From Ideal to Real: Teaching Physics for an Imperfect World

Elissa Levy (she/her)

Thomas Jefferson HS for Sci & Tech

10/11/25

Abstract

No physics classroom is an isolated system. Our students bring their whole selves—their emotions, dreams, and life history—into our learning spaces, and they carry their classroom experiences out into the world. In this talk, we'll explore frameworks for helping students connect the idealized content of the physics classroom with the complexities of the real world. By doing so, we can empower students to become more critical thinkers, preparing them to navigate a world that is anything but frictionless. We'll examine the **history of physics** and how it has shaped our modern curriculum, discuss the **structures of power and privilege** that influence who participates in physics, and **explore pedagogical approaches** that foster a more inclusive and relevant learning environment. Join us for specific and immediately usable strategies, as well as a roadmap for continuing this conversation—because there is no simple solution to teaching physics in today's complex world.

About me

- First career in financial services
- Teaching experience in NYC and NoVA
- Affiliations
  - Curriculum Writer and former Regional Lead at STEP UP
  - Editorial Board Member at the URC
  - Co-Chair of the AAPT Diversity Community
  - Board Member and Leader at STEMteachersNYC
  - Co-Founder of STEMteachersDMV
  - Secretary of the Yale Science & Engineering Association
  - Co-Founder of Yale Alumni Educators
  - Editorial Board Member for TPT
  - Fellow Emeritus at Math for America

Outline for this talk

1. The history of physics and how it shaped our modern curriculum
2. The structures of power and privilege that influence participation in physics
3. Pedagogical approaches for more inclusive and relevant learning

Generated by Gemini

1. History of physics

Tell the person next to you:

A. The physics lesson or unit that you most love teaching

B. Where in the world and when in history humanity developed the knowledge covered in this lesson or unit

Then we'll aggregate our data.

What we call “physics” is white and European

“The ‘European’ and ‘western’ worlds have often received credit for the advancement of science and the application of technology for development….It is as if the world is finally catching up with the realization that science and technology rose from the collective knowledge of the human experience….This is important to recognize; technological and scientific breakthroughs occurred independently in many parts of the world” (Paul E. Lovejoy for UNESCO).

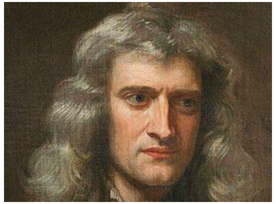
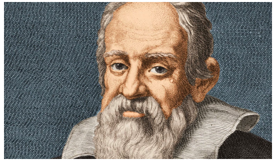
It’s great when we physics teachers highlight diverse researchers, but be aware: when this is done as a one-off, and not a part of the formal physics curriculum, we perpetuate the same narrative. We’re telling students that all cultures are worth studying but only the dominant white culture produced “real” physics.

When you're beholden to the canon…

…you still teach it, and you also help students engage critically with it!

1. Humanize physicists, so students realize they can be one too
2. Discuss the role of luck and circumstance in physicists' breakthroughs
3. Showcase the "supporting" characters that drove physicists' successes

Humanizing physicists

	**Isaac Newton** was born prematurely and was ill as a child. His father died three months before he was born. When Newton was three, his mother remarried and went to live with her new husband, leaving her son in the care of his grandmother. The young Isaac hated his stepfather for taking his mother away from him.
	**Alessandro Volta** showed no signs of talking until the age of 4; his family feared he was not very intelligent. His father died poor when Volta was seven, and his uncle helped raise and teach him. Volta's family wanted him to become a lawyer, but Volta wanted to be a scientist.
	**Galileo Galilei** lost two of his 5 siblings in early childhood. When Galileo was eight, the family moved from Pisa, Italy to Florence, leaving Galileo behind with a family friend for a few years.

Students reported that a career as a physicist felt less lofty and unreachable when they learned that physicists are people too.

Luck and circumstance

Why was it Newton who discovered Newton's Laws? Why not someone else?

- **Boris Hessen**: Newton's work was funded and socially acclaimed because of its political alignment with the 17th century merchant economy. Newton was just in the right place at the right time; someone was bound to make those discoveries at that time.
- **Loren Graham**: Be critical of Hessen's "product of his times" argument, because Hessen himself was a product of his own times. "Hessen was a participant in a fierce Soviet debate over the relationship of the social origins of science to its cognitive value."

(I gave students this graphic organizer to help them parse the articles.)

With thanks to Emma Jablonski

The “supporting” characters

- The wives who meaningfully contributed to their husbands’ work and fame (e.g., Marie Curie, Margrethe Bohr, Mileva Marić and Elsa Einstein)
- The unnamed people whose work around the world inspired the physicists we see as brilliant (e.g., Newton’s World)
- The insufficiently-cited names for content we teach in class (e.g., Snell’s Law instead of Ibn Sahl’s Law or Conservation of Momentum instead of Noether’s Theorem)

Crowdsourcing to tell the global stories

- Global discoveries from before Newton, which deserve accurate attribution

- Topic-specific one-pagers (e.g., next slide)

Universal gravitation has a global history

Student-facing slide

Greece (Aristotle): Posited that downward motion of heavy bodies is related to their nature (gravity)
https://en.wikipedia.org/wiki/History_of_gravitational_theory

India (Brahmagupta): "…all people on the earth stand upright, and all heavy things fall down to the earth by a law of nature, for it is the nature of the earth to attract and to keep things…"
https://en.wikipedia.org/wiki/Brahmagupta#Early_concept_of_Gravity

