Do well-developed hypotheses correlate with improved scientific writing?

Lauren Schiebelhut
Environmental Systems Ph.D. Candidate
University of California, Merced

Undergraduate Learning Outcomes Assessment: Pedagogy and Program Planning

- Semester long certificate program
- Pre-semester workshops
- Weekly meetings

CENTER FOR RESEARCH ON TEACHING EXCELLENCE
AT UC MERCED

Motivation

Spring 2013 teaching evaluation:

“Don't expect too much from the students, we are doing the best we can but he set such a high bar for us.”

“Lower expectations a bit for how students will do.”

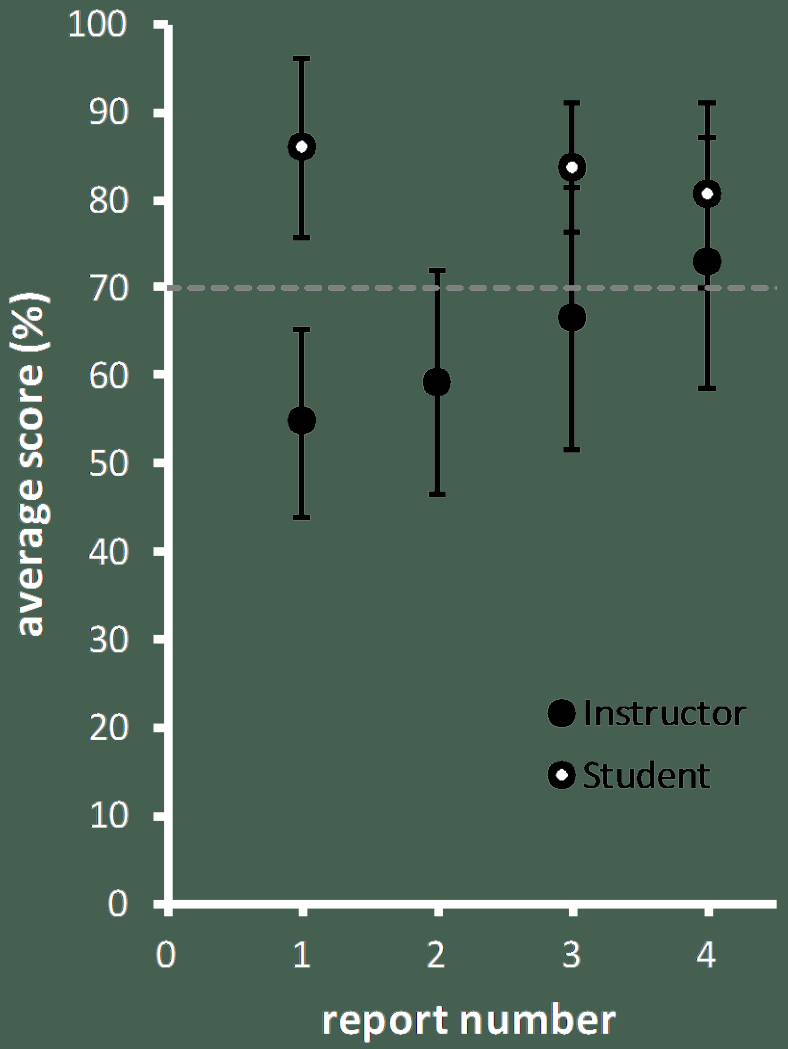
“Lower difficulty in grading.”

“Less harsh grading will lead to less frightening atmosphere.”

“Grading system should be easier.”

