Faculty Learning Community
Project Proposal Form

Name:Christina Collison
Course(s): 1013-431 Organic Chemistry I
Project Name: Organic Chemistry: An Innovative Studio-Based Approach
Date: April 2009

Identifying the problem:

1. **What is the problem you have identified?**

The traditional method for most chemistry courses (organic chemistry included) is to teach a lecture three times per week accompanied by a weekly 4-hour lab. Our data shows that this traditional method for teaching organic chemistry is flawed and the following problems arise[1]:

I. **Compartmentalization of the material.**

II. **Perception that lab material out-of-sync with lecture.**

III. **Minimized stress on lab techniques.**

IV. **No forum for reflection and critical thinking.**

These problems can be best addressed by teaching organic chemistry using a studio-approach. A "Chemistry Studio Classroom" combines lecture and lab activities into one space, and encourages students to learn science through a continuous cycle of observation, reasoning, and experiment.[2] The studio model is not a novel concept and has been implemented in chemistry, physics, biology, and mathematics programs across the country to wide acclaim[3]. However, a studio approach **has never been reported in an organic chemistry curriculum**. A professor in Physical Sciences and Engineering at Truman College states, “The studio classroom model is most appropriate for basic and general chemistry. It is not suitable for organic chemistry due to ventilation, plumbing, and hazardous chemical requirements of those classes.”[4]

In summary, we will pioneer a studio-based approach to a portion of organic chemistry I and compare our results with the same topic taught in the traditional method. In June 2008, one of two organic chemistry laboratories at RIT was renovated into an academically novel, industrially-inspired teaching space (see attached photos). These laboratories were redesigned with the ultimate intent to move towards a studio classroom. Our new lab features a smart classroom in the center of the lab with three walls of industrial hoods. As such, we are equipped

---

[1] See attached student survey data collected April 2009.
[2] Studio Chemistry: Combining laboratory and lecture into one spaceCharles Abrams, Truman College, Chicago IL. cabrams@ccc.edu http://faculty.ccc.edu/cabrams/studio/BCCE2008AbramsHandout.pdf
[3] (a) Tom Apple, Alan Cutler, *J. Chem. Ed.* **1999**, 76, 462-463. (b) Christina A. Bailey, Kevin Kingsbury, Kristen Kulinowski, Jeffrey Paradis, Rod Schoonover, *J. Chem. Ed.* **2000**, 77, 195-199. (c) Amy C. Gottfried, Ryan D. Sweeder, Jeffrey M. Bartolin, Jessica A. Hessler, Benjamin P. Reynolds, Ian C. Stewart, Brian P. Coppola, Mark M. Banaszak Holl, *J. Chem. Ed.* **2007**, 84, 265-270
[4] http://faculty.ccc.edu/cabrams/studio/#Vision

with the appropriate infrastructure to support a studio classroom curriculum in organic chemistry.

2. Who are your target students?

The students impacted by this model will be first- and second-year students taking the 400-level organic chemistry sequence (1013-431, 1013-432, 1013-433). These students all major in chemistry, biochemistry or chemical engineering.

3. What is your hypothesis or proposed solution?

The rationale for a studio-based approach in organic chemistry stems from the four common problems inherent when teaching in the traditional manner:

I. **Compartmentalization of the material.** What is learned in the class stays in the class and what is learned in the lab stays in the lab. This effect is further fostered by the fact that both the lab and the lecture have their own textbooks and their own credit hours. Only 17% of the students polled perceived a high correlation between Orgo I lecture and Orgo I lab. By Organic III half of the class still did not see a high correlation between the lecture and lab.[1]

- **Solution: Integrated lab and lecture.** By holding the lecture in the same space as the lab, we will break down that first dividing line between the lecture and lab. Additionally, the rhythm of the course delivery will be conducive to "best practices" for teaching: 20-minute intervals of varying techniques. We will observe (perform an experiment and collect data), reason (come up with an explanation for our observation), and test (try our hypothesis on a different case). This process will involve: going to the hood for experiments, sitting back down and working in groups, independent problem-solving time, and short bursts of explanations/help from the instructor.

II. **Perception that lab material out-of-sync with lecture.** 100% of the students polled told us that they prefer seeing the material either in the lecture before seeing it in the lab or simultaneously with the lab itself.[1] They explain that it gives them enough pre-lab preparation to have a better idea about what's actually happening in the lab. It's not impossible to take the first 10-20 minutes of lab for a pre-lab lecture. However, if you are introducing material for the first time during the pre-lab, there is far less time for the student to absorb it before putting it into practice at the bench. Additionally, students often do not recognize the direct correlation between what they are doing in the lecture with what they are doing in the lab. No matter how beautifully aligned some labs and lectures are, many students still miss the correlation.

