Pro-Lab: Assessment

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Overview

Semester Content

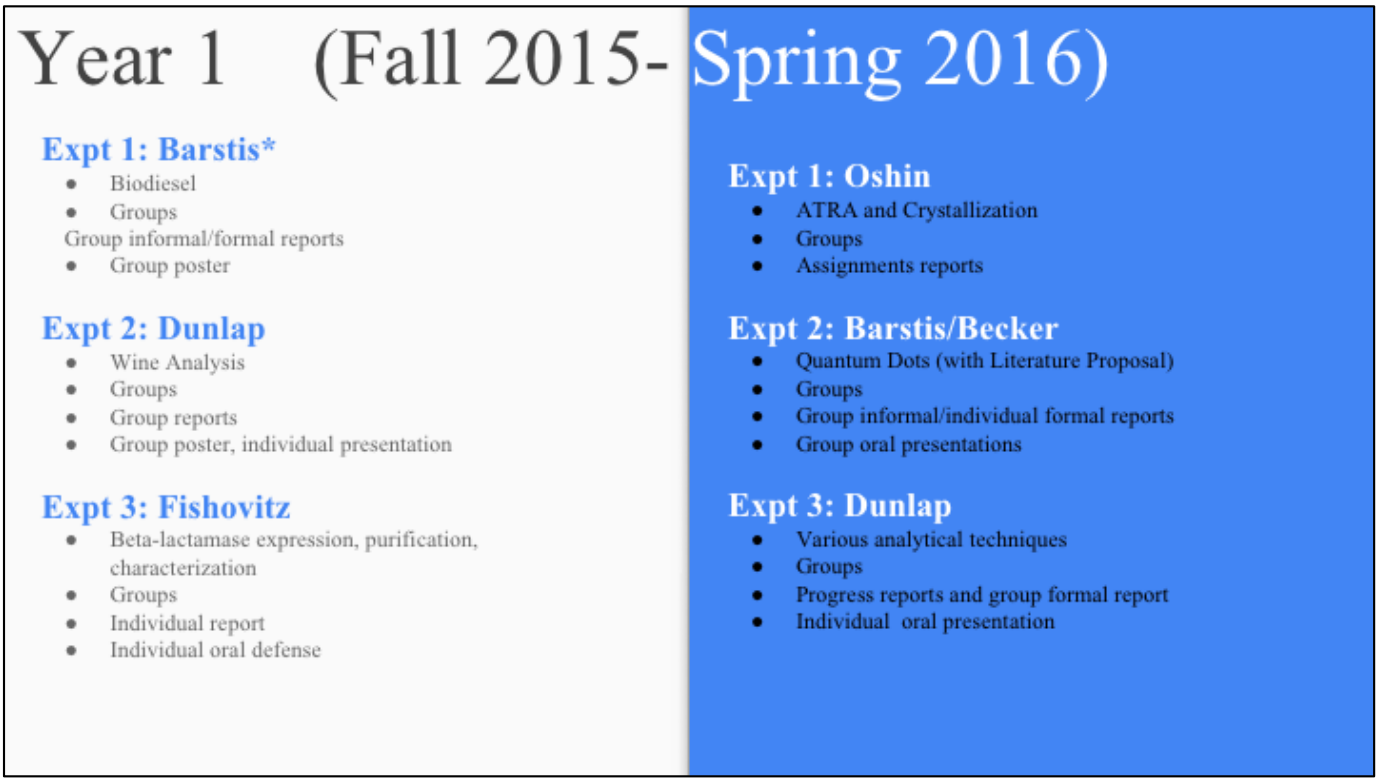
Fall 2016 Reflections

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.



