**College of Science and Mathematics**
**B.A. Natural Sciences**
**Student Outcomes Assessment Plan**

Mission Statement

The Bachelor of Arts degree in Natural Sciences serves as a subject matter preparation program for the single subject teaching credential in science although students planning on other professional goals can be admitted to the program. The program strives to provide preparation that stresses the importance of subject matter knowledge. Students completing the BA in Natural Sciences must complete breadth requirements in all of the sciences and depth requirements in a specific science discipline.

The BA Natural Sciences degree program has as its mission the preparation of science teachers who have a broad understanding of science as a way of thinking, as a tool for solving daily life problems and learning about the world around us. The program seeks to foster an understanding that all the sciences interface and are not isolated, compartmentalized areas totally unrelated to one another. The program further seeks to provide students with an opportunity to investigate, first hand, the phenomena of nature and to field test effective strategies for sharing this experience with others.

Common Goals for All Options

1.) Students will pursue academic preparation that leads to broad fundamental understanding of key scientific concepts within all of the major scientific disciplines as well as a depth of understanding within one specific science discipline

2.) Students will be able to think critically and to sharpen their analytical skills as scientifically literate individuals

3.) Students will become familiar with scientific methodology as well as with the basic tenets of science.

4.) Students will develop an appreciation for and understanding of how the various science disciplines interface in the real world and will be able to provide effective strategies for explaining and communicating these relationships.

Assessment Methods: Since all BA Natural Science majors in all options are required to take *Natural Science 106* as a culminating course whereby they demonstrate scientific literacy, this course will be used a basis for assessment common to all options. Natural Science 106 requires all students to make two seminar presentations. These seminar presentations are expected to be highly professional and follow guidelines for presentations common to scientific societies. Students present on topics in such a way as to reveal a depth of understanding of the underlying principles of science and scientific investigation. Topics deal with science versus pseudo-science, science versus technology, impact of society on science and science on society over the ages. Ethics in science and scientific research are also included in the menu of presentation topic areas. Students reflect on their presentations in a journal that is reviewed by the instructor. Also, other students react and comment on the seminar in a similar format. As a means of assessing scientific literacy and in order to evaluate quality of these professional-like presentations, selected science faculty from each of the disciplines will be invited to the seminar sessions and provide feedback. The instructor will also evaluate all components of the seminar requirement as part of the assessment process. Numerous readings and related journal entries associated with the readings are required. These curriculum artifacts along with a final exam designed to measure scientific literacy will be reviewed for all majors. A scientific literacy rubric will be created and used to score student performance. In addition, a "Science Understanding, Knowledge Attitude Survey " is administered during this class. The survey is designed to collect information from students concerning their perception of the nature of scientific research and the scientific enterprise. Survey themes (each theme includes 5 survey questions) are as follows:

Theme I: *Scientific knowledge is built through a complex process that relies, in part, on observations of nature.*
Theme II: *Scientific hypotheses and theories may be modified over time.*
Theme III: *Accepted hypotheses and theories are well-supported, reliable scientific explanations-not wild guesses*
Theme IV: *Hypotheses and theories are both scientific explanations, but they differ in their breadth*
Theme V: *The process of science is influenced by social and cultural factors.*
Theme VI: *The scientific community plays an important role in the progress of science*
Theme VII: *Science and society are intertwined.*
Theme VIII: *Science relies on imagination and creativity, as well as logic and objectivity.*
Theme IX: *The process of science is non-linear, complex, and contingent.*
Theme X: *Science is an ongoing process.*
Theme XI: *Scientific testing is central to science, but can occur in many different ways. One idea is often tested in multiple ways.*
Theme XII: *Scientific testing involves comparing evidence to figure out which explanation is the most accurate.*
Theme XIII: *Limits of science items*
Attitudes: *Attitude Items*
Evolution: *Acceptance of evolution questions*
Religiosity: (optional)

In addition to the above common assessments, beginning in the spring semester of 2011, all B.A. Natural Science majors will be expected to take the California Subject Examination for Teachers (CSET) in both general sciences (CSET 118 & CSET 119), in addition to the CSET in the subject concentration (i.e. physics, biology etc). The score report provides information about student performance for each subtest taken. If a student does not pass one of the CSET subtests, the score report will include diagnostic information for each subtest taken to provide you with information about your areas of strength and weakness in each subtest section. We will collect this information from students and make the results anonymous. Feedback on areas in which students tend to be weak in either the general sciences component and/or the subject specific area will be collected and will serve to inform the degree program concerning areas that perhaps need to be improved or revised to increase student understanding. Finally, an Alumni Survey will be administered periodically to collection perceptions of the degree program from its alumni. The idea is to use the results to inform the program in an effort to improve where/if necessary.

