Summer Fellowship 2005

Educational Transfer Plan

Elisa Stone

Assessing Student Lab Work in a High School Biotechnology Class

Education Transfer Plan- Elisa Stone, Summer 2005

Title: Assessing Student Lab Work in a High School Biotechnology Class

Abstract: (word limit: 50)

A rubric was developed to evaluate student progress in biotechnology laboratory work, including the ability to interpret data, formulate conclusions, identify sources of error, and reflect on next experiments. This rubric is intended to promote science writing skills, make grading more efficient, and provide the opportunity for more specific feedback.

Connections to Fellowship:

My ETP addresses ways to assess how students progress in their scientific thinking and writing. It is intimately connected to my summer fellowship because research scientists carry on a continuous discourse with each other using the scientific process of asking experimental questions, collecting and analyzing data, making conclusions, and proposing follow-up experiments. This is happening during my fellowship on a daily basis as we all share data with each other informally at our lab benches, brainstorm next experiments with our mentor, and listen to formal presentations on co-workers' research. Importantly, I am also keeping my own lab book and writing in it day-to-day as a record of my experiments for the lab. In my daily write-up, I include the same sections that I ask my students to record- experimental questions & hypotheses, procedures, calculations, data, and interpretations of results. This has helped me think more concretely about what my goals are for student research and scientific writing about their experiments, as I created the rubric that will be the product of this ETP.

Need & Objective/Outcome:

These ETP ideas will meet the need to develop grading rubrics for assessing student progress on lab reports in my biotechnology classroom. The biotechnology course that I teach is part of a 2-year program aimed at supporting students to enter a local community college for a 1-year lab technician certificate. It is a skills-based course, where hands-on experimentation is crucial to promote students success at college and the biotechnology internships that students participate in throughout the program. Writing laboratory reports are an important skill that students need to develop over a two year period and beyond. It will be essential for students to work on their writing skills in order for them to be prepared for their biotechnology job placement and introductory college courses.

Scoring systems that I used for assessing lab work in the past were not sufficient for evaluating student progress, because they tended to grade more for completion than for quality of scientific thinking. I also want a more effective and efficient way of giving students specific feedback on their lab reports, so it is obvious to them what areas they need to focus on to improve. For this ETP, I have designed a new lab report rubric for use in my biotechnology class, which is a skills-based vocational course that sequences into the local community college. I will use the rubrics throughout the year in my own class, which is the second year of a two year program. The identical rubric will also be used in the other biotechnology teacher's class at my school (who teaches the first year of the program), with modifications for point values of each category to scaffold expectations of lab writing skill development for entering and advanced students. I also intend to modify the biotechnology class rubric and put a similar lab report rubric in place for my biology classes, in collaboration with other biology teachers in my school once the academic year begins.

Identification of Resources:

1. http://rubistar.4teachers.org. This website is an excellent resource for getting started on making rubrics of all kinds for the classroom. Not only does it provide a general framework in which it is possible to choose categories and add detailed descriptions, but the site also gives numerous examples of rubrics in many subject areas to help the teacher generate ideas about what would work best for her own classroom.
2. Lab write-up rubrics from other teachers. I gathered a number of lab report rubrics that have been successful for other science teachers, and modified them for my own purposes. These include: Mary Murphy, another biology teacher at Berkeley High School: Diana Theriault, Jimmy Ikeda, and Judy Wu, biology and biotechnology teachers who I met through IISME and discussed rubrics with in detail at our mid-summer meeting; and Rebecca Huang and Preston Thomas, the biotechnology teachers at Oakland's Life Sciences Academy, who run a biotechnology program very similar to our own at Berkeley High School. I would recommend that anyone preparing to write a new rubric seek out teachers that have done something similar, and modify it for the specific classroom, because this was very helpful.