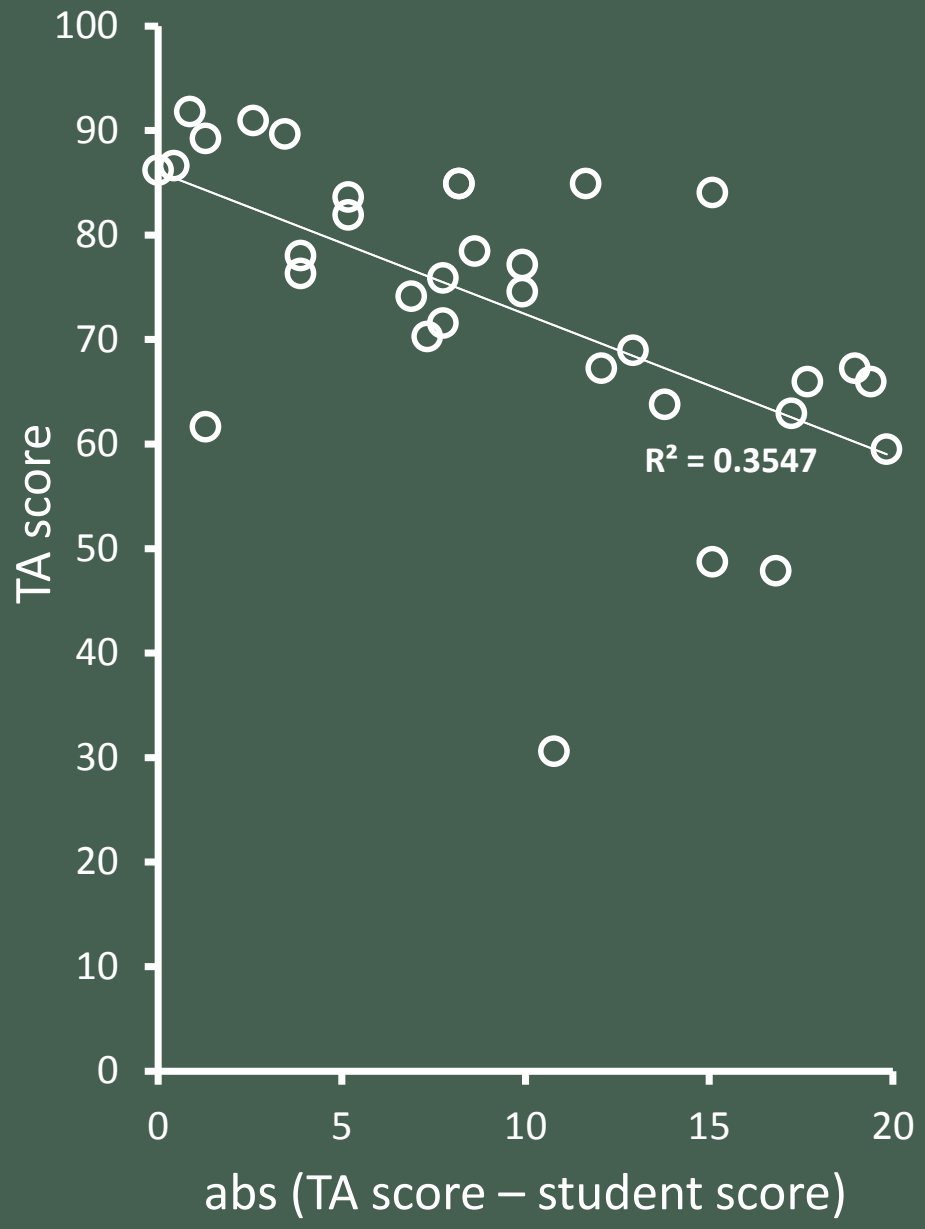
BIO 141: Evolution Spring 2013

· *Students generally score their work higher than instructors.*



BIO 141: Evolution Spring 2013

· *Students who were better able to assess their own work achieved higher scores.*



Needs assessment, Spring 2015:

In terms of your scientific writing, list two things you need to improve most.

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Biology Program Learning Outcomes:

PLO 2. An ability to develop and critique hypotheses and to design experiments, models, and/or calculations to address these hypotheses.

PLO 4. The ability to read, evaluate, interpret, and apply numerical and general scientific information.

Testable hypothesis as a threshold concept

- Requires integration of multiple ideas and articulation of these ideas in explaining the system being investigated (Taylor and Meyer 2010)

- Transition to understanding threshold concepts generally troublesome, but understanding the concept leads to a transformed way of thinking in the discipline, without which the learner cannot move forward successfully (Meyer and Land 2003)

- **Goal:** help students construct good (i.e. concise, clear, testable, understandable, and meaningful) hypotheses to help improve their reports.

