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September 4, 2019

Memorandum

TO: Faculty Senate Executive Committee

FROM: Jeffrey Brodd, Chair
Academic Program Review Oversight Committee

SUBJECT: Program Review of the Department of Physics & Astronomy

The Academic Program Review Oversight Committee has reviewed the Academic Program Review report of the Department of Physics & Astronomy prepared by Review Team chair Ben Amata and his team and agrees that it is ready for final approval. The Committee thanks and commends all of those involved in the review for their collegial and effective approach to the process.

The Review is ready for action by the Faculty Senate.

cc: Christopher Taylor, Chair, Department of Physics & Astronomy
Lisa Hammersley, Dean, College of Natural Sciences & Mathematics
Kitty Kelly, Chair, Curriculum Policies Committee
Amy Wallace, Associate Vice President, Academic Excellence
Steve Perez, Provost and Vice President for Academic Affairs (Interim)

Academic Program Review Report

Physics and Astronomy Department

California State University, Sacramento

Fall 2018/Spring 2019

Program Review Team

Ben Amata, Library, Team Chair

Professor Michelle Norris
Mathematics/Statistics

External Review Consultant

Associate Professor/Chair Erik Helgren,
Department of Physics University of
California East Bay

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1. Introduction:

The Physics/Astronomy Department is successful in fulfilling its, the College's, and the University's mission. Students express considerable satisfaction for its programs. The faculty are very productive in teaching and scholarship. This Program Review report recognizes the Department's successes in 18 commendations pertaining to its program review, curriculum, assessment, scholarly research, etc. It makes 15 recommendations relating primarily to curriculum and assessment to further strengthen its existing programs.

The Physics/Astronomy Department submitted its proposal on February 8 and completed its Self-study on September 4, 2018. Dr. Chris Taylor, Interim Department Chair, provided several names for an external consultant to Dr. Don Taylor in Academic Affairs, who invited Dr. Erik Helgren, Associate Professor/Chair for the Physics Department at California State University, East Bay to serve as the external consultant in fall 2018. Dr. Helgren accepted and visited on October 18-19, 2018. Dr. Michelle Norris, Mathematics/Statistics who served on the 2010 previous program review served as Natural Sciences and Mathematics (NSM) College's representative. The Senate and Academic Affairs were unable to provide another College representative.

Amata, Norris, and Helgren reviewed the Department's Self-study report. They met with Chair Taylor; toured the Department's facilities; met with the faculty (without the chair); met with adjunct faculty (without tenured/tenure track faculty and chair); met with Heidi Yamazaki, Administrative Support Coordinator II, and Tom Scarry, Instructional Support Technician II; and met with undergraduate students separately in order to evaluate the program and form its recommendations. Helgren interviewed College Dean Mott and Undergraduate Studies Dean German in telephone conversations after his visit. Amata met with Dean Mott and Dr. DeGraffenreid, former Department Chair who served for seven years spanning the time between the last and recent reviews, at later dates. Amata, Norris, and Helgren consulted the 2017 Fact Book. Amata prepared his report considering the original review materials, and the thorough and thoughtful consultant's report.

2. Commendations to the Department:

2.1 The Department provides high quality educational programs.

2.2 The Department prepared a Self-study report that addressed its curriculum, resources, student learning outcomes assessment, student diversity, graduation rates, student success, and student/faculty research.

2.3. Alumni overwhelmingly were satisfied (>75% very or somewhat satisfied) with their quality of instruction, quality of courses, intellectual challenge in the program, and overall experience with the major.

2.4 The Department has a reasonable success rate in students finding jobs.

2.5 The Department's Bachelor of Science provides a highly technical, rigorous curriculum that prepares its students for working in private industry and government or pursuing a post graduate education.

2.6 The Department created an innovative open house program that has doubled its majors, thus making it one of the largest in the U.S.

2.7 The Department has a large proportion of underrepresented minority majors (42%), well above the national average.

2.8 The faculty is dedicated to scholarship and research and have received substantial grant, contract, and project funding for a small department.

2.9 The Department's student average remediation rate (remedial math and English courses) is 14.6%, significantly lower than the College's average of 46.4%.

2.10 The Department serves the University by teaching lower and upper division physics requirements and service courses, (about 87% of its workload) for science, engineering, other disciplines, and general education courses.

2.11 The Department has a robust advising program that contributes to overall degree program success.

2.12 The Society of Physics Students has recognized the Department's club as a "Distinguished" or "Outstanding" chapter for 13 out of 16 years.

2.13 The Department furnishes significant research experiences for students through Physics 191 and other courses.

2.14 The Department pays for its seniors to take a national standardized examination, the Major Field Test, which enables comparisons with student performance at similar colleges and universities.

2.15 Dr. Morris obtained a grant to create a pilot program for Physics 11A (General Physics: Mechanics) to improve student learning outcomes.

2.16 Dr. Morris formed the Women in Physics (WiP) group in fall 2018 to mentor and support women, an underrepresented minority.

2.17 The Department utilizes social media to communicate with its students and alumni.

2.18 Faculty provide significant research opportunities at prestigious institutions and facilities, e.g. SETI, CERN, etc.

3. Recommendations to the Department:

3.1 The Department should review and implement the Office of Academic Assessment (OAPA) recommendations from its annual assessment feedback.

3.2 The Department should adopt External Consultant's and the Team's recommendation to provide greater detail in its assessment reports, future Self-Studies, etc. pertaining to the type, amount, and frequency of direct measures analyzed.

3.3 Faculty need to discuss if they should make greater efforts to impress upon students the importance of the Major Field Test as a student/program learning outcome, whether they think better preparation would be of value, and if the exam should be mandatory. As OAPA noted, it can be one but not the major direct measure for assessing knowledge. If the exam can be mapped to Blooms Taxonomy, the faculty should make the effort to do so.

3.4 The Department needs to provide greater detail about the types, amounts, and frequencies of writing and student achievement of the learning outcome.

3.5 The Department should review literature and consult with the OAPA and Center for Teaching and Learning (CTL) for ideas on how to strengthen their measurement of oral communication skills and provide greater specificity about the types, amounts, and frequencies of direct measures for assessment.