Denmark (Brahe): Described the solar system, made precise celestial measurements
https://mathshistory.st-andrews.ac.uk/Biographies/Brahe

United Kingdom (Newton): Developed law of universal gravitation
https://scholar.harvard.edu/kleelerner/publications/newtons-law-universal-gravitation

500 BCE | 1 CE | 500 | 1000 | 1500 | 2000

Americas: Predicted celestial events
https://mexikaresistance.files.wordpress.com/2013/09/american-indian-contributions-to-the-world.pdf

China: Showed the stars move but are not physically connected to anything
https://en.wikipedia.org/wiki/Chinese_astronomy

India (Bhāskara II): "Objects fall on the earth due to a force of attraction by the earth. Therefore, the earth, planets,… moon, and sun are held in orbit due to this attraction"
http://www.mysteryofindia.com/2015/02/law-gravity-discovered-indian.html

Germany (Kepler): Developed laws of planetary motion
https://www.britannica.com/biography/Johannes-Kepler

USA (LIGO): Detected gravitational waves
https://news.mit.edu/2016/ligo-first-detection-gravitational-waves-0211

Some physics pedagogy history (more here)

Turn of the century

American universities' research instructure was still forming. Only 5 physics Ph.D.s had been awarded in the US by 1875; people were studying in Europe.

The Committee of Ten (1894) called to unify instruction, give access to all students, and teach physics first.

APS (1899) and AAPT (1930) facilitated collaboration to improve physics instruction.

Post WWII

Physical Science Study Committee (PSSC) designed curricula where students would learn by doing, not memorizing. The goal: reach as many students as possible so the ones with aptitude would find their way into physics. High school video lectures were recorded because quality teachers were hard to find.

Youth were encouraged to pursue physics via summer programs, ISEF (1950), AP Physics (1954).

Modern times

We still face physics teacher shortages; we still face challenges ensuring all students have access to rigorous physics curricula.

We've continued to innovate physics pedagogy in many ways including NGSS, modeling, culturally responsive teaching, etc.

With thanks to Emma Jablonski

Meaning-making is the goal

Millikan Lecture 1998: Building a Science of Teaching Physics

Edward F. Redish
Department of Physics, University of Maryland, College Park, Maryland 20742-4111

In 1903, Robert Millikan published the first volume of a two-volume reform curriculum in introductory physics.[1] In the preface to this volume he makes the following statement:

> *The most serious criticism which can be urged against modern laboratory work in Physics is that it often degenerates into a servile following of directions, and thus loses all save a purely manipulative Important as is dexterity in the handling adjust-ment of apparatus, it can not be too strongly empha-sized that it is grasp of principles, not skill in manipu-lation which should be the primary object of General Physics courses.*

This is **not** a new idea!

With thanks to Emma Jablonski

2. Power, privilege, and participation in physics

Let's look at

- What drives the *content* of the physics curriculum
- What drives the demographics of *people who get to do physics*
- The nature of science and *whom physics serves*

The content hasn't changed much in 150 years

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24 University of the State of New York.

28th Advanced Academic Examination.

PHYSICS (Elementary).

June, 1887—Time two and one-half hours only.

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40 *credits, necessary to pass*, 30.

1. Define mass, molecule, and atom. State a form of attraction peculiar to each.......... 6
2. Name two general properties of matter and two specific properties 2
3. Name and define the three forms of matter, and explain how one form may be changed to another 3
4. State Pascal's law governing the transmission of pressure by liquids 1

*5. A body at the earth's surface weighs 1,200 lbs.: what would be its weight 1,800 miles below the surface? What, 1,800 miles above the surface? (Assume the earth's diameter to be 8,000 miles.) 2

*5. Upon what does the velocity of a jet of water depend? State the formula for calculating the velocity of a jet.......... 2

University of the State of New York. 25

28th Advanced Academic Examination.

ADVANCED PHYSICS.

June, 1887—Time two and one-half hours only.

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44 *credits, necessary to pass*, 33.

1. Distinguish between the weight of a body and its mass. One being given, how may the other be found? 3
2. On one arm of a false balance, a body weighs 11 lbs., on the other, 17 lbs. 3 oz.; what is the true weight? 1
3. A mass of granite contains 5,949 cu. ft. The specific gravity of a fragment of it is found to be 2.6; what is the weight of the mass? 1
4. Show how the pendulum is used in obtaining the form of the earth 1

*5. Make a drawing of Atwood's machine; explain how it is used; show what difficulties are overcome by its use; and state the laws that it verifies 4

*5. Give as complete an explanation as possible of the generally accepted theory of polarized light, illustrating it with the necessary diagrams 4

