Safety Education –
Not the same as Safety Training

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What Happens When Science Majors are not Educated in Safety

- Recent graduates suffer injuries to themselves and others
  - In past 20 years – 164 children and educators injured in demonstrations using flammable solvents\(^1\); Result of inadequate safety education (understanding)
  - Reported laboratory incidents – 2.5 incidents/week in academic setting\(^2\)
  - CDC reported Educational Services industry – 2\(^{nd}\) highest among top industries in injuries from chemical events; 2/3’s injuries among students\(^3\)

\(^1\)SB Sigmann, Playing with Fire: Chemical Safety Expertise Required, J Chem Ed, 2018, 95(10), 1736-1746; \(^2\)R Stuart, R Toreki, Learning Opportunities in Three Years of Hazmat Headlines, J Chem Health Saf, 2014, 21(2), 2; \(^3\)AR Anderson, J Wu, Top Five Industries Resulting in Injuries from Acute Chemical Incidents, Morbid Mortal Wkly Rep, 2015, 64 (2, April 10), 47-53.
What Happens When Science Majors are not Educated in Safety

- 32 incidents of solvent fires in demos caused 164 injuries – NOT included unreported, near misses (S. Sigmann, JCE, 95 (10), 1736-46, 2018)

- Educational system failing? (Systemic failure)

- Problem continues because teachers:
  - Have limited science education, chemical safety education
  - Lack training (safety education) in safely presenting science to children
  - Don’t have appropriate safety equipment or proper venue
  - Pressured by public perception of chemistry; “Wow” factor (blowup stuff)
  - Compete with Media, TV, Movies, Internet videos
What Happens When Science Majors are not Educated in Safety – Why?

- **1st Why**: Knew solvents flammable but did not understand flammable properties of solvents; and/or Did not have safety ethic and did not think about safety
- **2nd Why**: Did not learn to think critically about safety - Not educated in flammable (other hazardous) chemical properties and behaviors
- **3rd Why**: Did not receive a safety education that would teach knowledge of hazards, critical thinking about safety, assessing and minimizing risks, and would develop safety ethic
- **4th Why**: Safety education is missing from chemistry curriculum – A GAP in the professional chemists’ education
- **5th Why**: Unknown but Safety training has been substituted for safety education in most institutions and deemed adequate safety instruction
“THE GAP” in Chemists’ Professional Education – No Safety Education!

- Underlying cause for many incidents (Not acknowledged/recognized by academic institutions far removed from events)
- Chemists studying at our universities and colleges:
  - NOT taught how to: Recognize (understand) hazards; Assess risks of hazards; Minimize the risks of hazards; Prepare for emergencies
  - NOT prepared to think critically about safety when they go to their new jobs (researchers, bench chemists, teachers,…)
- New Graduates and Chemists DO NOT have safety knowledge to problem solve in safety and do not have strong safety ethics
- Safety Education is missing; “The Gap” in chemists education
“THE GAP” in Chemists’ Professional Education – No Safety Education!

- Consider that you might get a bad grade or be embarrassed or ridiculed, if you can’t explain or don’t understand:
  - Writing balanced equations; Quantum Theory, Diels-Alder Reactions, Molecular Orbital Levels, Stereochemistry of Organic Rings, Metal ion behaviors

- But you or others can be injured, maimed, or die, if you are not educated in safety, don’t think critically about safety, and don’t understand how to:
  - Recognize and understand hazards; Assess risks of hazards; Minimize risks of hazards; Prepare for emergencies
“Why” is Safety Education Missing

- Bravado – I survived without knowing or worrying about safety and you can too (*Real Chemists don’t need safety!*); Never educated in safety so don’t care much about safety education
- Think teaching safety presents a “negative” view of chemistry; only “positive” view should be taught
- Far removed from consequences of missing safety education (NOT held accountable for not teaching safety)
- Safety training meets student’s needs (and compliance), don’t need for safety education
- Somebody else’s job to teach safety; No room in the curriculum
- Don’t know enough to teach safety
“THE GAP” in Chemists’ Professional Education – What They Need to Know!