Likert scale rubric to help students assess level of proficiency achieved

	<==========UNACCEPTABLE |		| ACCEPTABLE==========>					
Enter "x" in grid cells below to mark level of student performance:	Absent	Poor		Sufficient		Excellent		21 TOTAL
	0	1	2	3	4	5		
1	Title / Other Frontice Matter						Weight	
Title						X	0.75	0.8
Other						X	0.25	0.3
4	Abstract							
Topic/issue, Question, Hypothesis					X		0.25	0.8
Method						X	0.25	1
Major Result						X	0.25	1
Conclusion/Discusion						X	0.25	1
3	Introduction							
General topic/issue					X		0.25	0.6
Research to date					X		0.25	0.6
Question arising					X		0.25	0.6
Hypothesis						X	0.25	0.8
2	Methods							
Description			X				1.00	0.8
5	Results							
Text summarising data						X	0.38	1.9
Data display: #, informative						X	0.38	1.9
Data display: format						X	0.25	1.3
4	Discussion							
Interpretation of results						X	0.25	1
Constraints on								

Descriptive rubric to help students assess level of proficiency achieved

BIO 141: Grading Rubric for Technical Reports (lab reports, essay exams, scientific papers, and similar written assignments)

Your tech reports will be graded on *Content* and *Style*

***Content*:** Points will be assigned based on quality as described in the table. A score of zero also is possible if the section is missing or extremely poor.

SECTION	GOAL	EVALUATION		
		Excellent Full points	Good Reduced points	Poor Minimal points
Title	To give content information to reader	• Engaging and descriptive	• Appropriate	• Not enough content information or too much
Authors	To recognize the sole author of the research paper	• Named in appropriate place & way	• n/a	• Not named.

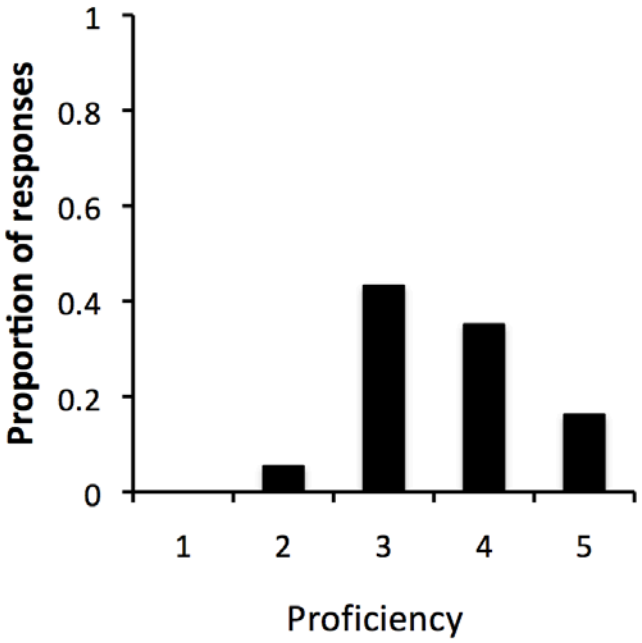
Abstract	To concisely summarize the context and question, general methods, major findings, and implications of the observations or experiments in relation to what is known or expected	• Key information included:
		  ○ *Problem statement*
		  ○ *Description of methods*
		  ○ *Major results*
		  ○ *Implications*
		• Presented clearly & concisely
		• All information is correct
		• Organization is logical
		• Captures any reader's interest
			• Sufficient information is presented in proper format
			• Would benefit from some reorganization
			• Understandable with some prior knowledge of experiment or observations
				• Some key information is omitted or tangential information is included
				• Some information is misrepresented
				• Some implications are omitted
				• Incorrect format is used

Introduction	To provide major context, identify central questions, and appropriate background information. To present an answerable and matching plausible hypothesis	• Relevant background information is presented in balanced, engaging way • Your question and hypothesis match and are a logical extension of existing knowledge • Clear statements of the study's goal (question), hypothesis, and predictions if relevant. • Writing is easy to read • All background information is correctly referenced	• Relevant background information is presented but could benefit from reorganization • A plausible hypothesis is given • With some effort, reader can connect your study to background information • Writing is understandable • Background information is correctly referenced	• Background information is too general, too specific, missing and/or misrepresented • Study question is incorrectly or not identified; a plausible hypothesis is not given • Writing style is not clear, correct or concise • References are missing, insufficient, or inappropriate