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

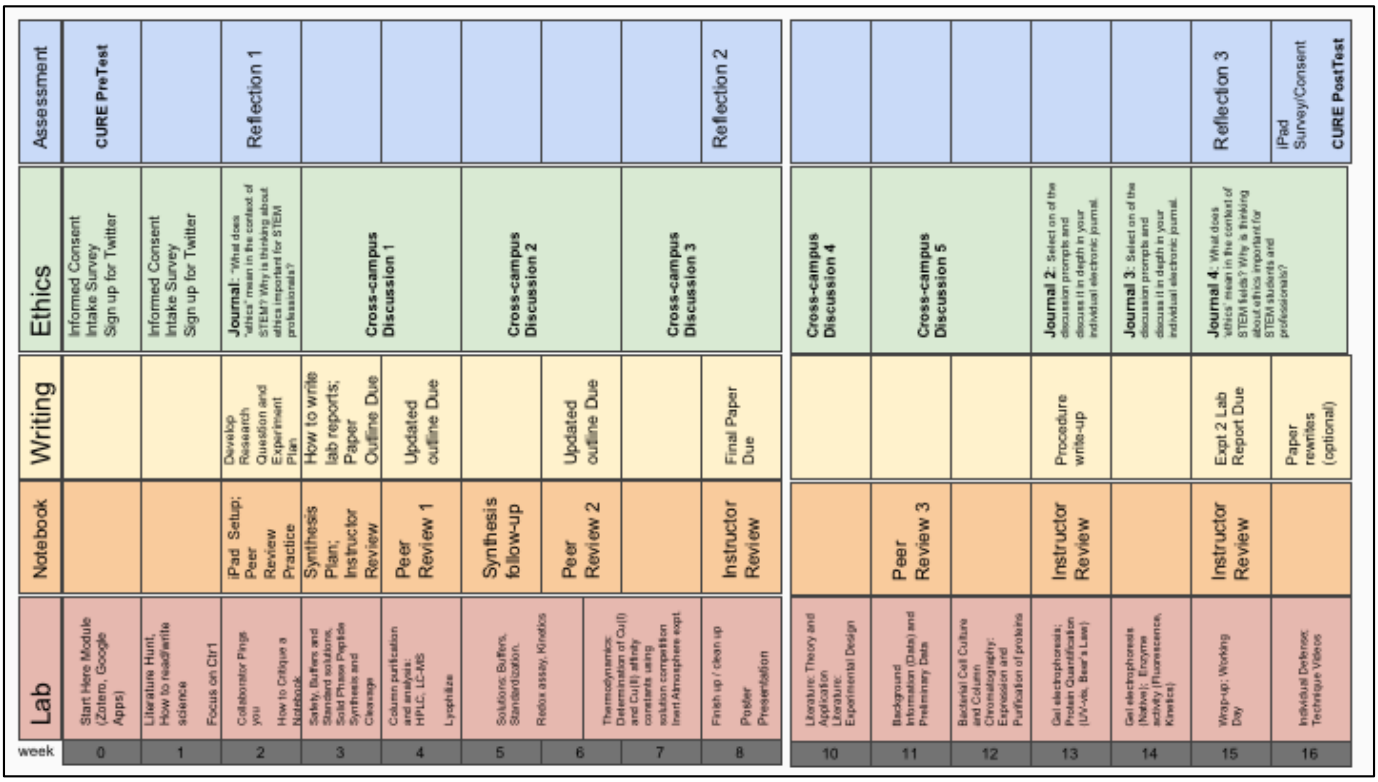
*Physical characteristics (of biodiesel synthesis) = IR, NMR, GC-MS; Physical characteristics (of biodiesel and petroleum diesel) = bomb calorimetry, cloud point (UV-Vis), and one other of the student's choice

