PROGRAM INFORMATION

Date submitted: __March 15, 2011________________

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<tr>
<th>Degree Program(s):</th>
<th>Baccalaureate (B.A./B.S.)</th>
<th>Department:</th>
<th>Biological Sciences</th>
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Note: Schedule is posted at: http://www.sjsu.edu/ugs/programplanning/

ARCHIVAL INFORMATION

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Assessment schedule is posted at http://www.sjsu.edu/ugs/assessment
Please send any changes to the schedule or to student learning outcomes to Jackie Snell jacqueline.snell@sjsu.edu

SLO2: Students will demonstrate knowledge and comprehension of basic concepts in biology across all biology programs.

Initial Evidence of Student Learning: We have used the Biology Major Field Test (MFT) since the Spring 2008 semester to assess students’ comprehension and understanding of biology concepts. The MFT is used as a cumulative type of assessment. The instrument is given in Bio 144, on the last semester prior to graduation. The Biology MFT is a validated, nationally recognized instrument that is administered by the Educational Testing Service (ETS). It includes four Biology sub-fields: (1) Cell Biology, (2) Molecular Biology & Genetics, (3) Organismal Biology, and (4) Population Biology, Evolution & Ecology. The Biology MFT overall scores are reported in a 120-200 scale. The sub-fields are scored between 20-100. Since 2008, 223 of our graduating seniors have taken the Biology MFT. ETS reports scores from students who have answered 50% of the questions in the MFT. Data collected from students’ MFTs are compared to all of the undergraduate students who have taken the exam nationally since 2005 (40,000 students). Figures 1 and 2 show comparative results for the overall Biology and sub-field scores, respectively (2008-2010). Our analysis indicates that 10% of our students ranked in the top 5-20% of all of the students who have taken the MFT nationally since 2005, while 11% ranked in the top 25-40% (Fig. 1). Twenty-four percent ranked in the bottom 35-55%, and 54% ranked in the bottom 1-30% of students who have taken the exam nationally since 2005.
Fig. 1. *Overall Biology Score.* SJSU Biology students’ scores were compared to national scores.

![Overall Biology Score](image1.png)

Fig. 2. *Biology Sub-Field Scores for SJSU Biology Students, 2008-2010.*

The sub-field scores indicate that some of our students have different learning gains when the data are separated by subfields (Fig. 2). Thus, in Cell Biology 8%, 13% in Molecular Biology & Genetics, 13% in Organismal Biology, and 9% in Population Biology, Ecology, & Evolution ranked in the top 5-20%, respectively. In the second higher ranked group, 16% in Cell Biology, 9% in Molecular Biology & Genetics, 15% in Organismal Biology, and 13% in Population Biology, Ecology, & Evolution ranked in the top 25-40%, respectively. However, approximately 70% of our students ranked at or below 55% in all subfields.
Change(s) to Curriculum or Pedagogy:
Two types of curricular changes have been implemented. We changed our curriculum at the introductory level and are developing upper division courses to deal with the low scoring of a large number of our students. We piloted our freshman biology core sequence with 40 students in the 2009-2010 academic year. Currently, we are implementing the core sequence with the entire freshman class (193 students). This narrative describes our objectives, progress, and assessment of the freshman biology core sequence.

What is the objective of this activity?
Two sets of objectives (dealing with success and pedagogy) were used to guide our curriculum implementation. Success objectives include: (a) reduce the failure rate for students enrolled in the new core, (b) increase retention of students in biology beyond the first year, and (c) improve preparation of students for conceptual learning in upper division courses. The following five pedagogical objectives were used: (a) students will be able to formulate hypotheses and design experimental approaches to answer scientific questions, (b) students will be able to use quantitative analysis to understand complex scientific concepts, (c) students will be able to work effectively in groups to solve problems, (d) students will be able to use multiple approaches to answer complex questions, and (e) students will be able to construct logical conclusions based on the different types of data they collect.

