What makes a good laboratory learning experience?  
(Evidence from the students’ perspective)

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Australasian Chemistry Enhanced Laboratory Learning Project

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>30 partner universities in Australia / NZ

Description of problem

Some “facts”:

- 35 Australian universities teach chemistry - at least to First Year.
- ~20,000 students per year take these courses.
- Laboratory training is an ESSENTIAL component in chemical education.
  - RACI accreditation = 350 hours / year

Laboratories

Chemistry is particularly vulnerable to student discontent in the laboratory

- Arcane concepts
- Perceived lack of relevance
- Reliance on expensive instrumentation that not all departments can afford
- Boring and/or repetitive

History of APCELL

- Project began 1999
  - Physical Chemistry focus
- Potential benefits from lab work
  - Develop technical skills
  - Make theory more concrete
  - Engage students in the practices of science
- Challenge: Providing a lab program that
  - Demonstrably lives up to its potential
  - Doing so within existing constraints

Outcomes of APCELL

- Database of educationally validated experiments
- The Educational Template
- Workshops at Aust. Phys. Chem. and Chem. Ed. conferences
- Collaboration with the Australian Journal of Education in Chemistry
- Uptake of experiments and methods by Chemistry departments
- Network of academics and students
- Communication
Refereeing and Publications

All of Chemistry – ACELL

Three principal aims
- Database of educationally and chemically sound experiments, that have been tested by both academic staff and students
- Provide for professional development of chemistry academic staff
- Facilitate the development of a chemistry education community of practice

February 2006 ACELL Workshop

- 33 academic staff (+8 Directors)
- 31 undergraduate students
- 27 universities from across Australia and New Zealand
- 33 experiments

⇒ 3 very full days

This addressed one of the "issues" in laboratory development raised this morning

Impact of ACELL workshop...

"The ACELL Project: Student participation, professional development, and improving laboratory learning"

Justin READ and the rest of the ACELL team

Thurs, 10:45am, Room 311

The Educational Template (Bridging Ed. and Chem.)

Section 1: Summary of the Experiment
Section 2: Educational Analysis (staff and student perspective)
  - What are the intended learning outcomes
  - How the outcomes are achieved
  - How the outcomes are monitored
Section 3: The Student Learning Experience
Section 4: Documentation
  - Student notes, demonstrator notes, technical notes, etc
Section 5: Peer Assessment Criteria

The "Student Learning Experience" Instrument

- Thoughtfully designed to test the educational issues expounded in the Educational Template
  - should serve to improve the student experience via aspects of education theory that the teacher has been exposed to and trained in.
- Questions reflect current educational theories
  - Interest, content knowledge, generic skills, discipline skills
  - diagnosed in "everyday" language
- Validation
  - 2 A(P)CELL workshops and 3 iterations
  - ongoing process
- 3 different metrics:
  - 14 x Likert questions
  - 5 x open ended questions
  - recorded interviews
14 Likert items:

Q1: This experiment has helped me to develop my data interpretation skills.
Q2: This experiment has helped me to develop my laboratory skills.
Q3: I found this to be an interesting experiment.
Q4: It was clear to me how this laboratory exercise would be assessed.
Q5: It was clear to me what I was expected to learn from completing this experiment.
Q6: Completing this experiment has increased my understanding of chemistry.
Q7: Sufficient background information, of an appropriate standard, is provided in the introduction.
Q8: The demonstrators offered effective support and guidance.
Q9: The experimental procedure was clearly explained in the lab manual or notes.
Q10: I can see the relevance of this experiment to my chemistry studies.
Q11: Working in a team to complete this experiment was beneficial.
Q12: The experiment provided me with the opportunity to take responsibility for my own learning.
Q13: I found that the time available to complete this experiment was:
Q14: Overall, as a learning experience, I would rate this experiment as:

Value for individual experiments...

Highlighting strengths and weaknesses:

Expt: "Investigation of rotation of plane polarised light using a home-made polarimeter"

Q10: "I can see the relevance of this experiment to my chemistry studies"

Factors

What is the main factor, from the students' perspective, that correlates with this overall experience?

Q1: Developing data interpretation skills
Q2: Developing laboratory skills
Q3: Interest
Q4: Clear assessment
Q5: Clear learning objectives
Q6: Increased chemistry understanding
Q7: Sufficient/appropriate background
Q8: Effective demonstrators
Q9: Good prac notes
Q10: Relevance to chemistry studies
Q11: Developing teamwork
Q12: Responsibility for own learning
Q13: Sufficient time to complete

The dataset

- 12 experiments
- surveyed in 6 different universities (same instrument)
- across all of chemistry (discipline and level)
- paper + web surveys
- combination of ACELL and "other" experiments
- 642 responses overall (min = 17, max = 143, av = 53)
Background

**APCELL**

**Outcomes ACELL**

**Research Summary**

27-Sept-2006

**Strongly correlated**

- "I found this to be an interesting experiment"

\[ Y = -0.17 + 0.70 X \]

\[ R^2 = 0.81 \]

- "Completing this experiment has increased my understanding of chemistry"

\[ Y = -0.46 + 1.06 X \]

\[ R^2 = 0.84 \]

- "The experiment provided me with the opportunity to take responsibility for my own learning"

\[ Y = -0.98 + 1.38 X \]

\[ R^2 = 0.79 \]

**Weakly correlated**

- "This experiment has helped me to develop my laboratory skills"

\[ Y = -0.42 + 0.72 X \]

\[ R^2 = 0.19 \]

- "Working in a team to complete this experiment was beneficial"

\[ Y = -0.32 + 0.50 X \]

\[ R^2 = 0.21 \]
Overall correlation:

Strong correlation ($R^2 > 0.75$)
- Interest, chemistry learning, data manipulation, own learning

Medium correlation ($0.5 \leq R^2 < 0.75$)
- Assessment, learning obj., proc notes, relevance

Weak correlation ($R^2 < 0.5$)
- Demonstrators, lab skills, teamwork, background info

Summary

- Database of student-tested, educationally sound undergraduate experiments
  - 30 under review, aim is to have >50 reviewed by mid-2007
- Professional development of delegates
- Provision of educational resources
- Building a community of practice
- Conducting research into student learning
- A model for other countries and domains
  - being trialled in immunology at U. Adelaide

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The ACELL Website

- Experiments and their documentation
- Publications, including published papers
  - 13 published experiments from ACELL
- Information on ACELL events
- Education resources for ongoing professional development
  - Process information - content analysis
  - Theory information - constructivism

http://acell.chem.usyd.edu.au