2006-2008 Assessment for B.S. in Astronomy
The University of Texas Department of Astronomy
Draft Revision 2008 July 30 by G. Shields

Mission

The B.S. in Astronomy aims to prepare students for advanced study and professional careers in the physical sciences and for life-long participation in the great intellectual adventures and explorations of astronomy.

Responsibility and Implementation Process

Responsibility for undergraduate instructions rests with the Undergraduate Studies Committee (UGSC), composed of the entire Department faculty in the case of Astronomy. UGSC considers and approves major changes to curriculum and course design. Responsibility for detailed oversight is delegated to the UGSC Executive Committee (EC), which is headed by the UGSC Chair working closely with the Undergraduate Advisor. The EC typically involves two additional faculty members, and the Department Chair ex officio. The Chair of the EC oversees the curriculum and assigns instructors, receives feedback faculty each semester, and works with instructors to design improvements for implementation the following year. Feedback includes assessments of coursework by instructors, focus groups with students, and exit interviews. The Undergraduate Advisor advises individual students on class choices and involvement in research, monitors their progress in class, and works with their research advisors to oversee their progress in research. The Executive Committee reports to the UGSC at least annually regarding the status of the undergraduate degree programs, proposed changes to course offerings, and other major issues involving the Astronomy degree programs and the undergraduate service courses. Post-graduation assessment of our program is done through an alumni survey; the Student Coordinator is responsible for collecting this data and reporting it to the EC for review and assessment.

Program Educational Objectives (PEOs)

The B.S. in Astronomy aims to prepare students for successful careers in graduate school or employment in government laboratories, education, or the private sector, in Astronomy or related disciplines.

Program Outcome: Physical Reasoning
Students will apply physical and mathematical reasoning to astronomical problems.

Method: Coursework Appraisals

Evaluation is based on homework, exams, and presentations in the basic course sequence (AST 307 Introduction, AST 352K Stellar Astronomy, AST 353 Astrophysics, AST 358 Galaxies and the Universe) and elective courses (AST 351 Instrumentation, AST 376 Cosmology, AST 376 Planets and Life; note: the

number 376 is used for several advanced topics courses). The rubric involves the following performance criteria: (1) students indicate strategy, reasoning, and procedures for solving problems; (2) students communicate their solution using mathematical representation (e.g., formulae, figures, diagrams, tables); (3) students indicate understanding of the problem by identifying the appropriate concepts and information necessary for the solution, and achieve the correct result. Scoring is on a scale of (1) needs improvement, (2) good and (3) excellent. Evaluation is based on written solutions to homework and exam problems involving quantitative application of physical principles to astronomical and physical systems. "Needs improvement" means that students demonstrate correct and effective physical reasoning, a clear explanation, and numerical accuracy in less than 50% of problems. A "good" performance shows, for 50 to 70% of problems, a broad understanding of the problem and concepts needed, effective physical reasoning and mathematical representation, a clear explanation, and numerical accuracy. An "excellent" performance shows for more than 70% of problems, a deep understanding of the question, efficient and sophisticated reasoning, effective mathematical representation, a clear and complete explanation, and numerical accuracy. Assessment will involve at least 50% of students in the B.S. program.

Competence goal:
80% of students perform at a "good" level
20% of students perform at an "excellent" level

Result: Results of Coursework Appraisals

In the "gateway" course AST 352K, assessment was based on homework problems and follow up questions on exams to test improved understanding of specific concepts previously covered in homework problems. Results for the initial homework problems on the key concepts averaged 92% good and 55% excellent, rising to 97% good and 76% excellent for the follow-up exam problems on the same key concepts that were assessed in the homework. See "actions" below for progress from Fall 2006 to Fall 2007.

For AST 353 in Spring 2007, the numbers of students performing at the 3/2/1 level and the percentage performing at "2" or better, were (in chronological order):

Problem Set 1	16 / 4 / 4	83%
Exam	14 / 6 / 4	83%
Problem Set 2	23 / 0 / 1	96%

On average, 87.5% of students achieved "good" or better on this outcome, exceeding expectation. Each entry retested elements of the previous one where students had difficulties, so that evidence of progress is visible.

