Integrating Toxicology into the Chemistry Classroom by Providing Relevance, Context, and Purpose for the Student

By Grace Lasker, PhD, MS, CHES, CN
Discussion Overview

• History of science education.
• Teaching to learn: What matters?
• What is social and environmental justice?
• Conclusion
A Brief History of Science...

• Science was born from positivism.
  – holds observation and measurement as the highest authority of valid knowledge
  – and as a foundational tool for scientific investigation.

• This empirical approach often leads to the idea that science is always better than or more valid than other disciplines.
One Discipline to Rule Them All

• Cobern (1994) wrote:
  – Even when interdisciplinary science curricula are adopted, they often continue to serve the interests of science.
  – These curricula acknowledge that students have other disciplinary interests but do so for the purpose of manipulating those interests to meet the traditional objectives of science education.
  – Thus, these other disciplinary interests become paths to science and the paths are clearly secondary to the destination, which is science.
Old School Chemistry

• Curriculum generally includes traditional laboratory exercises that were developed decades ago
• Content is based off of books that haven’t changed their “theme” in decades, either!
• Conventional teaching techniques are static and fail to provide interactive environments
How Do We Fix This?

• We need to re-envision the context of chemistry, it’s purpose for existence, it’s reason for requirement.
• We need to bring life back to chemistry through relevancy to life and living.
• We must flip the message: Chemistry supports all other things, not that all other things support Chemistry!
Students As Learners

• Students need to know *why* they need to learn something.
• They approach learning as *problem-solving*.
• They learn best when the topic is of *immediate value*.
• They need to learn *experientially*.

“What I hear, I forget; what I see, I remember; what I do, I know.”
What is Active Learning?

• The mission for higher education should be to bridge the gap between theory and practice.

• What is active learning?
  – As diverse as group problem-solving, worksheets or tutorials completed during class, use of personal response systems with or without peer instruction, and studio or workshop course designs.
What Should Active Learning Actually Be?

- Restructuring the classroom to increase interdisciplinary content and improve relevance for students.
- Integrating practical and hands-on experiences into curriculum to substantially increase critical thinking in students.
- Ask your students “why” not just “how.”
“Why Do We Need to Learn Chemistry?”

• The dreaded student question.
  – But our answer is just as dreadful: “It’s the basis of everything!”

• It’s like asking someone to explain “infinite.”
  – Too big, too cumbersome, not relevant to everyday life.

• Your answer must be more relevant! How?

• Social and Environmental Justice by way of toxicology.
Social Justice

- Social justice is a point of view that contends that everyone deserves equality in economic, political, and social rights, as well as equal access to important human rights.
- It is a movement that emphasizes equality of treatment of all kinds, among them issues of environment and health, safety, socioeconomic issues, justice, etc.
Environmental Justice

• Environmental Justice is the fair treatment and meaningful involvement of all people with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

• It encompasses areas not just related to the environment and ecology but also to civil rights, indigenous rights, labor, food, climate, culture, civility, immigration, and economics to name just a few.
Environmental Health

• According to the CDC:
  – Environmental health consists of preventing or controlling disease, injury, and disability related to the interactions between people and their environment.
  – Humans interact with the environment constantly.
  – These interactions affect quality of life, years of healthy life lived, and health disparities.
Toxicology is Environmental Health

• Toxicology is the scientific study of adverse effects that occur in living organisms due to chemicals.
  – Humans
  – Trees
  – Fish
  – Frogs
  – Whales
  – Plants
  – etc.
A → B → C

- Toxicology → Environmental Health → Environmental Justice → Social Justice
- And then there’s Green Chemistry...
Green Chemistry

• Green chemistry is the philosophy that chemicals should be designed to limit harm *before* they are produced.

• Imagine the justice potential with a world that has less harmful chemicals: less *disproportionate* exposure to children, minorities, economically disadvantaged populations; less class division for health advantages; and more relevancy for students learning chemistry.
Justice In the Classroom

• Green chemistry and toxicology provide a framework and lens for learning, teaching, and investigating chemistry through framing the chemistry content as solutions to these social and environmental justice issues.

• It allows relevancy to the student’s life and the ability to feel like change can happen through the power of knowledge.
Teaching Example #1

• Lesson Plan: Heavy Metals or Ions
  – Show the video Lead Astray (2015) about how lead increases crime rates in inner city youths and how in a study of Cincinnati children, those with a blood lead level up to ten micrograms/dL lost on average of seven IQ points.
    • Discuss forms of lead, where lead is found, and how lead interferes with calcium ions in neurons.
    • Then discuss how this affects people unequally: are people in depressed urban centers violent by choice or is it the lead in their sub-standard housing?
Teaching Example #2

• Lesson Plan: Oxidation/Reduction
  – Investigate Lead and Flint, MI.
  – Why not implement corrosion control treatment to keep the Pb(IV) from being reduced to more soluble Pb(II)?
  – Ethical and Justice Debate: City couldn’t afford upgrade to do corrosion control. Why not? State didn’t “care” about Flint residents for 2 years suffering? But MI governor’s rep stated they “weren’t required” so didn’t do it. Which one? At the expense of whom?
Teaching Example #3

• Lesson Plan: Polarity
  – Frame the discussion about polarity in terms of chemical movement into the body through cell membranes.
    • Cell membranes are made of phospholipids, which makes them largely soluble to lipids.
    • Many pesticides are lipophilic (because the chemical has to get inside the bug or plant’s cells to work! So it gets into ours, too).
    • Have students look at various molecular structures and predict whether they would get into our bodies, then have them find out if they are toxic or not! (SDS Analysis).
Conclusion

• Students need relevancy and context to recognize not just what they are learning but why they are learning it.
• “Because Chemistry” cannot be the answer to both those needs.
• Toxicology (by way of EH, EJ, and SJ) provides “real world” purpose to the content and help students become change agents.