

The Development of Scientific Writing Throughout the Biology Major Curriculum

**Final Report Bush Grant June 2005
Biology Department Faculty**

Introduction

As with most scholarly endeavors, the pursuit of scientific knowledge requires effective communication skills. One of the learning outcomes of Augustana College's Biology program is the ability of our students to communicate scientific information both verbally and in writing. For this assessment grant, we chose to focus on the assessment of writing in the Biology curriculum ("Biology majors report their laboratory work in written scientific form.").

As we began our discussions, it became obvious that developing writing rubrics for all of our courses in one summer was too ambitious an undertaking. We then discussed the course on which to focus our efforts. An obvious place was our first freshman course, Biology 120. That course, however, has a high enrollment and serves many non-biology majors. There are also several instructors leading the multiple sections of Biology 120. We chose to think like biochemists considering biochemical pathways. Key events occur at the first unique step of a sequence (pathway) – in the case of biology majors, our Biology 121 course. The majority of the students in this class are freshman biology majors, making this class a more likely starting point for instruction concerning communication in the biological sciences.

A number of the Biology 121 lab exercises are observational labs, not designed for development of communication skills. Fortunately, a number of our sophomore level labs in Biology 233 and 234 are perfect for teaching communication skills. Therefore, we chose to focus on Biology 233, our fall course for sophomore majors, for designing and implementing our writing checklist for Fall 2004. This activity fulfills our original goals #1 and part of #2 and #4:

1. To identify the components and characteristics of a well-written scientific paper and articulate a consistent lab report format.
2. To establish the level of writing expertise we expect of students in each year (freshman, **sophomore**, and junior/senior).
4. To modify and coordinate writing exercises in our courses in relation to our set of rubrics and expected outcome.

In addition, as a department we started to outline part of goal #3:

3. To formulate a developmental set of scientific writing rubrics that lead to the expected outcome at the end of four years.

And finally, we opened the discussion and considered the value and physical implications (storing files) of goal #5:

5. To discuss the value of maintaining student portfolios from freshman to senior year.

The departments will review the result of the Biology 233 experiment, including feedback from our students. We can then use that information to improve the checklist, develop rubrics for other courses, and eventually reach our goal of having a coherent writing rubric/set of rubrics to guide the students through biological writing from freshman year to graduation.

Biology 233: Writing in Biology, Rubric and Questionnaire

Biology 233, Genetics, is the third course in the Biology core and the first course of the sophomore major's sequence. Most of the students have completed Biology 120 and 121, except for those who have changed their major to biology or incoming transfer students who were given credit for Biology 120. Enrollment is usually 50-60 students with one lecture instructor and two laboratory instructors. The students are typically divided in four sections for lab. The laboratory exercises are both descriptive and experimental, and students work in teams of two or three. While sometimes the lab reports are completed individually, most of the time students submit a group report. In the past, lab report writing has focused on the analysis and understanding of laboratory results and activities, yet students are also expected to organize their report in discipline-appropriate format and write clearly and concisely.

For fall of 2004, we took our previous efforts at constructing a writing rubric and attempted to make it a more useful tool for both the students and instructors (Appendix 1). Students wrote four lab reports following the rubric, with one of those reports done individually and three submitted as a team effort. One instructor evaluated the reports for consistency among the four lab sections. As in the past, the evaluator made extensive comments on the reports and the reports were returned to the students before the next reports were due so that student could make use of the comments on the subsequent reports. At the end of the semester students were asked to complete a questionnaire (Appendix 2) about the writing rubric. The Biology department was graciously granted an extension on the Bush report deadline to incorporate the information gathered by the student responses to the questionnaire.

Results

Fifty-two of the fifty-three students taking the final exam completed the questionnaire. One student took the final exam early and did not receive a questionnaire. The complete summary of results are found in Appendix 3.

The lab report guideline (rubric) was distributed to the students, and according to the questionnaire all of the students received and used the rubric in preparing lab reports (Q1). Thirty-nine students strongly agreed that they carefully followed the rubric in

preparing their reports (Q 2), 41 strongly agreed that the rubric was useful (Q 5), and 51 agreed that the evaluation of the reports followed the rubric (Q3). Forty-seven strongly agree that each biology class should have such guidelines (Q 6).

