SCHOOL OF SCIENCE ASSESSMENT REPORT

Introduction—Student Learning Outcome Objectives

> *Science majors are expected to acquire knowledge, develop the ability to assess what they learn, and apply it effectively. To accomplish this, they should be able to read and think critically and to communicate—both orally and in writing—with clarity and precision. They should develop competence in, and an understanding of, quantitative and scientific reasoning, problem solving, and the nature of creative thinking and the process of discovery. They should become aware of the cultural, social, political and economic forces that shape our world and develop a sensitivity to the diverse perspectives offered by groups which differ in their gender, or in their cultural, religious, ethnic or racial backgrounds. Science students at all levels are expected to achieve a depth of understanding of both the essential content and principal modes of inquiry and to become familiar with ethical issues facing their chosen fields. A Purdue Science education should prepare students for a lifetime of continual learning, active contribution to society, and change.*

The School of Science Vision Statement and the University Student Learning Outcome Statement share most of the same goals for undergraduate education. In addition, the School of Science includes problem solving, the nature of creative thinking and the process of discovery. Not only should School of Science students be prepared for a lifetime of continual learning, but also for active contribution to society and continued change.

To meet the School of Science goals, the School has, even before its incorporation as a separate school within the university in 1963, embraced the concept that the curriculum should provide a broad-based education across not only the sciences and mathematics, but also across the liberal arts and humanities. Therefore, the School of Science has a Core requirement in science, mathematics, liberal arts and humanities. This Core represents approximately 50% of the 124-credit curriculum for a School of Science major. Approximately 50%-55% of this Core is in liberal arts and humanities. The Core consists of 3-6 credits of English composition, 12 credits of foreign language, 18 credits of liberal arts/humanities that are prescribed to include breadth and depth, 11 credits of mathematics at or above the level of calculus, and 4 laboratory sciences outside the major discipline (these may be 3, 4 or 5 credit courses). The departmental majors are designed to add breadth and depth within the discipline as well as strengthen a variety of cross-disciplinary science and math areas.

Almost all curricula allow about 10% of credits to be earned in areas chosen exclusively by each individual student. This allows many students to complete a minor either within the School of Science or outside of it. Many students take advantage of this opportunity to increase the breadth of their degree. In addition, students are encouraged to participate in activities at the Departmental, School, University and community levels. Multitudes of leadership opportunities are available and a great deal of learning occurs through participation in such informal activities.

Assessment Activities—School Level

The assessment tools used by the School of Science include:

a) Advisory Council recommendations
b) Alumni surveys/interviews
c) External peer review
d) Faculty observations
e) Focus groups
f) GRE and MCAT scores
g) Post graduate placement
h) Student surveys/interviews
i) University student data queries and reports

The School of Science regularly receives a large amount of data about entering and ongoing students. The data for entering students include self reported information, standardized test scores, high school GPA, rank in class and the probability of a 2.0/4.0 GPA the first semester at Purdue. In addition, all students are given a School of Science Math Placement exam. Those students with foreign language background are given an exam to assess their current knowledge for appropriate language placement. Students with low SATv scores are given a reading exam to assess their current reading level for appropriate English composition placement. Students with high ability are assessed for appropriate math, science and English placement.

The data for continuing students include semester grades, semester and overall GPA, percentile ranking with other students in their classification both within the School of Science and across the University, distinguished and semester honors designation, and distinction and highest distinction designation at graduation. For the past two years it has been possible to query university data to obtain reports on numerous questions concerning placement and success in future courses, among other questions. These outcomes are reported to departments and advisors who are able modify curricula, course prerequisites or advising.

The most recent two years of graduates (N= 760) have been reviewed in terms of their success in our general education core. The average GPA for these graduates is noted in the following table.

Summary Grade Information for 1996-1998 Graduates	
Subject Area	**GPA**
English Composition, 3-6 cr	3.5
Foreign Language, 12 cr	3.2
Liberal Arts & Humanities, 18 cr	3.4
Math/Stat/CS, 12 cr	2.9
Lab Science outside major, 12-20 cr	2.9

The overall average GPA of students at the university is about 2.7 which indicates that the School of Science students GPA in their general education component is well above that average. It indicates that School of Science students, in comparison to their other college peers, appear to have learned much in their general education courses. In addition English, liberal arts

and foreign language faculty regularly note that School of Science students are among the strongest students in their classes.

A major initiative resulting from various queries is the development of the PODS program. This program places groups of 12 students in the same English, math and major course during their first semester in science. Preliminary data indicate a higher GPA and higher retention to science than a comparable matched group. Although the data is just now being analyzed, it appears that participants have a high satisfaction with the program. **Appendix A** is a sample of the instrument.

A second major initiative resulted from data indicating the disparate attrition rate of women in the school of science as compared to men. This is also a national phenomenon. An undergraduate Women in Science Program began two years ago and consists of a residential program with a mentoring and tutoring component. The data from the first year indicate higher GPAs, lower probation, higher semester honors, and increased retention to science of the participants as opposed to a matched group. It will be several more years before we can determine graduation rates and retention trends with any degree of reliability. **Appendix B** shows some representative programs offered to women and assessment of those programs.

The University provides yearly retention data for the School and an internal School database provides retention data by department for all beginning classes from 1988 through the present. These data allow the school and departments to explore the effectiveness of various programs on retention rates to the school and to the university. The outcome of these assessments has indicated that orientation and career courses at an early stage in a student's career in Science positively influences retention to the sciences. **Appendix C** is a sample retention report.

Every two to three years the academic advisors survey students concerning academic advising in the School of Science. The outcome of these surveys has been very positive and all advisors have received above average ratings. When an issue comes up with more than a few students, it is reviewed and necessary changes are instituted as appropriate. **Appendix D** is a sample instrument and data.

Various departments have carried out graduation surveys on a yearly or periodic basis. To coordinate this effort, the School of Science is completing a web-based instrument intended to survey issues related to the School of Science requirements as well as departmental questions. This survey has been in preparation for well over a year and is nearing completion. Several technology issues had to be resolved prior to launching the survey but most of those are now resolved or shortly will be resolved. The intention is to survey graduating seniors and alumni two and five years post graduation. In the meantime, other departmental surveys have continued to supply useful information on which to base curricular, retention and advising decisions. **Appendix E** is a sample exit and graduate survey used by some of the departments. The web adress for the survey is:

https://www.science.purdue.edu/servlet/TestPilot/secure/?TEST_ID=AlumSurv&USER_ID=ScienceAlum

Several freshman surveys occur each year. Some like the Freshman Profile use self reported information along with University data to help describe a particular freshman class. The

Freshman Profile has been generated for each entering class since 1988. It allows assessing the preparedness of entering students over time. Comparing these profiles indicates that the quality of entering freshman has not declined over the past 11 years. There is also a graduating senior profile. By comparing the profile of graduating seniors it is possible to identify at-risk freshman students and design appropriate advising and intervention strategies. **Appendix F** is a sample Freshman Profile.

Another freshman survey introduced in the fall of 1998 was designed to determine the computer literacy of the entering class. The School of Science Educational Policy and Curriculum Committee requested this information prior to making a decision on a School computer literacy course requirement. The results of the survey indicate that entering freshman use and are very familiar with word processing, email, the web and to a lesser extent spreadsheets, databases, html and presentation software. The decision on a literacy course is still indecisive and a test out opportunity has been suggested. **Appendix G** is the instrument and data.

The Dean's Advisory Council, an outside group of prominent alumni, meets twice each year. A component of their visit includes meeting with a group of undergraduate students and a separate meeting with graduate students. The in-depth meeting is alternated each visit between these two groups. The Council presents their outcome assessment to the Deans and Heads who then evaluate the recommendations and implement those that are appropriate and significant. A number of Strategic Plan items were suggested by Council recommendations.

The Presidents of all the departmental student organizations make up an organization called the Science Forum. This group acts as a representative group from all the departments. They have been brought together as a focus group to review the Science Strategic Plan from the student viewpoint. Their recommendations and comments have been seriously discussed resulting in Strategic Plan action items or changes to items. Appropriate comments were also fed back to appropriate departments for evaluation and review.

Another activity coordinated by the School of Science is the inclusion of student focus groups as part of each department's five-year external review. External Review comments on the undergraduate curriculum and other issues are noted with each department.