3.6 The faculty should consider reviewing theirs and other STEM literature for potential measuring of professionalism/ethical reasoning and civic engagement. For example it could possibly use case studies or supplemental instruction to reinforce class discussions. Faculty should continue using colloquiums and utilize social media to bring attention to topics that address the subject.

3.7 The Department should provide greater detail in its assessment plans and when appropriate distinguish between the BS and BA.

3.8 The Faculty should research and discuss if e-portfolios would enhance their assessment program.

3.9 The Team encourages the Department to further study Morris's results and conduct other appropriate targeted investigations of their curriculum and report substantive investigations in their next Self-study.

3.10 If the faculty submit a proposal for a master's degree, they should develop an assessment plan as part of their proposal.

3.11 The Department will need to monitor the Applied Physics Concentration's enrollment and revise its assessment plan as appropriate. Furthermore, it will need to discuss if it will need to develop a culminating experience for it.

3.12 The Department needs to discuss the question of standardizing the 5A course (General Physics: Mechanics, Heat, Sound). It should solicit input from the lecturers who teach the courses. Whether or not it chooses to standardize, it should implement a meaningful assessment for the 5A-B series.

3.13 The Department should continue utilizing American Physical Society (APS) and American Association of Physics Teachers (AAPT) resources to support underrepresented students in the program.

3.14 The Department should provide a summary of faculty meetings with information that is appropriate to share.

3.15 The faculty should consider recording some of the colloquia sessions for lecturers and students who cannot attend but could still view or listen at a later time.

4. Recommendations to the College:

4.1 Natural Science & Mathematics Dean or their designee should consult with her departments to collect information to submit to Institutional Research Effectiveness and Planning (IREP) for additions to the Alumni Survey that better reflect how ethical thinking, civic engagement, and intercultural communication are represented in the sciences. See Appendix II for survey results.

4.2 The Physics chair should alert the Dean if serviced departments do not respond to future surveys or requests for information so that they or their designees can assist the Department in collecting information.

5. Recommendation to the Faculty Senate:

Based on this program review, the Self-study report prepared by the Physics/Astronomy Department, and the external consultant's report, the Review Team recommends that all of the Department's degree programs be approved for six years or until the next scheduled program review.

6. Program Review Narrative:

6.1 Previous Report Recommendations.

1. Continue the successful efforts of recruiting transfer students to increase and stabilize the number of Physics majors.
The Department has more than doubled the number of Physics majors, from 43 in spring 2011 to over 90 in fall 2019.

2. Request the University for immediate tenure-track hiring.
The Department has hired six tenure-track faculty members since the last Program review. However, in that time it has also lost two to retirement and two to administrative reassignments.

3. Review the recent changes in the introductory sequences to scale back the size of the lectures, increase the number of discussion sessions while bringing back the size of both the discussion and the laboratory sessions.
Budgetary and space realities at the University have allowed only partial progress on this front. It hasn't been able to restore discussion sections but have reduced the enrollments in both the PHYS 11A and 11C courses. Unfortunately, to meet the demand in PHYS 5A and 5B, its lab sections remain at 30 students. There is no opportunity in its lab room schedule to add additional lab sections to reduce enrollment.

4. Regularize the frequency and timing of course offerings.
Course offerings are now scheduled on a regular, repeating basis and planned several years in advance. This has greatly increased their ability to advise students.

5. Pay some attention to the current state of the demonstration facility in terms of technical support as well as organization and maintenance.
The Department's new technician has systematically organized all demonstration and laboratory equipment.

6. Incorporate the linkage between program outcomes and the Baccalaureate Learning Goals of the University into its Assessment Plan.
The Department accomplished this alignment in AY 14/15.

7. Develop metrics to evaluate the success of the program and the accomplishments of the students.
The Department developed new assessment rubrics based upon the VALUE rubrics of the AAC&U in AY 12/13.

8. Assess student learning of specific topics by developing questions accompanied by rubrics for answers to be used on exams.
Specific questions focused on the new rubrics were not developed; rather it adopted the use of the Major Field Test to assess disciplinary knowledge.

9. Examine Physics 5 series for content and pedagogy to develop a mode that afford coherence and consistency across sections.
Faculty are largely supportive of the new pedagogies in use in PHYS 5A, but lack of resources prevent any effort to transition PHYS 5B to that format.

10**.** Consider adding targeted study sessions or mathematics workshops instead of adding another introductory sequence.
No new introductory sequence was created, nor has it had the resources to offer PHYS 1, an existing preparatory course. There was at one time a plan to offer Peer Assisted Learning sections to PHYS 5A, but the resources from a campus NSF grant to do so were reallocated to expand offerings in Chemistry and Math instead. However, for several years it was able to offer additional support through a Learning Assistant program in PHYS 11A and 11C. Unfortunately, though the learning outcomes were positive with this program, the primary goal of the funding program (increasing STEM teachers) was not met and the funds were routed elsewhere in 2017-18. No additional funds have yet been identified to resurrect the LA program.

11. Consider methods to assess the mathematical competence of incoming students in Physics 5A.
The University has recently revamped its Math placement system; it is hoped that this will alleviate the issue of unprepared students entering the PHYS 5A/5B sequence. The Department may also be able to use diagnostic math scores as a prerequisite for admission into PHYS 5A to ensure student preparation. The Chemistry Department has recently adopted this strategy; it awaits the results of implementing this method on student success.

12. Examine the courses leading into the senior project to make sure that students have had the opportunity to practice designing and independently implementing investigations.
Courses such as PHYS 115, PHYS 116, and PHYS 163 each have project components which provide students practice in designing and implementing investigations.

13. Review the current instructions given to the students in the capstone course to make sure that the expectations are clearly stated.
The PHYS 191 (Senior Project) guidelines have been revised to clarify expectations. They have recently been posted into a Canvas page which will be made available to all students.

6.2. General Information:

The Department is collegial, engaged, and successful. It offers a BS in Physics and a BS Applied Physics Concentration, a liberal arts BA and a BA Teacher Preparation Concentration, and minors in physics and astronomy. Also it offers two certificate programs for developing specific technical skills. Since its last review, it discontinued its BA in Physical Science for a variety of reasons; the BA Teacher Preparation Concentration became a better program for developing science teachers. It is investigating the possibility of offering an MS physics degree. Figure 1 provides the number of graduates by degree type for the last eight years.

