HOW CAN CARS BE USED TO ESTABLISH RELEVANCE AND INTEREST IN SECONDARY CHEMISTRY INSTRUCTION?

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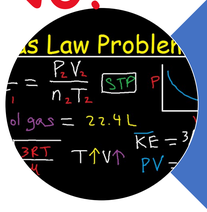
CHEMISTRY IS BORING AND HAS NO RELEVANCE…

Secondary chemistry instruction usually struggles with the stereotype of being a boring class with no real-world relevance. Part of this notion is a result of abstract lectures using words no one has heard before combined with experiments students can't make sense of. Research shows that relevant and interesting secondary chemistry learning can occur when teachers utilize topics the students use in everyday life and are already interested in, such as cars. "The emotional bonding to an object and the value that is attached to it is the two components which determine interest towards an object" (Graber, 2011). This teaching will take a concrete topic and scaffold it down to the abstract level. For example, the topic can be how a radiator works and this is scaffolded to learning about the design of an efficient radiator, down to the chemical concepts of heat exchange, heat capacity, and mass transport. These chemical abstracts now have relevant and interesting meanings in real-world applications.

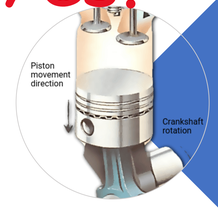
START WITH THE CONCRETE, NOT THE ABSTRACT

No!



Most teachers start with teaching the abstract chemical concepts high schoolers' brains haven't developed enough to understand, then bring in concrete examples to try to clarify.

Yes.



If you want students to be interested in the subject, you must start with the concrete, then teach the abstract. Instead of teaching ideal gas laws and using a piston as an example, teach first how a piston works, and then explain why using the gas laws.

TPEP CRITERION

This inquiry project is aligned with criterion 2 of the Washington State Teacher Evaluation Criteria. This criterion emphasizes that teachers need to demonstrate the use of effective, research-based instructional practices to meet the needs of all learners. Using relevant and interesting topics is an effective instructional practice that will engage all levels of learners.

Interesting and relevant? You bet. Photo credit: Ford Motor Co.

HOW TO GENERATE RELEVANCE AND INTEREST?

- A BIG IDEA is needed to generate relevance and interest
- BIG IDEAS are an overarching theme of something, for example cars or water quality
- Students must use or be exposed to the BIG IDEA every day in their personal lives for it to be relevant
- The BIG IDEA is even better if there are societal issues at play, like pollution or economic impacts
- The BIG IDEA must be big enough to be broken down so that many concepts can be applied to it
- A good BIG IDEA will even have students thinking about potential vocations

TRIGGER WORDS

Nomenclature, stoichiometry, magnetic resonance, kinetic molecular theory, crystal lattice structure, enthalpy, thermodynamics, calorimetry are all trigger words that immediately TURN OFF a student's interest.

WHY? They've never heard them before.

This puts THE BRAKES on learning!

AVOID trigger words when introducing a topic. Start with words the students already know.

WHAT WOULD THIS COURSE ACTUALLY LOOK LIKE?

For example, the first unit in a course could be about tire pressure. Tire pressure is not a trigger word that will turn off students' interest, it's a word that all students have heard talked about, and at least some have experienced a complete lack of tire pressure resulting in a flat tire. Relevance and interest are immediately present. The lesson could start with students taking a tire's pressure. This could then develop into relating pressure with the motion of gas molecules, talking about ideal gases, and relating tire pressure with the outside temperature. (Does the pressure in your tires go up on a hot day? Down? How does this affect you?) This necessitates knowledge of absolute temperature in Kelvin and evolves into doing calculations using Gay-Lussac's law. This aligns with NGSS HS-PS3-1: "Create a computational model to calculate the change in the energy of one component in a system."

Students then continue learning about gases when they learn how struts and shock absorbers work, where Boyle's and Charles' laws are introduced, along with the concept of energy dissipation. This is also a great place to discuss why your brake lines use a liquid instead of a gas. At this point, students have learned a great deal about kinetic molecular theory without even realizing it. This aligns with NGSS HS-PS3-2: "Illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles and the relative positions of particles."

Airbags also teach us about the behavior of gases. Due to their explosive nature, airbags bring even more interest into the chemistry classroom. Students learn reaction stoichiometry, kinetics, and thermodynamics in the airbag lessons and a review of Gay-Lussac's law. This aligns with NGSS HS-PS1-2: "Chemical reactions change the arrangement of atoms in the molecules of substances."

POSSIBLE UNITS

- Tires and tire pressure
- Struts and shock absorbers
- Airbags
- Combustion engines
- Engine efficiency
- Alternate forms of energy
- Batteries
- Catalytic converters
- Rust and corrosion
- Detergents and waxes
- Radiator and heat exchange
- Plastics, rubber, and alloys
- Lights, headlamps, and LEDs
- Brakes and brake lines

What does a catalytic converter do, and why do thieves want it? Photo credit: BBC

WHY CARS?

I viewed chemistry classes as a necessary evil throughout my high school and initial college courses. I memorized terms and equations just to pass tests but had no idea how many of them applied to real life. It wasn't until one of my professors made up questions about tankers full of acid tipping over and spilling onto a freeway and asked us how much bicarbonate would be needed to neutralize the acid, did I realize that chemistry had real-life applications. I want to take students' interest in cars and the inherent relevancy of cars in their lives and use all the systems and components of a car to teach a chemistry class.

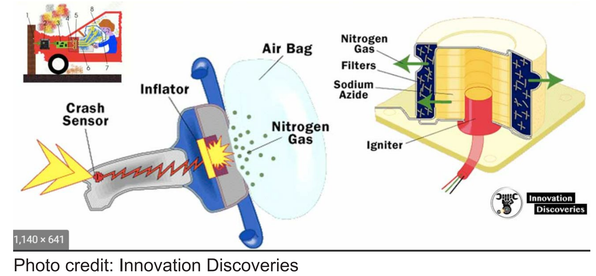


Photo credit: Innovation Discoveries

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