The last School of Science activity to highlight for this report is the gathering of scores of national exams taken by upper-class students. These results will be compared to national norms that are available. There is no current plan to require all students to take the GRE general exam although students, in general, are encouraged to do so. Because there is no electronic repository of GRE information on the Purdue University campus, the School of Science requested that electronic GRE information be obtained and forwarded to us for placement in our school database. Until Fall 1998, all the GRE data received by the university was in paper format. Therefore, we do not yet have a complete year of electronic data for the School of Science. The database is set up and comparison reports can be prepared beginning Fall 1999. MCAT data must be hand recorded as it is not typically available to us in electronic form. The numbers are much smaller and therefore not an issue.

Action Items at School Level

Feedback from the sources noted above have lead to the Pods Program, the Freshman Honors Program, Freshman Orientation and Career courses, the Women in Science Programs, the addition of minors—both internally and externally to the School of Science, a greater emphasis on study abroad, inclusion of alumni on the Dean's Honors Seminar speaker list, and better placement and advising for new students. Additional outcomes have resulted from the action plans noted below in the first School of Science Strategic Plan.

The 1994 School of Science Strategic Plan Action Items for undergraduate include:

Goal #1. To facilitate and encourage faculty to enhance their teaching.

a) Establish awards for Assistant Professors to recognize outstanding contributions to teaching while pursuing excellence in research.
b) Require all courses with enrollments of seven or higher to have a student evaluation at each offering.
c) The School shall develop a multifaceted system for the evaluation of teaching.
d) Provide summer salary or release time to selected faculty who will be extensively involved in curricular development or the reorganization of a course for the following academic year.
e) Assure that the quality and quantity of a faculty member's teaching effort are considered as significant factors in determining merit raises.

Goal #2. To increase the retention of the School's majors.

a) Use the School's K-12 Outreach Program to improve the mathematics and science background of entering Purdue freshmen.
b) Identify entering students who will require pre-calculus instruction at Purdue and arrange for summer courses which these students could take prior to August.
c) Establish a School of Science faculty committee to advise on new approaches for the teaching of calculus to School of Science majors (and non-majors).
d) Develop special programs and/or seminar courses for Freshmen in each discipline which would enhance a knowledge of career opportunities.
e) Assure that all departments encourage active participation by undergraduates in research as early as possible in the student's academic program.
f) Encourage interactions between upper-level undergraduate majors and freshmen majors.

Goal #3 was an undergraduate recruitment goal.

Goal #4. To keep the undergraduate curriculum current and vital.

a) Require Departments to intensively review their undergraduate courses and curricula at least every five years. This item should be included among the specific charges given by the Dean to external review committees and by the Department Heads to Departmental Advisory Committees.
b) Assure Departmental training courses for graduate teaching assistants are effective.

Goal #5. To increase the role of interdisciplinary studies in undergraduate education.

a) Create a School committee charged with developing courses for majors and non-majors that integrate disciplines. The courses should be designed around connected learning—should emphasize the application of knowledge from one context to another, and the relationship of science to the wider world.

b) Reexamine the School of Science General Science major, either make it more attractive to faculty and students or eliminate it.

Goal #6. To maximize the effective use of multimedia technology in undergraduate courses.

a) Create a workshop to highlight School of Science capabilities in multimedia technology. Establish departmental committees to evaluate the potential utilization of such technology for their laboratories and classrooms. Where appropriate, create departmental three-year plans for introducing/expanding the use of this technology in undergraduate and graduate instruction. Give proposals for the implementation of these plans, including the upgrade of teaching laboratories and classrooms for multimedia presentations, a high priority for departmental and School resources, and for the School's development efforts.
b) Assure that all departments participate in a School-wide multimedia technology effort. Encourage the University to develop a central facility which would train faculty/staff and create a library of multimedia resources.
c) Develop a plan for a Classroom of the Future and solicit Federal and industrial support to create such a classroom.

The School of Science or the University Central Administration addressed all of these 1994 action items, which came from various assessment means. Those that are on going in nature continue.

The 1998 Draft School of Science Strategic Plan which is, as of Spring 1999, in its final stages of review by various constituencies. This second Strategic Plan removes those action items that have been institutionalized and updates or adds new ones based on assessments gathered in the most recent four years from students, faculty, administrators, academic advisors, advisory council members, and alumni.

Goal #1. Enhance the effectiveness of undergraduate education

a) Encourage the constructive use of various techniques to obtain student and peer feedback regarding teaching effectiveness.
b) Ensure that faculty and graduate TA's receive diversity training, such as the University Classroom Climate Workshops.
c) Ensure that departmental graduate TA training programs utilize best-practice elements from across the School of Science.
d) Ensure that all faculty become familiar with the use of multimedia technology in the classroom.

Goal #2. Optimize the learning environment of our students and assure that they experience creative thinking and discovery.

a) Create an active learning environment which will provide students the opportunity to take a more active role in the learning experience.
b) Encourage active participation in research as early as possible in the student's academic program.
c) Optimize the use of resource rooms and assisted learning centers in the undergraduate learning experience.
d) Involve the use of student "teams" inside and outside the classroom and laboratory.
e) Expand the use of technology-based methods which allow for rapid interaction between students and instructor, both inside and outside of the classroom.

f) Facilitate student-to-student learning, for example, by the incorporation of Web-based tools in courses.
g) Create opportunities for off-campus internships.

Goal #3. Keep the undergraduate curricula current and vital.

a) Have each department formulate learning outcome expectations for its majors and for its courses.
b) Have each department intensively review its undergraduate courses and curricula every five years for consistency with its learning outcome expectations. Such review will also be included among the specific charges given by the Dean to external review committees and by the Department Heads to Departmental Advisory Committees.
c) Encourage and facilitate the inclusion of scientific ethics in School of Science courses.
d) Assure that all graduating SoS majors are computer literate.

Goal #4. Attract outstanding students to our undergraduate programs.

a) Not assessment item.
b) Not assessment item.
c) Maintain and strengthen the recently created School-wide Freshman Honors Program and assure that appropriate honors experiences are available to all science students from their sophomore year until graduation.
d) Aggressively assist undergraduates in competing for prestigious fellowships.
e) Enhance the annual Undergraduate Research Day to both recognize student research accomplishment and advertise opportunities for outstanding students.

Goal #5. Increase the diversity of our undergraduate student population.

a) Not assessment item.
b) Not assessment item.
c) Emphasize diversity awareness for all entering freshmen and transfer students during orientation programs at the beginning of the school year.
d) Not assessment item.

Goal #6. Increase the retention of the School's majors.

a) Expand the freshman Pods Program which coordinates small groups of science students into the same math, English, and major course sections.
b) Explore the development of freshman residential programs for science students in specific majors using the Women in Science model.
c) Encourage interactions between upper-level undergraduate majors and freshman majors.

Goal #7. Ensure that students can effectively communicate, both orally and in writing.

a) Consider the requirement of a course in Communication for all majors.
b) Consider the creation of a list of SLA courses which include English writing experiences and the requirement that SoS majors include two of these courses in their program. These would satisfy part of the SoS General Education requirement.
c) Encourage the offering of upper division seminars in all science majors which incorporate both writing and oral presentation experiences.

Goal #8. Develop improved methods to assess student learning outcomes.

a) Conduct exit interviews with randomly-selected graduating students to determine their level of satisfaction with their educational experience.
b) Use the discipline portion of the Graduate Record Exam to assess graduating students' knowledge in their major.

c) Utilize employers, graduate schools, and professional schools to obtain feedback regarding the quality of our students' education.
d) Survey graduates for 1-10 year feedback on the quality of their undergraduate education.

Appendix H is a copy of the 1994 School of Science Strategic Plan.

Feedback Loops

The feedback loops resulting in the development of the first and second School of Science Strategic Plan have been numerous and include the following.

1. The comments, concerns and recommendations from present and former students, academic advisors, faculty, employers, advisory council members, etc. come through a variety of mechanisms to departments, faculty, advisors and administrators.
2. Departmental undergraduate curricula committees review these comments, concerns and recommendations and begin the process of change. Recommendations are brought to the departmental faculty for action.
3. The Faculty Council of the School of Science brings issues to the School level for discussion and resolution.
4. The Educational Policy Committee of the School of Science responds to recommendations related to School of Science curricular issues and brings final recommendations to the whole faculty for action.
5. The Deans and Heads meet regularly to discuss issues of importance to the school and are active participants in the formulation of action items for a developing Strategic Plan.
6. A draft Strategic Plan is reviewed and modified as it is critiqued by students, faculty, academic advisors, alumni groups and advisory groups.
7. Resources of departments and the school are focused on the agreed upon action items.
8. The process is on going between strategic planning years which are 4-5 years apart. The process accelerates during the yearlong strategic plan review and update process.