## Goals and Objectives for Specific Options

The remainder of the Assessment Plan for the BA in Natural Sciences involves the incorporation of specific option assessment plans approved (or subject to final approval) by the university. It is the expectation of the BA Natural Sciences degree program that each major within his or her option area will meet the same goals and objectives of regular majors within those departments with minor exceptions. It is also expected that each BA Natural Sciences major will be subject to very similar assessment procedures for regular majors within the respective department. The following goals, objectives, and assessment plans are laid down for each option and are accordingly important components of the overall student outcomes assessment process for the BA in Natural Sciences.

*BA Natural Sciences:Chemistry Option:*

**Goals, objectives, and assessment activities**

**Cognitive goal C1. Chemistry majors and BA Natural Science: Chemistry Option majors should have functional knowledge of the analytical, biochemistry, inorganic, organic, and physical areas of chemistry.**

**Objective C1a:** Students completing our programs will be able to master a broad set of factual chemical knowledge concerning the properties of substances, molecules, and atoms appropriate to a chemistry degree program. Such knowledge will be consistent with specifications in the American Chemical Society guidelines for degree programs in chemistry

Outcome Criteria: Students will be able to successfully complete advanced courses in analytical, biochemistry, inorganic, organic, and physical chemistry, and will successfully perform on national standardized assessment tools (e.g. ETS field exam in chemistry)

Assessment Method: Each division within the Department will review final exams in their subject area for appropriate coverage of chemical principles. The same faculty groups will review American Chemical Society standardized tests and develop sets of Departmental expectations for students taking these tests. The Department will then administer these exams and evaluate student performance relative to expectations, and report to the Department.

**Cognitive goal C2. Chemistry majors and BA Natural Science:Chemistry Option majors shall have learned how to think critically and analyze chemical problems.**

**Objective C2a:** Students completing our programs will be able to critically evaluate chemical information.

Outcome Criteria: Students will be able to assimilate chemical information provided and critically evaluate it.

Assessment Method: Selected research and/or lab reports from Chemistry 190 and/or other laboratory classes will be collected and, along with oral/poster presentations, evaluated according to the appropriate scoring rubric.

**Cognitive goal C3. Chemistry majors and BA Natural Science:Chemistry Option majors shall become formal (abstract) thinkers as well as concrete thinkers.**

**Objective C3a:** Students completing our programs will be able to collect, interpret, and evaluate numerical data in the context of basic principles and theories.

Outcome Criteria: Students will be proficient in the collection, interpretation, and evaluation of numerical data. Students will also be proficient in relating these data to basic chemical theories and principles.

Assessment Method: Selected research and/or lab reports from Chemistry 190 and/or other laboratory classes will be collected and, along with oral/poster presentations, evaluated according to the appropriate scoring rubric.

**Objective C3b:** Students completing our programs will be able to solve problems competently using extrapolation, approximation, precision, accuracy, rational estimation, and statistical validity.

Outcome Criteria: Students will demonstrate their ability to solve problems competently using extrapolation, approximation, precision, accuracy, rational estimation, and statistical validity.

Assessment Method: Selected culminating or capstone type experiments and/or Chem 190 reports will be collected and evaluated.

**Cognitive goal C4. Chemistry majors and BA Natural Science:Chemistry Option majors should have the ability to use the power of computers in applications in chemistry**

**Objective C4a:** Students completing our programs will be able to describe the applications of computers and use available software in modeling and simulation of chemical phenomena.

Outcome Criteria: Students completing our programs will be able to describe the applications of computers and use available software in modeling and simulation of chemical phenomena.

Assessment Method: Selected culminating or capstone type experiments, Chem 190, or other lab reports will be collected and evaluated.

**Objective C4b:** Students completing our programs will be able to describe the applications of computers in data acquisition and processing and use available software as a tool in data analysis.

Outcome Criteria: Students will be able to demonstrate the applications of computers in data acquisition and processing and use available software as a tool in data analysis.

Assessment Method: Selected culminating or capstone type experiments, Chem 190, or other lab reports will be collected and evaluated.

Performance/Skill goal P1. Chemistry majors and or BA Natural Science:Chemistry option majors shall have the basic analytical and technical skills to work effectively in a contemporary laboratory environment.

**Objective P1a:** Students completing our programs will be able to perform accurate quantitative measurements.

Outcome Criteria: Students will be able to demonstrate their proficiency in a number of laboratory techniques.

Assessment Method: Selected culminating or capstone type experiments and/or Chem 190 reports will be collected and evaluated.

