Student Learning in Natural Science with Laboratory courses
Self-Study Assessment Plan

May 5, 2006

I. Goals

In the opinion of the faculty in the Departments of Biology, Chemistry, and Physics, during the completion of a Natural Science with Laboratory course at Millikin University, a student should:

1) Develop an understanding of how to use logic and the scientific method to analyze the natural world and solve problems.

2) Learn about issues in science which are important both personally and globally.

3) Utilize technology in laboratory and field environments in order to connect theories and descriptions found in lectures and textbooks with real-world phenomena.

A student who is able to reach these goals successfully will also be satisfying the core goals expressed in the mission statement of Millikin University. The first and third goals, in particular, will help a student achieve *professional success*, as being able to solve problems and utilize technology are skills necessary in any field. Meeting all three goals will also contribute to a Millikin graduate being a *democratic citizen in a global environment*. Dealing with problems in a global society requires integration of knowledge and strong problem solving skills. Performing informative and interesting experiments is one way scientists interact with the world; therefore, understanding issues in science and the process scientists go through is invaluable in understanding the impact of science-related issues on their lives. The second and third goals are particularly focused on *preparing students for a personal life of meaning and value*. Issues in science affect everyone everyday, and understanding what these issues are will better prepare students to understand how they in particular are affected. Also, being able to connect the theory in texts to the practical applications of science in their lives will help the students be life-long learners and continue to integrate future developments in science into their understanding of the world.

II. Snapshot

The departments of Biology, Chemistry, and Physics at Millikin University will be staffed in Fall 2006 by sixteen full-time faculty, one full time academic staff support person, and a small number of part-time adjuncts (the number is as yet undetermined, but is usually around five). One of the biology faculty (Cynthia Handler) has a half-time position in the department; the remaining half of her load is as the pre-professional advisor. The departments are housed in the Leighty-Tabor Science Center (LTSC), which opened in 2002, and provides an excellent facility for the teaching of science. Full-time faculty generally teach a wide range of courses, including service courses which are primarily aimed at a general audience, service courses aimed at a particular audience (such as courses for Nursing majors), and courses for science majors. Adjuncts primarily serve as laboratory instructors. The smallest science courses will have just a handful of students; these are usually required upper-level courses. The largest will have upwards of 60 students, including Anatomy and Physiology, Organic Chemistry, and Introductory Astronomy courses. Lab courses are capped at no more than 24.

The natural science departments are currently undergoing some exciting changes. In the last 3 years, the physics department has gone from one temporary full-time faculty member to two tenure-track faculty (including one who will start as of August 1), and has undergone a complete curricular revision. The chemistry department has hired a new faculty member, also starting August 1. The biology department hired two new faculty this past year, and is looking forward to even more changes (due to retirement) in the next few years. At the request of VPAA Comstock, the natural science departments underwent a review by an external consultant, and expect a report on the review shortly, at which point, it is expected that

additional changes and improvements to curriculum, workload, and departmental structure will be considered.

Courses taught this summer and fall which will include students satisfying their MPSL Natural Science with Lab requirement are:

Summer:
BI 220 01 - Field Ecology - Judith Parrish
BI 280 01 - Ecol Journey: Alaska Ecology - Judith Parrish

Fall:
BI 102 01 - Biochemistry of Food - Samuel Galewsky
BI 102 02 - Current Issues - Roslyn J. O'Conner
BI 102 03 - Physiology of Space - Harold L. Wilkinson
BI 102 04 - Human Genetics - Terry C. Matthews
BI 102 05 - Microbes & Humans - Thomas E. McQuistion
BI 105 02 - Ecology & Evolution - Marianne Robertson
BI 105 03 - Ecology & Evolution - Judith Parrish
BI 130 01 - Environmental Biology - David J. Horn

CH 121 01 - General Chemistry - Edward Acheson
CH 121 02 - General Chemistry - Paris Barnes
CH 121 04/05 - General Chem BLK - Clarence M. Josefson

PY 101 01 - Stars and Galaxies - Casey Watson
PY 111 01 - College Physics I - Eric C. Martell
PY 151 01 - University Physics I - Casey Watson

III. Learning Story

There are three main groups of students who take natural science courses at Millikin: 1) Natural Science majors, who take a dozen or more science courses, 2) students majoring in fields like Nursing or Exercise Science, who don't take quite as many science courses but still a sizable number, and 3) students who take one (or sometimes two) science courses to fulfill graduation requirements. The first group of students generally has a different set of learning goals – specifically, the goals for learning within the major. However, while some of the above courses (BI 102, PY 101) have students from the third group as their primary audience, other courses (CH 121, PY 151, for example) have very diverse audiences. These latter courses must be carefully constructed such that majors get a strong introduction to the field at the same time as non-majors or general education students satisfy the learning goals from section I.