Fewer students, thirty-seven, agreed that the guidelines were consistent with lab report instructions presented in Biology 120 and 121 (Q4). Some of the students, but certainly not 15 of them, may not have taken our Biology 120 and/or 121. As the Biology faculty have discussed in their meetings, we want to be more consistent in our expectations for student writing and thus the need for a cohesive set of writing rubrics.

Forty-seven students felt that their lab report writing improved during the semester (Q7). The lab report evaluator agreed that most students used the comments in writing improved subsequent reports.

The final three questions addressed the issue of individual and team reports. Thirty-eight students thought that having an individually prepared report increased the accountability of students in writing team reports (Q8). Thirty-five students preferred team reports while 11 did not (Q9). Seventeen students preferred individual reports, even at the expense of a longer turn-around time, and 26 did not (Q10). There was an inconsistency in the responses to questions 9 and 10, probably due to the wording of the questions.

In summary, students made use of the lab report writing guidelines and want them in each biology class where formal lab reports are written. Having departmentally-written rubrics for each course will improve the consistency of expectations as the students progress through the major. Most students felt that their writing improved, but unfortunately the question did not ask them to address whether they thought that the improvement was due to the guidelines. The students' preference for individual or team lab reports was divided, and perhaps a mixture of the two is the best approach, with individual reports having the potential to increase student accountability on the less-labor-intensive-for-each-student-and-instructor team reports.

With this first set of data we can now move forward on designing rubrics for other classes and having students and faculty members evaluate the usefulness of the rubrics.

APPENDIX 1. Rubric

Biology 233 Lab Report Competence Checklist

Up until this point we have not asked you to prepare full lab reports. As we move into the molecular biology labs, our lab report expectations are going to increase. Even with our truncated lab reports, Libby has been making comments about lab report format. We suggest you look over those previous lab reports and make note of her comments.

We will build on these expectations in Cell Biology and more advanced courses.

Scientific Expectations:

_____ Student organizes the lab report into three main sections: Introduction, Materials and Methods, Results and Discussion.

Introduction (one-few paragraphs)

_____ Student explains the general subject of the lab exercise.

_____ Student states the rationale for doing this experiment.

_____ Student identifies the organism or system of study and explains why it was chosen.

_____ Student provides additional background information relevant to the lab.

_____ Student states the specific objectives of the lab.

Materials and Methods (typically one or two fairly short paragraphs)

_____ Student summarizes how the data was collected and analyzed. Includes names of established protocols, key reagents, key instrumentation. Avoids “recipe” format, specific volumes of reagents, specific concentrations of reagents unless significant, incubation times, etc.

Results and Discussion (major portion of report)

_____ Student presents data in text, tables and figures. (Tables and figures may be integrated with text or assembled in order of discussion at end of report.)

_____ Student refers to tables and figures in the text of the report.

_____ Student sequentially numbers and titles tables (**above** table).

_____ Student sequentially numbers and titles figures (**below** figure).

_____ Student displays data logically in table(s), including relevant units.

_____ Student presents data in well-labeled drawing(s) or diagram(s). Gels or photos should be mounted on paper and labeled like other figures.

_____ Student displays calculations, if applicable.

_____ Student interprets the results and draws conclusions, referring to data (table, figures, calculations, etc.).

_____ Student is able to answer additional questions proposed in the lab handout.

_____ Student explains any experimental difficulties and makes suggestions for further work.

(Rubric cont.)

Mechanical Expectations:

- _____ Each individual report is the original work of each student.
- _____ Team reports represent the work of all team members.
- _____ Report is stapled.
- _____ Pages are numbered sequentially.
- _____ Title page is present, does not have a page number and is signed.
- _____ Voice is consistent and usually third person, past tense when describing the experiment. (May be present tense when describing current knowledge in the field.)
- _____ Writing is organized, logical and clear. Reader can follow line of reasoning.
- _____ Sentences are complete and grammatical and flow together smoothly.
- _____ Words are chosen for precise meaning. Formal English is used – no contractions, slang, colloquialisms, or abbreviations (unless scientific and properly explained).
- _____ Information (names, facts, etc.) is accurate.
- _____ Scientific names are presented appropriately, with capitalization and italics/underlining (*E. coli*, *Drosophila melanogaster*).
- _____ Appropriate significant figures are used (see handout).
- _____ Writing has **academic appeal**; it captures the reader's attention and is a pleasure to read.