**Objective P1b:** Students completing our programs will be able to explain in depth the theory and use of contemporary chemical instrumentation, interpret experimental results, perform calculations on these results, and draw reasonable, accurate conclusions.

Outcome Criteria: Students will be able to produce experimental laboratory reports of research quality including sections on Intro, Experimental, and Conclusions.

Assessment Method: Laboratory reports from culminating or capstone type experiments and/or Chemistry190 reports will be evaluated by the Assessment Committee

**Objective P1c:** Students completing our programs will be able to synthesize, separate, and purify, and characterize compounds using published reactions, protocols, standard laboratory equipment, and modern instrumentation.

Outcome Criteria: Students will have practiced and demonstrated proficiency in a variety of synthetic operations.

Assessment Method: Selected culminating or capstone type experiments and/or Chem 190 reports will be collected and evaluated.

**Performance/Skill goal P2. Chemistry majors and BA Natural Science:Chemistry Option majors shall have the ability to make effective use of the library and other information resources in chemistry.**

**Objective P2a:** Students completing our programs will be able to use information technology tools such as the Internet and computer-based literature searches as well as printed literature resources to locate and retrieve scientific information including safety information (MSDS).

Outcome Criteria: Students will have practiced and demonstrated proficiency in their ability to use information technology tools.

Assessment Method: Selected culminating or capstone type experiments, Chem 190 and/or graded literature reports will be collected and evaluated.

**Performance/Skill goal P3. Chemistry majors and BA Natural Science:Chemistry Option majors shall have the ability to communicate effectively in both oral speech and in writing.**

**Objective P3a:** Students completing our programs will be able to explain chemical concepts and results from laboratory experimentation through effective writing and oral communication skills.

Outcome Criteria: Students will be able to demonstrate their ability to communicate chemical concepts both orally and in writing

Assessment Method: Culminating or capstone type experimental reports or Chem 190 reports will be evaluated. Student presentations associated with these reports will be evaluated.

Affective goal A1. Chemistry majors and BA Natural Science:Chemistry Option majors shall have the ability to successfully pursue their career objectives, a related career, a graduate program, or further professional training following graduation.

**Objective A1a:** Students completing our programs will be able to identify current issues of safety, ethics, and society in the use of chemicals and apply ethical principles in their professional careers.

Outcome Criteria: Students will have become aware of current issues relating to chemistry and/or chemical education.

Assessment Method: Chemistry instructors will be surveyed by the Assessment Committee to determine which issues they have discussed in their classes. Alumni will also be surveyed to determine how such exposure to issues has benefited them in their careers.

**Objective A1b:** Students completing our programs will be able to identify the wide variety of activities in which chemists are employed including teaching.

Outcome Criteria: Graduating students will have been provided with an understanding of their career options.

Assessment Method: Alumni will be surveyed and asked whether they were aware of the various career options open to them. The Assessment Committee will prepare an alumni survey instrument with input from other Department members. This survey will be sent to all possible alumni and the results tabulated.

Feedback from Assessment Activities

A departmental Assessment Committee will be formed with yearly rotating membership. This committee will analyze exams, lab reports, student oral and written reports and presentations, and the Alumni Survey. The Assessment committee will summarize its assessment activities at the end of each academic year and will then report to the Chemistry Department at a special faculty meeting called for this purpose. The Department will decide upon and carry out appropriate follow-up to all assessment activities. *BA Natural Science:Chemistry Option majors do not take the exact same sequence of courses as the BA Chemistry students. Only those upper division courses included in the option will be included for assessment activities*

**Summary of Assessment Activities and Learning Outcomes**

| Assessment Activities | Outcomes code | Learning Outcomes |
|---|---|---|
| Division reviews final exams in subject areas, reviews culminating exam, sets expectations for exams | C1a<br><br>C2a | Demonstrated working knowledge of chemistry. Demonstrate ability to critically evaluate chemical information |
| Review selected reports of culminating or capstone type projects, relate to rubric<br>102/106/111/156 and 190 | C3a<br>C3b<br><br>P1a | Demonstrate ability to collect, interpret, and evaluate numerical data. Demonstrate ability to perform various laboratory skills required for quantitative measurements |
| Review special project laboratory reports and oral presentations 102/106/111/129/156 and 190 | P1b/P3a | Demonstrate ability to prepare research quality laboratory reports |
| Review selected reports of culminating or capstone type projects, relate to rubric<br>102/106/111/156 and 190 | P1c | Demonstrate ability to synthesize, separate, purify, and characterize |
| Review student reports of computer modeling/ comprehension exercises, relate to rubric 102/106/111/129/156 and 190 | C4a | Demonstrate use of software in modeling and simulation of chemical phenomena |
| Review reports of computer based data collection, analysis, and reporting 102/106/111/156 and 190 | C4b | Demonstrate ability to use computers to input and process measurement data and report the results |
| Review selected literature reports or | P2a | Demonstrate ability to |