With thanks to Keith Sheppard

The people who get to take physics

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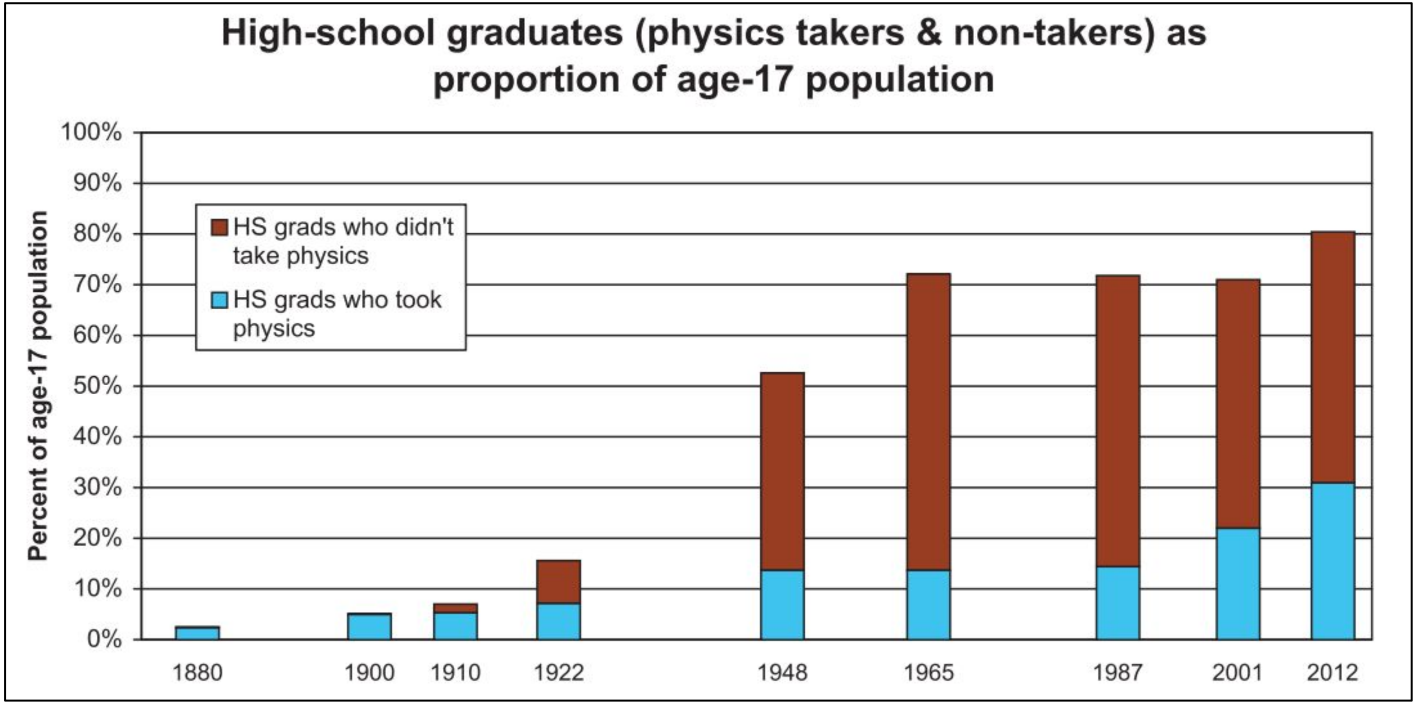
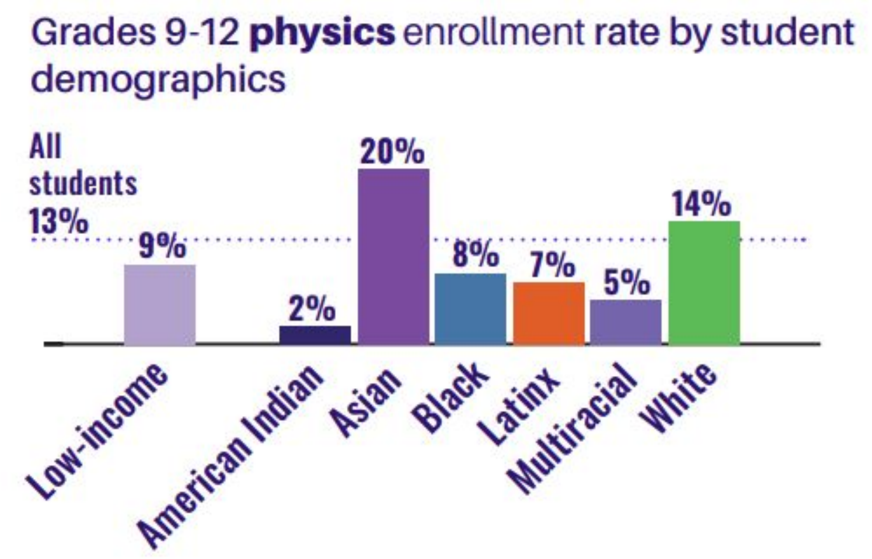
A brief history of physics education in the United States

