwards—and we see how this changes our view of the world. We also do some cool tabletop experiments with metronomes, with hot cocoa, and with hand sanitizer. What do these things have to do with [...]

Read More

LSOP LIVE: THE HEART OF THE MATTER, JANUARY 22, 2021

This week, we are trying something new! We treat topics that are part of the state science standards, to better connect with what students are learning in school. This week, we consider the following fact: matter is made of atoms. Understanding this helps understand matter's appearance and its behavior. Why is steel bouncy? (It is—very [...]

Read More

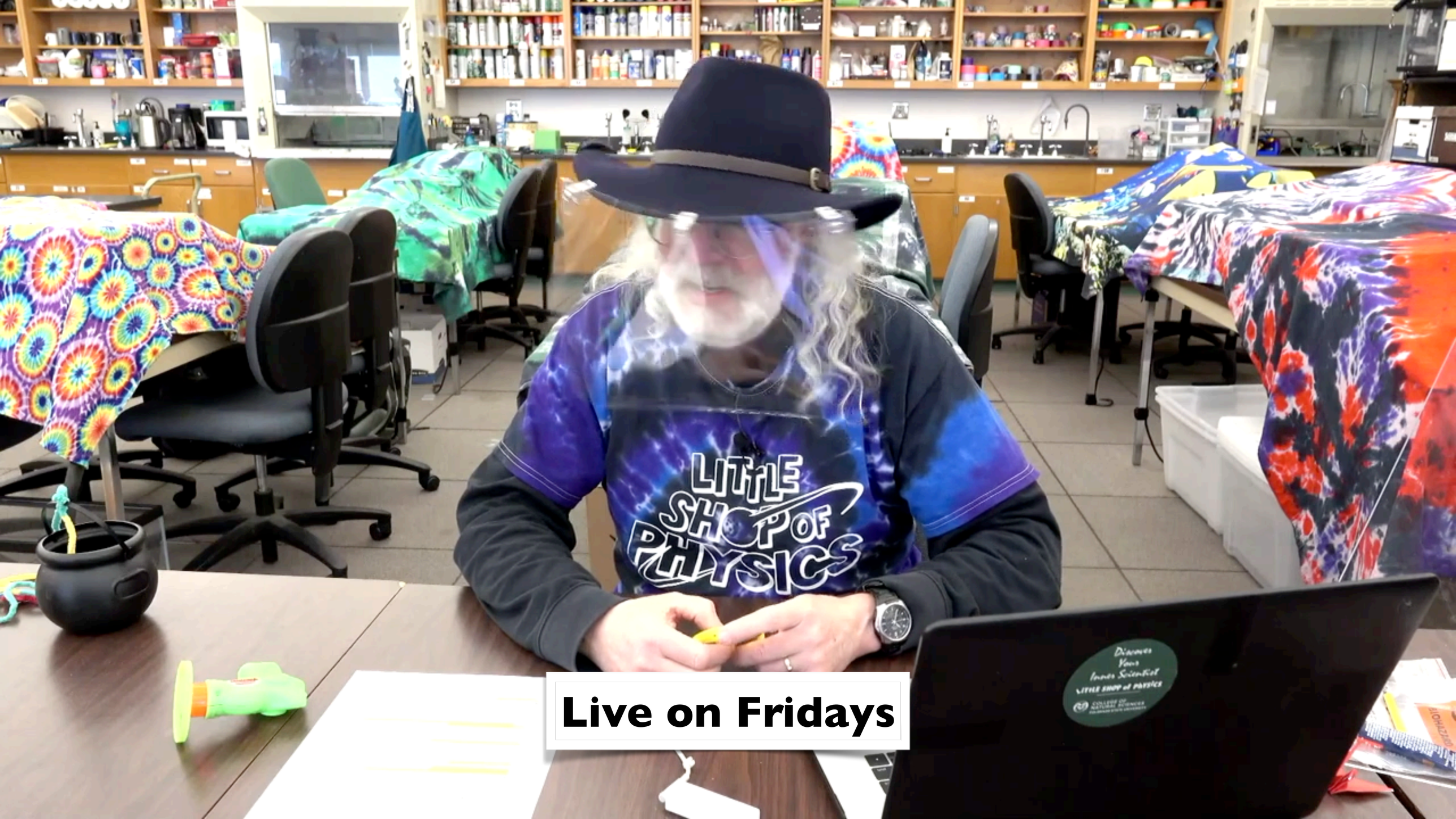
LSOP LIVE: THE WATER SHOW, JANUARY 15, 2021