For AST 358 in Spring 2006, assessment involved homework and exams and a research paper. Of 22 students, performance was good for 18 (82%) and excellent for 11 (50%).
For AST 376 Cosmology in Fall 2007, assessment was based on homework involving physical and mathematical problem solving; 83% of students scored at least "good" and 22% excellent.
For AST 376 Planets and Life (Spring 2008), assessment was based on homework and a final exam; of 6 students, performance was good for 83% and excellent for 33%.
For AST 358 in Spring 2006, of the 12 B.S. students enrolled, performance was good for 10 (82%) and excellent for 6 (50%). This is consistent with Spring 2006, but the statistical significance is limited and the sample selection is different.

Note: Except as noted, these assessments included all enrolled students as one group, and they did not involve a rubric as detailed as given above. For upper division courses in 2007 – 2008, appoximately 50% of students were Astronomy majors; of the Astronomy majors, approximately 25% were in the B.A. program and 75% in the B.S. program. Future assessments will be done for BA and BS Astronomy majors separately and will use the rubric.

Action Summary: Actions Taken

Performance in courses was generally satisfactory for "physical reasoning" and actions for improvement largely focused on other outcomes. Actions based on Fall 2006 assessments of AST 352K "Stellar Astronomy" included greater attention to celestial motions and appearances. Results in Fall 2007 showed improvement with 100%/59% (47/18% in Fall 2006) of students showing good/excellent performance (Homework I, problems 1, 2, 3), rising to 100%/93% (50%/38% in Fall 2006) when the same concepts appeared on exams (Exam I, problems 1,2). For AST 376 Planets and Life, numerical outcomes for physical reasoning were satisfactory. A reorganization is planned for future semesters to include student presentations and a greater use of "round table lectures" involving interactive problem-solving that students found beneficial.

Program Outcome: Communication skills

Students will communicate information effectively in written and oral work.

Method: Performance Appraisals

Faculty evaluate communication aspects of term papers, research reports, and journal reviews (written, oral, and posters). The performance criteria are: (1) students submit work with a minimum of errors in spelling, punctuation, grammar, and usage; (2) students make an oral presentation; students produce a poster or a PowerPoint presentation; and (3) in written, oral, or graphical

presentations, students provide content that is factually correct, supported by evidence, explained in sufficient detail, and properly documented.
AST 352K includes an emphasis on oral communication skills with two components: (1) each day, a short summary by one student of the previous class lecture, and (2) a term report, given as a PowerPoint presentation, based on a reading of papers in the professional literature. The instructor interacts with each student through several preliminary assignments upon which the students receive comments; these lead up to the final presentation and final evaluation on both content and communication skills. Astronomy 353 addresses communication skills through a team project involving oral progress interviews and a final written report. AST 358 includes in-class oral and written quizzes, and a research paper involving critical review of astrophysical journal papers.

Evaluation involves a rubric that includes purpose, content, audience, organization, and grammar. A presentation that "needs improvement" shows inadequate research, ineffective organization, and poor suitability for the audience. A "good" presentation has an adequate overall structure but could benefit from more research and specific development of arguments. An "excellent" presentation has a clear thesis, excellent development supported by thorough research, good attention to audience, and clear and effective organization.

Competence goal:
80% of students perform at a "good" level.
30% of students perform at an "excellent" level

Result: Results of Coursework Appraisals

For AST 353 in Spring 2007, 100% (5/5) of teams (4 or 5 students) gave a "good" or better performance, and 80% of teams (4/5) gave an excellent performance. For AST 358 in Spring 2007, 91% of students (20/22) gave a good performance and 41% (9/22) gave an excellent performance for communication.

Note: Except as noted, these assessments included all enrolled students as one group, and they did not involve a rubric as detailed as given above. For upper division courses in 2007 – 2008, appoximately 50% of students were Astronomy majors; of the Astronomy majors, approximately 25% were in the B.A. program and 75% in the B.S. program. Future assessments will be done for BA and BS Astronomy majors separately and will use the rubric.

Action Summary: Action Taken

Students in these upper division courses are meeting the competence goal for oral communication. We plan to include a lower-division course (AST 104 Seminar) in the communication appraisal in the future, along with assessments from AST 353 and AST 358.

Program Outcome: Critical evaluation of results

Students will critically evaluate research results.

Method: Performance Appraisals

Faculty assess student understanding and evaluation of published research studied for term papers, research reports, journal reviews, and homework assignments. The performance criteria are: (1) students retrieve information and discriminate among sources; (2) students identify arguments presented in a publication or oral presentation; and (3) students test a hypothesis versus data and/or physical laws. The evaluation rubric includes quality of sources, effective use of published and Internet resources, understanding of key concepts, ability to relate the topic to a broader context, and clarity of written or oral presentations.

