

Pro-Lab: Assessment

05.12.17

Dr. Jennifer Fishovitz and Dr. Kathryn Haas

Overview

Semester Content

Fall 2016 Reflections

iPad Survey

CURE Survey

Expected Outcomes of Pro-Lab

- Increased student satisfaction in laboratory courses
- Increased integration of knowledge across disciplines of chemistry and other STEM fields
- Increased student confidence in pursuit of undergraduate research experiences.

Year 1 (Fall 2015-Spring 2016)

Expt 1: Barstis*

- Biodiesel
 - Groups
- Group informal/formal reports
- Group poster

Expt 2: Dunlap

- Wine Analysis
- Groups
- Group reports
- Group poster, individual presentation

Expt 3: Fishovitz

- Beta-lactamase expression, purification, characterization
- Groups
- Individual report
- Individual oral defense

Expt 1: Oshin

- ATRA and Crystallization
- Groups
- Assignments reports

Expt 2: Barstis/Becker

- Quantum Dots (with Literature Proposal)
- Groups
- Group informal/individual formal reports
- Group oral presentations

Expt 3: Dunlap

- Various analytical techniques
- Groups
- Progress reports and group formal report
- Individual oral presentation

Paper notebooks + Lab Archives, both (uploading from lab notebooks to Lab Archives electronic notebook).

*Physical characteristics (of biodiesel synthesis) = IR, NMR, GC-MS; Physical characteristics (of biodiesel and petroleum diesel) = bomb calorimetry, cloud point (UV-Vis), and one other of the student's choice

Year 2 (Fall 2016-Spring 2017)

Expt 1: Haas

- Ctrl model peptides
- Pairs
- Group formal reports
- Group poster

Expt 2: Fishovitz**

- ClpXP purification and characterization
- Pairs/Groups
- Group formal report
- Individual oral defense

Final Projects

- Create technique video
- Individual revision of one formal report

Expt 1: Babbini*

- Ligand (organic) and metal complex synthesis; crystallization
- Pairs (2 groups of 3)
- Literature review proposal/Individual reports
- Individual posters

Expt 2: Dunlap

- Various experiments (Choose a topic from literature to perform an experiment.)
- Pairs
- Individual formal report
- Individual oral presentations

**Used fluorescence spectroscopy (Fall 2016)

*Used dry box and silica column chromatography; Schlenk line (inert atmosphere); NMR and MS, Evan's method (magnetic susceptibility), X-ray Crystallography. Wanted to do CV.

Entire year = electronic notebooks

CHEM 361: Pro Lab Fall 2016

Be Proactive...Be Professional...Be Productive



- **Blackboard modules to guide progress**
- **Paperless course**

week	Lab	Notebook	Writing	Ethics	Assessment
0	Start Here Module (Zoom, Google Apps)			Informed Consent Intake Survey Sign up for Twitter	CURE PreTest
1	Literature Hunt, How to read/write a science			Informed Consent Intake Survey Sign up for Twitter	
2	Focus on Cit1 Collaborator Prigle you How to Critique a Notebook	iPad Setup: Peer Review Practice	Develop Research Question and Experiment Plan	Journal: "What does 'ethics' mean in the context of STEM? Why is thinking about ethics important for STEM professionals?"	Reflection 1
3	Safety, Buffers and Standard solutions, Solid Phase Peptide Synthesis and Cleavage	Synthesis Plan; Instructor Review	How to write lab reports; Paper Outline Due	Cross-campus Discussion 1	
4	Column purification and analysis: HPLC, LC-MS	Peer Review 1	Updated outline Due	Cross-campus Discussion 2	
5	Lysophate	Synthesis follow-up		Cross-campus Discussion 3	
6	Solutions, Buffers, Standardization, Redox assay, Kinetics	Peer Review 2	Updated outline Due		
7	Thermodynamics: Determination of ΔG° and ΔH° affinity correlates using solution competition				
8	Inert Atmosphere expt Finish up / clean up Poster Presentation	Instructor Review	Final Paper Due		Reflection 2
10	Literature: Theory and Application Literature: Experimental Design			Cross-campus Discussion 4	
11	Background Information (Data) and Preliminary Data	Peer Review 3		Cross-campus Discussion 5	
12	Bacterial Cell Culture and Growth Chromatography: Expression and Purification of proteins			Journal 2: Select on of the discussion prompts and discuss it in depth in your individual electronic journal.	
13	Gel electrophoresis: Protein Quantification (UV-vis, Beer's Law)	Instructor Review	Procedure write-up	Journal 3: Select on of the discussion prompts and discuss it in depth in your individual electronic journal.	
14	Gel electrophoresis (bioRxiv): Enzyme activity (Fluorescence, Kinetics)			Journal 4: What does 'ethics' mean in the context of STEM fields? Why is thinking about ethics important for STEM students and professionals?	Reflection 3
15	Wrap-up: Working Day	Instructor Review	Expt 2 Lab Report Due		IPad Survey/Consent
16	Individual Defense: Technique Videos		Paper rewrites (optional)		CURE PostTest