What's so special about water? Quite a bit, as it turns out! In this episode, we show you a bunch of simple experiments you can do that illustrate the special properties of water. We make water freeze on command, make a stream of water follow a string, use water to lift writing off glass, and [...]

Read More

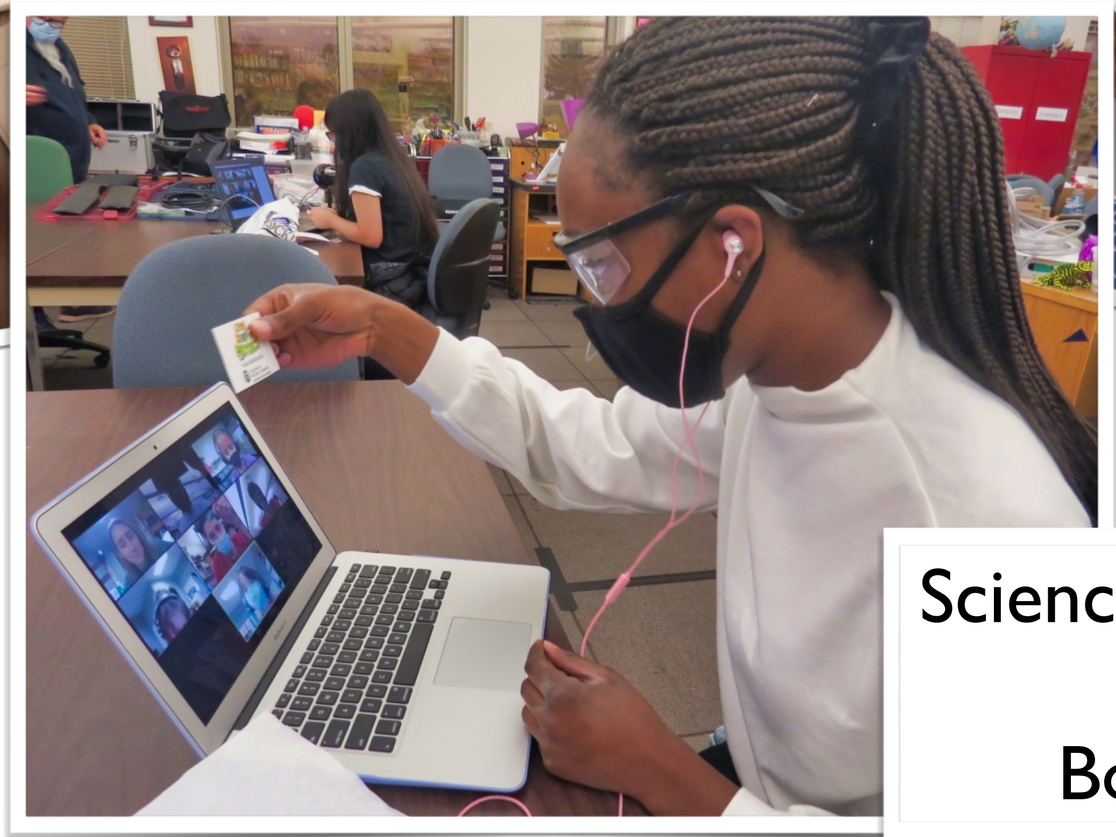
LSOP Live

https://www.lsop.colostate.edu/lsop-live/


LITTLE SHOP OF PHYSICS
Live on Fridays


LITTLE SHOP OF PHYSICS
Dunn Elementary School