Feed back loops for the data and reports which are generated from assessment activities include: Science Administration, Department Heads, Undergraduate Studies Committees, academic advisors, the Educational Policy and Curriculum Committee, the Faculty Council and the faculty as a whole.
Timeline

Alumni surveys will take place each year for graduating seniors and at 2 and 5-year intervals for that cohort. Freshman Profiles and other standard reports will occur yearly or each semester as appropriate. The Freshman survey data will be reviewed and the instrument evaluated. It will be used each year to determine trends and then every two years. Academic advisor evaluations will occur every 3-4 years. National exam data will be collected and reviewed yearly.

Future Assessment Plans

Undergraduate Exit and Alumni Surveys

Fully develop and deploy the Undergraduate Exit and Alumni Surveys. The development of the web-based surveys have presented a number of obstacles—most of which are resolved or near resolution. It is expected that the first round of combined School of Science data will be available by the Fall of 2000. The two and five-year alumni surveys will follow by the Fall of 2001. Depending on the assessment of these surveys, a ten year survey is being considered.

The feedback loop for these data will include the Educational Policy and Curriculum Committee of the School of Science, Science Administration, Academic Advising, the departmental Undergraduate Curriculum Committees, and various external advisory or review committees. The departmental surveys have, over the years, had significant impact on curriculum development in the departments. A combined survey should help to pin point areas of common concern as well as areas of common strength.

National Exam Reports

Expand the graduation reports to include national exams taken for post-graduate work. A database is currently set up and electronic GRE data for 1998-99 are the first year of data. The format for these reports is currently being developed and will draw upon the in-house database which contains all the School of Science students from 1988 to the present. Early analysis shows that some students from the 1988 database took the GRE exams during the 1998-99 academic year. We need to do additional research to determine what relevant questions we can ask with these data. Of the 700+ Purdue students that have taken the GRE this academic year, only 90 have records in the School of Science. At this point it is not clear how these data fit into our assessment efforts.

Freshman Student Survey

A freshman survey was developed this year and given to almost 90% of the freshman class. These data will complement the exit and alumni surveys. The data are currently being analyzed. It is planned that this will become a yearly survey with the data feeding back to the School of Science Administration, Science Counseling, and all the departments. It will likely be shared with the School Advisory Council and external reviewers on a periodic basis. **Appendix A** is the instrument.

DEPARTMENT OF BIOLOGICAL SCIENCES

Introduction

The Department of Biological Sciences is unique in its synthesis of all the areas of biology in one department. At the outset, there was a seven-semester Core which all students in biology completed. Today, the Core is four semesters and there are 11 majors. One of the more recent additions to the curriculum is a series of capstone lab courses which help students bring together all the skills and knowledge they have learned in a scientific discovery atmosphere. Success in these capstone courses is one of the best indicators that students have met the faculty's learning outcome objectives.

Student Learning Outcome Objectives

1. To acquire knowledge and understanding of the basic principles of biology, and to understand the fundamental tenets of biological disciplines including diversity, development, genetics, ecology, physiology, cell biology, evolution and biochemistry.
2. To read and be able to analyze scientific papers critically.
3. To be able to communicate clearly both orally and in writing.
4. To develop problem solving skills for lifetime learning.
5. To design and implement experiments to test hypotheses (experience the process of discovery).
6. To explore the relationship between biology and society including ethical issues raised by current biological research.

Assessment Activities

The Department of Biological Sciences utilizes several assessment tools to help them respond quickly to student concerns and to measure student learning outcome. Our freshman honors students are asked to evaluate their first year courses, while upper-level honors students complete a one-page questionnaire that addresses our stated learning objectives. Over the past five years the department has conducted a voluntary exit survey of graduating seniors that focuses on post-graduate outcomes. Focus groups of graduating seniors have also been utilized, and the department plans to expand and formalize this program.

The assessment tools used by the Department of Biological Science include:

a) Alumni surveys/interviews
b) Capstone courses
c) Departmental Advisory Committee
d) External peer review
e) Faculty observations
f) Focus groups
g) GRE and MCAT scores
h) Independent Research/data collection/oral presentation/written reporting
i) Internships
j) Post graduate placement

k) Research thesis
l) Senior papers and projects
m) Student surveys/interviews
n) Student teaching evaluations
o) University student data queries and reports

The Department of Biological Sciences advocates the development of reading/writing/interpretation skills across the curriculum. Freshman students begin with articles from Scientific American or equivalent publications and move to articles from the primary literature by the junior year. Students learn how to read scientific literature, analyze data and critique it orally and in writing. This developmental process occurs incrementally from freshman through senior year as the expectations increase. By the senior year students are in their capstone courses which often use original literature as the sole course material. Exams involve problem solving and the analysis and interpretation of data.

Faculty concern for the communication skills of students led to a coordinated communication across the curriculum. Writing skills begin in the freshman year with paragraph summaries, essays and lab reports. By the junior year these are developing into complete products. The oral communication component is measured as students present their work in poster sessions or class reports in Core laboratories and capstone courses. Nearly two-thirds of seniors complete either capstone laboratory courses or honors research. These experiences allow students to synthesize all the diverse elements of our curriculum and meet the goals set by the faculty.

Learning outcomes are assessed using the scientific paper as a model for reports in the capstone courses as well as honors theses, which frequently result in publishable papers. Oral communication is assessed as part of class participation, oral reports, group interaction, poster sessions and presentations at journal clubs and regional and national meetings for some.

In 1993, through a number of feedback sources, it became apparent to the department that its retention was very low. There was also considerable concern expressed by students that they were not receiving sufficient career information. As a result, in 1994 an 8-week first-semester freshman orientation seminar was developed, followed in another year by a one credit second semester career seminar. A comparison of the students taking the orientation seminar with a matched group not taking the seminar indicated a significantly increased retention of freshman students to biology. In fall 1999, key components of the orientation seminar, will become an integrated part of the first Core biology course taken by biology majors.

Key components of another experimental one-credit Biology Resource Seminar offered to some beginning biology majors will also be incorporated into the first Core course. A third experimental problem solving seminar will have some of its key components incorporated into the first Core course. As a result, the first Core course for biology majors will move from a 4-credit to a 5-credit course that contains these three components shown to help beginning biology majors be successful—orientation, problem solving, and additional opportunities to discuss difficult course material.

Feedback Loops

The Department of Biological Sciences has incorporated its students, faculty, advisors, peer reviewers and administrators in feedback loops for constant improvement of the curriculum since the inception of the Biology Core in the early 1960's. The department embraced the concept of a core of information, skills and experiences that all biology graduates should have. Regular reviews of the Core took place in which student learning outcomes were compared from course to course and experience to experience. Evolution of the Core was inevitable. Feedback from employers, professional schools and graduate schools indicated that graduates of this philosophy of education were highly sought after at all levels.

This early philosophy of almost 40 years ago continues today. The Department of Biological Sciences has incorporated assessment as a routine component of the undergraduate program. This is based on the receipt of the Howard Hughes Medical Institute Undergraduate Initiative of 1998 in which assessment is a key programmatic component. This will generate specific and quantitative assessments of the various undergraduate programs, such as undergraduate research, Women in Science, advanced laboratory training, computer courseware development and our outreach programs. This will be led by the Undergraduate Studies Committee and a Ph.D. graduate student in Statistics who is hired specifically to compile and analyze the data.

The most recent External Review of the Biology Department took place in 1994. Its assessment of the undergraduate teaching function was that it "is particularly impressive" . . . "the department can now recognize that it has achieved an excellent result" . . . "the teaching load per faculty member is at the high end for peer institutions, and this parameter must be carefully monitored to prevent faculty loss".

One recommendation was that the department enhance its career counseling activities and expand to include "non-traditional" avenues that can be pursued with a bachelors degree. The response to this recommendation—and other similar concerns from students—was to develop a career seminar for freshman students and expand the Career Development Center. The career-counseling component of advising was also enhanced.