David E. Meltzer; Valerie K. Otero



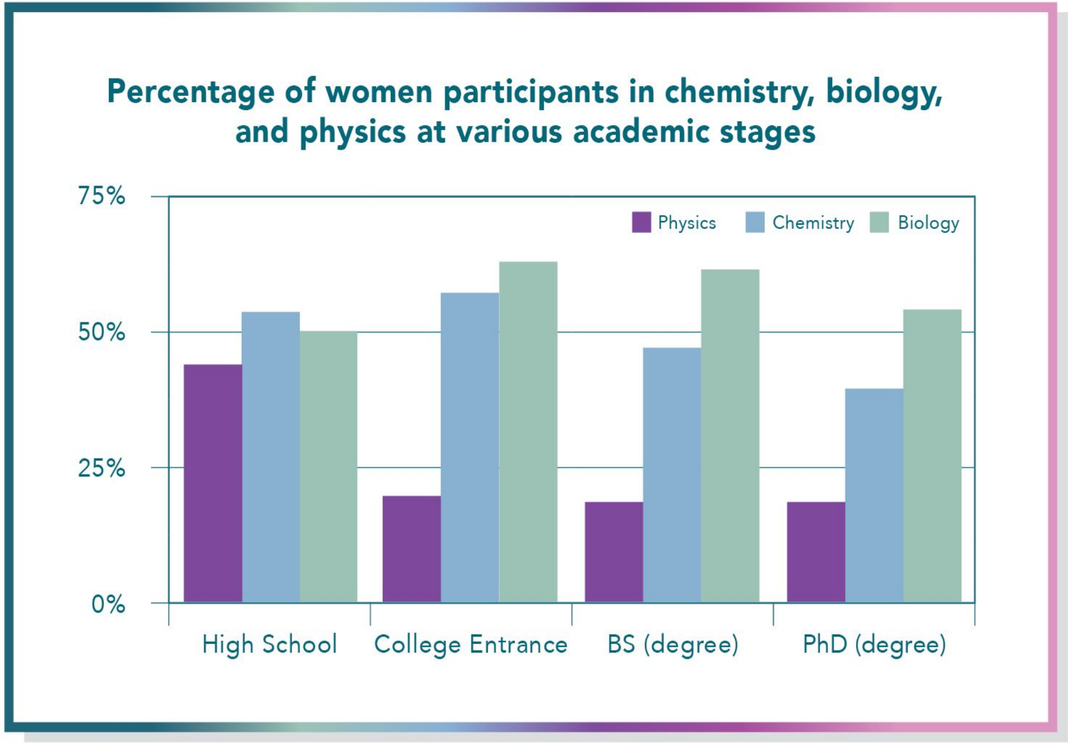
Physics student demographics remain uneven

High school physics enrollment by race in New York



Nationwide:
Access and performance in advanced high school physics have been persistently inequitable when considering student ethnicity and gender.
- Angela Kelly and Rob Krakehl

Physics student demographics remain uneven



Source: AIP, HERI, IPEDS

Subjectivity/objectivity and the nature of science

Questions I ask students to discuss:

1. Is science is more objective (fact-based) or subjective (influenced by humans)?
2. Can science tell us what’s true and what’s false?
3. Is there bias in science?
4. How are science and politics related?
5. How are science and culture related?

Some quotes:

What "emotional needs" are fulfilled by science?

Science has been described as being "heavily dependent on cultural contexts, power relationships, value systems, ideological dogma, and human emotional needs." (Harding, 1998)

What is an example of "power relationships" in science?

Sociocultural consciousness is "the awareness that one's worldview is not universal but is profoundly shaped by one's life experiences, as mediated by a variety of factors." (Villegas & Lucas, 2002, p.27)

How does this non-universality affect science?

"Both meter stick and retinal imprints are elaborate constructs to which experience has direct access only when the scientist...arranges....The alternative is not some hypothetical 'fixed' vision, but vision through another paradigm." (Kuhn, 1970)

Would Kuhn consider science to be more "subjective" or "objective"? Why?

"[K]nowledge of nature originates not with scholars but with ordinary working people in the course of their everyday productive activities." (Conner's ***A People's History of Science***, 2005, p. 393)

Does it matter where scientific knowledge comes from? Why or why not?

"The 'union of capital and science' was not and is not an alliance of equals; it has always been a master-servant relationship, with capital as the dominant partner." (Conner, 2005, p. 423)

How does money affect whether science is objective or subjective?

"The relation between science and people cannot be understood apart from the ideological uses to which science has been put." (Conner, 2005, p. 441)

Is it possible to disentangle science from society?

Physics is political

Physics serves those with money and power:

- Military (war/defense) funding drives university research (Giroux)
- Efficiency is sociopolitical and energy is sociopolitical (Scherr)
- Big tech drives physics research, setting priorities for innovation (Aka)

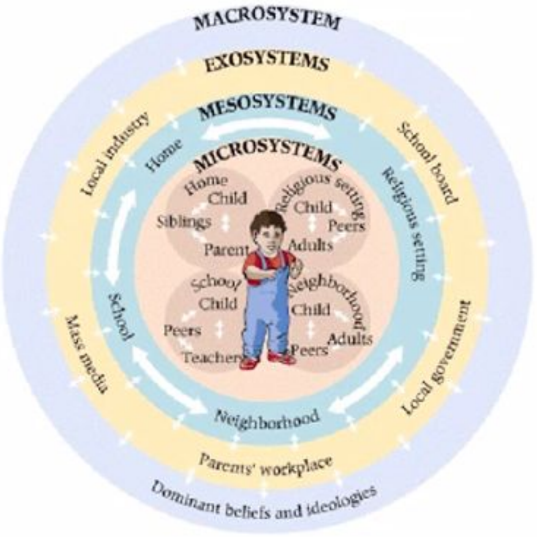
Claiming it's apolitical leads to "authoritarian science" (Harding):

- Race "science" and science as a "civilizing mission" (Haraway)
- Nuclear physics programs and the Cold War
- "Free market" science and "both sides" of acid rain, smoking, global warming

