Instruments for assessing practical skill development in a first-year chemistry laboratory course

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Background

The funding for the 1st-year chemistry lab course studied was **cut in half** (~10 years ago), resulting in a similar reduction of the number of experiments students would perform. Motivated by faculty concerns about students' practical skill development a departmental committee was formed, initiating research to examine the existing course. Aided by resources from the Carl Wieman Science Education Initiative, work to develop LGs and instruments to assess the achievement of these goals has begun.

Laboratory Learning Goals (LGs)

The development of Learning Goals (LGs), outcomes or objectives is an important step to inform curriculum, teaching, and evaluation methods. However:

♦ The chemistry lab is complex learning environment that is not well understood.

♦ Cognitive overload (chemical concepts, new manipulative skills, data recording and interpretation, etc.) is often a challenge.

♦ Faculty may have different views on the goals of the first-year chemistry lab.

⇒ The first-year chemistry lab course presents unique difficulties in the development of LGs.

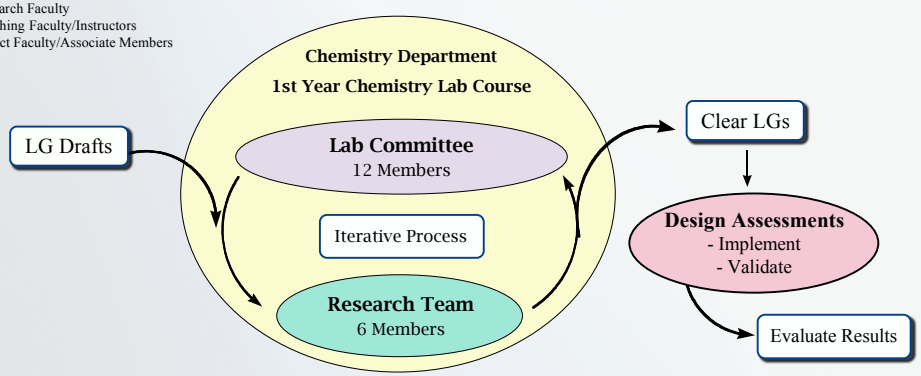
Fortunately, the laboratory educators at Rice University (RU) have recently developed interdisciplinary science laboratory LGs organized into five major categories.(1,2)

- Basic laboratory skills
- Communication and record keeping
- Maturity and responsibility
- Context
- Integration and application of knowledge

These broad, faculty/college-level learning goals from RU provide a global framework for lab LG development.

Consensus Building and the Development of Lab LGs

Department:
47 Research Faculty
11 Teaching Faculty/Instructors
7 Adjunct Faculty/Associate Members



The 1st-year chemistry course represents fundamental chemistry broadly, thus building consensus amongst representatives from the various chemistry disciplines is key.

1) Lab Committee drafts experiment-specific LGs.

2) Research Team synthesizes drafts and integrates into the RU global framework.

3) Iterative discussion between Research Group and Lab Committee

⇒ Improves LGs & builds consensus

4) Development of assessment instruments from LGs (implementation of assessments and validation).

5) Evaluation of results, re-examine LGs, adjust course, re-assess, etc.

Assessment Instruments

Pre-/In-/Post-Experiment Surveys

Written surveys that target "priority" LGs not already assessed by course deliverables

- Before students begin preparing for an experiment (Pre-, online)
- At the beginning of the lab period (In-, paper)
- After lab report has been completed (Post-, online)

Experiment Observations

Researchers observe students completing experiments to assess students' technical performance/practical skill.

Lab Skill Interviews (not yet completed)

Interview students about specific experimental techniques and observe their ability to perform that technique.

Pre/Post Course Surveys

♦ ***Beliefs/Attitudes Survey***:

CLASS-chem (see adjacent poster)

♦ ***Lab Background Survey***:

Previous laboratory experience and chemistry courses taken

Demographics

♦ ***Lab Skills Survey***

- Precision and significant figures
- Labware/Glassware recognition
- Appropriate use of labware/glassware
- Procedural questions
- Reading a buret and graduated cylinder
- Graphing data
- Error (identify type/definition)

Validation: Instruments validated through interviews with volunteer students selected to capture the breadth of the population.

Participation: ≥70% of class participate for minimal incentive (very small bonus).

Preliminary Results

✓ RU framework and consensus building model worked well to develop lab LGs.

✓ Background survey revealed unexpected demographic details (large ESL fraction)

✓ Lab skills survey useful but in need of further refinement.

✓ Clear themes emerge from experiment observations.

✓ Presently, no consistent relationship between students' written steps and performance of a technique.

Acknowledgements

- UBC Chemistry Lab Committee
- CWSEI Research Group
- Carl Wieman
- The Participants

References

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2. http://www.owlnet.rice.edu/~labgroup/index.htm