Workshops & courses

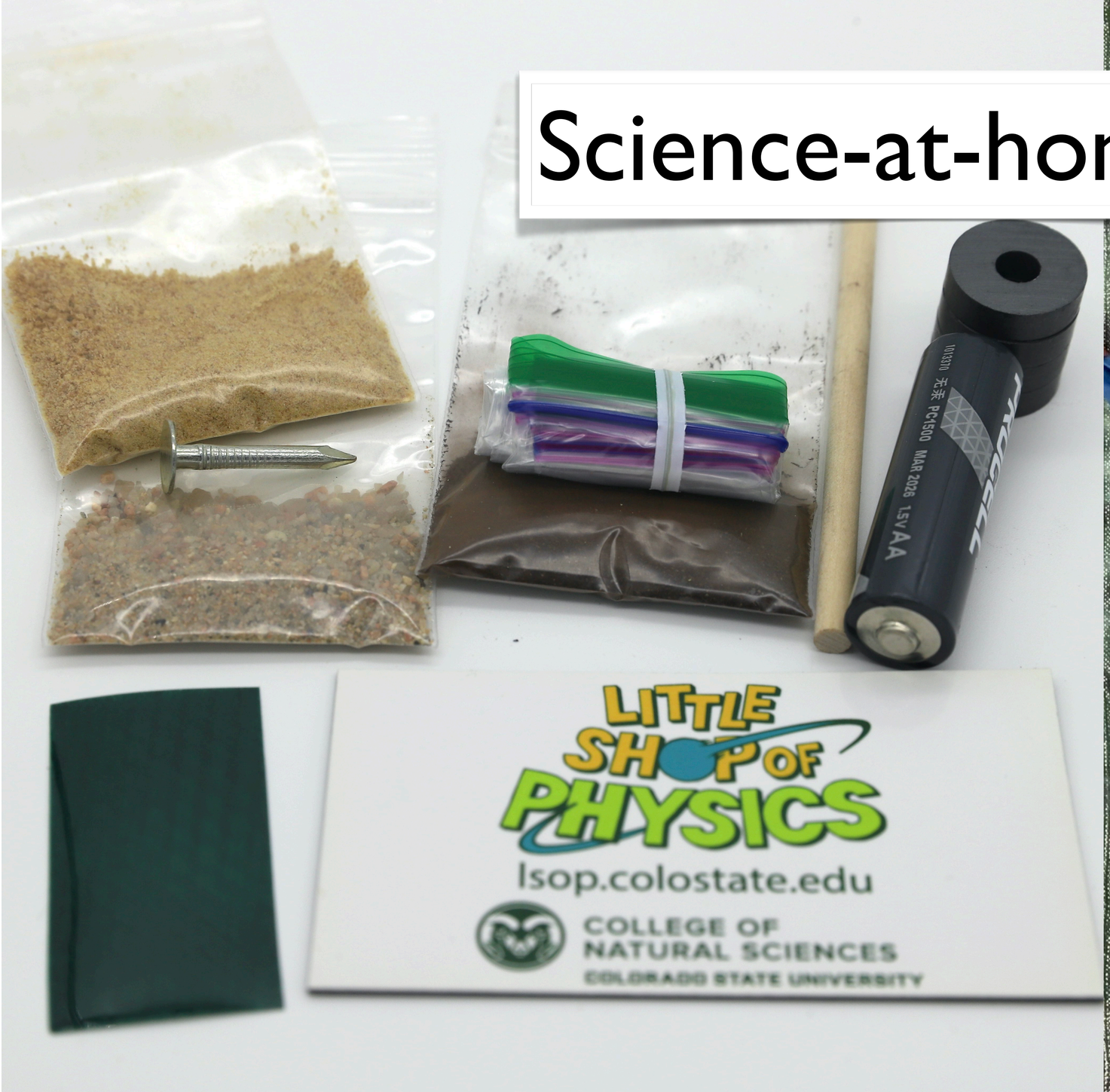


Science Outreach Scholars
&
Boys & Girls Club

Transition to in person learning

Classroom Connections

Science-at-home Kits



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COLLEGE OF
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What ideas do you have?

Breakout Rooms

Questions?

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LITTLE SHOP OF PHYSICS

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