- **First & Foremost – Learn to Recognize and understand hazards**
  - Not enough to know “flammable”, “toxic”, “explosive”, “pyrophoric”, “allergenic”
  - Need to understand these terms, properties, and chemical behaviors

- **Learn to Assess risks of hazards**

- **Learn to Minimize risks of hazards by understanding methods, equipment, procedures**

- **Learn to Prepare for emergencies**

- **RAMP** (from Hill & Finster, Laboratory Safety for Chemistry Students, 2nd Ed, 2016, John Wiley & Sons)
What should you need to recognize and understand hazards - Flammables

- Flammables
  - Why flammables important/needed
  - Chemistry of fire/combustion; Reaction profiles; Release of energy; Chemical properties (terms) pertaining to flammability; Using gas laws to predict behavior in fires and Flame jetting; Chemical structure associations
  - Hazard rating systems (GHS & NFPA)
  - How fires start – Fire Triangle/Tetrahedron; Sources of ignition; Types of fires and fire extinguishers;
What is Safety Training and Why is it Important

- Important: Helps ensure safety/compliance for employers and employees
- Usually delivered by EHS Professionals in classrooms or on-line instruction
- Teaches rules, processes, and procedures specific to institution
  - Safety compliance, chemical hygiene plans, basic lab safety, special procedures for high hazard materials, chemical waste management, fire extinguisher use, compressed gas use, respirator training/fit testing, shipping hazardous materials, radiation safety compliance, etc.
- Covers topics necessary for compliance with laws and regulations
- Mechanism for employer to demonstrate compliance with local and federal safety laws
Safety Education versus Safety Training

### Safety Education

- **Audience:** Students
- **Purpose:** Preparing students for independent thinking about safety in future
- **Goals:** Build knowledge continually over time, teach critical thinking
- **Targets:** Thought Processing
- **Emphasizes:** Principles, long-term learning

### Safety Training

- **Audience:** Employees, Students
- **Purpose:** Preparing employees & students to follow rules/processes; Documents employer compliance
- **Goals:** Prepares learners to do specific things; Skill-building, Learn institution rules, practices
- **Targets:** Behaviors
- **Emphasizes:** Specific applications, short-term learning
Safety Education versus Safety Training

Safety Education
- **Who teaches**: Faculty(?), Staff
- **Learning**: Continuous, spiraling, in-depth; apply principles/concepts
- **Testing**: Tests based on knowledge and problem solving skills
- **Focus**: Teaching general knowledge & theory, understanding, critical thinking, problem solving, the “why”;

Safety Training
- **Who trains**: EHS, staff
- **Learning**: Step-by-step, what & how to do something; memorize
- **Testing**: Tests, if given, based on memorizing facts
- **Focus**: Institution specific; Rules, Compliance; Learning specific processes;
What Can EHS Do About “The Gap” – New Role: Promote Safety Education

- Consider why safety education is needed; how it differs from you do
- Recognize safety training NOT adequate substitute for safety education
- Talk with faculty; Point out need for safety education in undergraduate curriculum – Not duplicated/replaced by safety training (both are necessary) [ACS Committee on Professional Development recommends]
- Offer assistance in developing safety education program
  - Using RAMP as basis for educational efforts; New ACS Exam available
- Recognize/Report institutions to ACS that include safety education in curriculum
Safety Education and Safety Training – Let’s Close the “Gap”!

- Different but both important & needed
- Students need both but only get Safety Training
- Graduates missing critical thinking ability in safety; missing strong safety ethics (from safety education)
- “The Gap” in learning puts future chemistry graduates at increased, unrecognized risks.
- “The GAP” in “The Chemist’s Education” result - Chemists not being properly prepared to meet the world’s needs

Concern for man and his fate must always form the chief interest of all technical endeavors. Never forget this in the midst of your diagrams and equations.”

Albert Einstein