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CSU- TIPS Chemistry

Chemistry Is Everywhere: Global Stories of Discovery and Innovation

2025-2026
TIPS Conference

CSU-TIPS Chemistry Team

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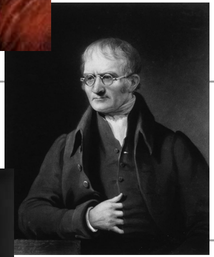
1st Semester General Chemistry
You Know What You're Teaching:

CH1- Introduction
CH2- Atoms
CH3- Molecules
CH4- Reactions
CH5- Gases
CH6- Thermochemistry
CH7- Atomic Orbitals
CH8- Periodic Trends
CH9- Lewis Structures
CH 10- VSEPR, hybridization, MO theory

First Topics and Scientists Discussed

Person	**Experiment**	**Discovery**
Lavoisier 1770s 	Conservation of Mass	Matter is neither created nor destroyed in chemical reactions.
John Dalton 1803 	Atomic Theory	Elements are made of atoms.
Rutherford 1911 	Gold Foil Experiment	The atomic nucleus.
Thomson 1897 	Cathode Ray Experiment	The electron

What does this say about who does chemistry? When did humans start doing chemistry?

- Intro to Chem and 1st semester Gen Chem has a lot of first time first year students
- We don’t see ourselves reflected- they are just old white men
- Makes it hard for students to connect and see relevance to why they are there
- Our aim: Change the perception of how chemistry is perceived, when chemistry started, and who does chemistry…
- This is hard
- We are trying to tackle 100s of years of how chemistry has been treated in educational institutions

Our dimensions: Ourstories/ Theirstories, Mirrors and Windows

Cultures/Our/Theirstories	Windows/Mirrors (In Lak'ech)
Funds of knowledge, algorithms from other countries, ethnomathematics, place-based and land-based science; politics	Appreciation, not just difference; standing alongside of others, seeing new things, new axioms, goal is not always consensus; fostering respect/dignity; becoming the best person in their own eyes
Students recognizing that science has actors/ancestors/roots, aesthetic choices	Students being able to see themselves in curriculum & in others; connecting with **others**

Framework of Rochelle Gutierrez

Lesson Study Plan

1. *“When you hear ‘chemistry,’ what comes to mind?”*- Used Mentimeter to capture a word cloud of responses and projected to the class

2. Students get into small groups and they were each assigned or allowed to pick a case card.
   a. How have **people all over the world practiced chemistry** throughout history, and what does that mean for how we define science today?”/“Where do you see **science in your culture** and/or at home?”
   b. Case cards (A Story, The Chemistry, Discussion Prompts)
      i. Fermentation, Coffee Extraction, Fish Sauce, Nixtamalization, Color TV

3. 20-30 min to address discussion prompts in a Google Slide presentation
   a. What was your example?, What kind of chemistry is happening?, What does this story tell us about how knowledge develops?
4. Each group presents to the class

5. Reflection Question

Focal Student Interviews Questions

- **When you think of a scientist/engineer, what kind of person comes to mind?**
  What characteristics or examples do you think of?
  (Follow-up: Do you see aspects of yourself in that image? Why or why not?)

- **In what way(s), if any, have the examples, experiments, or stories shared in your science classes reflected people like you or your community?**
  (Follow-up: How might it affect your motivation, persistence or sense of belonging if they did?)

- **Can you think of a time in class when you felt truly engaged or excited about learning science?**
  (What about that experience made it meaningful?)

- **Outside of class, what experiences (including with family or personal), clubs, or communities have influenced your motivation or confidence in science?**
  (This could include social groups, mentoring, research, jobs, or other experiences.)

- **When you think about your future as a scientist, professional, or community member who uses science, what do you envision?**
  (Follow-up: What supports or experiences would help you move toward that vision?

- **What stories, voices, or perspectives do you think are missing from the science curriculum?**
  (How could including them change your experience or others' experiences?)

When you think of a scientist/engineer, what kind of person comes to mind?

- someone that is patient, determined, creative, willing to look outside the box, curious, and a logical person.
- full of curiosity, patient, and problem-solvers.
- problem solve using skills learned in academia, as well as from life/work experience.
- Issacc Newton- I do see myself as leaning towards a scientist; those other people involve other people; stem is male dominated; women should more recognized
- Marie Curie- she died for what she was passionate about- something that can change; sometimes if I feel really passionate about something I will keep going

In what way(s), have the examples, experiments, or stories shared in your engineering or science classes reflected people like you or your community?