| | | |
|---|---|---|
| reports of culminating or capstone type projects related to literature reports 129B | | retrieve chemical information from printed and internet sources |
| Review special project laboratory reports and oral presentations 102/106/111/129/156 and 190 | P3a | Demonstrate ability to communicate chemical concepts |
| Survey department regarding issues covered in current courses. Review alumni response as to whether coverage of issues of safety, ethics, and society was sufficient to benefit them in their careers | A1a | Demonstrate that coverage of such subjects has a long-term benefit |
| Review alumni response regarding teaching of potential career options | A1b | Demonstrate that various professional career options were covered |
| Review alumni survey response regarding preparation for postgraduate work in the health professions (BA students) | A1c | Demonstrate that BA students admitted to health professional programs have been well prepared |

**Scoring Rubrics Scoring Rubrics**

**Scoring Rubrics**

Written report for independent study projects and laboratory projects

A written report should be written using clear and appropriate grammar and punctuation. A written report should include the following sections:

- Title, identifying the most important components of the work.
- Abstract, concisely indicating the nature of the project.
- Introduction, combining literature information and the major objectives of the project.
- Procedures, containing all pertinent experimental information.
- Results, summarizing the data generated.
- Discussion, providing interpretation, evidence and conclusions and integrating the results into a conceptual model.
- References, including all pertinent citations.

Oral Report for independent study projects and laboratory projects.

An oral report should be in a format similar to the written report with appropriate sections. The oral report should involve:

- Use of visual aids, such as blackboard, overheads, slides, Powerpoint or other computer graphics, videotapes.
- Handouts as appropriate.
- Concise presentation of charts and graphs.
- Presentation of the main concepts, rather than reading a written report.
- Clear speech and good eye contact.
- Invites questions.
- Reviews main conclusions as an end to the presentation.

The Research (independent study) Project. The student should:

Choose the project in consultation with a faculty member as an extension of student's previous work.
- Use literature information to formulate a research hypothesis.
- State the predicted outcome of the project.
- Identify the experimental design to be used to test the hypothesis.
- Describe the experimental protocol.
- Identify specific techniques and/or instrumentation to be used.
- Proceed to more sophisticated techniques as an outcome of the project.
- Execute the experimental protocol.
- Record and evaluate data generated in the experiments.
- State major conclusions of the experiments.
- Devise further experiments following from the data derived.
- Evaluate the original hypothesis according to the experimental data.
- Interpret the data as fitting into a conceptual model, modifying the model as appropriate.

*BA Natural Sciences:Biology Option*:

1. Goal
   To provide BA Natural Science,Biology Option majors a broad background in the fundamental concepts of the Biological Sciences

   Objectives

   1.1 Knowledge
   For each area will understand characteristics, relationships and mechanisms of change

| | | |
|---|---|---|
| 1.1A | principles of: | evolution |
| 1.1B | | ecology and environmental biology |
| 1.1C | | cell biology |
| 1.1E | | genetics |
| 1.1E | | molecular biology |
| 1.1F | | chemistry |
| 1.1G | | physiology |
| 1.1H | | biochemistry and metabolism |
| 1.1I | | biodiversity |
| 1.1J | | developmental biology |
| 1.1L | | history of science/process |

1.1M scientific method/process
1.1N science vs technology

1.2 Scientific Methods
- 1.2A knowledge of the hypothetical-deductive method of inquiry
- 1.2B application of method to problems e.g.
- 1.2C generating hypothesis
- 1.2D collecting data with appropriately designed experiments and or observations

1.3 Unifying themes
- 1.3A evolution
- 1.3B energy transformations
- 1.3C nutrient cycles
- 1.3 D homeostasis
- 1.3E networks
- 1.3 F biological information flow
- 1.3G structure-function relationships
- 1.3H hierarchy of biological organization
- 1.3I feedback loops
- 1.3J energy flow
- 1.3K developmental process
- 1.3L complexity of interactions in biological systems

1.4 Scientific Literacy
- 1.4A able to distinguish science from pseudoscience
- 1.4B sees science as a way of asking questions about the world and not just a collection of facts
- 1.4C understands the strengths and limitations of science
- 1.4D applies scientific thinking to everyday problems
- 1.4E recognizes the tentative nature of scientific explanations

1.5 Has depth of knowledge in at least one area of specialization recognizes and integrates relationships among and between biology and the other natural sciences and mathematics

2. <u>Goal</u>

To encourage students to develop critical thinking skills and develop intellectual independence.