What has been your progress in achieving these objectives during the past xc year?
Success objectives will be measured in the coming two-three years since this will require evaluation of student records long-term. However, all of the pedagogical objectives were met in the implementation of the new core sequence. Over the full year of the new Biology core (Bio 1A and 1B), students developed a research project, collected and analyzed their data, wrote a culminating report, and presented a poster describing their project. A new workshop component was implemented to increase quantitative, writing, and inquiry skills. All skills needed to complete their project were covered in the workshop and lab sections. Bio 1A, Foundations of Biodiversity (Bio96A in the pilot course) and 1B, Foundations of Cell Biology & Physiology (Bio96B in the pilot course) consist of two lectures (3 hrs), one workshop activity (2 hrs) and one laboratory (3 hrs) meeting per week, each. During the lectures, students were introduced to major concepts, focused around a series of sub-themes. During workshops, students worked in groups on skill building and problem-solving. Workshop activities reinforced lecture concepts, and also lead to the development of skills that were needed for the lab. In the labs, students were given the opportunity to explore topics in depth through a variety of integrated field- and bench-based research activities. A progression of laboratory activities was used as a strategy to develop inquiry. The beginning laboratory activities were prescribed and aimed at building skills. These were followed by guided inquiry activities, where students choose the hypotheses to be tested and some of the experimental design. Finally, the second semester culminated in a five-week research project that combined DNA analysis and traditional field sampling to answer biodiversity research questions.

What is the evidence on which you base your conclusion about your progress?
Different types of assessments were used. These included: (1) pre/post content assessments, (2) a SALG (Students Assessment of their Learning Gains) instrument to examine students’ attitudes regarding their own experience, (3) evaluation of videotaped research project presentations, and (4) interviews with students, TAs, and course instructors. We developed
rubrics for research projects, research papers, poster, Power Point, and oral presentations. We developed content pre/post assessments for the new course.

**Evidence of Student Learning after Change.**
We will assess long-term student learning outcomes with the MFT. Those students who were enrolled in the new freshman core sequence will take the MFT in 3-4 years (Fall or Spring 2014-2015). However, we developed content assessment instruments for our Biology freshman core. These were given during the first week (pre) and last week of instruction (post).

**-Content Assessment Gains:**
The pre- and post-assessments were given to the students who enrolled in the pilot core (Bio 96A-96B) and students that were enrolled in the traditional, three semesters core (Bio1, 2, 3). The following is an excerpt from the outside’s evaluator annual report.

“In the first semester of the new core, Bio96A (fall 2009), statistical analyses indicate significant gains in three areas: developmental biology, phylogenetics, and plant evolution (Fig.1). Students made additional advances in areas of genetics, ecology, anatomy, taxonomy, and population genetics.

**FIGURE 1 - BIO 96A Pre-/Post Composite Data**

![Graph showing pre-post composite data for Bio 96A](image)

Data collected during spring 2010 indicate statistically significant gains in areas of protein function, energetics, electrophoresis, and translation (Fig. 2). Students made other notable gains in the study of enzymes, cellular and membrane structures, glycolysis, and meiosis/mitosis.” (Everhart, J. 2010 outside evaluator report)

Significant gains in understanding by Bio 96A-B students are directly related to concepts that were reinforced in the workshop/activity portion of the new core sequence. In some cases reinforcement was provided by quantitative problems or by students producing models of biological concepts. These include: selection, genetics, plant evolution (Fig. 3); phylogenetics, genetics, anatomy, taxonomy, ecology (Fig. 4); glycolysis, cancer, transcription, and translation (Fig. 5). Lesser gains are apparent in use of the scientific method, ecology, and plant structure and function (Fig. 3). However, in other content areas students taking traditional courses
performed better than students enrolled in the new core sequence. “This can be likely attributable to reform faculty's decision to defer some content to upper division courses.” (Everhart, J. 2010 outside evaluator report)

**FIGURE 2 - BIO 96B Pre-/Post Composite Data**

**FIGURE 3 - COMPARATIVE DATA BIO1 and BIO 96A by Scientific Concept**
FIGURE 4 - COMPARATIVE DATA BIO2 and BIO96A by Scientific Concept

FIGURE 5 - COMPARATIVE DATA BIO 3 and BIO96B by Scientific Concept

The following are excerpts from the outside’s evaluator annual report.