- *NO*- the lack of knowledge I am not obtaining, lowers motivation to attend; i don't think they reflect my community; it affects it in a way; my test scores are good; getting good grades is motivation
- *Dont think a lot of the …; first gen; someone might be in construction working with something and they just know how it works without going to school- don't see enough of that in the university*
- *Feel a lot of imposter syndrome- my white classmates know a lot of stuff;*
- *I feel really discourage when stuff like that happens*
- *Always in the back of my mind- there's someone thats better of me*
- *Feeling like I am not good enough; I don't understand as easily → motivates me to do better; I am enough- Why am here? What am I doing it for? Who am I doing this for?*
- I really can't think of many instances where the material in the chemical engineering classes reflected anyone in particular regardless of background. I only started to feel "a sense of belonging" once I completed an internship at a refinery and finally had a "real-world" sense of where and how to apply these skills in industry.

Can you think of a time in class when you felt truly engaged or excited about learning engineering or applied science?

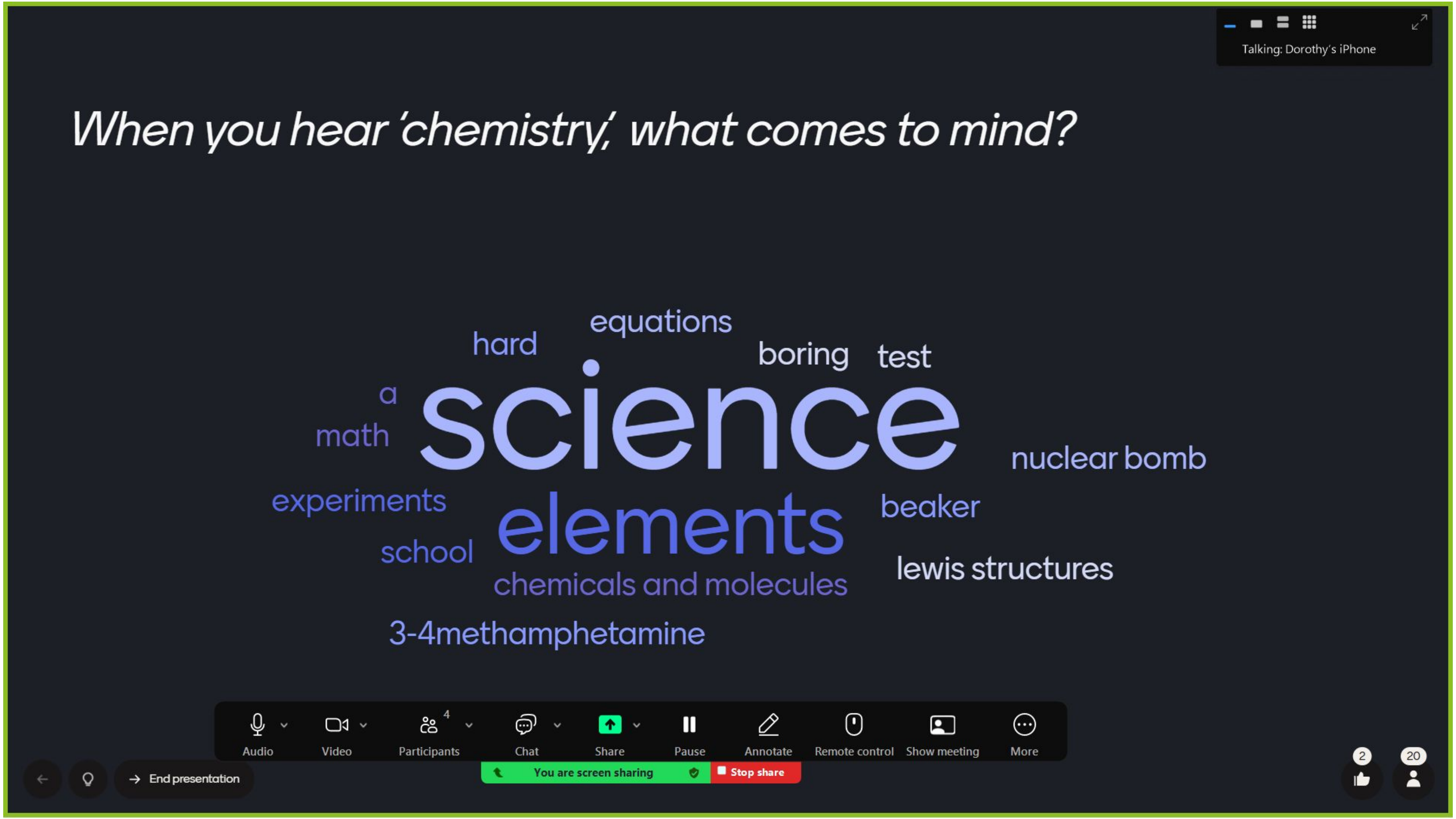
- When it relates to what I am interested in, when professors tell stories or related to real world stuff, relates to equations he puts on the board; humanizes science more
- felt truly engaged or excited about learning was when I was able to connect the concepts learned in class to real world applications.

