Mapping an integrated course in experimental chemistry

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CHEM 315|325|335|345: Integrated chemistry laboratories

- Comprises all of the third-year laboratory instruction offered by the Department of Chemistry
- ~350 students
- ~1/3 Chemistry majors, 1/3 Biochemistry majors, 1/3 BMLS & CMS
- Two semester-long course for Chemistry and Biochemistry students
- Recently integrated to bring four distinct lab courses into one
Examples of course objectives relating to interdisciplinarity

D2. Develop awareness of the interdependence of the traditional sub-disciplines of chemistry.

“...future chemical innovation will require an understanding of the potential contributions of each of the sub-disciplines to solve a given problem.”

D3. Become comfortable in an interdisciplinary research environment.

“...This course aims to prepare you for this “interdisciplinary future”, for example by encouraging you to appreciate that procedures are driven by scientific need and not by available equipment or disciplinary traditions.”
“Rank the top four of the following factors in terms of the extent to which they influenced your choice of experiments”

- Maximizing my grade: 21.2%
- Minimizing my workload: 18.7%
- Distributing my workload evenly: 16.3%
- Desire to learn or practice certain techniques: 10.0%
Skills and knowledge mapping

- Mapping skills and knowledge forming pre-requisites, taught or practiced in the ~ 60 experiments/labs. offered.
- To identify unreasonable cognitive demands on students (e.g. several new skills and/or concepts introduced during one experiment).
- To provide guidance to students for choosing an experiment and experiment sequence.
- To inform development of new experiments.
- To map skills and knowledge progression desired from 1st – 4th year.
“Indicate whether, in your opinion, the third-year laboratory course at UBC helped you to develop the following capabilities”

- Experimental skills and techniques: [Bar Graph]
- Ability to apply the relevant chemistry concepts: [Bar Graph]
- Ability to tackle a scientific problem experimentally: [Bar Graph]
Cognitive task mapping

C. E. Wieman, “Cognitive tasks involved in carrying out experimental research”
Cognitive task mapping: The big picture

### Area of Focus for 2014/15

| Establishing research goal                                                                    |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Defining criteria for suitable evidence                                                       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Determining feasibility of experiment                                                        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Experimental design                                                                            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Construction and testing of apparatus                                                        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Analyzing data                                                                                |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Evaluating results                                                                             |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Analyzing implications if novel                                                               |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Presenting the work                                                                           |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
Future directions

Pre- and post- measures collected:
- Attitudes: Full set of CLASS\(^1\) subscales

Post- measures that will be collected:
- SALG-style items with respect to interdisciplinarity, research-like experience
- Student perceptions of opportunities to practice cognitive tasks in experimental design, research-like experience

Expertise in experimental design in organic chemistry:
- Define\(^2\)
- Design laboratory learning experiences to target this

TA roles:
- Observations to understand interaction between pedagogy and TA/student interactions

\(^1\)J. Barbera \textit{et al.}, \textit{Journal of Chemical Education}, 2008, \textbf{85}, 1435A
\(^2\)D. L. Lafarge \textit{et al.}, \textit{Journal of Chemical Education}, 2014, \textbf{91}, 173
<table>
<thead>
<tr>
<th>Name</th>
<th>Contribution</th>
</tr>
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<tbody>
<tr>
<td>Jackie Stewart</td>
<td>Director: CWSEI in Chemistry</td>
</tr>
<tr>
<td>Tamara Kunz</td>
<td>Development of learning objectives</td>
</tr>
<tr>
<td>Ido Roll</td>
<td>Mapping inspiration and guidance</td>
</tr>
<tr>
<td>Jared Stang</td>
<td>Laboratory observation guidance and tools</td>
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