APPENDIX 2. Questionnaire

Biology 233: Genetics

Fall 2004

Assessment of formal lab report guidelines

5 = strongly agree

3 = neutral

1 = strongly disagree

Please circle the appropriate response:

- | | | | | | |
|----------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|
| 1. I received a copy of the guidelines. | Y | N | | | |
| 2. I followed the guidelines carefully in preparing my lab reports. | 5 | 4 | 3 | 2 | 1 |
| 3. The evaluation of my lab reports was in agreement with the guidelines. | 5 | 4 | 3 | 2 | 1 |
| 4. Many components of the guidelines were consistent with lab report instructions presented in Biology 120 and 121. | 5 | 4 | 3 | 2 | 1 |
| 5. The guidelines were useful. | 5 | 4 | 3 | 2 | 1 |
| 6. Each biology class, which requires the writing of formal lab reports, should have guidelines for preparing lab reports. | 5 | 4 | 3 | 2 | 1 |
| 7. My formal lab report writing improved in quality during the semester. | 5 | 4 | 3 | 2 | 1 |
| 8. Having some individually prepared lab reports makes students more accountable in preparing team reports. | 5 | 4 | 3 | 2 | 1 |
| 9. I prefer team reports over individual reports. | 5 | 4 | 3 | 2 | 1 |
| 10. I prefer individual reports, even at the expense of waiting longer for the reports to be graded and returned. | 5 | 4 | 3 | 2 | 1 |

Your feedback is important. Please feel free to include any written comments in the space below:

APPENDIX 3. Summary of results from questionnaire

“Assessment of formal lab report guidelines”

Biology 233: GENETICS

Fall 2004

Number of respondents: 52

1. I received a copy of the guidelines

Yes: 52 No: 0

2. I followed the guidelines carefully in preparing my lab reports.

Strongly agree	39
Agree	12
Neutral	1
Disagree	0
Strongly disagree	0

3. The evaluation of my lab reports was in agreement with the guidelines.

Strongly agree	40
Agree	11
Neutral	1
Disagree	0
Strongly disagree	0

4. Many components of the guidelines were consistent with lab report instructions presented in Biology 120 and 121.

Strongly agree	18
Agree	19
Neutral	13
Disagree	1
Strongly disagree	0
Could not remember	1

5. The guidelines were useful.

Strongly agree	41
Agree	11
Neutral	0
Disagree	0
Strongly disagree	0

6. Each biology class, which requires the writing of formal lab reports, should have guidelines for preparing lab reports.

Strongly agree	47
Agree	3
Neutral	1
Disagree	1
Strongly disagree	0

7. My formal lab report writing improved in quality during the semester.

Strongly agree	25
Agree	22
Neutral	5
Disagree	0
Strongly disagree	0

8. Having some individually prepared lab reports makes students more accountable in preparing team reports.

Strongly agree	26
Agree	12
Neutral	10
Disagree	4
Strongly disagree	0

9. I prefer team reports over individual reports.

Strongly agree	29
Agree	6
Neutral	6
Disagree	6
Strongly disagree	5

10. I prefer individual reports, even at the expense of waiting longer for the reports to be graded and returned.

Strongly agree	11
Agree	6
Neutral	9
Disagree	14
Strongly disagree	12

Written Comments:

The guideline check list was extremely useful! I used it for every lab. =)

Guidelines were excellent!

I had a great experience at lab, and I learned more with group reports, because everyone shares input.

I think both lab instructions did a wonderful job this semester!

The lab write-ups were beneficial because I honestly don't know if I would have understand the concepts if we weren't forced to **understand** what we did in lab.

Labs were informative and fairly easy understand.

I really appreciated the time Libby took to write comments on individual reports. It really helped to know what I was doing wrong and what I could improve on.

Team-written reports are difficult due to finding time and making the work load fair. My partner and I worked well together but there were times when it became very inconvenient.

Individual lab reports are better then team reports.

I felt the lab reports were very helpful in further understanding lab activities.