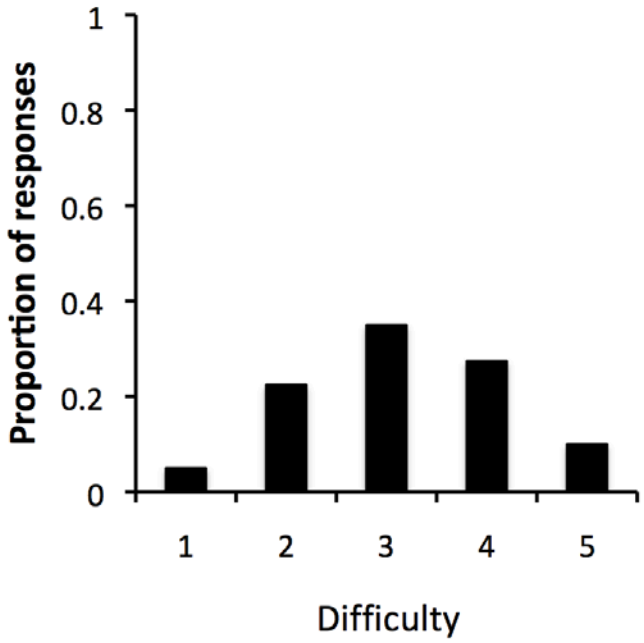
Materials and methods	To describe procedures correctly, clearly, and succinctly. Included one correctly formatted citation of the lab manual, and other citations as relevant.	• Sufficient for another researcher to repeat your experiment
		  ○ *May include informative, labeled diagram if/as needed*
		  ○ *Neither too broad nor too specific (i.e. not a rewrite of the manual)*
		• Lab manual cited
			• Procedures could be pieced together with some effort
			• Lab manual cited
				• Procedures incorrectly or unclearly described or omitted
				• Lab manual not cited

Needs assessment and mid-semester assessment:

Proficiency in writing hypotheses



How difficult is writing a hypothesis



Iterative hypothesis development for final report

· Students participating in all iterations of hypothesis development:

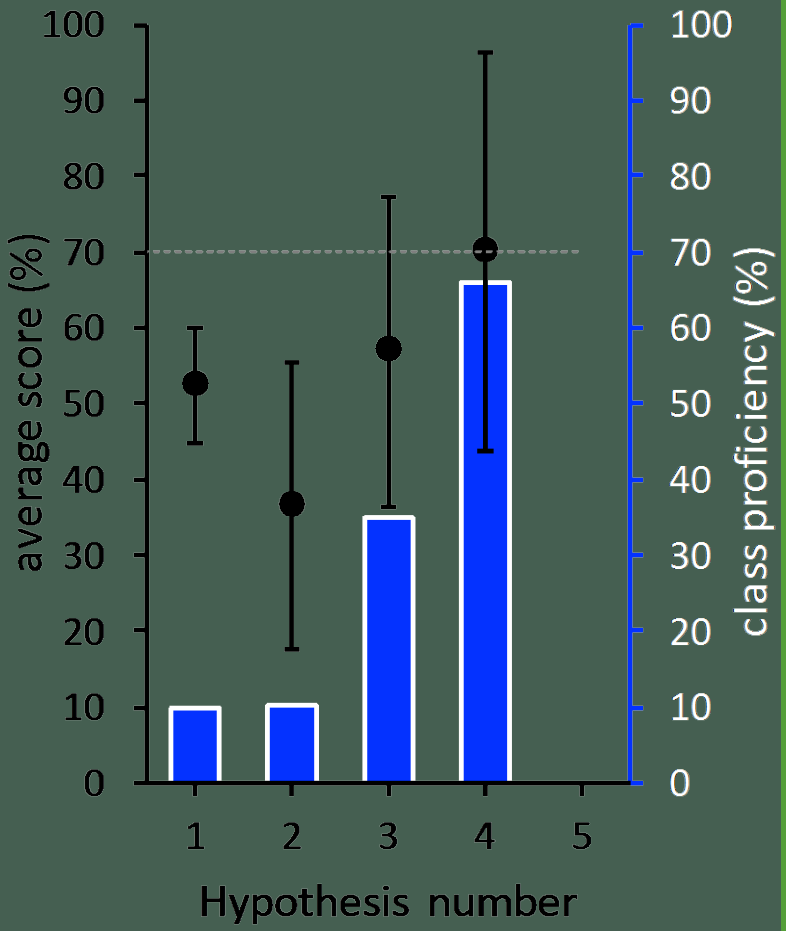
- mean score = 78% *(n = 29; s.d. = ±19)*

- average normalized gain = 61%

· Students forgoing one or more iterations:

- mean score = 50% *(n = 12, s.d. = ±31)*

- average normalized gain = 21%.

