Do well-developed hypotheses correlate with improved scientific writing?

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Undergraduate Learning Outcomes Assessment: Pedagogy and Program Planning

- Semester long certificate program
- Pre-semester workshops
- Weekly meetings
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.
· 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.*
Needs assessment, Spring 2015:

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

<table>
<thead>
<tr>
<th>Enter &quot;x&quot; in grid cells below to mark level of student performance:</th>
<th>Absent</th>
<th>Poor</th>
<th>Sufficient</th>
<th>Excellent</th>
<th>21 TOTAL</th>
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<tbody>
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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.

<table>
<thead>
<tr>
<th>SECTION</th>
<th>GOAL</th>
<th><strong>Excellent</strong></th>
<th><strong>EVALUATION</strong></th>
<th><strong>Poor</strong></th>
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<td><strong>Good</strong></td>
<td><strong>Minimal points</strong></td>
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<td>• Engaging and descriptive</td>
<td>• Appropriate</td>
<td>• Not enough content information or too much</td>
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<tr>
<td>Title</td>
<td>To give content information to reader</td>
<td>n/a</td>
<td>Not named.</td>
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<tr>
<td>Authors</td>
<td>To recognize the sole author of the research paper</td>
<td>• Named in appropriate place &amp; way</td>
<td>• Some key information is omitted or tangential information is included</td>
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</table>
| 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:  
  o Problem statement  
  o Description of methods  
  o Major results  
  o 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  
  o May include informative, labeled diagram if/as needed  
  o 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.
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?