<u>Attitude</u>

2.1 Embraces lifelong learning, has career knowledge
- 2.1A capability for self-directed learning
- 2.1B continuing interest in biology
- 2.1C knowledge of potential career paths
- 2.1D aware of requirements for career or professional advancement
- 2.1E has self confidence in knowledge, skills, and abilities

2.2 Biology and Society
- 2.2A values support of science by society
- 2.2B appreciates relevance of biology to society
- 2.2C understands and appreciates connectedness of science, society and history

2.3 Bioethics
- 2.3A can identify and evaluate ethical issues in biology
- 2.3B appreciates the value of integrity
- 2.3C values ethical behavior

2.4 Values learned
- 2.4A is open-minded
- 2.4B appreciates value of knowledge
- 2.4C appreciates and respects alternative possibilities and explanations
- 2.4D experiences the joy of discovery

2.5 Stewardship and advocacy
- 2.5A respects biodiversity
- 2.5B contributes to understanding of true science
- 2.5C helps public to make informed decisions
- 2.5D is responsible steward of biological resources

3. Goal

To educate students regarding the basic methods (including instrumentation) and philosophy used to conduct scientific research in the Biological Sciences.

Objective

3.1 Analytical and quantitative skills
- 3.1A create data sets
- 3.1B objectively analyze
- 3.1C interpret data
- 3.1D use quantitative methods of analysis

3.2 Biological information skills
- 3.2A ability to find
- 3.2B evaluate
- 3.2C use
- 3.2D integrate published information
- 3.2E use data bases and information

3.3 Lab and field skills
- 3.3A use appropriate technology
- 3.3B equipment
- 3.3C safety procedures
- 3.3D government regulations

3.4 Teamwork skills

3.4A works cooperatively in a group
3.4B solves problems in a group

4. Goal
To encourage the development of communication skills, both written and oral, for purposes of conveying biological information to both professional scientists and the lay public

Skill
4.1 Communication skills
4.1A communicate effectively orally
4.1B and in writing
4.1C write scientifically

4.2 Thinks critically and solves problems
4.2A can make an argument and support it
4.2B recognizes and uses deductive and inductive reasoning
4.2C integrates concepts within and among disciplines
4.2D recognizes patterns
4.2E findings unifying principles
4.2F solves problems
4.2G distinguishes between data and inferences based on data

## BA Natural Sciences: Biology Option Assessment Plan

Specific assessment activities for the BA Natural Sciences: Biology Option program in the Department of Biology will initially consist of 4 direct measures and 2 indirect measures of student learning outcomes. These include analysis of CORE courses, primary traits analysis of assignments in two upper division CORE courses, a standardized exit exam, pipeline analysis of student status and demographics and alumni and senior surveys.

Assessment activities:

1.)Analysis of core courses
The process will be the same here for BA Natural Science:Biology Option Majors as is the process for regular biology majors. Every five years, each faculty member teaching in the core will provide a course portfolio including the course syllabus; any explanatory notes; assignments; graded examples of student work representing a range of grade levels; and item analysis of objective examinations. Assessment of the CORE portfolios will be carried out by the Department Curriculum Committee to determine the extent to which the Department learning objectives are being met and the degree of integration among CORE courses.

2.)Analysis of Ecology laboratory reports
Primary trait analysis of laboratory reports in Biosci 130 will be used to determine students' grasp of quantitative skills, including graphing and data analysis.

3.) Analysis of Evolution term papers
Evolution (Biosci 180) is considered a culminating course in the Biology core that provides a means for students to synthesize their gained biological knowledge in an evolutionary perspective. Each student in the course writes a term paper that challenges the student to select a topic in biology, research the topic through the primary scientific literature, and to synthesize and summarize the information on that topic in an evolutionary perspective. Primary trait analysis of Evolution terms papers will be used to ascertain students' abilities to interpret the primary literature and integrate concepts, as well as their understandng of evolution and their scientific writing skills.
The following primary traits will be assessed through analysis of scoring rubrics: student's ability to formulate a topic of interest by considering a biological concept an evolutionary context, 2) student's ability to use current primary scientific literature from peer reviewed journals, 3) student's ability to integrate the results of different publications to present a review of the topic. 4) student's ability to present his or her own objective interpretation of published results.

4.) Exit examination
An exit exam, either locally developed or standardized will be administered to seniors in BioSci 180 or possibly in conjunction with the Natural Science 106 course. Students scoring in the top 10% will be awarded a certificate of achievement. Item analysis of results of the exit exam will be used to pinpoint departmental strengths and weaknesses.