In response to the large number of biology majors receiving unsatisfactory grades or withdrawing from the first Core course, the Biology Resource Seminar was developed. Current literature on freshman orientation courses, observation and feedback by academic advisors, as well as verbal feedback from thousands of new biology majors about their needs as beginning students led to the Biology Resource Seminar. In Fall 1998, the one-credit Biology Resource Seminar was offered to nearly 200 freshman biology majors. The course was designed to help integrate new biology students into the Department, to help them adjust to university life, and to assist them in developing academic and intellectual survival skills using the medium of the first Core course problem sets. The course met once a week in groups of 20-25 students. An academic advisor and an undergraduate teaching intern led each section. Students are asked to respond in writing at the end of every class period and advisors or undergraduate mentors address their concerns.

A very significant component of the course was the segment in which the Teaching Interns worked with students on the course problem sets. The most important benefit was not just simply assistance with homework. The teaching interns modeled effective problem-solving strategies. They required the students to think beyond the parameters of the question at hand. Students rated this the most valuable part of the course because they reaped tangible benefits, but the long-term benefits may actually be greater.

The effectiveness of the optional seminar was evaluated by comparing grades of seminar participants and non-participants in the first Core course. 179 participants and 83 non-participants were included in the analysis. The average lecture grade of the participants was 2.31/4.00 while that of the non-participants was 1.92/4.00—almost half a letter grade lower. This difference was shown to be highly significant. Analysis indicates that we can reasonably expect at least a 30% increase in the average number of successful students in the class if they participate in the seminar. These results were the impetus for incorporating the key components of this seminar into the first Core course for biology majors.

Timeline.

Year	1	2	3 & 4	2 & 5 yr postgrad
Assessment Tool	Grades; retention	Retention as Bio Major after 2nd yr	Research, Research reports, writing, analyze scientific papers; # grads	Questionnaire on current status & past satisfaction
Assessment Team	Counseling Office	Undergrad Studies Com	Undergrad Studies Com	Counseling Office
Task	Analyze student quality, course instruction, course grades	Program assessment of Biology Core and Chem/Math	Program assessment of higher order thinking and communication skills	Analyze admission into professional and graduaate schools, job satissfaction; comments on UG program
Report findings to:	Department Head, Assoc Head, Faculty Council	Department Head, Assoc Head, Faculty Council	Department Head, Assoc Head, Faculty Council	Department Head, Assoc Head, Faculty Council

Future Assessment Plans

Future assessment plans will include further evaluation of the incorporation of the Resource Seminar into the first Core course for Biology majors. We do not know if this addition will not only improve grades but also retention to biology.

The Counseling Office and the Undergraduate Studies Committee will do additional assessment related to student retention and satisfaction. Programs such as the Resources Seminar, the Biological Resources Center and our various tutoring programs are aimed at increasing student learning and retention. Once students have graduated, they will be given an exit survey and then provided questionnaires at two and five years post graduation to assess their academic or job status, as well as satisfaction with their undergraduate training. All of this information will be

analyzed by the Undergraduate Studies Committee and reported to the Department Head and Associate Head for discussion with the Faculty Council of the Department.

DEPARTMENT OF CHEMISTRY

Student Learning Outcome Objectives

1. To acquire knowledge of the traditional sub-disciplines of chemistry including analytical, biochemical, inorganic, organic and physical chemistry.
2. To recognize the development of chemical science as a continuing human endeavor on a global scale
3. To acquire knowledge of the role of instrumentation in experimentation.
4. To acquire knowledge of the principles and methods of information management and retrieval
5. To acquire knowledge of laboratory safety and the ethics of the practice of science.
6. To develop the ability to communicate scientific findings in both oral and written forms.
7. To develop the ability to design and interpret scientific experiments and the ability to manipulate experimental data.
8. To develop the ability to assess experimental results critically.

Assessment Activities

The Department of Chemistry has traditionally used a variety of different means to assess the undergraduate program. The American Chemical Society, the chemistry professional society, publishes guidelines through its Committee of Professional Training. That Committee meets regularly and periodically evaluates and certifies the Department's degree options.

Every five years the Department undergoes a formal review that entails a visit and a written report by representatives from other academic and industrial institutions. In addition, a Chemistry Department Advisory Committee convenes on at least a yearly basis. This group, consisting mainly of distinguished representatives from chemical industry, also counsels the Department.

A student member of the Department's Undergraduate Committee provides valuable input regarding student concerns and suggestions. All courses are evaluated each semester using a School of Science approved format. The form also encourages written comments. The teaching effectiveness of all assistant and associate professors are evaluated by a peer panel of three faculty members.

The assessment tools used by the Department of Chemistry include:

a) Alumni surveys/interviews
b) Capstone courses
c) Departmental Industrial Advisory Committee
d) External peer review
e) Faculty observations
f) Focus groups
g) GRE and MCAT scores
h) Independent Research/data collection/oral presentation/written reporting
i) Internships and coops

j) Post graduate placement
k) Professional Society recommendations and certification
l) Research thesis
m) Senior papers and projects
n) Student surveys/interviews
o) Student teaching evaluations
p) University student data queries and reports

Feedback Loops

By and large, the Undergraduate Committee handles assessment matters that relate to the undergraduate program; however, the Head of the Department reviews teaching evaluations and discusses any problems with individual faculty members. The Undergraduate Committee meets several times each semester, and the plan is to devote a meeting to assessment each fall. Traditionally the Committee has considered equipment needs for the teaching laboratories. In the future the Committee with also address survey information pertaining to the curriculum as well as alumni concerns and placement information about recent graduates. The Committee brings items of interest to the Chemistry Faculty on a regular basis.

Undergraduate resource area
In part in response to recommendations from the 1995 external review, the Department completely reorganized the resources it makes available to students and chemistry majors. The Resource Room, the Undergraduate Advisor's office, rooms for Teaching Assistants in general chemistry to hold office hours, and a lounge area for Chemistry Majors now all occur in a contiguous area.

Revision of the Honors Program
Recently the Undergraduate Committee spearheaded a revision of the Honors Program in response to suggestions from the external review committee as well as student input. Major changes include the institution of a Committee for the evaluation of the Honors thesis, increases the number of credit hours of research available for graduation credit, and provides for oral presentation of the Honors research.

Introduction of degree options
New degree options created in the past few years include one in atmospheric chemistry and one in computational chemistry. It is worth noting that latter option directly resulted from a student initiative.

Increase Flexibility of Degree Options
In response to changing external factors noted by the External Review Committee, the faculty reorganized and consolidated the physical chemistry requirement that allowed the introduction of quantum chemistry into the sequence. In addition a new advanced elective with a topical format became possible.

Student seminars
To encourage retention and to guarantee student proficiency with modern computer methods, the Department recently instituted a freshman seminar for all chemistry majors. In addition we have recently expanded the Seminar Program to include virtually all chemistry majors.

General Chemistry Uniform Grading Policy
In response to external review recommendations the very large multi-sectioned general chemistry sequence, which is by far the largest service course in chemistry, now makes it a policy to coordinate examinations and agree upon a common grading scale.

The Undergraduate Committee reviews ongoing assessment and will add future assessment items to its review process.

Timeline

Some tools, like faculty observations, provide input on an intermittent basis. Other instruments provide data on an annual or semiannual basis. These include teaching evaluations and exit surveys of graduating seniors—which provide useful statistics, curriculum evaluations, standardized test scores, and information about post-graduation plans. The School of Science coordinates the alumni surveys on a yearly basis. The Chemistry Department Advisory Committee reviews academic concerns periodically as directed by the Head of the Department. External Peer Reviews occur at five-year intervals.

Future Assessment Plans

Exit Survey
The department has developed an exit survey to be incorporated into the School of Science survey under the Department of Chemistry section.

CHM 499 as a Capstone Course
A major proportion of the chemistry majors take undergraduate research which is consider to be the capstone course. Students engage in research under the guidance of one of the faculty in the department. The goal is for students to actively participate in state-of-the-art research in chemistry. In so doing, the student is exposed to research problems of current interest. They also receive instruction and gain experience in 1) using modern research tools, 2) carrying out research investigations, 3) keeping research notebooks, 4) analyzing data, 5) communicating and disseminating their results.

Students are encouraged to begin their undergraduate research as soon as course schedules allow and can continue for multiple semesters. Longer periods of research benefit both the student and the research group. An internal mechanism exists for informing students about available research groups and faculty advisors.