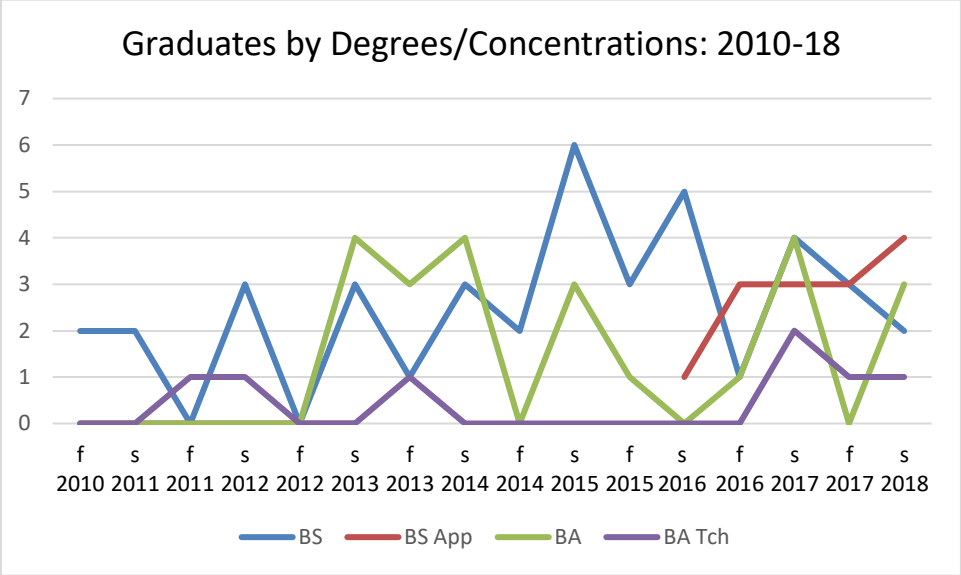

Figure 1

The mean or average undergraduate enrollment (2012-2016) is 80.4. Since 2006, it has doubled its number of majors (Self-study 2018 p 19). General education or service courses constitute 89% of the course offerings. Course size (mean 38.2) is larger than the College average (mean 32.36). The Remediation rate (14.8% five year mean) is far lower than the College's (46.4% five year mean); the University defines remediation as any remedial math and/or English courses that native or transfer undergraduate students must take. Unit load was slightly higher than the College's from 2012-14 but has become closer to the College mean. The mean graduating GPA (3.098) is slightly higher than the College's (3.048) and similar to the University's (3.096), however the preponderance of high level mathematics is an essential factor of the rigorous nature of the curriculum.

Commendation 2.9: The Department's student average remediation rate (remedial math and English courses) is 14.6% and significantly lower than the College's average of 46.4%.

6.3 Baccalaureate and Other Programs

6.3.1 Bachelor of Science

The degree in Physics is for students who intend to pursue further studies in the discipline or astrophysics. In 2016, the Department created a BS in Applied Physics Concentration for careers in technology fields that combines the rigor of the Physics curriculum with technical skills and flexibility in selecting elective courses. The Concentration has the potential of becoming the most popular degree. Undergraduate Physics programs are historically small. With the assistance Ed Mills, Vice President for Student Affairs, the Department created an open house program, an innovation that doubled the number of majors and made it one of the largest programs in the U.S. Helgren (2018 p 3) noted that "The program at Sacramento State University delivers an excellent balance of traditional theory courses required for students seeking to go to graduate school along with a strong, hands-on curriculum appropriate for students seeking employment in Industry after graduation." Furthermore he (Helgren 2018 p 5) wrote: "the scientific and technical skills students learn in these courses, along with communication and other professional skills, are exactly what employers desire in graduates, both those who intend to pursue graduate degrees as well those seeking employment in the wide-range of industry jobs available to students with a bachelor's degree in Physics. This approach is consistent with the J-TUPP recommendations as well." J-TUPP, the American Physics Society and the American Association of Physics Teachers joint task force, prepared *Phys21*, a report containing the skills and knowledge that the next generation of undergraduate physics degrees will need for a diverse set of careers. It also provided guidance for revising undergraduate curriculum to improve the education of a diverse student population and includes recommendations on content, pedagogy, professional skills, and student engagement and documents student outcomes.

Commendation 2.6: The Department created an innovative open house program that has doubled its majors, thus making it one of the largest in the U.S.

6.3.2 Bachelor of Arts

The BA is a general liberal arts degree, and the BA Teacher Preparation Concentration prepares students to teach high school physics. The BA also provides an opportunity for students who are unable to complete the BS program to graduate with a degree without having to find another major. Although the Teacher Preparation Concentration enrollment is small, it does not deprive resources from the other programs and fulfills the important service of training physics teachers.

6.3.3 Minors

Physics is a fundamental science that underlies the understanding of nearly all areas of science and technology. Physics (21 units) introduces major topics within the field. Astronomy (18 units) in combination with a major in a physical science prepares students for graduate study in astronomy, astrophysics, or careers in the discipline.

6.3.4 Certificates

The Scientific Computing and Simulation (14 units) focuses on the basic skills of applying computers to solve scientific problems that has wide applications. The skills include modeling and formulating problems, solving the resulting equations, and displaying the results graphically. They provide a foundation for industrial and academic careers. The Certificate in Scientific Instrument Development (11 units) focuses on using scientific instruments and the fundamentals of electronics, computer interfacing, and machining. It prepares students to design, develop prototypes, and construct instruments for a wide range of scientific applications. The programs are popular with the Department's and engineering majors but also majors within the College.

6.3.5 Student Research

The Department values and encourages Independent work and research. It offers a required capstone senior project course for the BS students and an elective course for students in other programs, including a special problems course in particle physics and astrophysics. In addition, many students have worked with faculty through the funded SURE, P-SURE, and W-SURE programs or unfunded opportunities. Students have had summer research opportunities at sites such as SETI, University of Oregon, University of Nebraska, Brookhaven National Laboratory, the American Institute of Physics, and CERN. For the past three summers, 10 different students have conducted research at CERN as part of Moss's research program. According to Helgren (2018 p 4), "The Faculty provide numerous meaningful research opportunities for their undergraduate majors. This is mostly accomplished through the required PHYS 191 Senior Capstone Project, however the students are exposed to a number of hands-on upper division lab courses leading into the PHYS 191 experience." DeGraffenreid's table (Figure 2) lists the number of independent research opportunities by major.