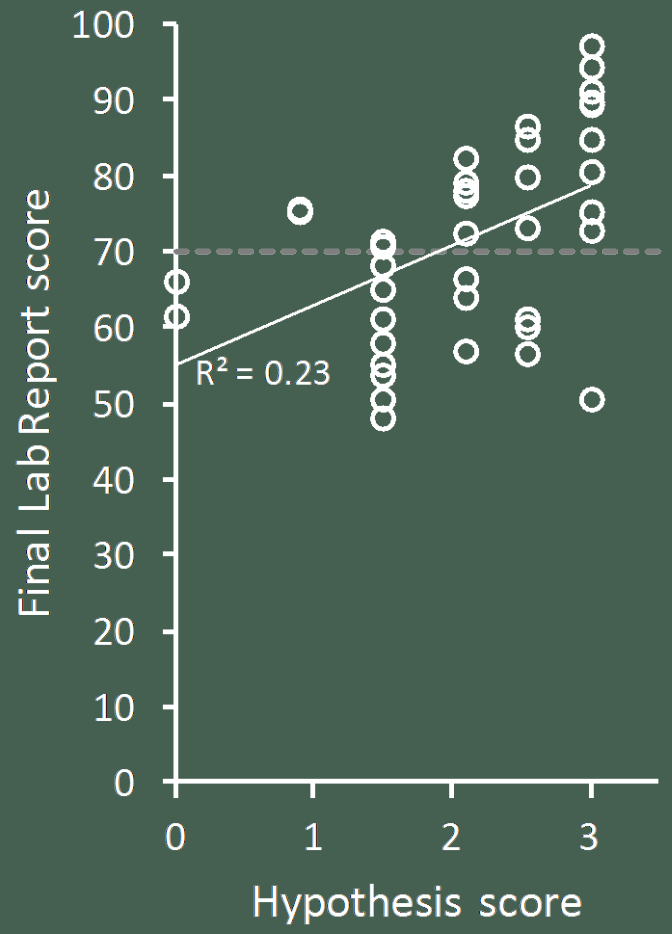


Final Hypothesis & Report

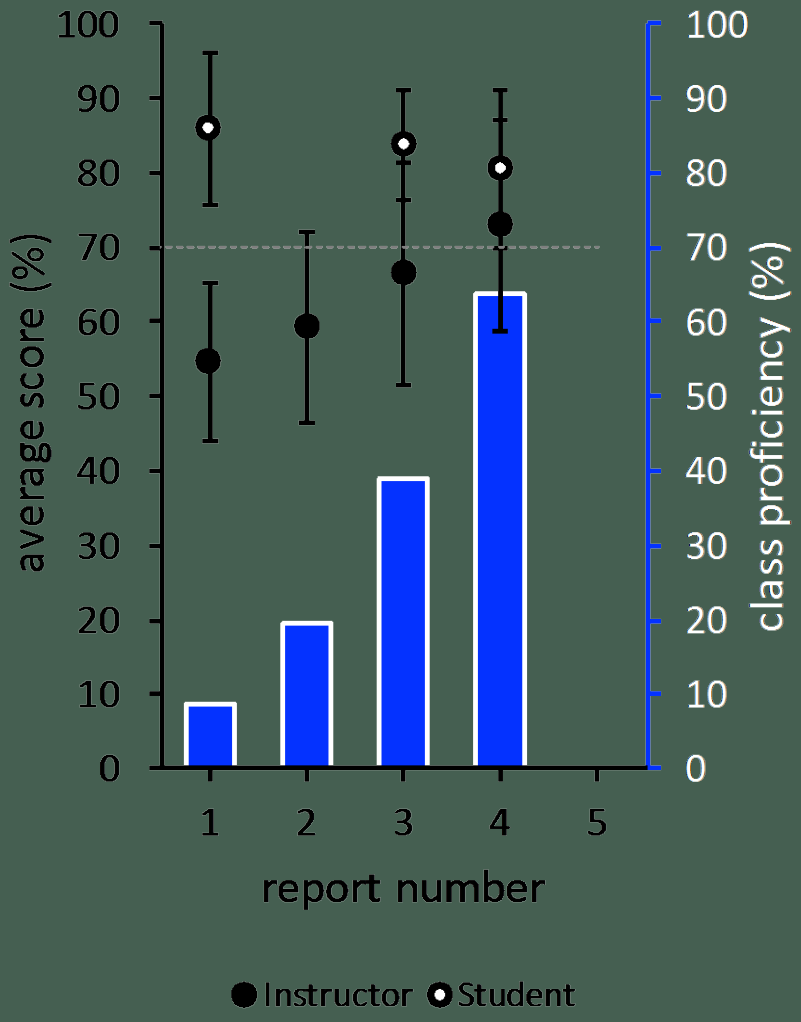
· *Relationship is weak, but …*

· *89% of students with a perfect hypothesis score earned at least a proficient grade on final report.*