*BA Natural Sciences: Physics Option*

BA Natural Sciences: Physics Option majors are given a comprehensive background in the fundamental areas of the discipline such as Classical Mechanics, Thermodynamics, Electricity and Magnetism, Modern Physics, Optics and Quantum Mechanics. Through other elective courses, students are encouraged to explore specialized areas such as atomic physics, geophysics, relativity, statistical mechanics, condensed matter, astronomy and astrophysics. Laboratory courses and independent study projects allow students to apply their knowledge to new problems. The B.A. degree Natural Science, Physics Option is typically used by students interested in pursuing a teaching career at the secondary level.

## BA Natural Sciences:Physics Option Specific Goals and Objectives

Goal 1. To provide students with a background in the fundamental areas of physics.

Objective 1.Successful students will pass courses in the fundamental areas listed above.

Objective 2.Students will be provided with experience in important additional topics through elective courses.

Goal 2. To provide adequate opportunity for students to apply their knowledge to practical experimental and theoretical problems

Objective 1.Two required lower division laboratory courses (4AL, 4BL) and two required and one elective upper division laboratories (104, 110, 130) along with independent study projects (Phys 190) will provide practical experience.

Objective 2. Students will gain computational experience through the use of "Mathematica" and/or "Excel" and other software packages in laboratory analysis and in lecture course homework.

Objective 3.Students will be required to become familiar with the operation of sophisticated research instruments.

Goal 3. To prepare students to assume responsible positions in education or science or industry and to provide scientific writing experience.

Objective 1.Students will solve problems, write laboratory experiment reports and present homework problem solutions in class.

Objective 2. Students will gain experience in scientific writing, and in using word processing, spreadsheet and graphics software in preparing written reports, transparencies, etc.

Objective 3. Students will acquire the requisite educational/technical background.

## BA Natural Sciences: Physics Option Assessment Plan

Goal 1. To provide students with a background in the fundamental areas of physics.

Objective 1. Successful students will pass courses in the fundamental areas listed in the Introduction.

Outcome Criteria: Undergraduate physics majors will be able to correctly describe and discuss the major concepts of physics.

Assessment Method: Specific embedded questions on exams of Physics 4A-B-C, 102, 105A-B, and 107A. It is the eventual goal of the physics department to also administer a locally written pre-test and post-test of first our majors, and later all students taking either 2A, 2B or 4A, 4B.

Time Frame: According to the course assessment schedule (see end of document)

Who Will Do The Assessment: The course instructor and assessment committee*.

Type of Feedback: The course instructor will tabulate final course grades and the names of BA Natural Science: Physics Option majors who took the course. This information will be passed on to and reviewed by the assessment committee. The assessment committee will compare the course performance of the students against their performance on national, standardized assessment tools (the Major Field
Achievement Test -- MFAT -- and similar tests). See Goal 3, Objective 3.

* Note: The department Assessment/Curriculum Committee will consist of three faculty members elected to three-year terms on a staggered basis. The election shall occur annually during the first week of school in the fall semester.

How Will The Data Be Used To Improve The Program And Revise Curricula: The assessment committee will summarize their findings and forward the summary to the appropriate instructor along with possible comments and suggestions.

Objective 2. Elective courses will provide students with experience in important additional topics.

GOAL 2. To provide adequate opportunity for students to apply their knowledge to practical experimental and theoretical problems.

Objective 1. Two required lower division laboratory courses and two required and one elective upper division laboratories, along with independent study projects, will provide practical experience.

Outcome Criteria: Students will become familiar with basic physics laboratory techniques by carrying out standard sets of experiments in mechanics, electromagnetism, thermodynamics and modern physics.

Assessment Method. The student will write laboratory reports which should display a thorough grasp of the theoretical and experimental methods used in the laboratory.

Time Frame: According to the course assessment schedule (see end of document).

Who Will Do The Assessment: Faculty instructors of the laboratory courses will grade the lab reports and tabulate the final course grades and names of physics majors for the assessment committee.

Type of Feedback: The instructor and the assessment committee will review and discuss student performance. The course performance will be compared with responses on the alumni survey forms that deal with the rigor of the experimental background, and also with departmental norms.

How Will The Data Be Used To Improve The Program And Revise Curricula: After the committee reviews student performance, any shortcomings in either the theoretical or experimental understanding displayed by the students, will result in modifications to the content or structure of the laboratory.

Objective 2. Computational experience will be gained using “Mathematica” and/or “Excel” and other software packages in coursework and laboratory analyses.

Outcome Criteria: Students will be able to use mathematical software to analyze data, solve theoretical problems, and display their final results in a compact and understandable format.