**Used fluorescence spectroscopy (Fall 2016)

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

Entire year = electronic notebooks

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



week	Lab	Notebook	Writing	Ethics	Assessment
0	Start Here Module (Zotero, Google Apps)			Informed Consent Intake Survey Sign up for Twitter	CURE PreTest
1	Literature Hunt; How to read/write science Focus on Ctrl			Informed Consent Intake Survey Sign up for Twitter	
2	Collaborator Pings 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 Lysis/dialysis	Peer Review 1	Updated outline Due		
5	Solutions, Buffers, Standardization. Redox assay, Kinetics	Synthesis follow-up		**Cross-campus Discussion 2**	
6	Thermodynamics: Determination of Cu(I) and Cu(II) affinity constants using solution competition Inert Atmosphere expt.	Peer Review 2	Updated outline Due		
7				**Cross-campus Discussion 3**	
8	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 Column Chromatography: Expression and Purification of proteins				
13	Gel electrophoresis: Protein Quantification (UV-vis, Beer's Law)	Instructor Review	Procedure write-up	**Journal 2**: Select on of the discussion prompts and discuss it in depth in your individual electronic journal.	
14	Gel electrophoresis (Native): Enzyme activity (Fluorescence, Kinetics)			**Journal 3**: Select on of the discussion prompts and discuss it in depth in your individual electronic journal.	
15	Wrap-up: Working Day	Instructor Review	Expt 2 Lab Report Due	**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
16	Individual Defense: Technique Videos		Paper rewrites (optional)		iPad Survey/Consent CURE PostTest

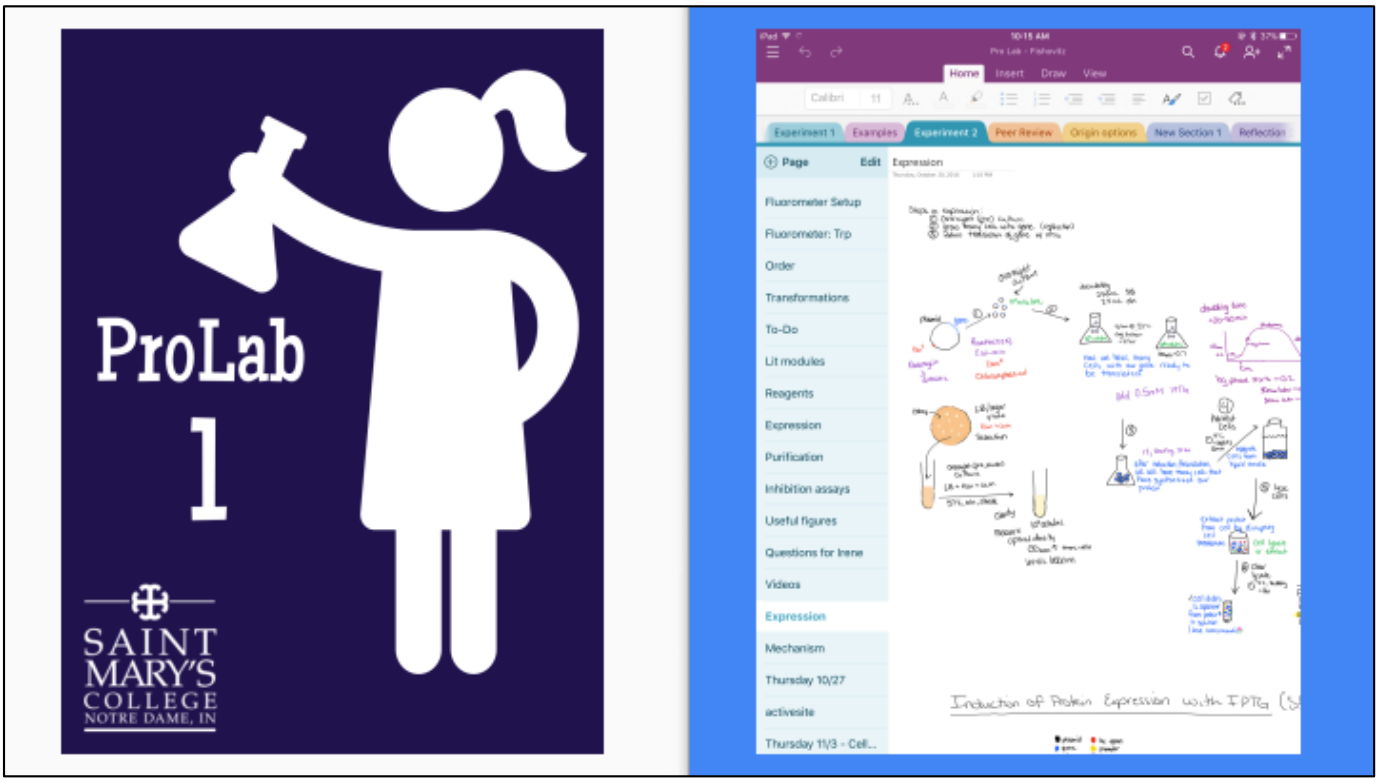
Main Talking Points:

- **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 imediately 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



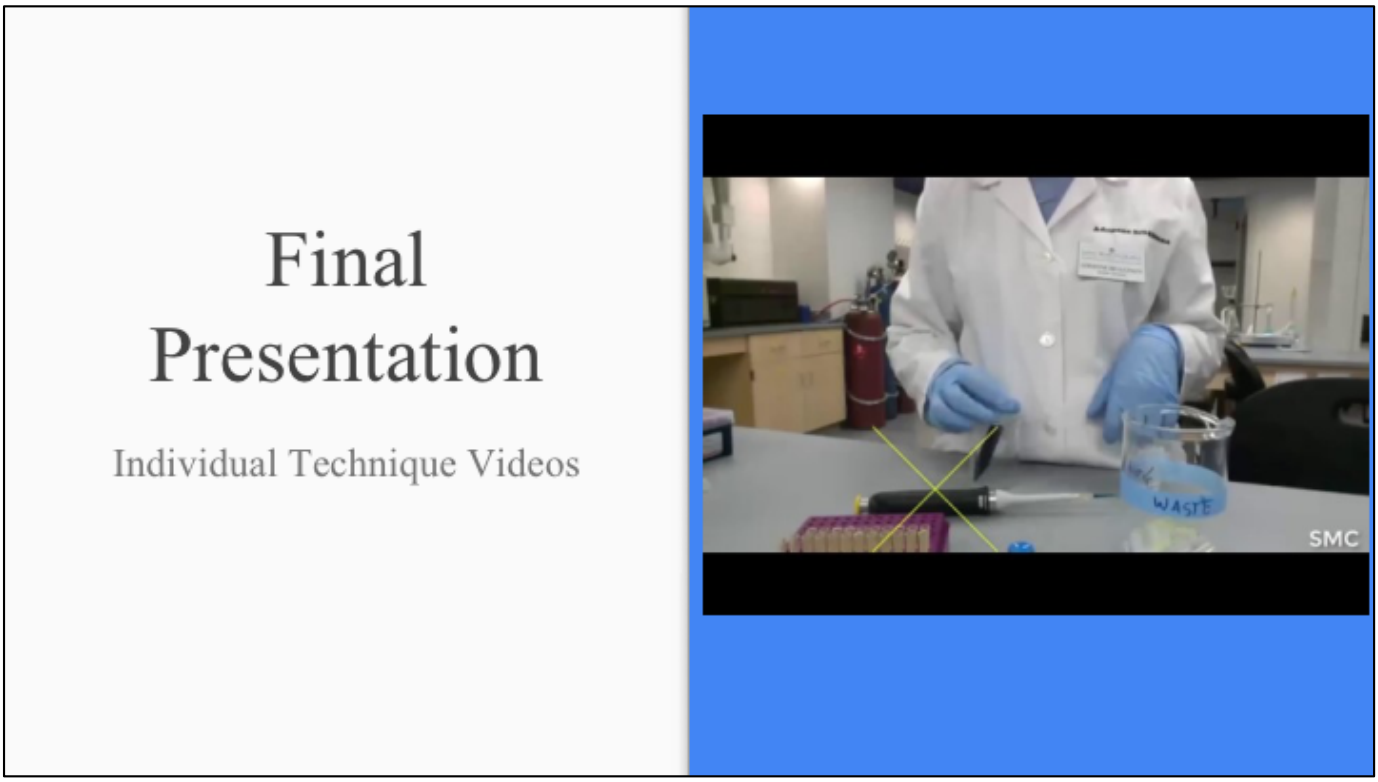
iPad Pro's as electronic lab notebooks (students and faculty are enthusiastic about this mode of notebook keeping)

