Department of Biology

Report: PRAC Assessment Grant

Assessment of Domain Knowledge Based Student Learning Outcomes (SLOs) in Biology for Curriculum Enhancement

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Project Summary

The purpose of this project is to use the Major Field Test (MFT) by ETS to evaluate the students' achievement of the SLOs at the conclusion of their senior year. Data gathered for the cohort will be analyzed for areas of strengths and weaknesses, as well as general patterns of performance. Once these areas are identified, work on curricular enhancement can progress to better prepare our students for post graduation endeavors.

Student learning outcomes (SLOs) have been set as a foundation for producing high-quality, well rounded students, as they describe the knowledge, skills, abilities, or attitudes that a student can demonstrate upon completion of his or her program of study (Suskie, 2004; Palomba and Banta, 1999). Student Learning Outcomes statements specify actions that are observable, measurable, and capable of being demonstrated by the student, and typically begin with action verbs. In the department of Biology, eight SLOs are stated that reflect the ideal learning experience acquired by a B.S. or B.A. student. These statements represent the knowledge and skills students should have acquired during the completion of their degree. SLOs can also serve as an evaluation metric for curricular competencies and deficiencies. The Biology Major Field Test is an ideal tool to measure all of the domain knowledge based SLOs defined by the Biology Department.

SLO #1

Demonstrate knowledge of how biological molecules such as DNA, RNA, proteins, lipids, and carbohydrates contribute to the structure and function of prokaryotic and eukaryotic cells.

Around 41% of the MFT falls into either the subcategory Cell Biology or Molecular Biology & Genetics. Tested areas include biochemistry and cell energetics; cellular structure, organization, and function; molecular genetics; and heredity. Questions in these categories allow for assessment of students' understanding of biological molecules that compose organisms. They also will have the opportunity to demonstrate their knowledge of how structure and function of biomolecules affect both prokaryotic and eukaryotic cells.

SLO #2

Integrate the cellular, molecular and physiological basis of how organisms develop structure, carry out functions, sense and control their environment, and respond to external change.

Organismal biology represents 33% of the material covered on the MFT. Diversity of organisms; comparative structure and function of organ systems; and reproduction, growth, and development are represented in this section.

SLO 3) Describe how genetic principles associated with natural selection contribute to the functioning of an organism and the evolutionary diversity of life on earth.

Population biology, evolution, and ecology account for 26% of the knowledge base being tested on the MFT. This section tests students on principles such as population genetics and natural selection, patterns of evolution, environmental impacts, and population ecology.

SLO #4
Exhibit problem solving and critical thinking skills needed to design and implement laboratory projects, and gather, analyze and draw conclusions from data.
AND
SLO #5
Apply basic principles of chemistry, math, and other disciplines to the functioning of living systems.
SLO's 4 and 5 are encompassed by questions posed in the analytical skills subcategory. Throughout the test, questions are posed to challenge students' analytical skills. ETS further defines this subcategory into three units, "Science as a Way of Knowing; Experimental Design; and Interpretation, Data Analysis, Inductive Reasoning, and Drawing Conclusions from Data." This section challenges students' critical thinking skills essential to the field of science. Students demonstrate their knowledge of hypothesis testing, experimental parameters, and their ability to analyze results through probability, statistics, and interpretation.

The MTF subscores and assessment indicators will allow for identification of concepts that are missing in the core. These findings, along with comparison to the core curriculum of peer institutes, will lead to the refinement of the Biology B.S. and B.A. degrees. With fine grain assessment and qualitative improvement, IUPUI will lead the way with a top-notch Biology program.
The current program of study for a Biology major is as follows:

- The current biology core consists of Concepts of Biology I and II, Genetics and Molecular Biology, and Principles of Ecology and Evolution.
- No defined sequence is required for the core, except Concepts of Biology I and II being prerequisites.
- Five Required Lectures: Genetics and Molecular Biology, Principles of Ecology, Embryology, Comparative Animal Physiology, Global Change Biology, Cell Biology, Microbiology, Immunology, Biological Chemistry, Cellular Biochemistry
- Three Required Labs BA Four Required Labs BS: Embryology, Genetics, Cell Biology, Immunology, Ecology, Microbiology

Project Outcomes

Sixteen students volunteered to participate in testing. On average, students placed in the 54th percentile for Cell Biology, 57th percentile for Molecular and Genetics, 54th percentile for Organismal Biology, and 44th percentile for Population Biology, Evolution, and Ecology. Each subject area of the MFT was correlated back to course offerings in the Department of Biology, along with if they are essential required courses.
Cell Biology:

- K324 Cell Biology (Not Required)
- K325 Cell Biology Lab (Not Required)
- K483 Biological Chemistry (Not Required)

- K484 Cellular Biochemistry (Not Required)
- K356 Microbiology (Not Required)
- K357 Microbiology Lab (Not Required)

Molecular Biology and Genetics:
- K322 Genetics and Molecular Biology (Required)
- K323 Genetics and Molecular Biology Lab (Not Required)
- K338 Immunology (Not Required)
- K339 Immunology Lab (Not Required)

Organismal Biology:
- K331 Embryology (Not Required)
- K332 Embryology Lab (Not Required)
- K350 Comparative Animal Physiology (Not Required)

Population Biology, Evolution, and Ecology:
- K341 Principles of Ecology and Evolution (Required)
- K342 Principles of Ecology and Evolution Lab (Not Required)
- K411 Global Change in Biology (Not Required)

Although the sample size was very small, due to lack of incentive for students to participate, a vast amount of valuable information was gained. Our students are performing with a wide distribution of scores, indicating we have many students that are doing very well, but also a gap of those lagging behind. Due to this, programs have been initiated to reinforce material for students such as, a genetics recitation funded by CI-STEP. The small sample size also indicated that our students were performing below average in Population Biology, Evolution, and Ecology. This reflects the small number of courses we offer in this area. An example modification in this area would be splitting Ecology and Evolution into two separate semester courses. Currently, they are offered in conjunction as a one-semester course. At many peer institutions, these subject areas are taught separately.

The insight gained by this project has lead to further investigation. The Department of Biology has decided to adopt the MFT to test students' knowledge to determine the optimal core for the program. In the 2013-2014 academic year, students who are enrolled in capstone will be highly encouraged by instructors to take the test, as indicated by the course syllabi. Currently, the department is planning to fully adopt the MFT, in collaboration with the IUPUI testing center, as a course requirement for capstone in the next bulletin cycle (Fall 2014). Students will be required to take the test as part of their course. With large, multi-year datasets, the Department of Biology will be able to revamp the biology curriculum to produce well-rounded successful biologists.

References

Palomba, C.A., & Banta, T.W. (1999). Assessment essentials: Planning, implementing, and improving assessment in higher education. San Francisco: Jossey-Bass.

Suskie, L. (2004). Assessing student learning: A common sense guide. Bolton, MA: Anker Publishing Company.