Assessment Method: The laboratory courses will mandate that students analyze some of their data using common software programs designed for this purpose.

Time Frame: According to the course assessment schedule for Physics 4AL, 4BL

Who Will Do The Assessment: The course instructors will report on software usage and student performance to the assessment committee.

Type of Feedback: The instructor and the assessment committee will review and discuss student performance.

How Will The Data Be Used To Improve The Program And Revise Curricula: The assessment committee will suggest changes, as need be, to course instructors.

Objective 3. Students will be required to become familiar with the operation of sophisticated research instruments.

Outcome Criteria: Students will use various research tools to take and analyze data within the framework of the laboratory classes.

Assessment Method: Students will make laboratory measurements and write up laboratory experiments. Their laboratory performance and written reports will demonstrate experimental competence.

Time Frame: According to the course assessment schedule (see end of document).

Who Will Do The Assessment: The laboratory instructor (and the course professor in courses which have both lecture and lab).

Type of Feedback: The assessment committee will meet at the end of the spring semester to review brief summaries and examples of student work provided by the laboratory instructor.

How Will Data Be Used To Improve The Program And Revise Curricula: After the assessment committee reviews the summaries and example laboratory reports, any significant deficiencies in student laboratory skills will lead to recommendations to revise the laboratory curriculum or research project format to address these deficiencies.

GOAL 3. To prepare students to assume responsible positions in education or science or industry and to provide scientific writing experience.

Objective 1. Students will organize and write laboratory experiment reports.

Outcome Criteria: Students will be able to effectively communicate the results and conclusions of a physics problem solution or experiment or investigation, in a written report and/or via an oral presentation in class or, on occasion, in a departmental colloquium.

Assessment Method: Written reports will be evaluated by the laboratory or course instructors.

Time Frame: According to the course assessment schedule (see end of document).

Who Will Do The Assessment: The course instructor.

Type of Feedback : Faculty instructors of the laboratory courses will summarize laboratory report writing quality for the assessment committee.

How Will The Data Be Used To Improve The Program And Revise Curricula: The instructor and the assessment committee will review and discuss student performance and, if necessary, modify the course to address any deficiency.

Objective 2. Students will gain experience using word-processing and graphics software in preparing written reports, transparencies, etc.

Outcome Criteria: Students will be able to utilize current software to prepare their written reports.

Assessment Method: Written reports will be evaluated by the laboratory or course instructors.

Time Frame: According to the course assessment schedule (see end of document).

Who Will Do The Assessment: The course instructor.

Type of Feedback : Faculty instructors of the laboratory courses will summarize graphics and word-processing software usage for the assessment committee.

How Will The Data Be Used To Improve The Program And Revise Curricula: The instructor and the assessment committee will review student performance and, if necessary, modify the course to address any deficiency.

Objective 3. Students will acquire the requisite educational background.

Outcome Criteria: Students will exhibit their competence by achieving a satisfactory score on the Physics II MFAT Examination produced by the Educational Testing Service (ETS). In addition, every five years, a general questionnaire will be mailed to alumni to solicit their feedback on the adequacy of their physics education.

Assessment Method: ETS examination outcome and survey form analysis.

Time Frame: According to the course assessment schedule . Note that this is a rotating schedule, so that every academic year only four courses will be assessed.

Who Will Do The Assessment: The Physics Department will administer the ETS examination and send the examination papers to ETS for grading and tabulation. The assessment committee will design, mail and analyze the survey form.

Type of Feedback: : ETS test results will be reviewed yearly by the assessment committee. The survey form results will be reviewed after each use.

How Will The Data be Used to Improve The Program and Revise Curricula: Specific deficiencies will be addressed by appropriately revising the curriculum.

## BA Natural Sciences: Geology Option Assessment Plan

**Goals**

1. To provide geology students with a strong background in the Earth Sciences and in supporting disciplines.

Objectives
Graduates from the BA Natural Science:Geology Option degree program should:

A.) Acquire a mastery of knowledge relevant to the basic components of Earth Sciences.

B.) Develop a command of map skills, including reading and interpretation of geologic, topographic, and other maps, as well as map making.

C.) Acquire competency and skills in chemistry, physics and mathematics that are related to, and supportive of, the upper division Earth Science curriculum.

2. To educate students in the basic methods and philosophy used to conduct scientific research, particularly in the Earth Sciences.

Objectives
Graduate students from this degree program should be able to:

A) Use the scientific method to organize and conduct research.

B) Demonstrate knowledge of the information resources available in the Earth Sciences such as scientific journals, geologic databases, and internet resources.

C) Be able to collect original data using field techniques and archival material.

D) Apply quantitative methods to solve problems, analyze data and formulate models.