3. Pedagogical approaches for an imperfect world

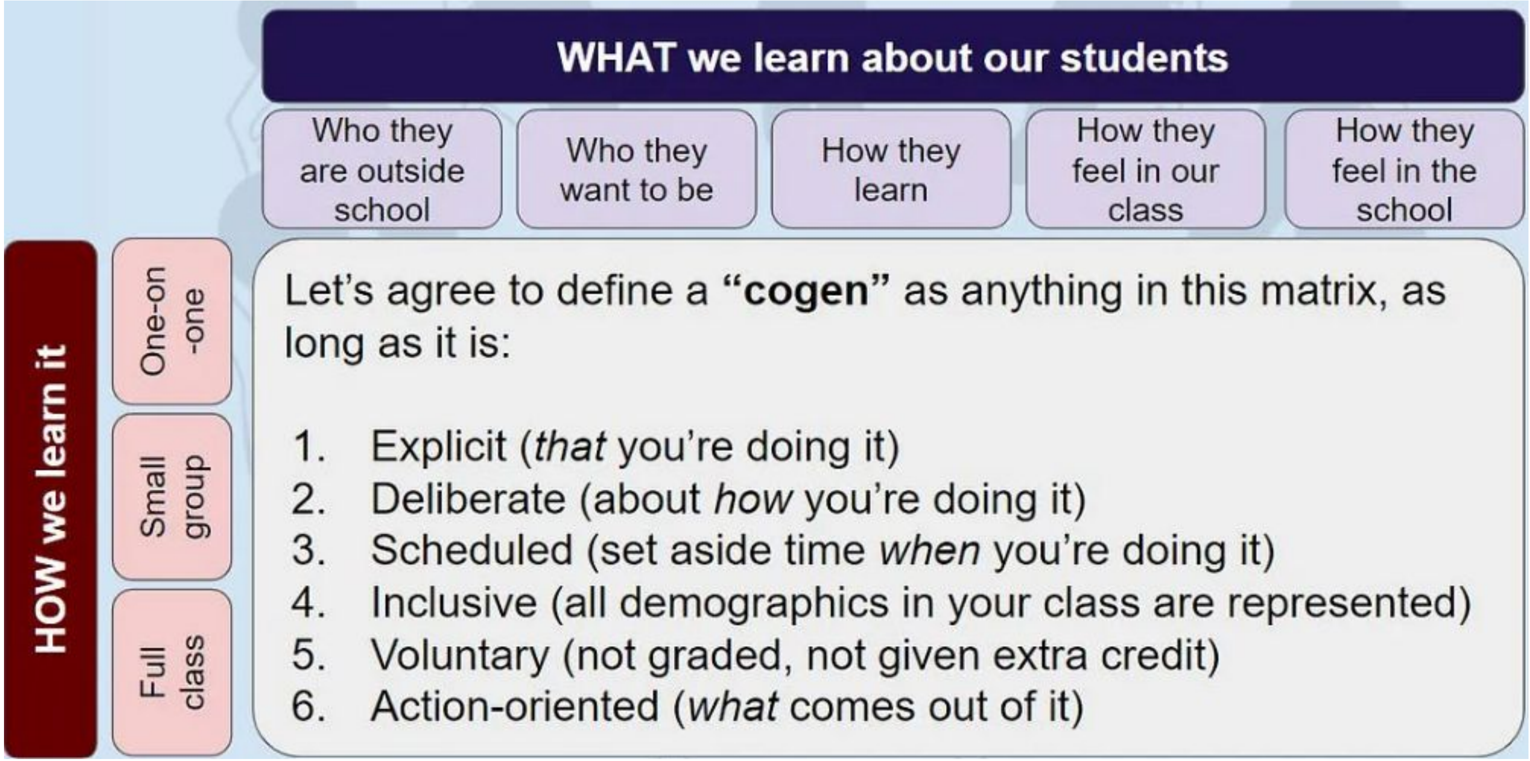
The Ecological Systems Theory (Bronfenbrenner, 1979)

- Individual Child (person)
- Microsystems (people)
- Mesosystems (institutions)
- Exosystems (society)
- Macrosystem (culture)



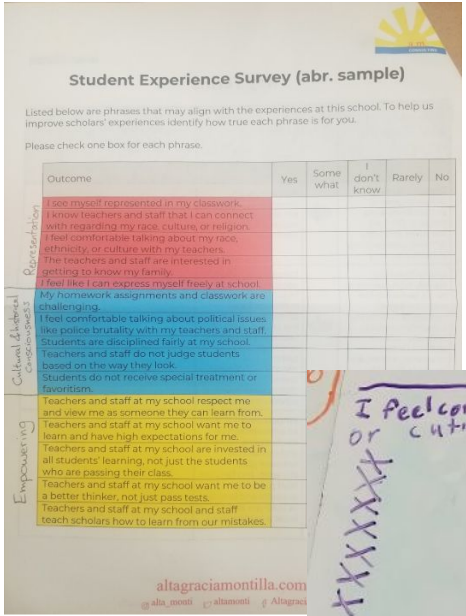
"Overlapping Spheres of Influence"

Cogens: to understand students' ecosystems



More detail in the article I wrote here

Types of cogens



Student Experience Survey (abr. sample)

Listed below are phrases that may align with the experiences at this school. To help us improve scholars' experiences identify how true each phrase is for you.

Please check one box for each phrase.

	Outcome	Yes	Some what	I don't know	Rarely	No
Representation	I see myself represented in my classwork.					
	I know teachers and staff that I can connect with regarding my race, culture, or religion.					
	I feel comfortable talking about my race, ethnicity, or culture with my teachers.					
	The teachers and staff are interested in getting to know my family.					
	I feel like I can express myself freely at school.					
Cultural & historical consciousness	My homework assignments and classwork are challenging.					
	I feel comfortable talking about political issues like police brutality with my teachers and staff.					
	Students are disciplined fairly at my school.					
	Teachers and staff do not judge students based on the way they look.					
	Students do not receive special treatment or favoritism.					
Empowering	Teachers and staff at my school respect me and view me as someone they can learn from.					
	Teachers and staff at my school want me to learn and have high expectations for me.					
	Teachers and staff at my school are invested in all students' learning, not just the students who are passing their class.					
	Teachers and staff at my school want me to be a better thinker, not just pass tests.					
	Teachers and staff at my school and staff teach scholars how to learn from our mistakes.					