Implementation Plan:

I developed a detailed rubric for evaluating student progress in laboratory work (please see "Report for Biotechnology Lab Report" attached below), with a focus on evaluating students' ability to interpret data, formulate conclusions, identify sources of error, and reflect on next experiments. The following sections of a lab report were included in the rubric: Background, Goals, Procedure, Data & Observations, Calculations & Graphs,

Conclusions and Overall Format. A four-level rubric details what is expected for expert, proficient, approaching proficient, and beginner performance. This is intended to be a generalized rubric for use throughout the school year. Different scores can be assigned for different categories, depending on the changing emphasis of the curriculum at any particular time (note point values in parentheses at the bottom of each box). For example, after they get in the habit of writing up labs in the overall format of a professional biotechnology lab book, the score could be reduced from 20 to 10 for proficient, while the emphasis on making hypotheses could be increased with a corresponding increase in the score from 10 to 20. In addition, by the end of the year, there will be an expectation that students must do "expert" work in all categories to receive a perfect score- while at the beginning of the year, the expert category receives extra credit points (EC). Typically labs will be worth a total of 100 points, with a possiblity of getting as much as 10% extra credit. Where appropriate, a lab may be worth more or less points, in which case the point values would be adjusted for each category. Thus, one feature of the rubric is its flexibility for changes in emphasis in the classroom as well as ongoing student development.

The rubric will be introduced to students when the first lab of the year is done. We will write the first lab report together, checking to see if we are fulfilling each step of the lab rubric as we go. Essentially, every student is expected to get full credit on the first lab. From then on, a copy of the lab rubric will be given to students before we start the next lab. Any emphases and changes in value for a particular category will be pointed out, and students will use the rubric as a guide in writing up every report. They will paste the rubric in their lab book each time after I grade it, and before they begin the next lab, so that it can be a reminder of any areas that need to be improved, and a record of their development over the year. Students will use the rubric to peer review other students' work routinely, so that they (1) get more familiar with the rubric itself, (2) see how other students write their reports, including where they achieve expertise and where they still need to work, (3) have a chance to re-write or fill-in any missing sections before I give them a final grade, and, importantly, (4) get used to giving and receiving feedback in the way that practicing scientists do routinely in a professional lab. Students will receive a grade for their peer review, as incentive to do a careful assessment. One lab report per semester will be formally written and typed after I grade it the first time, so that students learn the value of making multiple drafts in scientific writing and publishing. For this formal lab report, expertise will be required in all categories for full credit.

Assessment/Evaluation:

I have two plans for assessing the effectiveness of the rubric: (1) Because students will be using the rubric for peer review, as well as for assessing their own progress, they will become very familiar with it. After using it for the first marking period, I intend to ask

the students themselves to critique the rubric and make suggestions for changes. I will incorporate any of their suggestions that I think are consistent with the goals of the course. At the end of the course, I will ask students to complete a formal questionnaire that will provide them the opportunity to evaluate the course in general and the rubric specifically. (2) After the first grading period and at the end of the school year, I will ask my colleage Steven Fong to critique the rubric from the perspective of a teacher that will use it in his own classes (see Transferablity below). We work closely together, and in addition to informal discussions about using the rubric that I am sure will take place over the course of the year, I will ask him to spend some time reflecting on his experience with using it in writing. Note that Student Rubric Critique, Student Questionairre, and Teacher Rubric Critique instruments are attached below.

Transferability /Ability to Replicate:

There are three ways that I see this rubric being immediately transferable: (1) It will be used by at least one other teacher from the very beginning of the school year. My colleague Steven Fong and I both teach in Berkeley High School's Biotechnology Academy- Steven teaches the first year of the two year program, and I teach the second. We plan our curricula together, with the aim of making the instruction as seamless as possible from year to year. We also make opportunities to scaffold our instruction, and the use of a common lab rubric represents one of those efforts. Steven will use the rubric described here, and modify it for his own classroom wherever necessary in collaboration with me. (2) I will lead a discussion on the sucesses and limitations that Steven and I experience with this rubric with Rebecca Huang and Preston Thomas at the Life Sciences Academy, during one of our periodic meetings to discuss our curricula. Both of our schools have a partnership with the non-profit organization Berkeley Biotechnology Education, Inc., who maintains an interest in seeing us share curricula and collaborate wherever possible so that the students from Berkeley and Life Sciences enter the local community college having the same background and preparation. (3) I will be working in collaboration with Todd Higashi, another teacher at Berkeley High School, where both of us are the only science teachers in one of BHS's new small schools. Todd and I will be designing lab work for a Biology course together, and will modify the Biotechnology Lab Report rubric for use in our biology classes. We are likely to share it with other biology teachers at BHS in the next year or two, because it has been a frequent topic of discussion in science department meetings to unify our grading policy for biology labs.