- **Solution: Experiential Learning** (Hands-on training that links to coursework) The organic chemistry studio-model will directly place the students <u>in the lab at all times</u>. The concepts they learn and problems they face will be derived from their actual wet chemistry experiments and not from their textbook. The material will no longer be introduced before a lab or after a lab. The organic concepts/reactions will be seamlessly presented simultaneously with the wet chemistry. The direct correlation between lab and lecture will become undeniably obvious to the student.

III. **Minimized stress on lab techniques.** 71% of the students surveyed rated "learning to perform lab techniques properly" as very important with respect to their future career in chemistry.[1] Ultimately, the students we train as chemistry and biochemistry majors will go on to graduate programs or industrial jobs. In either case, our students will spend the majority of their time in a lab conducting experiments. In our current 3 + 1 credit system, we are, in effect, placing emphasis on the lecture over the lab. Does the student need to understand concepts and derive mechanisms and predict reactivity? Yes. But equally as important is the knowledge acquired with learning a technique and honing bench skills. If a student is struggling in the course or has only a finite amount of time to put into their work, they will invest that time in the coursework and allow their lab techniques and reports to take a backseat by rushing through and leaving from lab early.

- **Solution: Exams that integrate lab knowledge.** With the lecture and lab all rolled into one, the student must study both their techniques and their organic material. It will thus be feasible for the exams to incorporate concepts about lab work in addition to traditional organic problems.

IV. **No forum for reflection and critical thinking.** Once a traditional lab is completed, the students have their TA sign their notebook and they leave. The student is thus on their own reflecting on the lab and answering tough questions about their results. We have found that the lab reports are written well until the conclusions section where little to no thought is put in to their overall analysis. The students' ability to troubleshoot is very poor because they cannot make a connection between what's on paper and what's in the flask.

- **Solution: Self-guided discovery combined with group-based learning.** (Communication skills and accountability)The organic chemistry studio-model will be structured in a way to allow more time to the students to develop better critical-thinking and problem-solving skills. The new studio-based structure will also be conducive to group work that will further hone the students' communication skills and accountability. If the lecture and lab are fully integrated, the contact hours can be used more efficiently. As a result, students will not be leaving the lab at different times and thus group discussions may be conducted after an experiment's completion.

4. **How will you assess your project?**

The class (1013-431) is naturally divided into two groups based on the lab sections. One half of the class will be taught the subject matter of one lesson using the traditional model (**control group**) and the other half will be taught the same subject matter as a studio-model (**test group**). The groups will be given a quiz in their respective labs that will test their knowledge of the subject matter and critical thinking questions pertaining to the results in the lab. The student success data from both the control and test cases will be analyzed for statistically significant differences between the models effectiveness in decompartmentalizing the material and enhancing critical-thinking skills. The test and the control group will also be asked to complete a survey to ascertain the students comfort with the subject material among other things.

We fully intend to publish any relevant findings in the *Journal of Chemical Education* (peer-reviewed). We also intend to present this work at the National ACS Meeting in Boston, MA on August 22nd, 2010. Additionally, if our efforts support successful student outcomes, we intend to write a CCLI grant for full conversion of our organic curriculum to a studio-model.

Identify project resources:

1. Resources – Faculty/Student Advisors
    a. Dr. Jeremy Cody is the co-PI on this project
    b. Courtney Stanford is an undergraduate student who will be helping with the administration and preparation of the studio-class/lab

2. Resources – Conferences
    a. We plan to attend the ACS National meeting in San Francisco in March 2010 and present our findings as a poster.
    b. We plan to attend the ACS National meeting in Boston in August 2010 and present our findings as a talk.

3. Resources – Readings
    a. The references in the footnotes on the first page of this document were collected from the Journal of Chemical Education.

Action plan/Timeline:

Summer AY2008:

- Develop integrated lab/lecture for a 4 hour block.
- Develop an assessment lecture quiz and thought-questions for the lab.

Fall AY2009:

- Run the control and test case (PLIG funds used for student stipend)

Winter AY2009:

- Analyze the data

Spring AY2009:

- Write a peer-reviewed article on findings

Summer AY2009:

- Present findings at National American Chemical Society Meeting in Boston on August 22nd, 2010 (PLIG funds used for travel to meeting).
- Begin writing a CCLI

Reflection on your project:

1. What were your successes? *Not Yet Determined*

2. What obstacles did you face? *Not Yet Determined*

3. Any surprises ? *Not Yet Determined*

4. What would you do differently next time? *Not Yet Determined*

5. What opportunities exist for future work in this area?
   If the quality of the organic chemistry experience is improved and enhanced through this method, I predict a great shift in the way we teach organic chemistry across academia. This model however demands the infrastructure similar to the one designed for RIT. Such a teaching model would be costly to implement in universities needing major renovations to their labs.

Questions/Requests of FLC members: