

## **IPESL Final Report Outline:**

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

Developing, Implementing, and Assessing New Critical Thinking Curricula for Biology 106, Introduction to Biology II

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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 ~220 BIOL 106 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 106 lectures have been redesigned to include critical thinking during lecture. 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.

Four, rather than two, new labs have been developed which require students to think critically about concepts and the scientific method ("Bacteria and Protista," "Fungi," "Invertebrates," and "Vertebrates"). 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 or passively look at demonstrations, preserved materials, and slides, drawing what they see in their notebooks. The new and revised labs require students to think critically about biological concepts and the scientific method. Students must develop appropriate scientific questions and hypotheses, design their own experiments to investigate a biological concept, analyze experimental designs, and/or analyze their data. The demonstrations, slides, and preserved materials of organisms will still be viewed, but for each group of organisms, students will now also investigate the organisms' diversity, form, and/or function in a student-designed experiment. For example, after observing the vertebrate group, students will design and experiment to contrast vertebrates' different strategies for thermoregulation.

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. Some course topics did not fit with overall course goals and were removed from the course sequence.

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.