**SA LG Data:**
“The curriculum reform activities were punctuated with the recurring theme that these processes are what scientists do. The course exit survey showed student-reported gains in their ability to identify patterns, recognize/develop a sound argument and appropriate use of data, develop documents in discipline appropriate formats, and work effectively with others (Table 2).
More than half of survey respondents reported gains in **enthusiasm, interest in taking additional biology courses, personal confidence, confidence in working with complex ideas, and willingness to seek help on academic problems.** No trends were apparent in the data showing marked declines in attitudes though a few outliers voiced strong negative opinions about instructors and their instructional strategies; approximately 15% of respondents report no change or gains in attitudes as a consequence of taking BIO 96 A & B.” (Everhart, J. 2010 outside evaluator report)

**Interviews:**

“The external evaluator conducted interviews of exiting BIO96 B students one week after oral presentations of their posters - the culminating assignment in the course laboratory. Without exception, student interviewees cited the poster session as their most memorable and most important part of the laboratory. Students characterized the lab's poster assignment as "difficult", but students recounted the experience in positive terms and shared that the experience helped in their overall understanding of scientific research. Forty-five percent of survey respondents were pleased with the assignment and in an interview a student said: "I didn't think I could do something like this" and followed that he was "proud" of his poster. Other comments by students include, "I learned that a problem will be solved a lot more precisely and timely if there is a process of research, and a logical, more reasonable argument will be produced."

At the onset of the assignment students admitted that they were "unsure" of the connection between the DNA lab-based analysis and the field-based plant population study. Students reported that they had never considered possible connections and were "surprised" at a research model that employed statistical analyses to support or complement data collected in the field. At the beginning of the inquiry lab, students saw little connection between genetics and environmental research, yet, all student posters clearly reflected relationships made between DNA analysis and population studies conducted in a meadow and sloping area outside San José. Posters contained graphs representing numbers of specific types of plants found along a transect in a meadow and on a hillside; they also included flow charts showing relationships of surveyed plants based on shared genetic material. Based on their research, students' conclusions reflected their understanding of genetics as well as field-based, data-driven observations about richness and diversity of plants.

Most students expressed improved confidence in dealing with science content and processes. Scientific concepts formulated in high school (after BIO96 A & B) appeared incomplete and naive. One student stated: “I don't know everything. This is what the class taught me. My attitude has changed from arrogance to humility. There is a lot in the world I do not know, but from my experience in this class, anything can be learned. I enjoy biology a lot more after taking this class. There is so much complexity in the world, so many biological mechanisms.
and forces at work in our life, one would be a fool not to find interest in it.” In similar fashion, another student appreciated biology more as a result of the class -- not because the courses were easy, but because they were difficult. She/he stated, "The course has really changed my attitude toward the subject because there is a lot more than I imagined. You really have to understand the concepts."

BIO96 A & B's expectation for collaboration and teamwork may be the most obvious skills-related innovation. Opportunities for students to communicate are apparent in workshops and laboratories. Students cited numerous informal and formal venues where they worked collectively on assignments.

Students appeared to change their study habits as a natural extension of the new course design. Outside class, students formed study groups to prepare for tests and complete other assignments. So effective were study groups that BIO96 students suggest that instructors build them into the course syllabi and schedules

-Video Analysis:
In videos of the group presentations of their poster sessions (laboratory final project), students displayed command of scientific terminology and scientific processes (linked to the scientific method). Students were well-versed in the scientific method always stating the question, hypothesis, methodology, resisting forming conclusions without data, and stating outcomes. They employed science process skills citing problems in the procedure (evaluation), supporting conclusions using lab results and field data (synthesis), and developed tables and graphs showing specific elements of their research (analysis). Responses to spontaneous questions during the formal presentation indicated a high degree of scientific fluency (comprehension). Descriptions of their research were factual and well reasoned. When gaps of understanding became apparent in student presentations, professors used probing questions that either helped guide students to conclusions or revealed the depth of comprehension on specific aspects of the investigation. Consistent with data from student exit surveys, instructors never told students answers to questions.” (Everhart, J. 2010 outside evaluator report)