Commendation 2.13: The Department furnishes significant research experiences for students through Physics 191 and other courses.

Commendation 2.18: Faculty provide significant research opportunities at prestigious institutions and facilities, e.g. SETI, CERN, etc.

Degree	Number	Percent		Senior Project/116/163/199	195	Total	% w/ Best Practice
BS	40	48.2%		40		40	100%
BS-Applied	12	14.5%		12		12	100%
BA	24	28.9%		18		18	75%
BA-Teacher Preparation Concentration	7	8.4%			7	7	100%
Total	83					77	93%

Figure 2 (Fall 2010 through Summer of 2018, Physics issued 83 degrees)

6.3.6 Alumni Survey

The Institutional Research, Effectiveness, & Planning (IREP) office prepares and administers a standardized instrument that furnishes data from the last five years for departmental program reviews. Thirteen graduates responded for the latest review (Self-study 2018 Appendix E p 20-1). Amata summarized survey satisfaction in Figure 3 that demonstrates that the Department enjoys high satisfaction ratings for the quality of instruction and curriculum. Only "skills needed to succeed" scored lower (53.84%) in comparison. DeGraffenreid opined that this result may not reflect more recent student perceptions but those graduating after the 2011 recession when the Department struggled as did many others. The next program review will provide data that will allow the faculty to determine if this presents an area to address.

Commendation 2.3: Alumni were overwhelmingly satisfied (>75% very or somewhat satisfied) with their quality of instruction, quality of courses, intellectual challenge in the program, and overall experience with the major.

Question	**Very satisfied %**	**Some what satisfied %**	**Total %**
Quality of instruction	38.46	46.15	84.61
Quality of courses	53.85	38.46	92.31
Overall experience	53.85	38.46	92.46
Preparation for succeeding after college	46.15	30.77	76.92
Skills needed to succeed in the field	15.38	38.46	53.84
Intellectual challenge in the major	69.23	7.69	76.92

Figure 3

Since graduation 35.29% of graduates work in the private sector, 23.53% for governments, and 35.29% are pursuing post graduate education. At the time of the survey, the majority of graduates were working full time

38.48% and a smaller number part-time 7.69%. For those in graduate school, 15.38% were in full time and 7.69% part-time. Thirty percent reported not working or pursuing an education. It is noteworthy that some alumni do not work as physicists but in occupations where they utilize their skills for working with complex problems.

Commendation 2.4: The Department has a reasonable success rate in students finding jobs.

Commendation 2.5: The Department's Bachelor of Science provides a highly technical, rigorous curriculum that prepares its students for working in private industry and government or pursuing a post graduate education.

6.3.7 Graduation Rates/Student Success

There are various factors contributing to graduation rates: course offerings and scheduling, academic advising, and most importantly student intent and behavior. The Department has control over the first two, if there are adequate resources. According to the Alumni Survey (2017 p 2), 46.23% of students were very satisfied with the ability to schedule classes to graduate at a reasonable time and 23.08% somewhat satisfied. An important consideration is that the Department can only offer some courses in the major every other semester because of the small number of majors and the service course workload. Furthermore, the program is highly sequential, rigorous, and demanding. Helgren wrote (2018 p 5): "The sequential nature of the major and prerequisite enforcement make it so that students need to stay on track and take the courses when offered in the major. External and internal circumstances, e.g. employment and/or family life and the difficulty of the major, result in many students taking extra time to graduate. As such the average time to graduation, i.e., the 4-6 year graduation rates for native freshmen as well as the 2-4 year graduation rates for transfer students is somewhat lower than the University average. This should not reflect poorly on the department." He also noted the critical value of advising: 'All faculty advise students each term. This advising session is mandatory and "registration holds" are placed on each student until the meeting takes place. This "intrusive advising" was acknowledged by the students as a key factor to their continued success and keeping on pace to graduate in a timely manner. Students reported many opportunities to work with faculty, including undergraduate research, that increased their sense of community/belonging and provided informal advising.' At the student meeting, all students stated they intended to take more than four years total to graduate. The mean graduation rate is 5.3 years, the same as the College's. This is a very good rate given the nature of the program and student intent. The University shouldn't expect the Department to improve its rate given the aforementioned conditions.

Commendation 2.11: The Department has a robust advising program that contributes to overall degree program success.

6.3.8 Program Satisfaction

In the Alumni Survey and at their meeting, students expressed a high degree of satisfaction with their programs (Figure 3). Moreover they felt they belonged to a community with their faculty, staff and with each other. Helgren wrote (2018 pp 3-4): "Student satisfaction with the program is very high…A strong sense of community, caring faculty, opportunities for undergraduate research, and quality courses were all cited by Physics majors. During the site visit, students reported being very pleased with the quality of instruction and the dedication of the faculty. Alumni report satisfactory levels of finding employment (59%) related to their degree, and/or have been accepted to graduate school (35%) (Self-study Appendix E p 24). These accomplishments all point to a successful program." Students praised faculty who inserted buffers in their syllabi, extra time for dealing with traditionally difficult concepts. Also faculty take as much time as needed to explain difficult concepts. Many faculty put their lectures online so that they can spend more time in discussions and helping students to learn how to solve problems.

6.4 Assessment

6.4.1 The Department's Self-study and annual assessment reports provide two different assessment efforts and activities.

6.4.1.2 Annual Assessment Reports

The Team reviewed all available reports. In the 2012/13 report, the Department collected and evaluated data for analytic reasoning, technical skills, and communication skills. It reviewed senior projects (a direct measure) and conducted senior exit interviews (an indirect measure). Previously they collected examples of student work from specific courses, but not during that transition year. Faculty assessed critical thinking in 2013/14 but didn't use direct measures. They didn't collect any data or evaluate any programmatic learning outcomes (PLOs) during 2014/15; they answered negatively the question: do you know explicitly where the assessment of student learning occurs in the curriculum? In the fall of 2015 they used the Major Field Test (MFT) to assess physics knowledge for their graduating and near graduating cohort in PHYS 175 (Advanced Physics Laboratory), the course taken by all students near the end of their studies. Although voluntary, all students in spring 2016 took the test. During 2016/17, the Department (Assessment Report p 5) relied on the MFT for assessing disciplinary knowledge and found that their "students (N=18) performed right at average when compared to students from other similar institutions (regional comprehensive colleges/universities) with a total student set of nearly 1,000 students in the past five years." Also in 2017/18, it reported similar results with some nuances. At the faculty meeting, Sergan stated that overall 80% of the students are taking the exam.