E) Develop the ability to work independently and collaboratively in teams to solve open-ended questions.

3. To help students develop effective oral and written communication skills.

Objectives
Graduates from this degree program should be able to:

A) Effectively disseminate technical findings and conclusions by means of written reports in the format used in professional/technical writing.

B) Organize and give professional oral presentations.

C) Use maps, three-dimensional diagrams and other earth imagery to summarize findings and display them to a range of different audiences.

4. To provide students with an opportunity to become familiar with the function and use of scientific instruments.

Objectives
Graduates from this degree program should be able to

A) Use a variety of field geological equipment for data collection.

B) Use common geological laboratory instrumentation and equipment.

C) Perform data analysis and interpretation using computers.

5. To encourage students to develop intellectual independence and academic skills that will assist them in continuing to learn after graduation.

Objectives

A) Provide students with culminating experiences in Earth Sciences that allows them to integrate knowledge previously acquired throughout the curriculum into independent projects.

Assessment Methods

***Student Learning Assessment***

Research papers, oral reports, field projects

Students are asked to summarize, evaluate, and utilize technical readings in research papers, oral reports, and field projects. The students' ability to understand and summarize these readings provides a means for assessing their mastery of the basic components of Earth Sciences. Students' work on these assignments is always evaluated by the class instructor, who provides students with both written comments and a grade. Occasionally, fellow students provide peer review on the oral presentations and report drafts.

Examination

Students' ability to understand and interpret subject matter is tested by written examination. Exams are evaluated by the instructor and assigned a grade.

Maps and other spatial imagery

Students produce original maps and other spatial imagery to solve problems in the Earth Sciences. This material is evaluated by the instructor.

Culminating experiences

Students conduct original research and/or produce review summaries in many of the upper-division core courses. These assignments require the students to synthesize their knowledge acquired in earlier classes, apply the skill they have learned to conduct the research, and describe and explain their results to an educated audience. Some assignments require that students develop hypotheses or lines of investigation required to solve a problem; collect original or archival data; and analyze and summarize data using computer, quantitative and mapping tools. These assignments are guided and evaluated by the instructor.

***Program Assessment***

Feedback From Current Students

The Department of Geology does not presently conduct any formal internal feedback reviews of the program. On an informal basis we solicit input from advisees, graduating seniors, and fellow faculty from within the university.

Feedback From Outside Constituencies

The Department of Geology has from time to time solicited comments from student employers regarding the qualifications of our students and the strengths and weaknesses of their training. There is not, however, a formalized process for conducting these evaluations on an annual basis.

Evaluation of Teaching

The Department of Geology evaluates teaching competency on the basis of:

(1) responses on student questionnaires conducted at the end of each class
(2) teaching awards which faculty receive
(3) peer evaluations of tenure-track and post-tenure faculty
(4) creative teaching activities and class revisions initiated by the instructor

Curriculum Review

The Department of Geology will thoroughly evaluate and revise curriculum on a regular basis beginning in years one and two (see Table 1) of the five year assessment plan. The evaluation will take into account changing job markets, advances in Earth Sciences, student feedback on courses, and employer feedback on students and their training
(year one).

Table 2 shows the correlation between the core curriculum and the objectives established for the Bachelor of Science degree in Geology.

***Application***

The learning environment in the major is improved through:

1. curriculum revision, which changes the course requirements to reflect changes in the Earth Sciences field, student needs, and market forces.
2. continual revision of class content based on student and faculty feedback.
3. continual effort to improve teaching within classes.

Improved teaching results from each faculty member receiving student evaluations as well as an annual evaluation by the chair. Tenure-track faculty and post-tenure faculty (five-year cycle) have peer reviews and receive comments from their colleagues. The reviews provide constructive criticism which the faculty can use to improve their teaching.

The Department of Geology will evaluate whether its assessment programs are working to improve the program by:

1. tracking student evaluations over time to document trends.
2. tracking student employment over time to determine if the program is preparing students for the workplace.

3. holding annual faculty retreats to evaluate internal and external comments and reviews about the major and its quality.
4. conducting performance appraisal of student learning, e.g. writing skills
5. following the five year assessment plan as outlined in Table 1.

Finally, the SOAP will eventually include a symposium in which BA Natural Science students present research posters to faculty and others based upon undergraduate research experiences which the program plans to implement in the future.

**It should be noted that the BA Natural Sciences Degree program serves as the Subject Matter Preparation Program for Fresno State's Single Subject Science Credential Program and as of November 2011 is fully approved (for all four science areas) by the California Commission for Teacher Credentialing (CCTC). The student outcomes assessment plan as laid out herein was included in the CTTC-approved document.**