In order to assess the progress of students enrolled in CHM 499, a final written report of research activities is required. Some faculty require a report each semester a student is enrolled in the course. The American Chemical Society guidelines are used for this preparation. An oral

presentation is made at appropriate times during the project. Students taking this course during the senior year are encouraged to bring their project to completion in the form of a senior thesis. Such a thesis serves as a useful project to demonstrate potential to potential employers or graduate schools. Some projects become part of published papers.

Every student enrolled in CHM 499 must take the two-hour safety training session.

DEPARTMENT OF COMPUTER SCIENCES

Introduction

The Department of Computer Science offers courses in a wide variety of Computer Science areas—including Programming Languages, Computer Architecture, Data Structures, Information Systems, Compilers, Operating Systems, Networks, Security, Graphics, Artificial Intelligence, Algorithms and Complexity, Numerical Computing, and Software Engineering. Students must complete four core courses (which now contain or soon will contain labs), as well as seven more Computer Science courses.

Student Learning Outcome Objectives

1. To acquire knowledge.
   Computer science students acquire the knowledge of the basic principles of computer science.
2. Achieve depth of understanding of essential content in their specialization.
   Computer science students develop an understanding of computer architecture as well as how information is represented, stored, manipulated, and transmitted.
3. Develop ability to assess what they learn.
   Computer science students learn several techniques, algorithms, and strategies for solving problems and are taught ways of analyzing those techniques, algorithms, and strategies to determine a suitable or optimal choice.
4. Apply what they learn effectively.
   Computer science students receive hands-on experience with state-of-the-art computing facilities, as well as knowledge of the general properties of commercially available computer hardware and software.
5. Read and think critically.
   Computer science students learn to read and think critically. Rather than accepting any statement from a textbook, paper, or instructor, computer science students are taught to subject such statements to experimentation and actual use.
6. Communicate both orally and in writing with clarity and precision.
   Computer science students develop the skill of computer programming, a far more clear and precise form of communication than any natural language.
7. Develop competence in quantitative and scientific reasoning.
   Computer science students learn to reason about issues by gathering actual quantitative data and by subjecting hypotheses to testing.
8. Understand the principal modes of inquiry in their area of specialization.
   Computer science students receive a thorough technical preparation and the background needed for success in future employment or graduate education.
9. Become familiar with the cultural, social, political, and economic forces that shape our world.
   Computer science students become familiar with the effects of cultural, social, political, and economic forces in terms of their effect of computer software, hardware, and networks.

10. Become familiar with the technologies that shape our world.
    Computer science students become familiar with multiple facets of the computer science discipline, including programming languages and compilers, operating systems and networking, software engineering, numerical and computational methods, and mathematical foundations, as well as an appreciation for the rate of change in computer technologies.
11. Become familiar with the ethical issues that face their chosen field.
    Computer science students become familiar with several ethical issues including privacy and security of personal data.
12. Be prepared for a lifetime of continual learning.
    Computer science students receive education rather than training; they are taught the basic principles and multiple facets of computer science in addition to state-of-the-are hardware and software. While the effects of training fade quickly as the state-of-the-are changes, education prepares them for a lifetime of continual learning.

Assessment Activities

The Department of Computer Sciences takes advantage of a variety of assessment activities. We have a one-semester course for freshmen, CS 192, that requires students to meet one-to-one with the Director of Undergraduate Office, Jean Jackson. All undergraduate courses are also required to complete the Student Teaching Evaluations for each lecture, lab, and recitation section in which students are enrolled. The Departmental Industrial Advisory Council periodically reviews our curriculum to suggest additions, deletions, or modifications based on recent changes in the industry. Finally, the Department invites periodic external review of its programs by distinguished members of the field.

The assessment tools used by the Department of Computer Sciences include:

a) Alumni surveys/interviews
b) Departmental Industrial Advisory Council
c) Employer surveys and interviews
d) External peer review
e) Faculty observations
f) GRE scores
g) Internships and coops
h) Post graduate placement
i) Student major projects
j) Student surveys/interviews
k) Student teaching evaluations
l) University student data queries and reports

Feedback Loops

One feedback loop arises from the external reviews. For example, the External Review Report of 1994 made several observations and recommendations in regard to undergraduate education to which the Department responded.

The Undergraduate Curriculum

The External Review noted that the “undergraduate program needs updating and modernization.” In response the faculty reviewed the entire undergraduate curriculum which resulted in several major curriculum revisions, the latest in 1998. That revision continues today with changes being proposed in the four core courses. The Departmental Industrial Advisory Council periodically reviews our curriculum to suggest additions, deletions, or modifications based on recent changes in the industry.

The External Review noted that "better laboratory support is needed and the computer support currently offered by PUCC is insufficient." Considerable space and updated equipment has been made possible through the efforts of Science Administration, the Central Administration and various corporate sources. More control of the laboratories has been taken over by the department. Labs are currently being added to the three core courses that did not have them in the past.

The External Review noted that "there was no discrete mathematics course being offered." The Computer Science faculty and Mathematics faculty have worked together to develop a discrete math course (MA 276) that is the most appropriate for Computer Science majors. This course, which is currently being offered by the Math Department, is now available to our undergraduates.

The External Review noted that "It is essential that Computer Science departments take control of service courses." Revisions have been made in existing service courses. Some new service courses have been developed. The Computer Science department is determining the course content of all such courses in consultation with the department or departments whose students will take the courses. Service courses such as CS 190W and CS 290W (both Web-related courses), have become extremely popular among students in other disciplines.

In the past 3-5 years assessment activities and recommendations from the Industrial Advisory Council, alumni, and students returning from internships have led the department to change the primary programming language used in our courses, as well as to update emphasis and maintain state-of-the-art content in courses on operating systems, computer networks, databases, and software engineering.

Timeline

All assessment activities occur annually with the exception of teacher evaluations and external reviews. Teacher evaluations occur each semester and the External Peer Review occurs every five years.

Future Assessment Plans

Future assessment plans will include the use of random student surveys and interviews after graduation, as well as random employer surveys and interviews.

DEPARTMENT OF EARTH AND ATMOSPHERIC SCIENCES

Introduction

The mission of the Department of Earth and Atmospheric Sciences is to create a community of scholars in an atmosphere that fosters innovative scientific research, education of scientists and scientifically literate citizens, and activities that reach beyond the Purdue campus. The department offers undergraduate majors in four areas, Solid Earth (Geology), Atmospheric Sciences, Environmental Geosciences and Earth / Space Science Teaching. Using common introductory courses combined with specialized advanced requirements for each degree, the educational goals of the majors are acquired in courses both within and outside the department. Skills and information acquired outside the department are reinforced and used in the disciplinary courses to allow students to develop both knowledge and skills appropriate for development of a professional career in the discipline.

Student Learning Outcome Objectives

The following skills and areas of knowledge are central to our undergraduate degree programs in Earth and Atmospheric Sciences:

General

1. Knowledge about real world opportunities and careers in which an education in Earth and Atmospheric Sciences can be used.
2. Ability to use an understanding of career choices to select a major and electives that provide appropriate advanced knowledge and skills in a specific subfield of the discipline.
3. Ability to research, read and critically evaluate relevant literature in the sciences.
4. Ability to apply fundamental scientific / mathematical knowledge to solve problems.
5. Knowledge of basic scientific and engineering measurement principles.
6. Knowledge of basic US and world geography.
7. Ability to communicate ideas clearly and accurately in writing and orally.
8. Ability to solve problems and formulate physical concepts in a mathematical form, using linear algebra, multivariate differential and integral calculus, and partial and ordinary differential equations.
9. Ability to apply principles of probability, time series analysis, and linear regression.
10. An understanding of the concept of inference and scientific methods, and a sense of the importance of uncertainty and limitations in models and solutions.
11. A working understanding of fundamental concepts embodied in classical thermodynamics, electricity and magnetism and mechanics.
12. A working understanding of fundamental knowledge of inorganic and organic elements and the chemical processes to which they are subjected.
13. Basic programming and data management skills using a computing language.
14. Use of commercial word processing, spreadsheets, and computational packages.