One-Note Notebooks

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

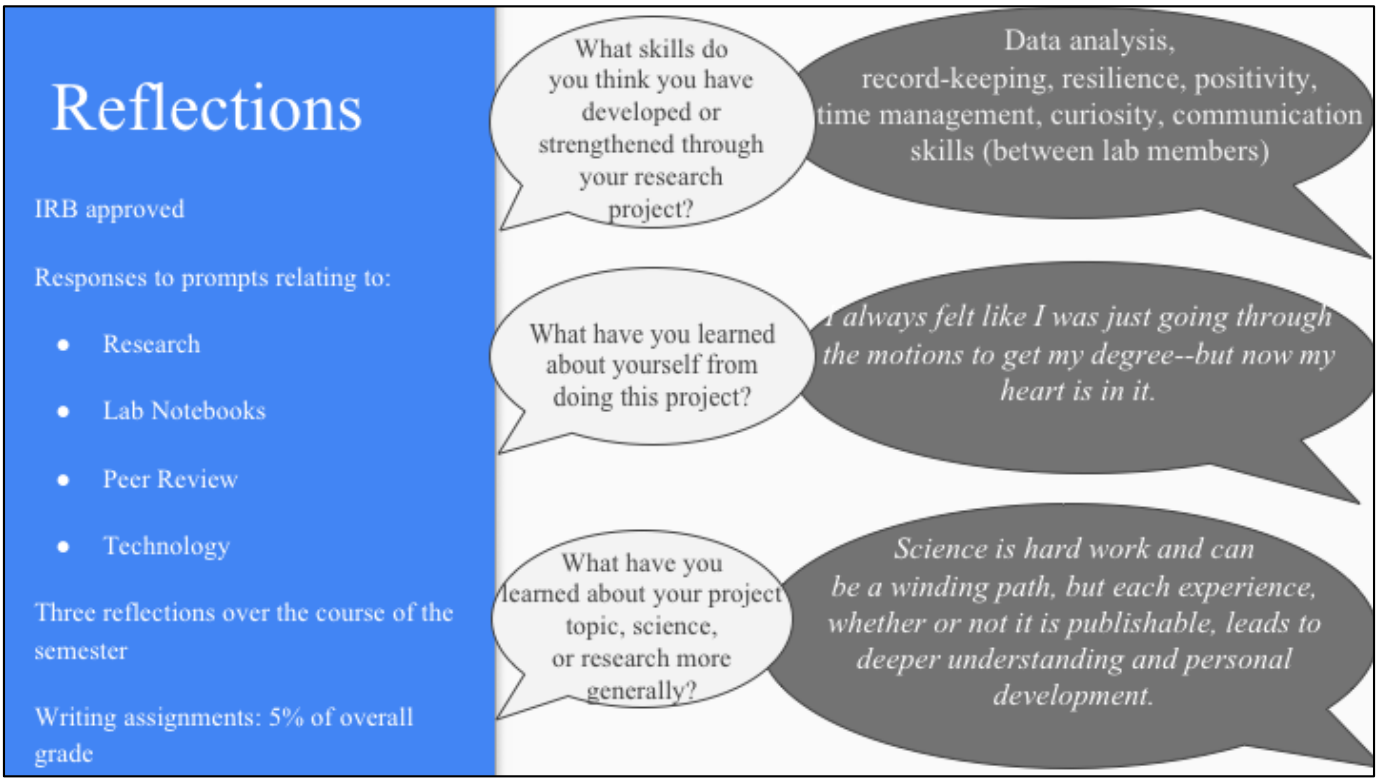
Other useful features:

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



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.