Rubric for Biotechnology Lab Report

Name _____ (Peer Reviewer _____) Lab # _____

	Expert	Proficient	Approaching	Beginner
Overall	Extremely well- organized and professional lay-out. Uses clear language and proper terminology. Grammar and spelling are near perfect. References other labs and sources of data appropriately; important entries are witnessed. Neither too little nor too much detail. (EC)	Must follow lab write-up rules including lab title & section titles; page numbers; updated table of contents; labs dated, lined & signed. Single line through mistakes, and initials. Grammar and spelling are good (any minor errors don't take away from the work). (20)	Breaks lab write-up rules in one or two minor ways, including white-out, pencil, pen that does not have blue or black ink, tape. Somewhat messy or disorganized. Grammatical and spelling errors detract from work. Way too much detail or redundant (don't repeat yourself!). (16)	Breaks several lab write-up rules. Sloppy, disorganized, missing sections, handwriting difficult to read, many grammatical and spelling mistakes, incomplete sentences. (12)
Background	Clear, precise, well-defined scientific concepts and how they relate to the purpose of the lab. New techniques & equipment explained; diagrams are included to help reader. (EC)	New concepts introduced, and solid understanding of how they relate to the lab. New techniques and equipment briefly explained. (10)	Introduction of concepts shows a basic understanding of how they relate to the lab, but some relevant information is missing. (8)	Little evidence of understanding of concept, missing relevant parts of explanation of concept or new techniques and equipment. (6)
Goals	Sophisticated statement of the lab's purpose in the form of an experimental question, hypothesis & prediction. Explanation of why you made your hypothesis and prediction must be included. (EC)	Clear statement of the goals of the lab- including (a) the experimental question you are trying to answer, (b) the hypothesis and/or prediction you will test. (10)	Incomplete statement of purpose of the lab; unclear question, hypothesis or prediction. (8)	Purpose of lab is not well-stated. Leaves reader wondering, "What is the point of this lab?" (6)
Procedure	Every detail of procedure is clear, neat, in order, and the most important steps are summarized in an outline or flow-chart. (EC)	Materials are listed, and protocols are written completely or are attached, so that a reader could duplicate what you did in lab. (10)	Some steps in procedure and/or some materials are missing, or are not in the appropriate order. (8)	So many steps in the procedure are missing that it is unclear how the lab was done. (6)
Data & Observations	Clear effort to organize data in lists, tables, charts, or labeled drawings. Very easy-to-read and nice to look at. Notes are neatly recorded throughout procedure. (EC)	Data and observations are clear, complete and neat. Lists, tables, charts, drawings, and/or descriptions are labeled. Units are identified. Notes are taken during procedure. (10)	Missing relevant data. Lists, tables, charts, or drawings are missing labels or are messy. Units are missing. (8)	Data collection unfinished or unclear. Difficult to tell what happened. (6)