Discipline Specific

1. General knowledge of the setting of the Earth in space, the origin and composition of the Earth and atmosphere, and the history of life on Earth.
2. Knowledge of the history of discoveries and ideas that have contributed to our current awareness of Earth and Atmospheric Sciences.
3. An understanding of relationships between hydrosphere, lithosphere, biosphere, and atmosphere, and between people and the environment.
4. An understanding of the concepts of scale and context, and how controlling variables change with different time and space scales.
5. Knowledge of appropriate techniques for measuring and recording both past and present Earth processes.
6. A working understanding of how fundamental concepts and knowledge in physics and chemistry are applied to understanding Earth and atmospheric science processes.
7. Ability to use quantitative analysis applied to geoscience data to solve problems in Earth and Atmospheric Sciences.
8. Working knowledge of commonly used coordinate systems.
9. Ability to effectively use discipline-specific software.

Major Specific

<u>Atmospheric Sciences</u>

1. Detailed knowledge of the composition of the atmosphere
2. Knowledge of mean horizontal and vertical distributions of atmospheric variables
3. Thermodynamics of dry and moist atmospheric processes, including the equation of state, thermodynamic laws, principles of cloud and precipitation formation, latent heat, adiabatic processes, hydrostatic stability, and the use of thermodynamic diagrams to represent atmospheric processes and states.
4. Kinematics and dynamics of large-scale and mesoscale circulation systems as represented in various coordinate systems, including representation and interpretation of the three-dimensional equations of motion and mass continuity.
5. Simplified geostrophic, quasigeostrophic, gradient, inertial and cyclostrophic representations of atmospheric flow.
6. Large-scale and mesoscale atmospheric waves and wave stability.
7. Principles of numerical weather prediction and current operational models.
8. Solar and terrestrial radiation and their relationship to local and global temperature and circulation features.
9. Characteristics of shallow and deep convection and relationships to larger-scale weather systems and boundary-layer processes.
10. Concepts of fronts, jet streams, and turbulence and relationships to large-scale and mesoscale circulations.
11. Principles of hand and machine isopleth analysis.
12. Relationship of mid latitude wave patterns to sensible weather events.

13. Basic radar and satellite image interpretation.

Solid Earth

1. Detailed knowledge of the composition of the Earth.
2. Knowledge of the ways in which Earth responds to internal and external forces within the framework of Earth systems sciences.
3. An understanding of Earth processes, including plate tectonics, erosion and sedimentation, and the use of stratigraphy, paleobiology, structural geology, and the role of geophysics and tectonics in understanding the nature of the Earth's interior and exterior, and its history.
4. Knowledge of methods used to map and interpret diverse rock types and structures.
5. The ability to observe and measure, both in the field and in the laboratory, physical, chemical and biological aspects of rock successions, and to use these to develop interpretations of Earth history.
6. Knowledge of the methods used to assess natural hazards and to explore for natural resources.

Environmental Geosciences

In addition to basic skills and knowledge in the Solid Earth major, the environmental Geosciences major adds:

1. Knowledge of major environmental problems at the local to global level, and of the scientific, social, legal, historic and economic contexts of these problems.
2. Knowledge of how geosciences are used as part of developing solutions to interdisciplinary environmental problems.
3. Development of skills of independent inquiry and learning in response to problems not previously encountered.
4. Ability to identify environmental problems, and develop appropriate management approaches.
5. Ability to work as part of an interdisciplinary team, and engage in team-based real-world problem definition, inquiry, solution and report preparation.
6. An understanding of ethical issues faced by environmental professionals.
7. A working knowledge of soil science, ecology, hydrogeology, applied geomorphology and engineering geology.

Earth/Space Science Teaching

In addition to basic skills and knowledge in the Solid Earth major, the ESST major adds:

1. Pedagogy skills via working with faculty who hold joint appointments between the School of Science and the School of Education.
2. An understanding of content drawn from the Earth and Atmospheric Sciences that is tied to the National Science Education Standards and state science proficiencies.
3. A capstone Earth/Space Science student teaching experience that results in grade 5-12 Indiana State certification with physical science and/or mathematics as a supporting area.

Assessment Activities

The department uses multiple approaches to evaluate achievement of its goals.

Alumni survey
A survey of alumni was conducted in 1993. This written evaluation tool provided both structured and open-ended questions concerning the undergraduate education the respondent had received, the use of that education in the respondent's career, the respondent's preparation compared to colleagues who graduated from other schools, and the content and style of individual courses. This survey resulted in both changes to individual courses, and played a part in our comprehensive revision of the curriculum in 1996-1998.

External evaluation
The department undergoes formal external review every 5 years, using both academics and representatives from industry and government to assess all elements of our program. The reviewers assess our curricula, talk to undergraduates and the undergraduate committee, and provide suggestions for change in their review document. The 1993 evaluation was a motivating force behind extensive curricular changes in 1996-1998. In addition the Earth / Space Science Teaching Program is evaluated and accredited by the National Council for the Accreditation of Teacher Education, and is evaluated for recognition as a program by the National Science Teachers Association.

Course evaluations
All courses use a common multiple-choice style student evaluation, completed at the end of the semester. This tool surveys student opinion on a wide range of aspects of the course and instructor, and allows the student to add further narrative comments.

Capstone courses
All four majors include capstone courses that students take during their senior year. These courses integrate many areas of the students curriculum, requiring demonstration of both skills and knowledge, thus a student's performance in the capstone course is a good indication of the level of achievement of the overall goals of the major.

Peer evaluation
The department has a peer teaching evaluation program in which faculty evaluate a colleague's teaching using review of class materials (curriculum, readings, laboratory exercises, homework assignments, term papers and exams) and in-class visits. Typically a faculty member will undergo peer evaluation once every 3-5 years.

The assessment tools used by the Department of Earth and Atmospheric Sciences include:

a) Alumni surveys/interviews
b) Capstone courses
c) Departmental Industrial Advisory Committee
d) External peer review
e) Faculty observations
f) Focus groups

g) GRE and MCAT scores
h) Independent Research/data collection/oral presentation/written reporting
i) Internships
j) Post graduate placement
k) Professional Society recommendations and certification
l) Research thesis
m) Student surveys/interviews
n) Student teaching evaluations
o) University student data queries and reports

Feedback Loops

The assessment tools have contributed to several important changes in our undergraduate program in the past 4 years. In addition to faculty members revising individual courses in response to student, alumni and peer comments, the department went through major curricular revision in 1996-1998. Highlights of this include:

1. Development of four new tracks within the Atmospheric Sciences undergraduate major, matched to the major career areas in the field
2. Design and adoption of the new Environmental Geosciences major, to allow a stronger focus on courses within and outside the department that provide skills and knowledge for students interested in a career in the environmental field.
3. Creation of a new introductory course for our majors that combines both Earth and atmospheric sciences, so that students in all of our majors have an understanding of key areas across the discipline, and the interconnections between the major areas of the field.
4. Revision and reorganization of some existing courses to provide learning experiences that integrate skills and knowledge around issues or themes.
5. Expansion and reorganization of our field methods class to better prepare solid Earth students for field camp.
6. Addition of a course emphasizing geologic applications of mathematics and computers at the junior level.
7. Receipt of a National science Foundation, Collaborative for Excellence in Teacher preparation Grant to foster the use of action-based research teams to reform undergraduate courses in earth and Atmospheric Sciences.

Timeline

All assessment will be carried out yearly with the exceptions of teacher evaluations, which occur each semester, and the External Peer Reviews, which occur every five years.

Future Assessment Plans

The department recognizes that its current assessment tools, although successful in several ways, need to be enhanced to provide regular feedback from students and alumni, continued external input, and more formal tracking of student achievement after graduation. We have considered

several approaches, and based on our department's size and context our goal is to adopt/enhance the following tools:

1. Alumni tracking and survey. Building on our current approach we will institute a regular survey schedule, coordinated with the School of Science's online survey of graduates. This survey will be designed to allow us to collect information on former students' jobs and career development, to collect their input on how their education has prepared them for the demands of their career, and to receive their suggestions for improvements in individual courses or the curriculum as a whole.
2. Student focus group. To improve communication of suggestions from current students, we will institute regular meetings between the undergraduate committee and representatives from the discipline-oriented student organizations in the department. This focus group will use student organization meetings to collect input from a broad spectrum of students.
3. Exit interview. All graduating seniors will complete a written exit questionnaire, and an oral exit interview with the department chair.

DEPARTMENT OF MATHEMATICS

Introduction

The Department of Mathematics aims to balance the needs of the students across campus who take mathematics courses with the mathematics majors and the needs of one group of majors with the needs of other groups of majors. The most popular options in the Mathematics major are Core Math, Mathematics Education (for those students who intend to be junior high or high school mathematics teachers), Math with Computer Science. The Actuarial Science major is a separate major supported jointly by the Mathematics and Statistics Departments. In addition, we cooperate extensively with the Statistics Department because our students enter in the same pool. To be successful, we must meet the needs of students from all of these diverse groups of our majors.