6.4.1.3 Self-study

The Department analyzed physics knowledge, analytic reasoning, technical skills, and communication skills.

There are four analyses for physics knowledge (Self-study p 9-10). 1) The Department's Committee reviewed exams, final reports, and course grades using the old policy from 2010/11 through 2013/14. It was satisfied that their evidence adequately described the level of physics knowledge. 2) They analyzed final course scores in lower division physics PHYS 11A (AY 10/11). Ninety one percent (91%) of students obtained grades of D- or better, and 82% C- or better. The Self-study (2018 p 10) stated: "While not ideal, this rate is consistent with our expectations and well within the National range." 3) The senior project coordinator concluded that students are doing well in the mechanics of writing and in the oral presentations. The coordinator noted (Self-study 2018 p 10) that the reports lacked "in the description of the background physics relating to the research topic, and that not enough attention was devoted to error analysis." 4) Since spring 2016, students have taken the MFT (N=30) and performed right at average when compared to students from other similar institutions (regional comprehensive colleges/universities).

Faculty conducted two analyses of analytical reasoning (Self-study p 10-11). 1) They used the same evidence for physics knowledge. The Assessment Committee concluded that course grades indicate that about 83% of students have demonstrated a satisfactory level or higher. 2) The Senior Project Coordinator examined and concluded that senior project reports and presentations demonstrated analytical reasoning. Students work with a high degree of independence and most are capable of planning their project, identifying problems, and finding solutions to those problems.

The Department assesses technical skills through an analysis of upper division lab work and senior projects (Self-study 2018 p 10). The senior project encompasses all the competencies that students need to complete a project, including use of experimental equipment, data analysis, design of novel instruments, and computational work. The faculty state that the high grades in upper-division laboratory courses and the quality of the senior projects indicate that students are achieving technical skills.

There are two analyses of communication skills (Self-study 2018 p 11-12). 1) The Department analyses upper-division physics exams (written communication skills) for effective use of mathematical symbolism when solving physics problems. Students are to explain in writing the relationship between the math and the physical concepts that the math describes. The Department's analysis of final exams exhibits that majors can effectively communicate physics concepts using mathematical symbolism. 2) For senior projects, students must make an oral presentation. Faculty and majors are the audience and provide feedback forms to the presenters. The Committee examined the feedback forms for evidence of effective oral communication skills. It found that all of the reviewed projects illustrated a good grasp of essential writing concepts like grammar and organization. Furthermore it noted

(Self-study 2018 p 12) “that some student work is nearly at a level suitable for publication in a peer-reviewed journal.”

6.4.1.4 Assessment Plans
In 2015, the Department created two identical assessment plans, one for its BS and a draft plan for the BA.

6.4.2 External Consultant’s Report
Helgren made several observations about the current assessment plan. 1) The Analytical Reasoning Rubric applies to the final exam questions in courses: PHYS 110, 135, 150, 151, and 175 (Advanced Physics lab taken by all majors). It appropriately differentiates between the levels of achievement for the B.S. and B.A. majors. 2) Experimental and Computation Technical Skill Rubrics apply to PHYS 115, 116, 145,162, 163, and 175 (Advanced Physics lab taken by all majors). He wrote (2018 p 7): “These courses seem appropriate for this assessment, however the plan does not describe the types of assignments, i.e., exercises, exams, reports, etc. for evaluation.” 3) Written, Oral and Visual Communication of Data Communication Skill Rubrics apply to PHYS 191 (Senior Project course only required of BS Physics majors, not the BS Applied Physics majors and 175 (Advanced Physics Laboratory taken by all majors). In PHYS 175, the assessment plan states faculty will evaluate communication skills for the final written and oral reports. He noted: “The assessment plan is vague on the student’s advisor will evaluate the Communication Skill in the Senior Project course.”

Based on his observations, he made three recommendations (2018 p 8): 1) “The department is encouraged to provide more detail regarding their assessment in their department’s assessment plan, Self-study report, and in annual reports.” 2) “The department is encouraged to continue its assessment efforts, with a focus on understanding the impact that a possible Master’s program would have on the success of their undergraduates.” 3) “The university should continue providing, and consider increasing the level of, support for the department to carry out its assessment plans.”

6.4.3 OAPA Annual Assessment Feedback
Recommendations from the 2017/18 annual assessment report feedback (p 4).
https://www.csus.edu/programassessment/annual-assessment/2017-18assessment.html.

To improve overall programmatic assessment:

- Assess other PLOs (analytic reasoning, technical skills, and communication skills) aside from physics knowledge which it has done for several years. All PLOs should be assessed during the 6-year program review cycle. Use the assessment plan to schedule and manage the process.
- When assessing knowledge and skills, provide sufficient details in what students are to know and accomplish. Use Bloom’s taxonomy and verbs to explicitly define each specific program learning outcome.
- Describe how each specific PLO for the Overall Disciplinary Knowledge is explicitly aligned with the 70 multiple choice questions in the Major Field Test. Justify if the MFT isn’t required and if so, what other direct measure should be. For example, a required senior project may be a better measure.
- Consider adopting and adapting nationally developed VALUE rubrics to explicitly assess student complex skills and values. For example, see Oral and Written Communication skills rubrics.
- Develop explicit standards of performance for each specific PLO, and report the percentages of students who meet these standards at graduation. For example: 80% of students will perform above a certain score at on the MFT.”

6.4.4 Team Observations/Recommendations

6.4.4.1 The Program Review Team concurs with OAPA feedback and recommendations from the last two annual (2016/17 and 2017/18) assessment cycles. According to DeGraffenreid, the MFT doesn’t provide very granular data. The Department should provide as much detail as possible for how the test aligns with disciplinary knowledge outcomes.

Recommendation 3.1: The Department should review and implement the Office of Academic Assessment

(OAPA) recommendations from its annual assessment feedback.

6.4.4.2 The Program Review Team concurs with the External Consultant's recommendations to provide greater detail in its annual assessment reports, future self-studies, etc., the impact of a master's program (if submitted for approval), and appropriate support from the Dean for conducting assessment efforts.

