

## **IPESL Final Report Outline:**

### 1. Title of Project and name of participant(s)

Developing, Implementing, and Assessing New Critical Thinking Curricula for Biology 105W, Introduction to Biology I

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### 2. Purpose: Identify the purpose of your project (one to two sentences). If your work changed in any way from the original proposal – please note.

The goals of this project are to 1) engage students in critical thinking during lecture and lab, 2) develop new curriculum products emphasizing critical thinking (new lectures, labs and assessments), and 3) disseminate critical thinking teaching strategies within the biology department, via the IPESL website, and at a professional conference. This project will affect approximately 500 BIOL 105W students per academic year.

### 3. Results: Describe how your project enhanced\* (or will enhance - if project results are to be implemented in future semesters) students' critical thinking through one or more of the following activities:

- development, implementation, and assessment of new instructional or curriculum materials
- development, implementation, and assessment of new support mechanisms
- development and implementation of new assessments

This project will enhance students' critical thinking skills through the development, implementation, and assessment of new instructional or curriculum materials during Fall 2007 and beyond. These labs and lectures will be taught and assessed during Fall 2007.

Ten BIOL 105W lectures have been redesigned to include critical thinking during lecture.

1. Students will answer three to five “quiz” questions during these lectures after reading experiment cases as homework. The questions ask students to think critically by doing activities such as analyzing experimental design, applying concepts and definitions, or analyzing experimental results. These lectures will actively engage students in critical thinking during lecture and move the course away from predominantly asking students to memorize information.
2. Students will compare a popular media “science” article to primary scientific literature, comparing the writing format, the styles employed and the demonstrated use of the scientific method.
3. Students will work in small groups to complete genetic problems. Group responses will be shared with the entire class body. Genetic problems include pedigree analysis, Mendelian genetics and probability.

4. Students will be required to utilize a writing manual which highlights the technical style of scientific writing. Students will critique “poor” scientific writing, applying key concepts from the manual.
5. Students will work in small groups to complete molecular biology problems including anticipated DNA replication, transcription and translation products. Group responses will be shared with the entire class body.
6. The content of BIOL105 was changed, eliminating organ and organ systems, and adopting gene regulation and developmental biology. Changing the course content has streamlined the approach of the class, building the course material from small molecules, macromolecules, cells, metabolism, genetics, molecular biology and finally the processes leading the organization of complex organisms. This order of course material is a logical progression of complexity that is more amenable to critical evaluation.

Several labs have been modified, eliminated, or added to emphasize critical thinking in lab.

1. To reflect the changes to BIOL105 lecture, two labs have been eliminated: dissection of the fetal pig I and II. One lab was modified, Gas Exchange in Goldfish, requiring students to identify a variable, formulate a hypothesis and prediction based upon manipulation of the variable, design an experiment using appropriate controls, collect and interpret the data and draw conclusions. In addition, a second BIOL 105 lab, DNA fingerprinting, was developed which requires students to think critically about molecular biology techniques and concepts.
2. In addition several other labs have been revised to prepare students to conduct their own experiments and to teach both the scientific writing process and statistical analysis with more clarity and depth. Each of the new or revised labs will change the way the labs are taught. As previously taught, students verify biological concepts using “canned” experiments already completely developed in their laboratory manuals.

During Fall 2007, the effect of the new curricula and teaching of it will be assessed via pre- and post-tests, student course evaluations and a professor survey. Student critical thinking gains will be measured comparing students scores on the first lecture “quiz” and the last lecture “quiz” or several final exam items, which will both ask parallel questions about scientific method using parallel experiment cases. Student critical thinking gains will also be measured using an experimental write-up rubric to grade their first and last experimental write ups during the semester. Students will also complete course evaluations asking them how much critical thinking they learned during the course.

During Spring 2008, professors teaching courses with students who took Biology 106 during Fall 2007 will be surveyed about these students’ critical thinking skills compared to those of past students and/or students who did not take Biology 106 during Fall 2007.

#### 4. Issues: What issues or challenges arose during project implementation/completion? How were they addressed?

During the project, the issue of students’ scientific writing and statistical analysis skills arose. Because students need to develop these skills more than they have in the past in order to think critically about the scientific method, BIOL 105W and 106 instructors

worked together to create a uniform writing rubric, adopt a common writing manual as a class text, and teach statistics in a coherent way that builds from one course to the next.

Another challenge that arose during the project was that of fitting critical thinking into the already unmanageable curriculum. BIOL 105W and 106 instructors worked together to analyze all learning outcomes for both courses and reorganize what content was taught in each course. In addition, a few areas such as development, were missing from the course sequence and needed to be added while others, such as physiology, needed to be taught within the biological diversity unit.

Finally, the text used with the courses did not focus sufficiently on critical thinking. Course instructors selected a new text which has an experimental and critical thinking emphasis.

5. Dissemination: How did you (or do you plan to) disseminate your project and/or its results? (e.g., published article, department colloquium, professional conference, meeting, college colloquium, university-wide colloquium, publication, IPESL website).

Results will be disseminated by posting our project description and results on the IPESL website and by submitting a presentation proposal of this project and its results to a professional conference hosted by the Association of Biology Laboratory Educators, the National Biology Teachers' Association, or the National Science Teachers' Association. Successful curriculum elements from this project will also be implemented in higher level courses taught by the BIOL 105W/106 instructors.