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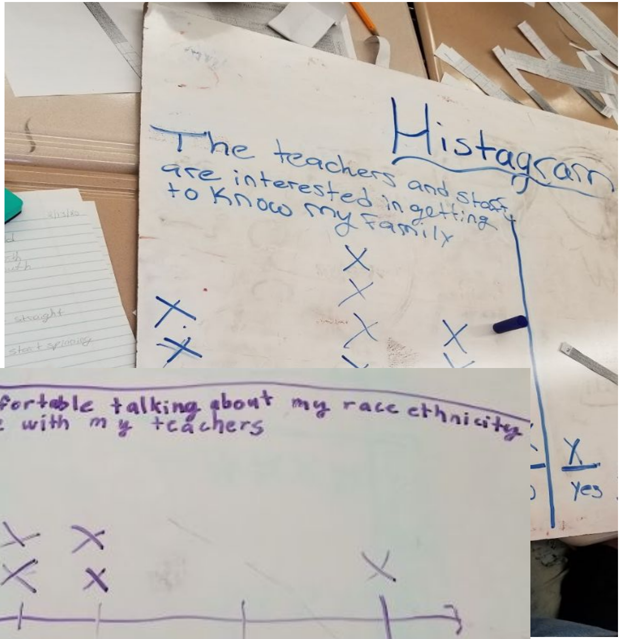
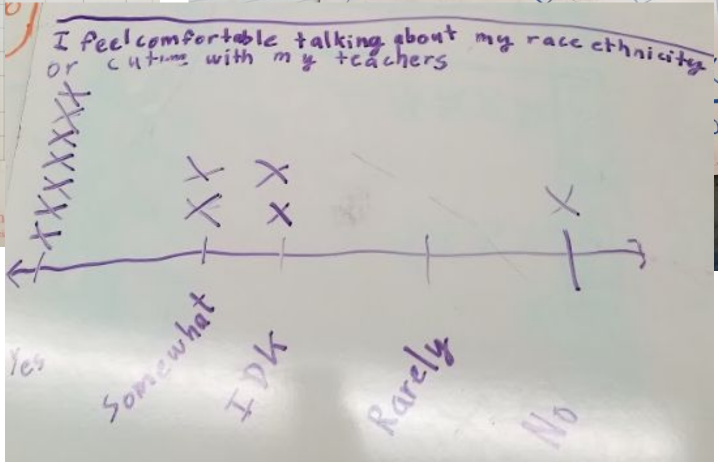
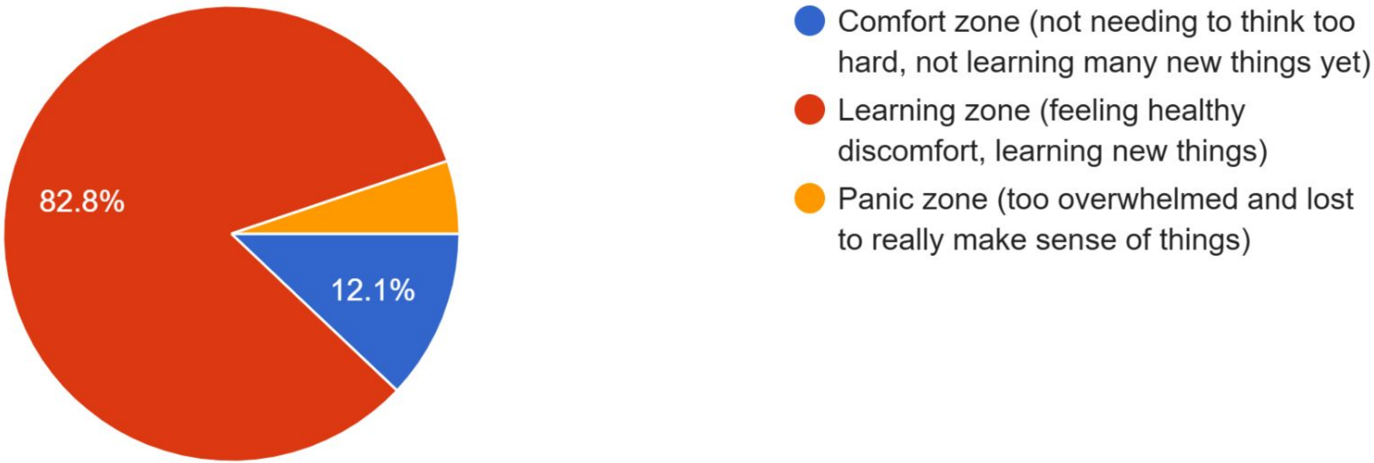




Surveys: to take a pulse and boost metacognition

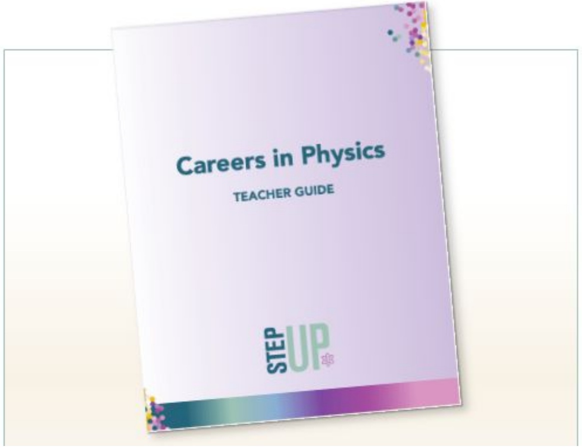
For this class so far, which engagement zone have you been in the most?