Recommendation 3.2: The Department should adopt External Consultant's and the Team's recommendation to provide greater detail in its assessment reports, future Self-Studies, etc. pertaining to the type, amount and frequency of direct measures analyzed.

6.4.4.3 Physics Knowledge

Helgren noted the advantages of using the MFT for assessing disciplinary knowledge. It is nationally-normed, a research-based conceptual assessment, a national dataset for comparison, validated and reliable, and easy to administer and score with a large numbers of students. He cautions (2018 p 7) that it should be "evaluated in the broader contexts of institutional type, student preparation, and course design. Comparisons to historical trends in the department can be useful as well, and provide feedback on changes to the curriculum." While the Department stated in 2012/13 it could use it to potentially modify the curriculum, it hasn't found it necessary so far. Amata asked DeGraffenreid who responded that curriculum changes probably wouldn't result in student improvement. He opined that the students possibly don't understand the Department's reliance on it as a significant element for assessment since they don't associate any benefits to it. The Department places considerable weight on the exam for assessing disciplinary knowledge and has been the sole direct measure for the last three years.

Commendation 2.14: The Department pays for its seniors to take a national standardized examination, the Major Field Test, which permits comparisons with similar colleges and universities student's performance.

Recommendation 3.3: Faculty need to discuss if they should make greater efforts to impress upon students the importance of the Major Field Test as a student/program learning outcome, whether they think better preparation would be of value, and if the exam should be mandatory. As OAPA noted, it can be one but not the major direct measure for assessing knowledge. If the exam can be mapped to Blooms Taxonomy the faculty should make the effort to do so.

6.4.4.4 Written Communication

According to their assessment plan, faculty were to evaluate writing for the academic year 2017/18 (the Self-study was submitted in August 2018). In the Alumni Survey (Figure 3) 61% (46% sufficiently and 15% considerably) of students reported an acceptable confidence in their writing ability. There are several outstanding questions the Department should investigate. The Department's evaluation of student's writing doesn't align with the alumni's confidence level. This is one of the lower confidence rates for an essential learning outcome compared to other skills. The Self-study (2018 p 10) does not comment if the faculty have addressed the problem of senior project reports lacking background physics to the research topic and error analysis. The coordinator reviewed senior projects in 2013/14 (Self-study 2018 p 9). The assessment plan does not address writing in sufficient detail on the types, frequencies, etc., except for the senior project which is at the end of their experience. Also, while too early to know, it is possible that the BS Applied Physics Concentration may displace the BS as the most popular degree and doesn't require a senior project.

Recommendation 3.4: The Department needs to provide greater detail about the types, amounts, and frequencies of writing and student achievement of the learning outcome.

6.4.4.5 Oral Communication

The faculty stated that oral communication skills were adequate (Self-study 2018 p 31). However, only 38% (23%

sufficiently and 15% considerably) (Figure 4) of alumni reported confidence in oral communication skills (Self-study 2018 p 52). There is insufficient detail about their experiences in both Assessment Plans (2015 p 2): "Our students learn about all of these modes of communication and gain experiences in them through their work in classes and Senior Projects.

Recommendation 3.5: The Department should review literature and consult with the OAPA and CTL for ideas on how to strengthen their measurement of this skill and provide greater specificity about the types, amounts, and frequencies of direct measures for assessment.

6.4.4.6 Ethical Thinking, Civic Knowledge/Engagement, and Intercultural Knowledge

Students rate low levels of confidence for these baccalaureate goals (ethical thinking 38%, civic knowledge 39%, and intercultural knowledge 15%). At the student meeting, none understood what was meant by ethical reasoning. They do understand issues of plagiarism and data integrity. DeGraffenreid explained that the discipline uses the term professionalism rather than ethics and ethical behavior. He has written about this issue and created case studies. (https://www.spsnational.org/resources/chapters/ethics-resources). In addition, students rate their confidence for civil engagement low also. The American Physical Society created a statement that encourages scientists to provide their expertise and participate in public policy discussions. (https://www.aps.org/policy/statements/15_1.cfm) At their meeting, students stated they thought civic engagement was important, and the Department has hosted speakers who have discussed the topic at colloquiums. Intercultural communication remains the lowest scoring baccalaureate goal and doesn't align well with the discipline. There is some literature on the role of social justice that the Department could examine to see if it can be integrated into the curriculum or would be better suited for them to incorporate in the aforementioned methods, e.g. case studies or colloquiums.

Recommendation 3.6: The faculty should consider reviewing theirs and other STEM literature for potential measuring of professionalism/ethical reasoning and civic engagement. For example it could possibly use case studies or supplemental instruction to reinforce class discussions. Faculty should continue using colloquiums and utilize social media to bring attention to topics that address the subject.

Recommendation 4.1: The Dean or their designee should consult with their departments to collect information to submit to Institutional Research Effectiveness and Planning (IREP) for additions to the Alumni Survey that better reflect how ethical thinking, civic engagement, and intercultural communication are represented in the sciences. See Appendix II for survey results.

6.4.4.7 Assessment Plans

The Department doesn't distinguish between plans for the BS degree for preparing scientists and the BA for a liberal arts education and teacher preparation. The plans lack sufficient detail on the types and amounts of direct measures (student work) for evaluating whether or not students are meeting the PLOs. It should examine the Geology Department's assessment plan as a model. https://www.csus.edu/programassessment/assessment-plans/2017-18plans/1718%20BA%20Geol%20Plan.pdf

Recommendation 3.7: The Department should provide greater detail in its assessment plans and when appropriate distinguish between the BS and BA.

6.4.4.8 E-Portfolios

Similar to other departments in the College, faculty are unaware of the potential value of e-portfolios for their assessment program. The University provides all students and faculty with free e-portfolio software. While there is almost no literature in the discipline, there is a substantial body that could inform the Department. Lorenzo and Ittelson (2005) discussed the general benefits for all programs. Fenton (2013) reviewed the book *ePortfolios: A Guide for College Instructors*. Additionally, faculty can consult with OAPA and CTL. Dr. Stephanie Biaggetti is

available to attend a department meeting to discuss e-portfolios since the College of Education has been an extensive adopter.