Student Learning Outcome Objectives

1. To acquire a broad knowledge of mathematics.
2. To acquire knowledge of specific mathematical concepts and techniques from subject areas such as calculus of one and several variables, linear algebra, discrete mathematics, differential equations, abstract algebra, real and complex analysis.
3. To develop problem solving skills.
4. To learn both concrete and abstract reasoning in a mathematical context.
5. To become familiar with the principal modes of discovery in mathematics. Specifically, students should learn how to use technology as an investigative tool and how to formulate and prove conjectures.
6. To be able to understand and critically analyze mathematical arguments.
7. To communicate mathematical ideas precisely and clearly both orally and in writing.
8. To become familiar with the cultural, social and economic forces that shape our world.
9. To prepare for a lifetime of continual learning.

Assessment Activities

The Department of Mathematics takes advantage of a variety of assessment activities:

The department seeks input from both current and past students in many different forms. Student teaching evaluations have been mandatory for most mathematics classes for over 20 years. The data goes both to the instructor and to the administration. The Actuarial Sciences Program has used exit interviews since 1993. In 1999, the exit interview program was extended to all options in the mathematics department. In 1991 and again in 1994 alumni employment surveys of graduates from the previous three or four years were conducted. Since 1997, the department began collecting employment data on a yearly (or, in some cases, twice yearly) basis.

Another component of assessment is input from our faculty. There are at least six different departmental committees concerned all or in part with undergraduate education. Their membership includes over a third of the faculty. At the end of each academic year, their comments and observations are shared with the rest of the faculty in the form of a report presented at a faculty meeting. In 1997, the Head instituted a program of meeting personally with each faculty member on a yearly basis. While not primarily intended as an assessment tool,

these meetings can, and often do, provide valuable assessment information. When the department chooses a new Head (roughly, every five years), an extensive internal review is conducted of all aspects of the educational program. The Head selection committee submits a "state of the department" document for the new Head's consideration. Recently, we have instituted peer evaluations of teaching for some classes.

The department also seeks assessment data from outside the department. The Actuarial Sciences Advisory Council, which includes representatives from the Actuarial Science Industry, was created in 1993. In 1997 the department created a Mathematics Department Advisory Council with representatives from industry and all levels of education. Both councils review our academic program on a regular basis. Every five years, the department undergoes an extensive external review. The Mathematics Education program underwent an extensive review by National Council for Accreditation of Teacher Education (NCATE) in 1992. We have also received valuable input from the K-12 teachers who supervise our students during their student teaching.

The department also obtains valuable insights from recruiters and visitors to our department. The Actuarial Sciences program has its own placement program, totally separate from the campus placement services. The recruiters usually meet personally with the Director of Actuarial Sciences, providing valuable input concerning both the strengths and weaknesses of the students they interview. The other options within the department receive similar input from our "Career Night" program that brings representatives from industry and education to campus to speak to our students both in large groups and individually. Every summer the department hosts a calculus workshop for in-service high school teachers that is team taught by a member of the Mathematics Department and an in-service high school teacher. This is a valuable source for input, especially considering that since 1993, there have been only two different teachers from the department: the current and past Undergraduate Chairs, both of whom still serve on the Undergraduate Committee.

The assessment tools used by the Department of Mathematics include:

a) Exit interviews of graduating students
b) Alumni surveys/interviews
c) Certification and licensure examinations
d) External accreditation reports
e) Departmental advisory committees
f) External peer review
g) Comments from recruiters and other industrial representatives
h) Faculty observations
i) GRE examinations
j) Feed back from internships and student teaching
k) Post graduate placement
l) Student surveys/interviews
m) Student teaching evaluations
n) University student data queries and reports

Feedback Loops

The External Review Report of 1996 made several observations and recommendations in regard to undergraduate education.

“The Department is to be commended for the imaginative improvements it has made in the service courses, in large part in response to requests from client departments. This is especially true with respect to the redesign of the sophomore courses taken principally by engineering students.” In response to this outside need, the Department redesigned the second year courses which have become useful to a variety of audiences. One negative noted by the review team was the use of “outside” faculty. This issue has been a source of vigorous and continuing debate within the department and will be officially reviewed in the fall of 1999.

A second issue noted by the review committee was the lack of appropriate computer labs and technology in the classroom for math teaching. Both components of this issue have been significantly improved by the development of additional computer labs on campus and by the increased number of lecture rooms with advanced technology—in specific the lecture hall in the Math Building. More widely available math software has also helped to improve this concern. In the spring of 1999, the department unveiled a new state of the art interactive classroom that allows each student to interact immediately with the instructor via his/her individual computer.

In 1993, the Departments of Mathematics and Statistics appointed an Actuarial Advisory Council consisting of more than a dozen practicing actuaries. In annual meetings since then, the department has sought the council's advice on all aspects of the Actuarial Program, but especially on curricular issues. Based on their advice, the curriculum was radically changed in 1994-95, including the development of several new courses that they advised us were needed for our graduates to be well prepared for their careers. More recently, the department has sought their advice on the changes in the curriculum that will be effective summer 1999 that have been stimulated by the changes in the professional exams for actuarial certification. Throughout this time period, the council has praised our progress in responding to the needs of our students and supported our efforts by speaking to our students about the changes in the profession and the effects that will have on them.

In 1992, the department's mathematics education program went through an extensive evaluation by NCATE, which accredits mathematics education programs. They stressed the need for more instruction in graphing calculator technology. These comments were echoed by the in-service teachers in our summer calculus workshop. As a result, graphing calculator instruction was included in the syllabus for MA 301, which is taken by all mathematics education students. The Undergraduate Committee is also discussing ways for measuring the classroom competency of out Mathematics Education graduates. This initiative is in response to input from some of the high school teachers who supervise our student teachers.

In 1997, the Department of Mathematics created a Department of Mathematics Advisory Council. (The Statistics Department has a separate advisory council that has some joint meetings with our advisory council.) One of the K-12 educators on the advisory council commented that our program still does not include sufficient instruction in graphing calculator technology. As a

result, we are working to institute the use of graphing calculators in our majors' calculus sequence MA 161M-162M.

Many of the employers who come to recruit our students both for permanent positions and internships expressed a need for individuals knowledgeable in spreadsheet programs such as Microsoft Excel. As a direct result, spreadsheet programming has been incorporated into our Introduction to Actuarial Science class (SCI 170). The Undergraduate Committee is currently discussing proposals for incorporating spreadsheet programming into our new Mathematics-Business option.

Employment surveys of our graduates consistently indicated a surprisingly diverse set of job titles, many representing positions in the financial/business sector. Furthermore, a number of our Career Night speakers expressed a need for technically capable workers with training in business. Such input played a significant role in our decision in 1996 to create our Mathematics-Business option.

Future Assessment Plans

As evidenced from the previous comments, the Mathematics Department already has in place a wide variety of very effective assessment tools. The new School of Science Alumni Survey will contain questions specific to the Mathematics Department that will provide yet another source of input. We also plan to continue the exit interviews begun this year and perhaps augment them with student focus groups. The Undergraduate Committee is discussing proposals (such as a competency exam) for assessing the mathematical competency of all of our Mathematics Education students.

We need to strengthen and institutionalize feedback mechanisms. Assessment data needs to be channeled to the appropriate persons and committees within the department. Our newer assessment tools, such as the exit interviews, do have such feedback channels built into them, but some of the older ones do not. In particular, the employment data has not always been shared with the Undergraduate Committee. We hope to correct this problem.

DEPARTMENT OF PHYSICS

Student Learning Outcome Objectives

1. Acquire knowledge of the traditional subdisciplines of physics, including classical mechanics, electricity and magnetism, optics, statistical mechanics and thermodynamics.
2. Recognition of the development of physics as a continuing human endeavor on a global scale
3. Knowledge of the role of instrumentation in experimentation
4. Knowledge of the principles of information management and retrieval
5. Knowledge of laboratory safety and the ethics of the practice of science
6. Communicate scientific findings in both oral and written forms
7. Design and interpret scientific experiments and manipulate experimental data
8. Assess experimental results critically

Assessment Activities

The Department of Physics takes advantage of a variety of assessment activities.

