TO: I'elleen Miller, General Education Coordinating Committee (GECC) Chair  
FROM: Dr. Joanna Joyner-Matos, Assistant Professor  
DATE: June 4, 2010  
SUBJECT: General Education Assessment for BIOL 490 Senior Capstone (490-02, 490-03)

My senior capstone course in Biology, Animal Physiology, uses an integrative approach to explore the physiology of vertebrates and invertebrates. The lecture material and laboratory experience in physiological research are intended to prepare students for advanced studies in the biological and medical sciences, careers in biotechnology, or teaching at secondary or post-secondary institutions. I list the following information as “Course Objectives” in my syllabus: Students will gain an understanding of the fundamental principles of physiology and the interplay between physiology, ecology, and evolution; enhance skills in critical thinking; gain experience in reading and understanding primary literature; gain practical experience in hypothesis development and experimental design; and acquire skills in data collection, analysis, interpretation, and presentation. The laboratory portion of the courses focuses on synthesizing discipline-specific methods and skills. As I explain to the students during the first week of class, science is no longer conducted by independently wealthy, upper-class gentlemen of leisure who have essentially complete freedom to pursue their ideas. Modern-day science is collaborative and structured on a rigorous system of peer review; this course is intended to mimic the working conditions of professional biologists. Therefore, the students work in groups that I create (we cannot always choose our coworkers) and we peer review during the quarter.

This is my third time teaching this course (Fall 2008, Spring 2009, Spring 2010). I have made substantial changes to the organization and assessment of the group research project (the “capstone” aspect of the course) over the three quarters. The laboratory portion of the course is worth 45% of the final grade. I assign the students to groups based on an initial “research interests” assignment. The groups then design an experiment synthesizing the most interesting aspects of their previous coursework, prepare a proposal for the Institutional Animal Care and Use Committee (IACUC) and communicate with IACUC to gain permission, implement the project while maintaining a lab book, and prepare a final paper (I evaluate drafts) and a PowerPoint presentation. The points for the laboratory project are partitioned as:

- Proposal: 5%
- Planning and Implementation: 25%
- Group lab book: 5%
- Rough Drafts: 10%
- Final paper: 30%
- Final presentation: 25%

Each group is assigned a grade for the project, which is then individualized for each student based on their effort in the project (see below). After my first time teaching this course I added the “Group lab book” grade and took the 5% away from the final paper score. I have found that making the groups maintain a detailed lab book not only facilitates communication between group members but also allows me to more accurately assess which students contributed the most to the lab work.
I have always asked the students to complete a Self and Group Assessment worksheet (appended below) at the end of the quarter. This confidential assessment is designed to help me determine whether the work was divided equitably. I combine the scores from these assessments with information provided by my graduate teaching assistants and by my own observations. Each student’s research project score is then adjusted to reflect proportional input to the project. The students are made aware of this process during the first week of class and reminded several times during the quarter. The first time I taught this course, the variation in final project grades among group members averaged 8.6% (range 0 – 20.4%). For example, one group (0% variation in grade) had four students who clearly divided the work equitably; at the other end of the spectrum was a group (20.4%) which had two members who took the lead on the project and two members who, by all reports, contributed very little to the project. The second time I taught this course, when I required the lab book, variance in group grades increased to an average of 18% (range 0 – 33.9%). I attribute the increased variance in grades among group members to more accurate assessments of individual effort, in large part due to my surveillance of the lab book records. This trend was repeated the third time I taught the course. Now that I feel I am getting an accurate assessment of individual student effort, I would like to see this variance among group members decrease and am exploring ways to encourage the students to share the group work equally.

Between the first and second times I taught the course I added a peer-review element to the IACUC proposal section of the course. I run the proposal reviews as they do at the major granting agencies, the National Institutes of Health and the National Science Foundation. This peer review is done the week before proposals are submitted to IACUC; the final proposal grade reflects participation in the review, quality of the final proposal, and number of rounds of revision the groups must complete before gaining IACUC approval. The first quarter I taught the course, the proposal grades averaged 8.4 out of 10 points (range 7.5 – 9.5) and it took us nearly three weeks to get the projects approved by IACUC. The second quarter I taught the course, the quarter I implemented the peer review, the average proposal score was 9.8 out of 10 points (range 9-10) and everyone got approved within just over a week. While the proposal grades did not change during the third quarter, the number of rounds of revision has continued to decrease, indicating that the peer review activity is increasing the quality of our submitted proposals. More importantly, the students have stated that they learned more about experimental design during the peer review lab than they did during lectures on the topic.

I have always used a grading rubric for the final group paper. The rubric is appended below. Students are taught how to write scientific papers in their sophomore-level methods course (Biology 270) and practice several times during their upper division coursework. The first quarter I taught the course I took substantial lecture time explaining in detail how to write all of the sections of the papers. I did not do so the second or third times I taught the course but rather I provided them with extensive handouts. Final paper grades did not differ among the three quarters (average 92.4% in the first quarter, 92.5% in the second quarter, 91.3% in the third quarter).