Competence goal:
50% of students give excellent or good performance in all metrics.
30% of students perform at excellent level showing readiness for top graduate programs.

Result: Results of Performance Appraisals

No data were gathered on this outcome in the 2007-08 academic year.

Program Outcome: Research Participation

Students will participate in scientific research.

Method: Performance Appraisals

Research supervisors evaluate student participation in research projects conducted in the Astronomy Department, other departments at UT, or as part of outside research opportunities, such as competitive NSF-funded Research Experience for Undergraduates (REU). Performance criteria include: (1) students conduct observations or access archival data; (2) students apply critical reasoning in the analysis of the data; (3) students relate empirical findings to new or existing physical models; and (4) students author or co-author a paper or make a presentation at the College of Natural Sciences Research Forum for undergraduate or at a professional meeting. The assessment rubric includes familiarity with background literature, understanding of current problems in the specialty, originality of approach, quantity and quality of theoretical or observational results obtained, and clarity of written or oral presentations. The Executive Committee

reviews student products for level of student involvement in research and quality of results.

Competence goal:
50% of students make significant contributions to a research project in astronomy or a related field, such as would justify authorship or co-authorship of a journal article or presentation at a professional meeting.

Result: Results of Performance Appraisals

More than 40% Astronomy majors participate by graduation in research supervised by faculty or research scientists in Astronomy or another science department, usually Physics. About 25% of upper division students presented research at the January 2008 meeting of the American Astronomical Society in Austin. Of 4 students graduating with the B.S. in Astronomy in May 2007, one was coauthor of a professional conference presentation and a journal article. Of 7 B.S. graduates in 2008, 5 students were author or coauthor of a professional conference presentation, and 1 was coauthor of a journal publication. The department believes that this is a good level of research participation, given the diverse interests and goals of students in our B.S. program. (Note that research publications may require several years after graduation
To be completed and published in the journal.)

Action Summary: Actions Taken

The Executive Committee is working to improve the Department's webpage listing research opportunities, to encourage more faculty to mentor undergraduate research projects, and to promote student awareness of campus-wide research opportunities. Record keeping on the significance of student accomplishments in research was found to be inadequate for statistical evaluation. The Undergraduate Advisor and Student Coordinator are working to systematize record keeping on student research involvement and public presentations of results and on the significance of research contributions.

Score/Criteria	1 Needs Improvement	2 Good	3 Excellent
Problem Solving	Students indicate strategy, reasoning, and procedures for solving problems ***less than half*** of the time (***<50%***) through a ***mis-understanding*** of the necessary problem/ concepts, ***ineffective*** physical reasoning, ***unclear*** explanation and/or ***numerical inaccuracy.***	Students indicate strategy, reasoning, and procedures for solving problems ***most*** of the time (***50-70%***) through a ***broad*** understanding of the necessary problem/ concepts, ***effective*** physical reasoning, ***clear*** explanation and ***numerical accuracy***.	Students indicate strategy, reasoning, and procedures for solving problems ***nearly all*** of the time (***71-100%***) through a ***deep*** understanding of the necessary problem/ concepts, ***efficient and sophisticated*** physical reasoning, ***clear and complete*** explanation, and ***numerical accuracy***.
Mathematically Communicate Solutions	Students accurately communicate their solutions ***less than half*** of the time (***<50%***) using mathematical representation (e.g., formulae, figures, diagrams, tables).	Students accurately communicate their solution ***most*** of the time (***50-70%***) through mathematical representation (e.g., formulae, figures, diagrams, tables).	Students accurately communicate their solution ***nearly all*** of the time (***71-100%***) through mathematical representation (e.g., formulae, figures, diagrams, tables).
Identify Concepts and Information	Students indicate understanding of the problem ***less than half*** of the time (***<50%***) by ***failing*** to identify basic concepts and information necessary for the correct solution and result.	Students indicate understanding of the problem ***most*** of the time (***50-70%***) by identifying the appropriate ***basic*** concepts and information necessary for the ***basic*** solution, and achieve a ***correct*** result.	Students indicate understanding of the problem ***nearly all*** of the time (***71-100%***) by identifying the appropriate ***advanced*** concepts and information necessary for a ***complex*** solution, and achieve a ***correct*** result.