One of these is our on-going mentoring program. All physics majors are invited to participate. Students meet in groups of about 5 or 6 with a single professor one time per week during the first semester to discuss a wide variety of current physics topics as well as career issues. The written feedback from the students indicates that this program is greatly appreciated and has played an important role in integrating new students into the culture of physics.

The Society of Physics Students (SPS) is a vital and strong student organization. With strong student leadership under the guidance of a caring faculty member, this group has helped build a sense of community among the undergraduate students. This groups regularly gives feedback on all aspects of the undergraduate experience in physics. They are also called upon to nominate a faculty member for the department's most prestigious teaching award.

Students who originally applied to the Physics Department and change to another school are regularly interviewed to determine the reason for their leaving the Physics program and in some cases, not beginning the program.

The assessment tools used by the Department of Physics include: **(Are there additional tools?)**

a) Alumni surveys/interviews
b) Departmental Advisory Committee
c) External peer review
d) Faculty observations
e) GRE scores
f) Internships
g) Independent Research/data collection/oral presentation/written reporting
h) Post graduate placement
i) Research thesis
j) Student surveys/interviews

k) Student teaching evaluations
l) University student data queries and reports

Feedback Loops

In the early 90's the Physics Department began a Seminar in Careers in Physics. It was not very successful in its original format and faded away. During the 1998-99 school year the seminar was revived with a new format. Instead of only academics, like the original, there was a good mixture of alumni from the "real world" and academics. This format is receiving positive feedback from both the students and the visiting alumni. Students indicate that this seminar opens up a wide vista of possible opportunities for physics majors.

During a recent departmental Advisory Committee visit, a student focus group expressed extreme satisfaction with their experience in physics. The department attributes this satisfaction to the response to observations and recommendations made by the External Review Committee following their visit in 1995 as well as earlier feed back from students and alumni.

The External Review Committee noted "the decline in undergraduate majors" as an area of concern. They noted that "substantial efforts have been launched to stem this trend and it appears that the department is on the right track." The efforts included promoting interest among high school students, the development of a freshman mentor system, new courses in computational physics and complex systems, and opening of the senior project to all physics majors. They also noted the development of a new Industrial Physics course, which demonstrated to them the department's sensitivity to the needs of industry. They concluded, "the department seems to have a strong commitment to quality undergraduate education."

In response to the observation of declining physics majors, the External Review Committee noted that through planning for recruitment the enrollment of physics majors had increased 15% which they felt was very positive though still well below the past highs. Some of the changes they noted included establishment of impressive workstations, computer facilities and an expert support staff; creation of a learning center and SPS lounge; introductory and advanced laboratory improvements; use of the world wide web; curricular changes such as the transfer of quantum mechanics to the junior year and new course developments; and a mentoring program. They noted that "the enthusiasm and departmental support for undergraduate education is excellent and the actions taken in this area are at the forefront of what is being attempted at universities today.

There was an impression that the best senior faculty do little teaching at the introductory level and that an increase in the number of physics majors might result from a real commitment to put the best teachers in the introductory courses. In response, the department has made a major effort to bring the best teachers into the early lives of the physics major.

The Review Committee commended the department on the strength of its undergraduate laboratories and the planned upgrades for others. The committee felt these state-of-the-art laboratories provide a rich source of data for research on how students understand concepts in physics. Departmental, Science Administration and University resources have made the

modernization of many of the undergraduate laboratories possible—for both majors and non-majors. Dedicated faculty have made this a priority. This is a continuing process.

The committee noted a new recruitment approach used an in-house video which emphasized physics as an entrée to non-physics careers. They felt this was not an effective tool and that it should be monitored. The Department has received both positive and negative reactions from students and advisors and are currently responding to the negative concerns.

In response to external feedback from alumni as well as the trends observed by faculty, several new courses have been created over the past four years. These include Science-Based Dating, Industrial Physics and Advanced Computational Physics. Each of these has met specific needs of physics and non-physics majors. Other new courses are planned.

Timeline

The assessment timeline is annual for all except teacher evaluations and external reviews. Teacher evaluations are carried out each semester and external peer reviews occur every five years.

Future Assessment Plans

A survey instrument is being developed which will ask for student feedback on all the lecture and lab courses in the Physics major as well as the facilities and services available to Physics majors. **Appendix I** is a copy of the survey.

Our internship program has been very successful for students who participate. We plan more and better surveys/interviews with returning students to better assess whether our teaching is preparing students for jobs and to improve the participation rate.

DEPARTMENT OF STATISTICS

Student Learning Outcome Objectives

Statistics majors

1. To learn methods used to analyze data statistically.
2. To understand the theoretical foundations of statistical inference.
3. To know the assumptions required for using statistical methods.
4. To analyze real data and draw appropriate conclusions.
5. To be able to read publications that use statistical methods and evaluate the validity of the statistical arguments.
6. To prepare written reports summarizing the analysis of real data and to present the conclusions orally.
7. To understand how statistics are used to draw conclusions and to understand the limitations of those conclusions.
8. To understand how research questions are translated into a form that can be addressed with statistical methods.
9. To understand how statistics are used to understand cultural, social, political and economic forces that shape our world.
10. To be skilled in the use of computers for statistical calculations.
11. To understand how statistics can be misused.
12. To understand the foundations and basic issues regarding the use of statistics so that new methods and techniques can be mastered easily.

Actuarial Science majors in addition to the above:

1. Will pass one or more professional exams before graduation
2. Will understand the concept of risk management
3. Become familiar with insurance terminology

Assessment Activities

The Department of Statistics takes advantage of a variety of assessment activities. **We need some examples of activities here in addition to the list below. They should relate to goals.**

The assessment tools used by the Department of Statistics include: **(Are there additional tools?)**

a) Alumni surveys/interviews
b) Departmental Advisory Committee
c) Exit interviews
d) External peer review
e) Faculty observations
f) GRE scores
g) Internships
h) Post graduate placement
i) Professional exams
j) Student surveys/interviews
k) Student teaching evaluations

l) University student data queries and reports

Feedback Loops

The External Review Committee of 1994 made several observations and recommendations.

An observation was that the “department’s undergraduate enrollment has been minuscule. This reflects the general pattern seen in Statistics Departments nationwide where the Statistics major is viewed as a terminal degree of limited use with a joint mathematics statistics major or mathematics major being the usual entry to graduate study in statistics.”

They recommended that, “given the increased emphasis in statistics on applications and the School’s new emphasis on minors it may well be reasonable for the Department to consider devoting resources to a major degree with minors in substantive fields such as the physical or biological sciences or business viewed as an entry degree to higher degrees in other fields.” “The Department shares the actuarial science major and a mathematics/statistics major with mathematics.” “Alternatively, the Department might want to consider using the statistics minor to make other degrees more attractive.” A Third possibility is the reinvigoration of the five-year combined BA/Applied MA program.”

In response to the recommendations, the Statistics Department revised the undergraduate applied Statistics major including two new courses STAT 506 and STAT 350. This revised major is now easily available to students who take the Actuarial Science major with the addition of one or two courses. The second undergraduate statistics major that emphasizes mathematics was revised so that it is now identical to the mathematics major with statistics option. No major was created that emphasized a minor in such fields as the physical or biological sciences or business (other than actuarial science). Statistics minors have also been created. No resources were expended to emphasize the 5-year BS/Applied MS program.

In 1993, the Departments of Mathematics and Statistics appointed an Actuarial Advisory Council consisting of more than a dozen practicing actuaries who were interested in our program. In annual meetings since then, we have sought the council's advice on all aspects of the Actuarial Program, but especially on curricular issues. Based on their advice, we radically changed the curriculum in 1994-95, developing several new courses that they advised us were needed for our graduates to be well prepared for their careers. More recently, we have sought their advice on the changes in the curriculum that will be effective summer 1999 that have been stimulated by the changes in the professional exams for actuarial certification. Throughout this time period, the council has praised our progress in responding to the needs of our students and supported our efforts by speaking to our students about the changes in the profession and the effects that will have on them.

Timeline

All assessment will take place on an annual basis except for teacher evaluations and External Peer Reviews. Teaching evaluations will be reviewed each semester and the External Peer

Reviews will take place every five years. The Departmental Advisory Council will provide recommendations on a random basis, but usually at least yearly.

Future Assessment Plans

The department will utilize the graduate and alum survey data to help in the assessment of its courses and curriculum effectiveness.