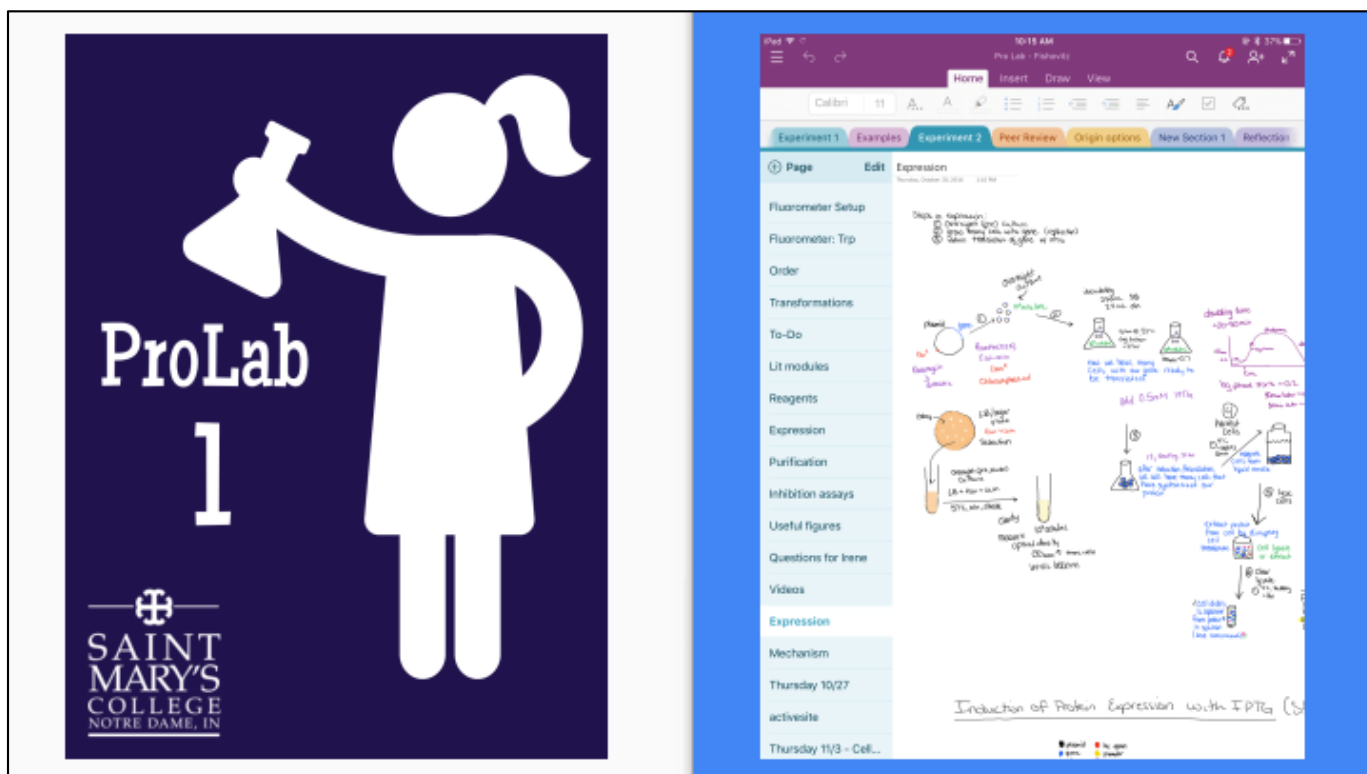
Main Talking Points:

- Pre-lab preparation (week 0 and every day) was expected and enforced.
- Literature: two full weeks, starting generally (leading questions) and guided inquiry through specific.
- Peer review of notebooks: modeled good and bad practices first
- Enforced policies heavily with constant, immediate feedback during first segment (google drive and electronic notebooks were critical for this, as we could see in real time what ever student was doing and immediately comment). Students had to earn release from constant review.
- Students had to perform tasks for LEARNING, not just points. (ex: peer review)

Grading:

- 25% Prep and Performance
 - Daily notebook prep, safety, lab citizenship, performance in lab (Had a rubric for each day)
- 20% Notebook
 - 1 notebook grade for Expt 1 + 1 notebook grade for Expt 2.
 - Mastery-based grading (7 total checks, by faculty: 4 on Expt1 / 3 on Expt 2)
 - Practicing 0%
 - Proficient 50%
 - Mastery 100%

- 25% Writing
 - 80% Lab reports
 - 50% for Expt 1
 - 50% for Expt 2
 - Students could re-write one in response to feedback (this was a surprise at the end of the semester)
 - 20% Reflections
- 20% Presentation
 - 1 poster
 - 1 oral defense
 - Final video on one technique
- 10% Ethics writing assignments assignments



iPad Pro's as electronic lab notebooks (students and faculty are enthusiastic about this mode of notebook keeping)

One-Note Notebooks

- Shared notebook
- Individual notebooks
- Practicing/Proficient/
Mastery levels
- Notebook Peer Review

Other useful features:

- Camera
- Google Drive
- AirDrop: share data
- Blackboard

Final Presentation

Individual Technique Videos



After each of the two research projects, students wrote a formal publication-style paper on their work and gave either a poster presentation or an oral defense of their project.

As the last project, we asked students to choose a laboratory technique for which they wished they had a video before or during the semester to help them learn this technique. Students made their own videos on these techniques as a way to help future students.

Students were enthusiastic about this assignment. Faculty did not give formative feedback on this project in Fall 2016, however, we recommend that formative assessment be given on draft projects in the future.

Reflections

IRB approved

Responses to prompts relating to:

- Research
- Lab Notebooks
- Peer Review
- Technology

Three reflections over the course of the semester

Writing assignments: 5% of overall grade

What skills do you think you have developed or strengthened through your research project?

Data analysis, record-keeping, resilience, positivity, time management, curiosity, communication skills (between lab members)

What have you learned about yourself from doing this project?

I always felt like I was just going through the motions to get my degree--but now my heart is in it.

What have you learned about your project topic, science, or research more generally?

Science is hard work and can be a winding path, but each experience, whether or not it is publishable, leads to deeper understanding and personal development.

Students were asked to do reflective writing assignments three times throughout the semester.

iPADs Survey

How has the electronic notebook format affected your learning experience in this course?

Please comment about how the notebook format has changed the way you interact with your notebook.

How has the peer-review format affected your learning in this course?

...the iPad was ... more of a resource and tool than an ordinary notebook. Thus the iPad was able to improve my learning in the course because I didn't have to run around looking for other materials, I could just be present.

