Inventory of Program Assessment Activities, through 2011

PROGRAM/DEGREE: BA Physics - Concentration in Astronomy **COLLEGE: Science and Engineering** **DATE: January 8, 2010**

Program Mission: This program is designed to educate students who need knowledge and skills in the fundamentals of physics and astronomy in order to pursue careers as high school teachers, observatory or planetarium staff, technical writers, or aerospace business people, or to possibly continue to a graduate program in astronomy. Graduates should have the fundamental mathematical, scientific, and learning skills to enable them to be lifelong learners who can rapidly learn and master new scientific and technical developments and who can present these ideas to others.

Measurable Learning Objectives	Place in curriculum where objective addressed	Academic year objective was/ will be assessed	Assessment/Procedures Methods/Strategies	Summary of Findings about Student Learning	Use of Findings for Program Improvement
1 Knowledge and understanding of, and ability to use, essential concepts and methods in essential areas of physics and astronomy.	Phys 220,230, 240 (I) Astr 320 (D) Phys 320 (D)	2008-2011	Performance on standardized examinations. We are adding a new "culminating experience" course Phys 695 to the BA degree. Beginning in Fall 2008, the final exam in this course will be the ETS Physics Major Field Test.	MFT was first administered in F 2008. We could not enforce this requirement as it was not in the bulletin when this year's graduates began their studies here. No BA (Astronomy) students have taken the test to date.	

		2007-2008	Evaluation of essay assignment in Astr 320 that tests understanding of and ability to apply key concepts. Use FCI as pre-Phys 220 exam to identify weaknesses that must be addressed in Phys 220. Use MEAT pre and post exams in Phys 230 to assess effectiveness of instructional program in E&M.	Phys 220: We have given the FCI as a pre-test at the start of the semester and as a post-test the week before finals in both the Spring and Fall 2009 semesters. For courses taught in lecture format, the typical gain across the country is around 25%. The gain for Physics 220 at SFSU in Spring 2009 is 30.7%, and for Fall 2009, the gain is 30.4%. With respect to this measure, we are showing better than average improvement in our students' conceptual and qualitative understanding. However, by the end of Physics 220, only approximately 20% of the students can be said to be at a mastery level of ``Newtonian'' thinking, with another 30% showing adequate levels of ``Newtonian'' thinking for further study. Phys 230: Three questions from the MEAT were administered to students in Phys 230, one at the beginning and two at the end of the semester. The first question addressed a topic covered in Phys 220, and 64% of the students answered incorrectly. After a closely related topic was covered in Phys 230, 76% of the students answered the second two questions correctly.	Phys 220: Now that we have quantitative data on this phenomenon, we as a department will be in a better position to address the discrepancy between conceptual understanding and rote calculation. The first and easiest change to implement will be to include more challenging conceptual homework problems to supplement the typical calculation-oriented problems. Instructors should also require students to write brief paragraphs explaining their logic and reasoning in addition to the equations and computation. When the CSU budget improves, COSE should restart the 1-unit discussion sections that supplement the lecture. Phys 230: The pre-test results are not too surprising as the topic is not a major focus of Phys 220 (although students should have covered this material in high school). The strong improvement shown in the post-test scores is encouraging. It is probably not realistic to spend more time on this topic in Phys 220. We will monitor the situation over the next few semesters to determine whether a curricular change is warranted.
		2006-2007	Performance on standardized examination. We are planning to use the ETS Physics Major Field Test in Spring 2007.	Field test could not be implemented without further lead time.	

		2005-2006	Performance in required courses as indicated by grades. Faculty have developed grading rubrics and have integrated grading standards into syllabi.	Major course grades followed a general pattern of 70% A/B (good knowledge/ understanding) and 30% C/less (minimal/inadequate)	Course outlines are modified and updated to address weak areas. Advisors use results to recommend course sequencing.
		2003-2004	Survey of students in program as to their progress toward attaining this objective.	Program students rated their progress 1.75/5 (1 best). Comments suggested changing curriculum in one course.	Instructor of courses in question was asked to adjust curriculum.
2. Adequate ability to utilize mathematical relationships and methods to describe physical and astronomical phenomena.	Phys 220,230, 240 (I) Phys 320, Astr 320 (D) Astr 410 (M)	2007-2008	Evaluation of homework assignment in Astr 410. Benchmark final exam problem in P385.	No BA (Astr) students took Phys 385 in F 2007 The problem evaluated in Astr 410 tested the students' understanding of one of the most important relationships in astronomy: the virial theorem. The problem links measurable kinematic quantities to the mass-density profile and is designed to reveal the underlying assumptions that play an essential role in most mass measurements in extragalactic astronomy. The problem was scored out of a total of 40 points, and the mean score was 32.3, or 81%. This score indicates that on average, students are mastering the concepts addressed by this problem. On the other hand, there is an appreciable gap between the performance of students in the BA/Astronomy program and the performance of students in the BS/Astrophysics program. The average score for BA/Astronomy students was 60%, while the average score for BS/Astrophysics students was 94%.	In Astr 410, the gap in performance between BA/Astronomy students and BS/Astrophysics students has long been recognized and played a central role in our decision to revise the astronomy curriculum in spring 2009. A new course, Astronomy 340, now serves the BA/Astronomy students with material more appropriate to their level. A newly proposed course, Astronomy 442/742, addresses the BS/Astrophysics and MS students directly in a format that is tailored to their needs.
		2005-2006	Performance in required courses as indicated by grades. Faculty have developed grading rubrics and have integrated grading standards into syllabi.	Grade patterns as above; informal tracking of ability w/ mathematical relationships and methods shows adequacy in 70% of BA-Astron. majors.	Course outlines are modified and updated to address mathematical content and development.

		2004-2005	Career success (alumni survey)	Alumni felt the program served them well in this regard.	Alumni felt that we did well in this area.
		2003-2004	Survey of students in program as to their progress toward attaining this objective.	Program students rated their progress 2.25/5 (1 best).	Students feel we are doing well in this area.
3. Ability to solve problems of moderate difficulty in physics and astronomy by integrating conceptual understanding, quantitative understanding, logical reasoning, and use of mathematical methods.	Phys 220,230, 240 (I) Phys 320 Astr 320 (D) Astr 410 (M)	2008-2009	Evaluation of final exam problem in Astr 410. Evaluation of portfolio problem in Phys 695.	In Astr 410, the evaluated exam problem tests the students' understanding of several aspects of cosmology and requires an ability to work with mathematical descriptions of a spatially flat, expanding universe. The first part of the question requires the student to make the link between the path of a photon from a distant galaxy to our telescopes and the various terms in the spacetime metric. The remaining parts test the students' ability to account for expansion in the mathematical expression for the observed flux. The average score in this case was 15.6 out of a total of 20 points, or 78%. There was a significant difference between the performance of students in the BA/Astronomy program and the performance of students in the BS/Astrophysics program (64% *vs.* 83%, respectively).	The gap in performance between BA/Astronomy students and BS/Astrophysics students has long been recognized and played a central role in our decision to revise the astronomy curriculum in spring 2009. A new course, Astronomy 340, now serves the BA/Astronomy students with material more appropriate to their level. A newly proposed course, Astronomy 442/742, addresses the BS/Astrophysics and MS students directly in a format that is tailored to their needs.
		2005-2006	Performance in required courses as indicated by grades, with special consideration of homework performance. Faculty have developed grading rubrics and have integrated grading standards into syllabi.	Grade patterns as above. Informal tracking of problem-solving performance shows adequacy in 75% of BA majors.	Course outlines are modified and updated to address problem-solving content and development.
		2004-2005	Career success (alumni survey)	Alumni felt the program served them well in this regard.	Continue present course.
		2003-2004	Survey of students in program as to their progress toward attaining this objective.	Program students rated their progress 2.25/5 (1 best).	Students feel we are doing well here.

4. Adequate ability to analyze and interpret data, with proper treatment of measurement uncertainties.	Astr 321, Phys 321 (I) Astr 470 (D)	2009-2010	In Phys 321 a series of computer exercises using Excel or Matlab will be used to assess ability to apply computer methods to analyze experimental data. Evaluation of lab report in Astr 470/321 Evaluation of lab report in portfolio.	In Astr 321, all students were successful at interpreting the significance of the data they collected and nearly all reached conclusions that followed from their data. However, many students found it difficult to communicate in very much detail exactly how they had reached their conclusions .	Continue providing detailed feedback on lab reports, so that students can incorporate what they learn from one report into their new report. Continue to discuss the importance of linking conclusions to data in detail in advance of when lab reports are due. Consider whether examples and/or in-class exercises could be designed to help students practice certain key elements that tend to present difficulty.
		2005-2006	Performance in laboratory courses as indicated by grades. Faculty have developed grading rubrics and have integrated grading standards into syllabi.	Upper-division laboratory grades run higher than in theory courses; 80% A/B. Likely due to small class size and extensive feedback from instructor.	Curriculum and required activities in laboratory courses are reviewed and updated as indicated.
		2004-2005	Career success (alumni survey)	Alumni felt that some improvement could be made.	Laboratory courses expanded their coverage of data analysis.
		2003-2004	Survey of students in program as to their progress toward attaining this objective.	Program students rated their progress 2.75/5 (1 best).	Laboratory courses are being reviewed to strengthen coverage of data analysis. Considering whether to make Astr 490 a required course (significant content in data interpretation and measurement uncertainties).
		2002-2003	Evaluation of laboratory reports and journals.	Informal reports from upper-division lab instructors indicate 70-80% adequate handling of data analysis.	Laboratory courses are being reviewed to insure adequate coverage in this area.
5. Adequate ability to design and implement experimental investigations, with proper use of instrumentation .	Astr 321 (I) Phys 321 (I) Astr 470 (D)	2010-2011	Evaluation of lab report in each of Astr 321 and Astr 470.		
		2005-2006	Performance in laboratory courses as indicated by grades. Faculty have developed grading rubrics and have integrated grading standards into syllabi.	Upper-division laboratory grades run higher than in theory courses; 80% A/B.	Curriculum and required activities in laboratory courses are reviewed and updated as indicated.
		2004-2005	Career success (alumni survey)	Alumni felt that lab courses could use some strengthening.	More modern instrumentation and apparatus was obtained for advanced labs.

		2003-2004	Survey of students in program as to their progress toward attaining this objective.	Program students rated their progress 2.75/5 (1 best).	Curriculum and activities in the relevant lab courses will be reviewed and revised.
		2002-2003	Evaluation of laboratory reports and journals.	Informal reports from upper-division lab instructors indicate 70-80% adequate ability in experiment design by end of lab sequence.	
6. Adequate ability to communicate knowledge and results to others in written and oral form.	Phys 321, Astr 321 (I) Astr 470 (D) Astr 410 (D) UD electives (D)	2007-2008	Evaluation of lab report in Astr 321 and 470.	The organization of the reports in Astr 470 improved substantially over previous years. Most of the improvement in the presentation resulted from a better understanding of the underlying material. In particular, the reports demonstrated a more logical progression from astrophysical theory to astronomical observation and a better correspondence between statistical theory and estimated uncertainties.	In Astr 470, students seem to be benefiting from the decision (based on the instructor's earlier informal assessments) to weave theory and observation more tightly together and to provide a more thorough discussion of statistics early in the course. In order to provide this extra help (which included extra homework assignments) without overworking the students, several useful labs had to be cut. In order to reinstate those labs, we proposed that Astronomy 470/770 be increased from a 2-unit course to a 3-unit course. The department approved this change, and the revision is currently under review by the Academic Senate.
		2004-2005	Career success (alumni survey)	Alumni suggested we have more opportunities for student presentations.	We have increased the student presentations in advanced lab, have added a "senior seminar" in astronomy which will incorporate student presentations, and are looking to add a similar seminar in physics.
		2003-2004	Survey of students in program as to their progress toward attaining this objective.	Program students rated their progress 1.75/5 (1 best).	We plan to incorporate somewhat more writing into upper-division courses
		2002-2003	Evaluation of laboratory reports and research projects.	Informal reports from upper-division lab instructors indicate 70-80% adequate quality of written reports after instructor correction and by end of lab sequence.	Adequacy of writing and presentation requirements and correction/grading is reviewed. Considering whether to make Astr 490 a required course (considerable written and oral presentation requirements).

7. Adequate ability to utilize print and electronic resources, computers, and software to gain information and perform calculations.	CSC 209 (I) Astr 321, Phys 321 (I) Phys 330, Astr 470 (D)	2008-2009	Evaluation of lab report in Astr 321 and 470. In Phys 321 a series of computer exercises using Excel or Matlab will be used to assess ability to apply computer methods to analyze experimental data.	Astr 321 makes extensive use of high-quality printed star charts that include stars down to magnitude 8.5 ("Tirion Sky Atlas"), with different sized dots representing stars of different brightnesses. All students were successful in being able to relate what they saw with their unaided eyes to what was in the Tirion Sky Atlases. Most students were also successful in comparing what they saw on the charts to what they could see through binoculars, although some had difficulty pointing the binoculars reliably (and repeatedly) at the relevant portion of the sky. In Astr 470, students' ability to work with IDL software in the Linux environment improved modestly compared to earlier semesters. Most students entered the course with less programming ability than one should be able to expect (based on the prerequisites), but the extensive IDL tutorial given during the first two weeks of class appears to be helping.	In the future, Astr 321 students will have the option to attach their binoculars to a tripod so that once they find the relevant portion of the sky they won't have to keep finding it over and over in between recording their observations. In Astr 470, continue to refine the software tutorials presented to the students early in the semester. It has also helped that Astronomy 420 has adopted IDL for numerical assignments; this coordination has enabled students to make faster progress on the purely technical elements of Astronomy 470.
		2004-2005	Career success (alumni survey)	Alumni suggested we provide better computing and software resources.	Department computing has been upgraded, especially in intermediate and advanced labs.
		2003-2004	Survey of students in program as to their progress toward attaining this objective.	Program students rated their progress 2.2/5 (1 best).	Relevant courses and projects will be reviewed and revised to address this need.
		2002-2003	Evaluation of problem assignments, lab reports, and research projects.	Informal reports from upper-division lab and theory instructors indicate 70-80% adequate performance.	Changes in syllabus/content of upper-division lab and project courses to address this need. Considering whether to make Astr 490 required (considerable use of print and electronic resources).