Calculations & Graphs	Clear effort to make calculations very easy to follow and reproduce. Purpose of calculation is clearly stated. Graphs are created or used to express ideas and interpret data. (EC)	Easy-to-follow calculations using data from lab. When relevant, data is graphed according to guidelines. Minor errors may be present. (10)	Critical errors in some calculations or graphs, or missing some relevant information. Number line on graph is not accurate. (8)	Calculations missing or do not make sense. Units not included. Graph is incomplete (not titled, axes not labeled, trend lines not drawn, legends not included). (6)
Conclusions (*ReePeePa*)	All criteria for Proficiency are met, and goes beyond: (a) Objectives are restated, conclusions are linked to a deep understanding of lab background, thought process used to draw conclusions is clear and logical, trends or patterns in data are noted. (b) Additional sources of error are noted. If you could do the experiment again, how would you change it? (c) How will you apply your results to the biotechnology industry or to life outside of the lab? Has your investigation supported, expanded or questioned current scientific thinking on this topic? In other words, why are your results important or relevant? (EC)	Conclusion written in at least one paragraph for each section: (a) **Results with Evidence & Explanation** (Ree): Does your data support your hypothesis? Explain why or why not. Summarize what happened during your experiment, and refer to <u>specific</u> data that provide evidence for your conclusion. Do not restate procedure. (b) **Possible Errors & Explanation** (Pee): reflect on at least two possible sources of error, and how these may have affected the data. (c) **Practical Applications** (Pa): What new experimental questions and hypotheses come up from this lab? What would be the next logical step for a follow-up experiment? (30)	One section of conclusion is incomplete. (25)	Two sections of conclusion are incomplete. (20)

Total Score: _____

Student Rubric Critique
Biotech 3, Stone 2005

As we finish off the first quarter, I want us all to spend some time as a class to critically evaluate the rubric we have been using for Biotechnology Lab Reports. To do this, you will first make your own rubric to think about how to rubrics are put together. Then you will make specific suggestions about the rubric we have used in class, which I will take seriously when I make changes in the rubric we use for next semester.

Day 1: We have talked a few times about how lab work is a lot like cooking- and that good scientists are often good cooks! Pretend you are a judge at an apple pie cooking contest in which each contestant must provide a pie for tasting and a recipe so that others can make the same pie. You want to make a fair system for rating different pies and recipes, and you choose to do it in a rubric. On a separate sheet of paper, make a rubric with at least four categories, in which each category assesses beginner, intermediate and expert cooks. You may do this alone, or with a partner. After you have made your first draft of a rubric, exchange with someone else and give them suggestions for making their rubric better. Ask me for help if you have trouble getting started!

Day 2: Look over the copies of the Rubric for Biotechnology Lab Reports that are pasted in your lab book. Reflect on the advantages and disadvantages of this rubric when you answer the following questions: (use the back if you need more room)

1. What did you like about the rubric? Name at least three things.

2. What did you NOT like about the rubric? Name at least three things.

3. When you compare your rubrics from the beginning and the end of the first quarter, what progress did you make in your lab reports? What areas do you want to work on for the second semester?

4. What do you think should be changed about the rubric? Make at least two suggestions. You can talk about this with other students, but make sure you each have different suggestions.

Student Questionnaire
Biotech 3/4, Stone 2005

As year comes to a close, I am asking for your feedback on what the Biotechnology course has been like for you. Please answer in as much detail as possible, because I will be taking all of your suggestions seriously when I plan for next year. Use the back of this sheet if you need more room.

1. What have you liked about the Biotech course this year?

2. What have you NOT liked about the Biotech course this year?

3. If you had a little brother or sister taking Biotechnology next year, what suggestions do you have for me to make the course better?

4. If you had a little brother or sister taking Biotechnology next year, what advice would you have for him or her for getting the most out of the course?

5. We have all tried hard to make the Rubric for Biotechnology Lab Reports work well for us. Please look at the attached copy of the rubric, and reflect on your experience with it.

    a. What did you like about the rubric?

    b. What did you NOT like about the rubric?

    c. Look back over the rubrics in your lab notebook- what progress did you notice you made over the year?

    d. If you could make two changes in the rubric for next year, what would they be?

Teacher Rubric Critique

Rubric for Biotechnology Lab Report

I am looking for your feedback as a teacher on the lab report rubric we have been using to assess our students, so that we can make any changes necessary to improve the rubric. Please reflect on your experience using it by answering the prompts below.

1. What did you like about the rubric for assessing student lab reports?

2. What did you NOT like about the rubric for assessing student lab reports?

3. Do you think the rubric was fair? Why or why not?

4. Do you think that using the rubric made grading lab reports more or less efficient? Why?

5. Do you think that students used feedback from rubrics to improve their next lab report?

6. How well do you think that students were able to use it for peer reviewing?

7. What suggestions do you have for improving the rubric?

8. Other comments?