Because of the variety of courses students can take to fulfill this requirement, there is no single story which best describes the experiences a student gets in a first Natural Science with Lab course. There are some commonalities which all students will experience, such as a full-time faculty or staff member as an instructor and extensive hands-on laboratory experiences (between 24 and 45 hours in the lab, depending on the course), but the ways in which a student can achieve the stated learning goals are as varied as the different courses they can choose to take. A student in the block Gen Chem course will have an intense experience in which lab and lecture are integrated, and they are tested every day to ensure that they keep pace with the material. A student in Ecology and Evolution will study some of the most controversial topics facing our society and may develop projects which require them to interact with the Decatur community and deal with issues such as conservation and recycling. A student in Stars and Galaxies will become an expert at setting up, taking down, and maintaining a telescope, and learn what it is about the night sky that has captivated mankind for millennia. Students in all courses will be exposed to time-honored and trusted teaching methods as well as research-based pedagogical techniques that are on the cutting edge of teaching and learning in the field.

IV. Assessment Methods

During the Fall 2006 semester, each faculty member teaching a course which satisfies the MPSL Natural Science with Lab requirement will collect a group (generally between 4-6) of artifacts for each of the three goals. The individual faculty will include a rubric or grading scale to indicate how successful each student was at achieving the stated goal. For some courses, faculty will collect a sufficiently complex single artifact which will be used for all three goals; for others, three separate artifacts will be collected.

The types of artifacts that will be collected include:

- Exam questions measuring student understanding of scientific issues.
- Laboratory reports demonstrating student experience with technology and applications of that technology to research.
- Written or oral reports requiring students to explain uses of technology or the practice of science or to reflect on issues in science which are relevant to them and to the world at large.
- Term projects which include components related to all three learning goals.

There is no expectation that faculty will choose artifacts from successful or unsuccessful students in particular, rather, faculty will choose a sampling which reflects the range and quality of student learning occurring in the course.

V. Assessment Data

There is no data for any of the goals at this point.

VI. Analysis

Goal 1 – Blank

Goal 2 – Blank

Goal 3 – Blank

Since there is no data gathered at this point, no analysis is possible.

VII. Plans

While the individual departments involved have a history of doing internal analyses and making changes as necessary in order to focus on issues related to student learning, there is no obvious history of interdepartmental collaboration to address the more general learning goals which have been developed as part of this study. Heretofore, the assumption has largely been that chemists know how to teach introductory chemistry, and what the goals of that course should be, physicists know how to teach astronomy, and what the goals of that course should be, and so on. Fortunately, there exists a strong bond of collegiality and camaraderie between the three departments, so a process whereby the artifacts and data required to complete the analysis outlined in this self-study is being developed. The complicating factor is the sheer number of different faculty involved in these courses, some who are just beginning their career and thus perhaps unfamiliar with such studies, and some who are more experienced and perhaps somewhat resistant to additional external analyses of their courses. In an effort to keep the year-to-year analysis and self-study both manageable and informative, the following plan has been developed:

1) As mentioned above, in Fall 2006, faculty from each of the courses which satisfy the MPSL requirement will collect a number of artifacts which address each of the three learning goals and compile them with a grading scale or rubric indicating the level of success students are having with meeting the learning goals.

2) These materials will be discussed both at the departmental level as well as in a broader discussion across the sciences, in order to highlight particularly successful methodologies, provide an environment in which newer faculty are indoctrinated into a culture of assessment and reflection, and to open a discussion about what it means to "teach science," especially to a general audience.

3) In succeeding years, a subset of courses will be chosen for study, such that each course will be studied at least once every three years. This will reduce the burden of data gathering and artifact storage, as well as provide faculty time to reflect on the group analysis, try new things, and evaluate them within the course before the course is re-analyzed.

Appendix I – Executive Summary

The departments of Biology, Chemistry, and Physics have developed the following learning goals for students taking a course which satisfies the MPSL Natural Science with Lab non-sequential requirement:

1) (Students will…) Develop an understanding of how to use logic and the scientific method to analyze the natural world and solve problems.

2) Learn about issues in science which are important both personally and globally.

3) Utilize technology in laboratory and field environments in order to connect theories and descriptions found in lectures and textbooks with real-world phenomena.

The courses which students take to satisfy these learning goals come from all three departments and are taught by a substantial majority of the faculty in each department. As a result, the learning experiences of students may vary widely in the process of their study of science.

These learning goals were developed during the 2005-2006 academic year, and have only recently been adopted by the science faculty as a whole. Therefore, no data has yet been collected or analyzed in order to measure student learning. However, a process has been developed which will begin in the fall 2006 semester.

Each year, faculty will gather an assortment of artifacts from their courses which measure student learning with respect to the above goals, along with a rubric which describes how the learning has been assessed. These artifacts will be studied individually, departmentally, and within the science departments as a whole in order to better understand how faculty collectively work to help students achieve learning goals. Faculty will then be given time to reflect on feedback and make changes before they are assessed again. For the purposes of this self-study and re-accreditation, the first year (2006-2007), each course taught in the fall will be studied; after that, a subset of courses will be chosen for analysis.