· *Only 24% of students earning less than 2/3 points on their hypothesis earned a proficient grade.*



2013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average score (%)
class proficiency (%)
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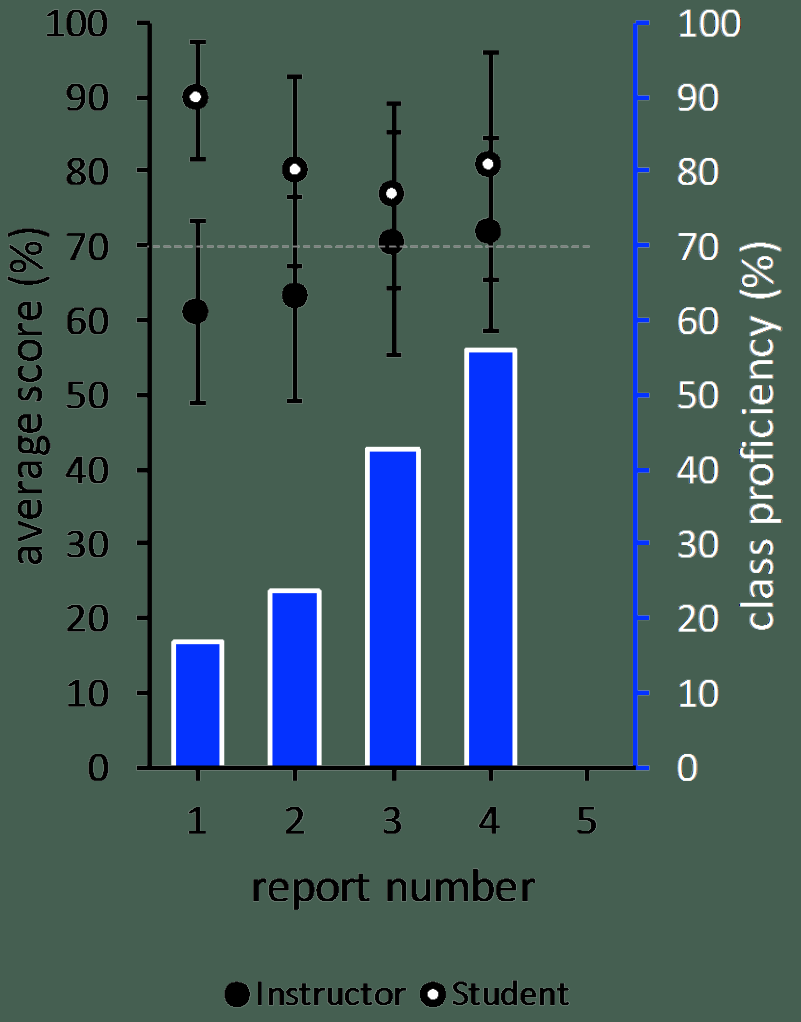
5
report number
Instructor
Student

2015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What skill(s) have you learned or improved in Evolution, if anything, that you think will help you be successful in your other courses and/or career in the future?

"Guiding my own learning has been a fundamental skill I have been taught in this class. I think it was acquired with the greatest skill in writing my own hypotheses and directed what my lab reports explored."

"… I have learned a multitude of skills and knowledge not only about evolution, but scientific skills and reasoning as well. I went from not knowing the importance of, and how to write reports, to being able to identify mine, and others strong and weak points of a paper."

"… writing an effective hypothesis. This semester, the fact that I knew what an effective hypothesis looked like helped me write better papers in my Writing 116 … class."

What I learned:

- Using assessment throughout the semester allowed me to adjust/add activities for students to practice skills before large assignments.

- Students who actively engaged with these practice assignments performed better in general than students who skipped them.

- Focusing on learning outcomes and establishing goals at the start of the class allowed for clear planning throughout the semester.

Questions?