Providing laboratory safety education to REU audiences

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My Lab Safety History

• I worked in environmental chemistry labs at Cornell and UVM for 5 years, then started the lab safety program at UVM in 1985
• In 2011, I went back to Cornell as Chemical Hygiene Officer for 3 years
• In 2014, I moved to Keene State to be the Environmental Safety Manager and Chemical Hygiene Officer
The REU Opportunity

NSF Says:

- “The REU program seeks to expand student participation in all kinds of research…
- “The program seeks to attract a diverse pool of talented students into careers in science and engineering and to help ensure that they receive the best education possible.”
1. Safety is everyone's responsibility. It operates at an institutional level (service)
2. Good science is safe science (research)
3. Safety training and education are essential elements of research and education (teaching)
4. An improved culture of safety is necessary (continuous improvement)
5. Diverse methods and flexible approaches are necessary (institutionally-driven)

Emerging Safety Challenges of 21st Century Science
- More science
- New interdisciplinary sciences: nano, r/sNA, big science
- Discovery education
Modern Lab Safety

21st Century Lab Safety involves both Technical and Cultural Challenges

20th Century: Controls Based on Rules, guided by Chemical Intuition

Culture Change through Safety Education

21st Century: a Safety System based On Risk Assessment

Lab Safety iRAMP

- Recognize Hazards
- Assess Risks
- Manage Safety
- Plan for emergencies / Protect the environment

Lessons Learned

Documentation

Improved Safety Culture
The Starting Safety Culture: The Cringe Factor
Other Science Cringe Factors

Biosafety; lasers, 3D printing

Radiation
What is a Safety Culture?

Four priorities:

– The physical safety and health of the campus community
– Complying with government regulations
– Productive teamwork: teaching, research, service
– Safety education
Element 1: Community Safety

One person’s problem is everyone’s problem.
Element 2: Legal Aspects

Higher Education has a tradition of "fissured workforces".

**Students and Visitors**
- Pay Keene State to work here
- *Are not* covered by labor or environmental regulations
- Could sue Keene State for harm that KSC should have prevented

**Employees**
- Are paid by Keene State to work here
- *Are* covered by OSHA, **Worker's Compensation** and other labor regulations
- Can’t sue KSC for workplace injuries; workers’ compensation is available for medical costs and time off
- Are part of KSC’s environmental programs
Element 3: The Academic Mission

- Teaching
- Research
- Service
Element 4: The Safety Education Process

Fast Thinking: Cognitive Biases

- How do we react when we need to act fast?
- How do we decide when there's not enough meaning in what we remember?
- What should we remember?
- How do we handle too much information?

Situational Awareness

Culture

Education and Training

Public Perception (the Cringe Factor)

Slow Thinking: Bloom's Taxonomy

- Creating
- Evaluating / Analyzing
- Understanding / Applying
- Remembering

How do we react when we need to act fast?
How do we decide when there's not enough meaning in what we remember?
What should we remember?
How do we handle too much information?
### Spiral Learning Model for Lab Safety Competencies

**Educational competencies include:**
- Knowledge / Science
- Skill / Group performance
- Attitude / Culture

<table>
<thead>
<tr>
<th>Developmental Stage</th>
<th>Science</th>
<th>Group Performance</th>
<th>Culture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional chemist</td>
<td>Identify and estimate significance of emerging risks</td>
<td>Make risk decisions and teach risk assessment</td>
<td>Accountable for group safety performance</td>
</tr>
<tr>
<td>Graduate researcher</td>
<td>Develop procedures with risks in mind</td>
<td>Use Risk Assessment tools to propose risk levels for review</td>
<td>Oversee others’ safety practices</td>
</tr>
<tr>
<td>Mentored researcher (CURE, REU, etc.)</td>
<td>Review procedure and locate information to identify hazards</td>
<td>Learn to use Risk Assessment tools</td>
<td>Raise questions and concerns related to risk</td>
</tr>
<tr>
<td>Student</td>
<td>Based on prerequisite requirements</td>
<td>Identify applicable rules</td>
<td>Respect Rules</td>
</tr>
</tbody>
</table>

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Cultural Awareness

The four stages of competence

- Unconscious competence
- Conscious competence
- Conscious incompetence
- Unconscious incompetence

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Sports Analogs

- Games
- Team Practice
- Individual Skill Development

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Technical Chemical Safety Resources

- NFPA 45 requirements for instructional and educational labs, 2015
- Safety in Academic Chemistry Laboratories, 8th edition, 2017
- Prudent Practices, 2011
- Identifying and Evaluating Hazards in Research Laboratories, 2016
- PubChem Lab Chemical Safety Summaries, 2016
- Pistoia Chemical Safety Library, 2017
Key ACS Technical Resources

SACL 8th Edition for First and Second Year University Students, 2017

Education Guidelines for Chemical Lab Safety, 2016 (HS & Academic settings)
Cultural Lab Safety Resources

- Creating Safety Cultures in Academic Institutions from ACS, 2013
- Laboratory Safety Guidelines, ACS Committee on Professional Training, 2015
- A Guide to Implementing a Safety Culture in our Universities from the APLU, 2016
- ACS Safety Guidelines for the Chemistry Professional 2017
- Safe Science from the National Research Council, 2014
- ACS journals policy, 2016
A 2016 Cultural Initiative: ACS Publications Safety Policy

Ingredients for a Positive Safety Culture

ACS journals enact new safety policy
Authors to be required to address novel or significant hazards

By Jyllian Kemsley
Suggestions for Safety Education in REU’s

1. Build safety culture education into the program by developing interdisciplinary safety programming

2. Have students use risk assessment tools as part of their work

3. Use safety professionals while planning the REU program; we need some warning to produce relevant material

4. Recruit outside speakers to highlight CPT professional skills such as Information Literacy, Ethics and Risk Assessment

5. Identify safety role models for experiential learning: e.g. field trips to corporate labs
The Take Home Messages

1. **Community safety** is a core value in academic laboratories; *academic freedom* does not mean *free agent*.

2. **Risk Assessment** is how we move from the *Cringe Reflex* to a *Safety Culture*; teach risk assessment rather than rule based safety.

3. Safety professionals are **here to support** the academic mission.

4. Safety **planning helps get things done**: serendipity benefits from being organized.
Frazz by Jef Mallett

WHAT'S MORE IMPORTANT, EDUCATION OR TRAINING?

YOU WON'T GET INTO NASA WITHOUT THE ONE, AND YOU WON'T MAKE IT THROUGH THE MISSION WITHOUT THE OTHER.

Questions?