Recommendation 3.8: Faculty should research and discuss if e-portfolios would enhance their assessment program.

6.4.4.9 Targeted Curriculum Review

Since the Department is small, faculty are used to having informal discussions that result in correcting, resolving, or modifying their program/curriculum. They need to develop a mindset for recording and reporting substantive changes to demonstrate and receive credit for improvements, especially as it relates to assessment efforts.

Dr. Morris received three Weighted Teaching Units (WTUs) from a Senate Exceptional Assigned Time Award to experiment with integrating a Physics 11A course, the Calculus Based Introductory Physics, to determine if it improved student success. Her initial finding was that this change had a positive effect on student learning (Appendix I). "Students in Physics 11A enroll in a lecture/discussion section with 81 students as well as a laboratory section with 27 students. The two sections are often taught by different instructors, and are taught as separate (though related) sections. The integrated course structure was implemented as a pilot program with one third of students in a Physics 11A lecture also attending the same laboratory section in fall 2018, allowing for enhanced interplay and coordination between the sections. A cursory look at performance indicates success rates far higher than those in the traditionally structured sections. However, these results need to be reproduced and properly analyzed and quantified."

Commendation 2.15: Dr. Morris obtained a grant to create a pilot program for Physics 11A (General Physics: Mechanics) to improve student learning outcomes.

Recommendation 3.9: The Team encourages the Department to further study Morris's results and conduct other appropriate targeted investigations of their curriculum and report substantive investigations in their next Self-study.

6.4.4.10 Reported Baccalaureate Goals Alumni Confidence

Learning Goal	Considerably %	Sufficiently %	Total %
Careful reading	30	46	**76**
Critical thinking	77	15	**92**
Creative thinking	46	15	**61**
Quantitative reasoning	69	15	**84**
Information literacy	38	46	**84**
Technical skills	85	8	**93**
Effective writing communication	15	46	**61**
Teamwork	46	31	**77**
Oral communication	15	23	**38**
Problem solving	77	15	**92**
Ethical reasoning	15	23	**38**
Civic knowledge/engagement	8	31	**39**
Intercultural knowledge	0	15	**15**
Ability to integrate	54	31	**85**
Apply knowledge to new problems	69	15	**84**
Lifelong learning	54	23	**77**

Figure 4

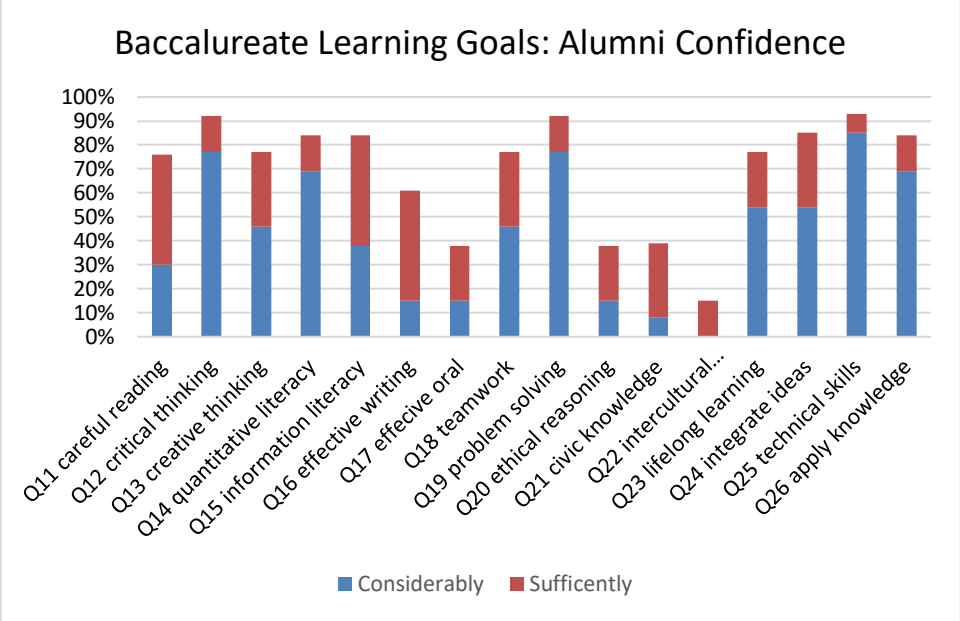

Figure 5

6.4.4.11 Potential Master's Program

The Department is researching the possibility of submitting a master's degree proposal. There are many benefits that the degree could provide for the Department and the region if there are sufficient resources. If it does submit a proposal, it should examine the Geology Department's assessment plan which provides an excellent model. https://www.csus.edu/programassessment/assessment-plans/2015-16Plans/15-16%20ms%20geol%20plan.pdf

Recommendation 3.10: If the faculty submit a proposal for a master's degree, they should develop an assessment plan as part of their proposal.

6.4.4.12 BS Applied Physics Concentration

The degree has the potential for replacing the BS as the most popular program by the next program review.

Recommendation 3.11: The Department will need to monitor the Applied Physics Concentration's enrollment and revise its assessment plan as appropriate. Furthermore, it will need to discuss if it will need to develop a culminating experience for it.

6.5 Focused Inquiry:

The Department investigated its Physics 5A/B course sequence, algebra based introductory physics service courses, that serve the biology, chemistry, geology and the health sciences majors. Recently Construction Management and Computer Science have adopted it for their curriculum. It is the largest service course that the Department offers of which 5A is also a General Education course but 5B is not." Figure 6 furnishes total enrollment for the last five years.

Commendation 2.10: The Department serves the University by teaching lower and upper division physics requirements, service courses, (about 87% of its workload), for science, engineering, other disciplines, and general education courses.

Course	Fall12	Spring13	Fall13	Spring14	Fall14	Spring15	Fall15	Spring16	Fall16	Spring17	Total
PHYS005A	254	269	262	264	259	269	274	261	271	334	2,717
PHYS005B	145	145	142	150	143	146	138	47	132	163	1,451

Figure 6 (2017 Fact Book, Table 8, page 8)

In order to determine if the courses are sufficiently serving the needs of a wide variety of students, the Department surveyed the serviced departments about its content and the laboratory experience to determine if it should continue to offer a general one-size-fits-all series or develop a series of individually tailored courses. It planned on conducting this inquiry in its last program review (2010) but didn't because of a shortage of faculty at that time.