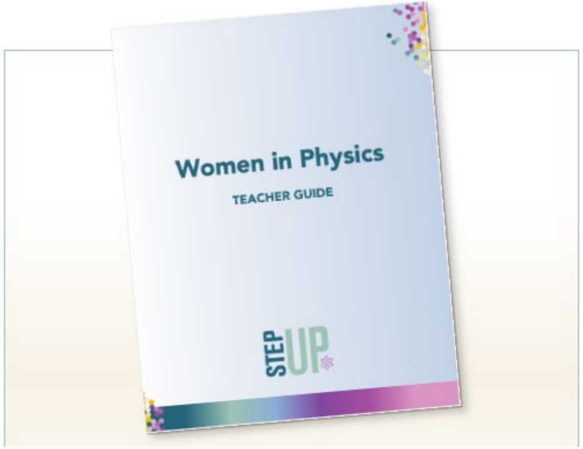
58 responses



Share the aggregated data with students, and decide as a class what to do about it.

STEP UP materials (here)





STEP UP PHYSICS TOGETHER

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EVERYDAY ACTIONS SELF-REFLECTION

On a scale of 1-5, how would you rate your use of the everyday actions?

When you… Talk to students individually	NOT AT ALL					VERY MUCH
Discuss with students why they would be a good fit for physics	0	1	2	3	4	5
Direct other students to female students for help	0	1	2	3	4	5
Direct students toward clubs, camps, internships, or other programs	0	1	2	3	4	5
Encourage students to take advantage of academic opportunities in physics	0	1	2	3	4	5
Connect with students about what they value and are interested in	0	1	2	3	4	5
Provide for students' different needs with support and feedback	0	1	2	3	4	5
When you… Facilitate group work/labs	**NOT AT ALL**					**VERY MUCH**
Avoid isolating women in a group of mostly men	0	1	2	3	4	5
Ensure women are taking active roles	0	1	2	3	4	5
Bolster confidence around lab equipment	0	1	2	3	4	5
Teach collaboration skills during or before initial group activities	0	1	2	3	4	5

When you… Address the whole class	NOT AT ALL					VERY MUCH
Set expectations for success	0	1	2	3	4	5
Promote a sense of community	0	1	2	3	4	5
Promote a growth mindset	0	1	2	3	4	5
Value many different types of skills, such as communication and teamwork	0	1	2	3	4	5
Distribute attention during class discussions	0	1	2	3	4	5
When you… Plan and assess	**NOT AT ALL**					**VERY MUCH**
Incorporate real world physics examples	0	1	2	3	4	5
Connect physics to other disciplines	0	1	2	3	4	5
Establish clear grading rules	0	1	2	3	4	5
When you're… Outside the classroom	**NOT AT ALL**					**VERY MUCH**
Find out which teachers have the students who feed into physics	0	1	2	3	4	5
Talk to school counselors	0	1	2	3	4	5
Have open doors of communication with parents	0	1	2	3	4	5
Support students who want to start a physics club, or take part in physics/ science organizations and competitions	0	1	2	3	4	5
Find out about outreach and community activities for student engagement	0	1	2	3	4	5

Physics Identity

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1. To what extent do you agree or disagree with the following statements?

Physics Identity: Present Self

	Not At All 0	1	2	3	4	5	6	7	8	9	10 Very Much So
a. I see myself as a physics person.											
b. My physics teacher sees me as a physics person.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
c. My family sees me as a physics person.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
d. My friends/classmates see me as a physics person.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
e. Others ask for my advice/input in physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
f. I am confident that I can understand physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
g. I can do well on exams in physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
h. I understand concepts I have studied in physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
i. Learning physics is comfortable for me.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
j. I feel confident solving physics problems.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
k. I can overcome setbacks in physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
l. I am interested in learning more about physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
m. Topics in physics excite my curiosity.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩

STEP UP PHYSICS TOGETHER

Physics Identity

1. To what extent do you agree or disagree with the following statements?

Not At All	0	1	2	3	4	5	6	7	8	9	10 Very Much So
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b. My physics teacher sees me as a physics person.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
c. My family sees me as a physics person.	⓪	①	②	③	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
d. My friends/classmates see me as a physics person.	⓪	①	②	③	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
e. Others ask for my advice/input in physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
f. I am confident that I can understand physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
g. I can do well on exams in physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
h. I understand concepts I have studied in physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
i. Learning physics is comfortable for me.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
j. I feel confident solving physics problems.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
k. I can overcome setbacks in physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
l. I am interested in learning more about physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
m. Topics in physics excite my curiosity.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩

Physics Identity: Recognition by others

Physics Identity

1. To what extent do you agree or disagree with the following statements?

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c. My family sees me as a physics person.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
d. My friends/classmates see me as a physics person.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
e. Others ask for my advice/input in physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
f. I am confident that I can understand physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
g. I can do well on exams in physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
h. I understand concepts I have studied in physics.	⓪	①	②	③							
i. Learning physics is comfortable for me.	⓪	①	②	③							
j. I feel confident solving physics problems.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
k. I can overcome setbacks in physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
l. I am interested in learning more about physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
m. Topics in physics excite my curiosity.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩

Physics Identity: Competency and Performance Beliefs

Physics Identity

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1. To what extent do you agree or disagree with the following statements?

Not At All	0	1	2	3	4	5	6	7	8	9	10 Very Much So
a. I see myself as a physics person.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
b. My physics teacher sees me as a physics person.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
c. My family sees me as a physics person.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
d. My friends/classmates see me as a physics person.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
e. Others ask for my advice/input in physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
f. I am confident that I can understand physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
g. I can do well on exams in physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
h. I understand concepts I have studied in physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
i. Learning physics is comfortable for me.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
j. I feel confident solving physics problems.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
k. I can overcome setbacks in physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
l. I am interested in learning more about physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
m. Topics in physics excite my curiosity.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩

STEP UP PHYSICS TOGETHER

Physics Identity

Physics Identity: Interest

n. I enjoy learning about physics.	⓪	①	②	③	④						
o. Physics is fun for me.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
p. I can see myself as a physicist.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
q. A future in physics is a possibility for me.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
r. I am likely to major in physics in college/university.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
s. I could see myself pursuing a physics-related career.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
t. The skills I learn in physics will be useful for my future.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
u. Studying physics gives me a clear advantage in the future.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
v. Learning physics will be beneficial for my career.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩

AAPT 2025 PHYSICS EDUCATION®

STEP UP PHYSICS TOGETHER

Physics Identity

n. I enjoy learning about physics.	⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩
o. Physics is fun for me.	⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩
p. I can see myself as a physicist.	⓪ ① ② ③ ④ ⑥ ⑦ ⑧ ⑨ ⑩
q. A future in physics is a possibility for me.	⓪ ① ② ③ ④
r. I am likely to major in physics in college/university.	⓪ ① ② ③ ④ ⑥ ⑦ ⑧ ⑨ ⑩
s. I could see myself pursuing a physics-related career.	⓪ ① ② ③ ④ ⑥ ⑦ ⑧ ⑨ ⑩
t. The skills I learn in physics will be useful for my future.	⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩
u. Studying physics gives me a clear advantage in the future.	⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩
v. Learning physics will be beneficial for my career.	⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

Future Self

Physics Identity

n. I enjoy learning about physics.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
o. Physics is fun for me.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
p. I can see myself as a physicist.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
q. A future in physics is a possibility for me.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
r. I am likely to major in physics in college/university.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
s. I could see myself pursuing a physics-related career.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
t. The skills I learn in physics will be useful for my future.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
u. Studying physics gives me a clear advantage in the future.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩
v. Learning physics will be beneficial for my career.	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩

Utility Value

A quote from a student of mine

"I'm proud of how much more comfortable I've become with asking questions and being okay with not understanding things right away. I've learned to embrace the learning process instead of rushing to have all the answers....Overall, I'm proud of how my mindset around school and learning has changed this year. This class helped me realize that majoring in something like physics is less about just learning physics or physics content and more about developing a way of thinking. That kind of mindset in terms of problem solving, reasoning, and curiosity is valuable across so many fields, and is true with a lot of majors. It's changed how I think about college majors and learning in general. I used to think science classes were mostly solo efforts, where you sit down and just figure things out yourself. But white-boarding with others has taught me how valuable collaboration and different perspectives are. Working through problems first and then understanding the concepts afterward helped me realize that real understanding often starts with curiosity and struggle. That shift made learning more engaging and meaningful to me and resulted in a lot of "woahhhhhhh" moments. I was surprised to learn that physics and math majors tend to do really well on the MCAT and LSAT (both of which are tests I'm considering taking in the future). It made me seriously consider minoring in physics or math, even though I'm not completely sure yet, because the skills and logic learned in those majors are applicable in so many different settings. I've also started thinking more about teaching as a future career (maybe not something I do my entire life but definitely something I would want to do at least once, possibly a substitute teacher when I retire?? or an elementary school teacher before I go to grad school). This class, especially during that one class we had discussing college and the future, has made me realize that I don't need to have a career path that goes in a straight line. I can play around and explore the things I truly like. ...my mindset when it comes to school and grades has shifted. I used to be hyper-focused on grades, but this class, and your style of teaching Ms. Levy, has helped me really love learning and the learning process. I've started to prioritize understanding and relevance over my numeric grade. I love that feeling of being able to explain how an everyday phenomena in my life works the way it works. And I've also realized that it's okay if I'm not interested in every topic—we all connect to different things, and that's part of what makes learning personal and valuable."

Frameworks that shape my instructional practice

- NGSS (DCI, CCC, SEP)
- Modeling Instruction
- ISLE Physics
- Building Thinking Classrooms

Principles that shape my instructional practice

- Ask juicy questions, and celebrate when students' approaches vary
- Have every student answer every question (even if it's only in their head)
- Celebrate guesses (guessing wrong fosters learning better than not guessing)
- Read the room, and change your plan as you go
- Hear from everyone
- Value teamwork and risk-taking over getting it "right"
- Regularly promote student metacognition

More resources

James Poskett: Horizons, Diversity in STEM Challenge, Lesson Plans

Clifford Conner: People's History of Science

David Peat: Blackfoot Physics

Daniel Kelves: The Physicists: The History of a Scientific Community in Modern America

Thomas Kuhn: The Structure of Scientific Revolutions

Meltzer and Otero: A brief history of physics education in the United States

Stay in touch!

elissadunnlevy@gmail.com