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Learning Independence through Guided-Inquiry in a Bioanalytical Laboratory Course

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Rationale

Many students have trouble transferring a set of skills acquired in one chemistry course (such as analytical chemistry) to a different chemistry course (such as biochemistry) and visualizing how two different chemistry disciplines overlap with each other in a true interdisciplinary manner. Therefore, a new interdisciplinary laboratory course (Bioanalytical Chemistry) was created to solve this problem in which the laboratory of a sophomore analytical chemistry course is integrated with a first-semester biochemistry course. This course was evaluated via a research protocol which assessed student learning at three stages, including entry-level, periodically during the course, and at the end of the course.

Methodology

- **Student Confidence and Attitudes**
  - Formative surveys – Strengths, improvements, and insights survey (SII)
    - Offered after Phase 1 (analytical lab portion) and again after the Phase 2 (biochemical lab portion).
    - Measured student confidence in a lab skill set and asked for comments on student likes and dislikes regarding the labs.
  - Summative Assessment – Student Assessment of Learning Gains (SALG).
    - Offered post course.
    - Measured student perceptions of understanding, skills, attitudes, and learning integration on a 5 point Likert scale.
  - Student Confidence – Chemistry Self-Concept Inventory (CSCI)
    - Adapted from a General Chemistry instrument developed by Christopher Bauer. (Bauer, C.F., J. Chem. Educ., 2005, 82 (12), 1864.)
    - Offered pre- and post-course.
    - Measured student confidence in areas of math, analytical chemistry, and biochemistry.

- **Student Learning**
  - Written Lab Final
  - Given post Phase 2.
  - Measured student learning vs. control group: Biochemistry I students taking a similar lab final.

Results

**Formative: (SII)**

Student feedback on laboratory experience (N=20)

Formative Summary

A number of experiments did not work out as expected in the student’s hands. For the experiments that were reasonably successful, the student confidence on laboratory skills was high. (+3.5 on a 1-5 scale)

**Summative: Student Assessment of Learning Gains**

1-5 with 1=not at all, 5=a great deal (N=14)

Summative Summary

A clear majority of the students felt they gained an understanding of the concepts. A clear majority of the students felt they gained all relevant laboratory skills. Most students had a less than enthusiastic attitude about their laboratory experience. Most student are able to integrate this course into their learning.

**Student Learning: Lab Final**

Spring 2009 Biochemistry I Lab: 56.7 ± 6.8 (N=22)
Fall 2009 Bioanalytical Lab: 71.8 ± 12.7 (N=20)

Statistically significant at p=0.10 using t-test.

Conclusions

**Evaluation of the Curriculum**

Based on the survey and learning data, the instructors gained the following insights:

1. Identify the labs that did not work and reorganize them for future offerings.
2. Reorganize the course offering so that the perception of “lab too long” is removed.
3. Having two labs a week with the same instructor can improve student learning in a laboratory course.

**Assessment of Learning**

Based on the survey and learning data, students

1. attained a reasonable level of understanding of the laboratory concepts.
2. acquired laboratory skill in the desired areas, especially using an analytical balance, micropipetting, and operation of a u-v-vis spectrophotometer.
3. had a better attitude when the laboratory experiments worked.
4. learned more in this laboratory than a control group of biochemistry students.

**Future Work**

- **Course Offering Modification**
  - Offer all parts of course in same semester.
  - Alleviate scheduling conflicts
  - Alleviate negative student perceptions of “lab too long”

- **Group Comparison**
  - Track the attitudes of a control group of students taking unlinked biochemistry and analytical chemistry.
  - Provides a control group.

- **Experiment Revision**
  - Revise experiments that became less feasible after “scale-up” to a full class of sophomore/junior students.

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