My notebook is more thorough and was kept updated more regularly. I was better about adding material to the notebook. I also enjoyed the notebook a lot more because I could add pictures straight from lab for preliminary work of concentrations, spectra etc. It made drawing conclusions a lot easier when looking back at the notebook.

I was able to hear what my peers thought I needed to improve. I was also able to see the other ways and thought processes behind how people organized their notebooks and was able to learn from those techniques.

CURE Survey: Fall 2016 and Fall 2015

The CURE survey offers a comparison of learning benefits between course experiences and undergraduate research experiences. The pre-course survey collects student data based upon demographic questions, reasons for taking the course, level of experience on various course elements, science attitudes, and learning style. The post-course survey parallels the pre-course survey and includes additional questions that focus on *student estimates of learning gains in specified course elements, estimates of learning benefits that parallel questions in the SURE surveys, overall evaluation of the experience, and science attitudes.*

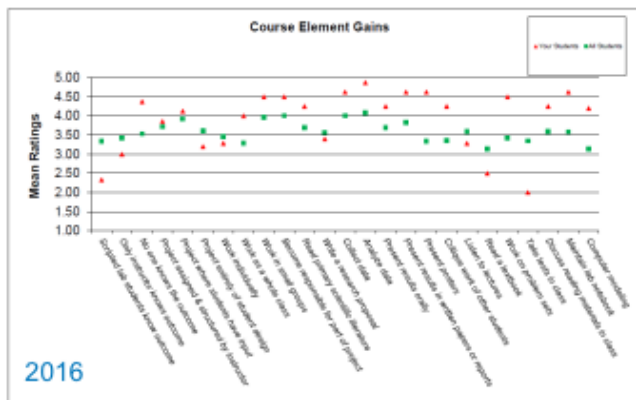


Figure 1. The figure illustrates the mean ratings by students of gains in 25 areas corresponding to the course elements above.

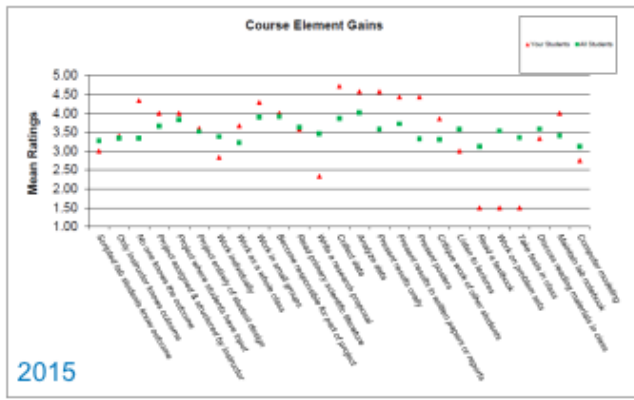


Figure 1. The figure illustrates the mean ratings by students of gains in 25 areas corresponding to the course elements above.

Course Element Gains: 2016 and 2015

Below:

- Scripted lab, students know outcome
- Instructor knows outcome
- Project entirely of student design
- Work individually
- Write a research proposal
- Listen to lectures
- Read a textbook
- Take tests

Gains:

No one knows the outcome

Group work

Become responsible for part of the project

Read primary literature

Collect data

Analyze data

Present results orally

Present results in reports

Present posters

Critique work of other students

Work on problem sets

Discuss reading materials in class
Maintain lab notebook
Computer modeling

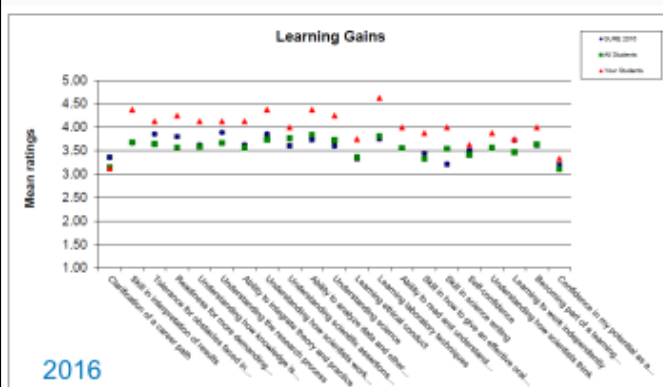


Figure 2. The figure illustrates the mean ratings by students of gains in 21 areas, corresponding to the areas above. As these same items are evaluated by students who participate in summer undergraduate research, the recent results of the Summer Undergraduate Research Experience (SURE) survey are presented for reference. Also presented (green squares) are the overall mean ratings by the reference cohort of students who completed the CURE survey in the fall of 2016. The vertical lines around the SURE means represent 2 standard errors above and below. Note: Data from students who completed the pre-course survey and those who did not are indistinguishable.

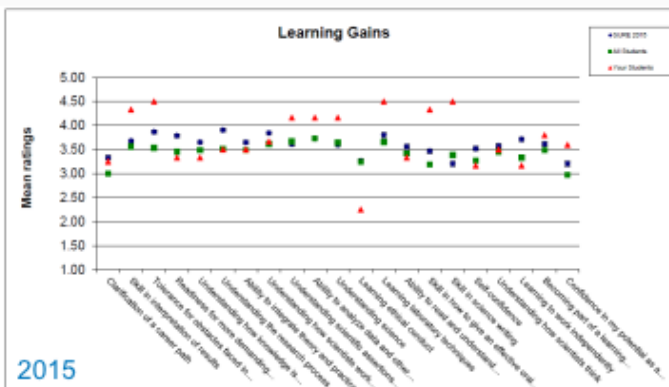


Figure 2. The figure illustrates the mean ratings by students of gains in 21 areas, corresponding to the areas above. As these same items are evaluated by students who participate in summer undergraduate research, the recent results of the Summer Undergraduate Research Experience (SURE) survey are presented for reference. Also presented (green squares) are the overall mean ratings by the reference cohort of students who completed the CURE survey in the fall of 2015. The vertical lines around the SURE means represent 2 standard errors above and below. Note: Data from students who completed the pre-course survey and those who did not are indistinguishable.

PostCourse Survey: Overall Assessment

These four questions serve as an overall assessment of the course. Note that the scale is 1 (strongly disagree) to 5 (strongly agree). The questions are on the post-course survey only. *Means are used to represent the data.*

Your Students	All Students	SD	
4.88	4.14	0.92	This course was a good way of learning about the subject
4.88	4.24	0.89	This course was a good way of learning about the process of scientific research
4.63	3.98	1.08	This course had a positive effect on my interest in science
4.50	4.19	0.95	I was able to ask questions in this class and get helpful responses

2016

PostCourse Survey: Overall Assessment

These four questions serve as an overall assessment of the course. Note that the scale is 1 (strongly disagree) to 5 (strongly agree). The questions are on the post-course survey only. *Means are used to represent the data.*

Your Students	All Students	SD	
4.14	4.06	0.99	This course was a good way of learning about the subject
4.14	4.03	1.04	This course was a good way of learning about the process of scientific research
4.00	3.87	1.13	This course had a positive effect on my interest in science
4.43	4.10	1.00	I was able to ask questions in this class and get helpful responses

2015

Post-Course Overall Assessment: 2016 and 2015

First two weeks: Literature

Before first class:

- Familiarize themselves with Google Apps (Docs, Sheets, Drive)
- Zotero
- CURE Pretest survey

Week 1: Literature

- How to read journal articles
- Answering questions using literature (general)
- Answering questions using literature (specific)
- Analysis of literature (broad impact and future directions)

First two weeks: Literature

Week 2: Preliminary Data

- Data from collaborator
- Research project outline

Week 2: Notebook Critiques

- Examples of “good” and “bad” notebooks
- Feedback on examples

Remainder of semester:

- Blackboard modules to guide progress
- Paperless course