Outside of class, what experiences, clubs, or communities have influenced your motivation or confidence in science?

- Outside of class, my parents – especially my mother is the one that influenced my motivation of going into science from a show called *NCIS*. The moment I saw the forensic scientist, Abby Sciuto, I knew that is what I wanted to go into. A female being able to be a forensic scientist in law enforcement that are both considered an male dominated profession. Adding my passion for chemistry and wanting to use it to help people – that is what sparked my interest in Forensic Toxicology. All from my mom showing me crime shows, that is what motivated me towards science more!
- My mom- a great role model, she is in the medical field, her love for science grew on me; some one I look up to
- Family doesn’t see school as helpful; that motivates me more- I want to prove that wrong
- Have a big family- only 3 of us are going to college; they are doing humanities majors; mom is black sheep of the family; out of spite

What stories, voices, or perspectives do you think are missing from the science curriculum?

- More women - women of color stories could be included
- These are stories that need to be included
- If they can do it, I can do it too
- 1st gen stories, find that connection and inspiration
- Cultural thing- a lot of young women don't go to college- they get married and have kids right away; access to resources; can be frustrating
- I think the engineering curriculum often misses stories and perspectives from underrepresented groups, especially women, people of color, first-generation students. Including these missing voices could really change how students connect with the material.
- I think the voices and perspectives that are currently missing are more females, more people of color, more people that are part of the LGTBQIA community, people with disabilities, and individuals that come from a family that had to fight to get to their success in life. Adding them into the science curriculum, it can bring an extra bit of connection with people that are similar to them and show individuals that they can be part of the science world just like those role models. A person that also has a different perspective of topics, can add a brand new perspective and idea to a theory or idea that is part of the Chemistry world.


Talking: Dorothy's iPhone
When you hear 'chemistry,' what comes to mind?
equations
hard
boring
test
a
science
math
nuclear bomb
experiments
elements
beaker
school
lewis structures
chemicals and molecules
3-4methamphetamine
Audio
Video
Participants
Chat
Share
Pause
Annotate
Remote control
Show meeting
More
End presentation
You are screen sharing
Stop share

Case Card Example

Coffee Extraction

1) Story
Coffee has been part of human culture for over 1,000 years. Its origins trace back to **Ethiopia**, where legend says that a shepherd noticed his goats becoming energetic after eating red coffee cherries. The drink spread through **Yemen**, where Sufi monks used coffee to stay awake during night prayers. By the 15th–16th century, coffee houses (*qahveh khaneh*) flourished across the **Middle East**, becoming centers of music, debate, and scholarship. Europe later adopted coffee as part of intellectual life—Paris cafés, English coffeehouses (“penny universities”), and the rise of the Italian espresso tradition.

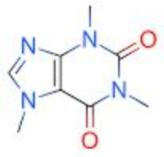
Although recipes differed, all cultures shared a common process:
heat the water, grind the beans, extract the flavor.
This centuries-old tradition is, in fact, a highly engineered chemical extraction process.

2) Chemistry / Chemical Engineering Connection

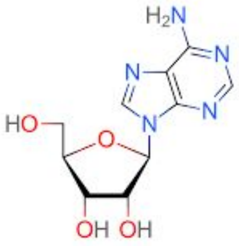
- **Heat Transfer**
  - Brewing temperature controls extraction rate (Arrhenius-type dependence).
  - Heat loss in kettles, drippers, and cups acts like a non-isothermal reactor.
- **Mass Transfer**
  - Coffee is a classic **solid–liquid extraction system**.
  - Diffusion inside porous coffee particles controls the yield.
  - Particle size governs surface area and extraction rate.
- **Reaction Engineering**
  - Flavor precursors are created during roasting through **Maillard reactions** and caramelization.
  - Brewing then isolates these compounds rather than forming new ones.
  - Brewing method = reactor design: immersion (French press), percolation (pour-over), packed bed at high pressure (espresso).

3) Discussion Prompts:

•How do cultural brewing traditions (e.g., Turkish coffee, Italian espresso, Ethiopian ceremony) reflect different engineering “design choices”?
• How does particle size influence extraction?
• Why do different brewing temperatures lead to different flavor profiles?
• How does selective extraction apply to caffeine control, and which brewing variables influence how much caffeine is extracted?
• If you were to optimize a coffee brewing process as a chemical engineer, which variables would you control?



Caffeine



Adenosine

Video- Focusing on the Science, also struggled with the task

VIDEO DELETED

Video: Nixtamalization

VIDEO DELETED

Students were asked to consider…

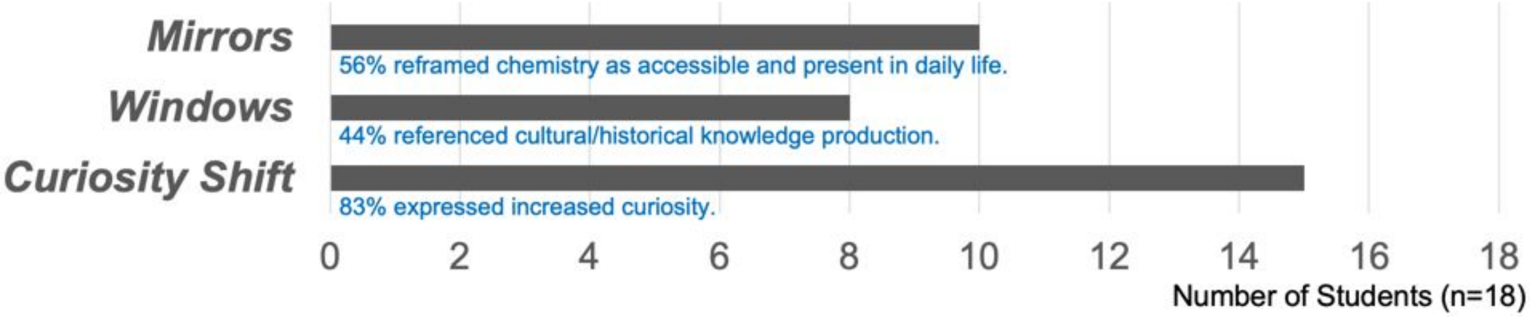
- Why might communities have developed this process?
- What “experimenting” might have led to it?
- How is this different from or similar to the way we talk about discoveries in chemistry textbooks?
- Changed last questions to: How is this different from or similar to the way we talk about discoveries in modern society? (designed for first year students, so many may not have seen a chemistry text book before)

Exit Ticket/ Reflection

“Chemistry is a global, communal, problem-solving, ever-changing endeavor. It is normal people figuring things out. Every culture has contributed to the knowledge we study today.”

Reflection Question on Canvas:
“How did today’s examples change or expand your idea of who does chemistry and why?”
“Does this make you more curious?”

Student Reflections as Evidence of Rehumanizing Dimensions



Mirrors (Identity & Access)

Repeated language:
- “Chemistry is everywhere”
- “Can be done anywhere”
- “Not just in labs”

Student voices:
“Chemistry can be done anywhere.”
“Many kinds of people, not just scientists.”
“Today made me less scared of chemistry.”

Windows (Culture & History)

Repeated language:
- “Different cultures”
- “Expanded my idea”
- “Indigenous knowledge”

Student voices:
“Came from many different cultures.”
“Expanded my idea of who does chemistry.”
“They didn’t know about it but knew the process.”

Curiosity Shift

Repeated language:
- “More curious”
- “More engaged”
- “Want to learn more”

Student voices:
“Makes me want to look more in depth.”
“I want to know what other things chemistry can be in.”
“Definitely got more curious.”

Changes to lesson- Focus on the humanizing

- Consulted with Rochelle
- Students focused too much on the science (that they may not understand at that point) rather than on the humanizing part
- This was hard to see until we actually did the lesson
- Discussion prompts
- Time was also a constraint (@ SSU Gen Chem is a 50min. class)
  - Ways to share out
    - 1 minute lightning talk
    - 6 word thesis

Discussion Prompts: Before and After

Old Discussion Prompts:

•Many traditional vessels (ollas de barro in Mexico, onggi in Korea, amphorae in Greece, oak barrels in Europe) are porous. How might gas or moisture transport through vessel walls influence fermentation?

• Why does fermentation slow or fail at high temperatures? How does this relate to enzyme kinetics?
• How did traditional cultures control fermentation temperature without modern equipment?
• Compare wine, beer, and rice alcohol fermentation—what engineering variables differ among these processes?

New Discussion Prompts:

- Where have you seen fermentation in foods or drinks connected to your culture?
- What problems was fermentation helping people solve?
- How did communities learn to control this process without formal science?

General Discussion Prompts

Why might communities have developed this process?

What “experimenting” might have led to it?

How is this different from or similar to the way we talk about discoveries in chemistry textbooks?

Challenges

- Time
- Designed for first year students, but there was so much science behind each case, how much information do they need to complete the assignment?
- Having cameras on the first day of class would be challenging
- Finding a topic, the history, making it relevant and the science is actually is beyond gen chem; we don't have the stories ourselves
- Still need to get it into a first semester general chemistry class

Working Across Campuses

- Chemistry & Chemical Engineering
- Awesome to meet and connect with colleagues at other campuses
- Zoom only interaction
- See that we have similar thoughts about General Chemistry

Conclusions

It’s important to avoid anachronistic judgments: pre-colonial Indigenous “chemistry” might not align with the formal, discipline-based conception of chemistry (with atomic theory, equations, etc.), but in functional terms it is fully chemical knowledge embedded in practice.