The groups present their results to the class in the form of a PowerPoint presentation, modeled on the 10-minute presentations given at professional scientific meetings. Students may or may not have been taught how to give research presentations in previous classes (some methods courses end with a poster presentation). The first quarter I demonstrated one presentation for them and provided them with a short handout about PowerPoint presentations. The average score on the presentations was 9.2
out of 10 (range 8-10 points). The second quarter I added a PowerPoint activity to the lecture portion of the course, in which groups of students (not the research groups) presented a published article as if it was their own work. I reviewed a draft of these literature presentations and discussed PowerPoint presentation strategies with each group. Final research presentation grades increased only slightly during the second quarter, averaging 9.3 out of 10 points (range 7.5 – 10). One group in my second quarter gave a very poor presentation (the 7.5 score), the rest of the groups ranged from 8.75-10 points. Although the grades may not reflect it, the overall quality of the presentations increased, likely because the students had given this type of presentation once before and watched eight other presentations during the quarter. During my third quarter I introduced a presentation rubric (appended below) and discussed the rubric with the class on several occasions. During my third quarter, the average presentation score was 8.5 (range 7.5 – 9.3). Although these scores are lower than in previous quarters, this reflects a more detailed and consistent grading on my part. More importantly, the quality of the presentations was substantially improved during this latest quarter. The students, on the whole, gave much more detailed and complete presentations than my students have given in past quarters. They made a point of including all of the small details outlined on the grading rubric. My teaching assistants, who have taught with me in the past, also noted that the talks this quarter were more professional and complete than in previous quarters.

In summary, I have found that requiring multiple assessments of group dynamics (lab book and confidential self and group assessments) has increased my ability to evaluate the success of the group work aspect of capstone. Adding the lab book has substantially enhanced communication among group members and between group members and animal care facility staff. While my system certainly could use more refinement and I am looking for ways to improve group dynamics, I am hesitant to move into micromanaging the groups. Group work is inherently difficult and one of the valuable learning opportunities of capstone is for students to try to solve the problems within their groups without resorting to instructor interference. I also have found that presentation of grading rubrics has increased the quality of student work and facilitated communication of my expectations.

This capstone experience provides the students with a realistic glimpse into the life of a professional biologist. They experience the joys and frustrations of group work, peer review, seeking permission to conduct research, methods development, data collection and analysis, and results presentation. They work extremely hard, typically every day, and seem to put more hours into their project than into any other coursework in Biology.

Future directions: When I teach this course in the fall I likely will institute a “scoring rubric” for the proposals, which I will give to students while they are writing the proposals and will ask students to fill out during the peer review session. I believe that this approach will help students structure their own proposals and more constructively and completely evaluate the proposals they review. I will continue to use the rubrics that I have developed and will have students “grade” the published research papers they present in lecture using my rubric. I anticipate that this activity will force them to carefully evaluate a scientific manuscript prior to the time that they are writing their own papers.
Confidential Assessment of Group Work

Your group’s research topic ______________________________________________

Your name _____________________________
% of the total effort on the group project _______________________________
(in other words, how much of the work do you feel you did?)
Extra details you would like me to know about your work effort:

Group member name _____________________________
% of the total effort on the group project _______________________________
Extra details you would like me to know about his/her work effort:

Group member name _____________________________
% of the total effort on the group project _______________________________
Extra details you would like me to know about his/her work effort:

Group member name _____________________________
% of the total effort on the group project _______________________________
Extra details you would like me to know about his/her work effort:

Group member name _____________________________
% of the total effort on the group project _______________________________
Extra details you would like me to know about his/her work effort:
Grading Rubric for Bio 490 Group Research Papers

Total: 70 points

- _______ (3) All sections of paper present (1/3 point each)
- _______ (3) Spelling and grammar correct throughout
- _______ (1) Double-spaced throughout, page numbers
- _______ (3) Correct scientific grammar, including italicized species names, genus is abbreviated, plural verbs paired with ‘data’.
- _______ (2) Title page complete with name, title, date
- _______ (4) Abstract is ≤ 300 words, touches upon all parts of the study
- _______ (2) Introduction organization starts broad, ends with specifics
- _______ (2) References properly used in introduction
- _______ (1) Hole in the literature defined
- _______ (2) Hypotheses stated
- _______ (2) Methods organization consistent with rest of paper
- _______ (4) Methods detailed
- _______ (1) Statistics defined
- _______ (2) Results organization consistent with rest of paper
- _______ (4) Results clearly described with reference to statistics and figures/tables
- _______ (1) No interpretative statements
- _______ (2) Discussion organization consistent with rest of paper
- _______ (2) Introductory paragraph summarizes hypotheses and results
- _______ (6) Results discussed in depth
- _______ (2) Comparisons to published literature present for all results
- _______ (2) References properly used in Discussion
- _______ (1) Future directions/speculations included
- _______ (4) Literature cited is present and properly formatted
- _______ (4) Figure legends/table captions are present and complete
- _______ (2) Figures are present and are cited within the text
- _______ (8) Graphs have completely labeled axes with units, significance indicators, are formatted properly for the type of data presented &/or Tables are organized logically, completely labeled, informative.
Grading Rubric for Bio 490 Group Research Presentation

Total:  /40 points

Overall organization, General details:
•   _______ (4) All sections of presentation present
•   _______ (2) Spelling and grammar on slides correct
•   _______ (2) Stayed within 10 minute limit
•   _______ (2) Correct scientific grammar, including italicized species names, plural verbs paired with ‘data’.
•   _______ (2) Introduction organization starts broadly, ends with specifics
•   _______ (1) Hole in the literature defined
•   _______ (2) Hypotheses stated
•   _______ (1) Methods organization consistent with rest of talk
•   _______ (4) Methods concisely presented, taking no more than 3 minutes (2 better)
•   _______ (1) Results organization consistent with rest of talk
•   _______ (4) Results clearly described with reference to statistics and figures
•   _______ (1) No interpretative statements
•   _______ (5) Graphs have completely labeled axes with units, significance indicators, are formatted properly for the type of data presented.
•   _______ (2) Students orient audience to the graphs
•   _______ (1) Discussion organization consistent with rest of talk
•   _______ (3) Results discussed (not just summarized) in depth
•   _______ (2) Comparisons to published literature present for all results
•   _______ (1) Future directions/speculations included