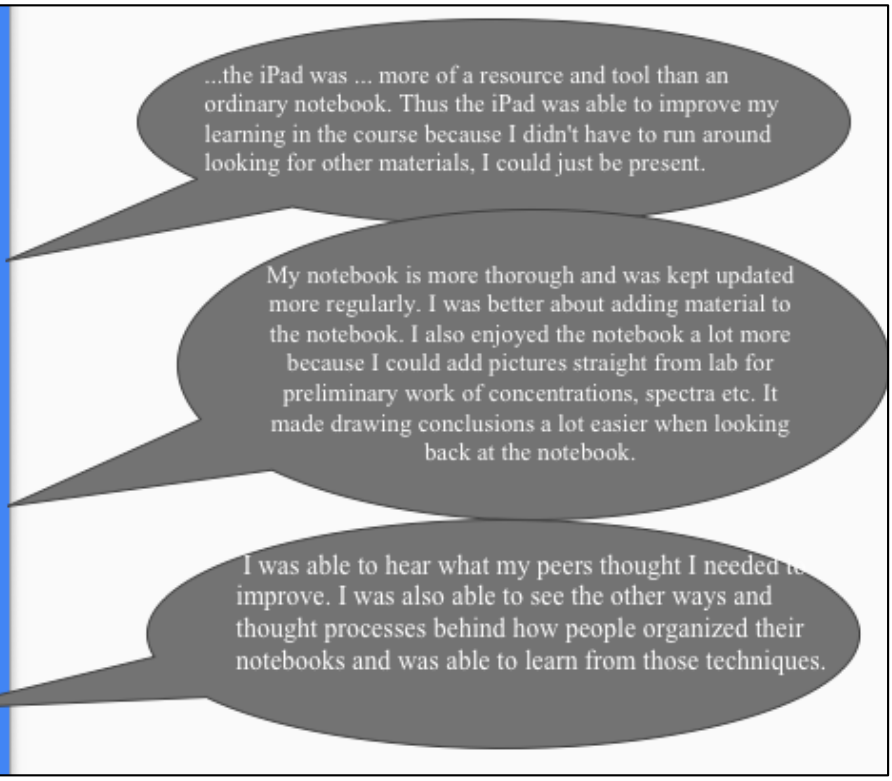
Students were asked to do reflective writing assignments three times throughout the semester.

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?



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.*

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

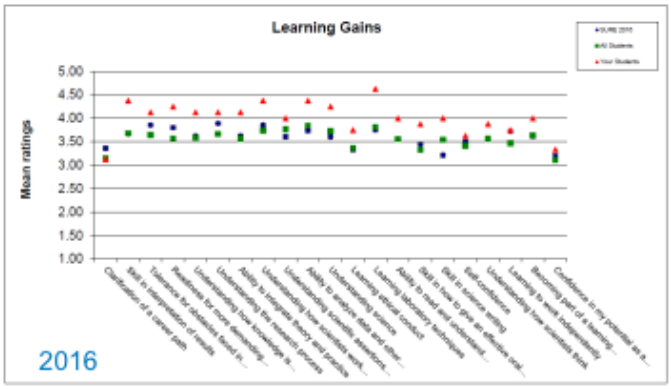
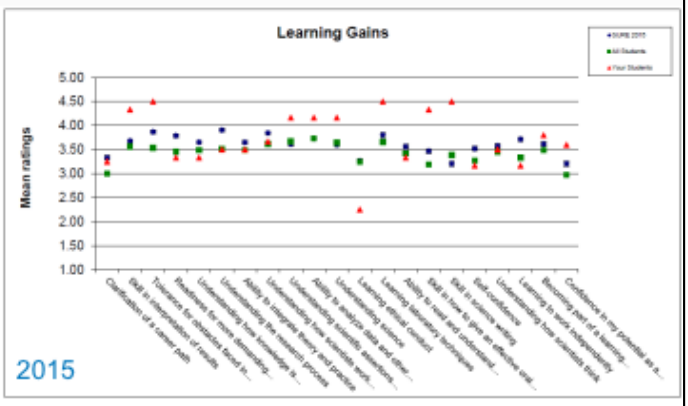


Figure 2. The figure illustrates the mean ratings by students of gains in 21 areas, corresponding to the areas above. As these same items are evaluated by students who participate in summer undergraduate research, the recent results of the Summer Undergraduate Research Experience (SURE) survey are presented 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.



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Learning Gains: 2016 and 2015

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