The departments indicated that they were satisfied with the courses as currently structured (Self-study 2018 p 12-13). The breakdown of students by major who take the course are Biology 28%, Computer Science 17%, Kinesiology (Exercise Science) 16%, Construction Management 12%, Chemistry/Biochemistry 8%, and Geology 2%. Unfortunately, the two largest departments didn't complete the survey, even after repeated requests. Chair Taylor doesn't believe that obtaining the data at this time would change the results, but Biology and Computer Science should have completed the survey. In the future when the Department doesn't receive cooperation from others, it should request assistance from the Dean.

Helgren noted that many years ago the faculty altered the course in order to furnish a richer experience by incorporating high impact practices for engaging students. Additionally there were financial pressures. They transformed a three unit lecture, one unit discussion, and one unit lab to two lecture hours, one hour discussion, and three hours lab. Faculty have implemented the lecture plus discussion in different ways. In most cases, students enrolled in a lecture section must take a specific lab section taught by the same lecture instructor. While this format has an underlying value, it may also lead to a sometimes widely ranging disparity in the labs offered to different students in different sections according to Helgren.

The drop/failure/withdrawal rates for PHYS 5A and 5B as well as PHYS 11A, 11B and 11C courses are not unusual or too high. Some faculty expressed a desire to re-institute a "Learning Assistants" program that had been operated in the program for these types of classes in the past. Margoiner who was responsible for overseeing the program is submitting an analysis for publication. It was expensive to operate the program and ceased to a lack of funding. Helgren wrote (2018 p 5-6): "In light of the CO GI2025 Initiative, peer-mentoring programs such as the Learning Assistants, or perhaps the more well-established Supplemental Instruction Program do seem appropriate for the department's General Physics courses." Helgren recommended that the Department standardize the series. The department should develop and implement a

consistent and universal set of learning objectives for their PHYS 5A and 5B General Physics sequence, including the lab sections (I recommend reviewing the J-TUPP report and other recommendations on undergraduate education from APS and AAPT.)." Standardizing the course's content and outcomes makes sense for continuing a one size fits all model. At present there is insufficient data for the Department or the departments serviced to sufficiently understand student performance. At the lecturer's meeting, some stated there were problems with a one size fits all and adequate student math skills preparation, an issue raised in the previous program review report (see recommendation number 11 from the previous 2010 program review report on page 7 of this report). One lecturer administers an algebra test to determine if students are prepared for the course.

Recommendation 3.12: The Department needs to discuss the question of standardizing the 5A course (General Physics: Mechanics, Heat, Sound). It should solicit input from the lecturers who teach the courses. Whether or not it chooses to standardize, it should implement a meaningful assessment for the 5A-B series.

Recommendation 4.2: The Physics chair should alert the Dean if serviced departments do not respond to future surveys or requests for information so that they or their designees can assist the Department in collecting information.

The IREP can produce a report each semester of the student's grades by major (Figure 7). The Department can supply a report to the serviced departments to see if they would find it useful but this may not be adequate. One lecturer stated that enrollment by student majors varied by semester and that the major was less an indicator of success than the strength of the student's abilities and algebra skills.

Dept.	Course				# of Grade Levels Assigned				Total N=	Total grades assigned	GPA Mean
		A	B	C	D	F	Inc	Withdrawals			
Biology	5A 5B										
Computer Science	5A 5B										
Kinesiology (Exer Sci)	5A 5B										
Construction Management	5A 5B										
Chemistry (Biochem)	5A 5B										
Geology	5A 5B										

Figure 7

6.6 Faculty, Staff, and Resources

6.6.1 Department Faculty

The Department reached 12 FTE faculty (Figure 8) as of 2018 and nearly fully rebounded from the aughts when a lack of adequate tenure track/tenured faculty was a problem. There are six pre-tenured, three tenured associates, and three tenured full professors. Tashiro is the Center of Teaching and Learning Director and DeGraffenreid has held two different campus administrative positions since 2018/19 and isn't teaching at present. There is one full-time lecturer who has a three-year contract. The majority of the teaching load (87%) is service courses fulfilling the physics requirements for science, engineering, and other disciplines and general education. The degree programs are 13% of

the teaching load. In AY 2017-18 the Department taught 802 FTES, compared to 560 from the last Self-study in AY 2009-10. Temporary faculty members increased from four in 2010 to 12 in 2018.

Faculty Workload

Faculty	Level	14/15 WTU	14/15 Release	15/16 WTU	15/16 Release	16/17 WTU	16/17 Release	17/18 WTU	17/18 Release	18/19 WTU	18/19 Release
Block	assistant	18	6	18	6	24	0	18	6	24	0
Burki	associate	18	6	17	5	20	4	22	2	12	13(S)
DeGraffenreid	full	6*	18*	4*	20*	6*	18*	2*	9*	0	0
Duran	assistant							14	10	16	10
Jensen	full			16	8	11	13	20	4	20	4
Margoiner	associate	13	11	3	21(S)	14	10	6	18	7	17
Morris	assistant									15	9
Moss	assistant	18	6	12	12	12	12	13	12	12	12
Osborne	Full-time lecturer	30	0	30	0	30	0	30	0	30	0
Ray	assistant			18	6	18	6	18	6	20	4
Sergan T	associate	20	4	20	4	10	2(S)	20	4	19	5
Sergan V	full	21	23	4	0	20	4	23	1	21	3
Tashiro #	full	0	24	0	24	0	24	0	24	0	24
Taylor (interim Chair)	full	24	0	21	3	18	6	12*	12*	6*	18*

Notes: (S)=sabbatical; (*)=chair; (#) Center for Teaching and Learning Director

Figure 8

The University recognized the faculty's outstanding performance within the College -- two for teaching, two for scholarly activity, three for University service, and two for community service since 2010. They have maintained a high level of scholarly production with 30 published journal articles since the last review. Since 2014/15, they have been very successful in obtaining grants, contracts, and projects that totaled $ 1,473,204, a noteworthy accomplishment for a small department in the College. University Enterprises Inc. tracks only the external grants that it administers, and Figure 9 illustrates the Department's success. The Self-study noted that Moss and Ray, current probationary faculty, received National Science Foundation (NSF) grants. In addition Duran received funding after the Self-Study was submitted. Block has annually received supercomputing allocations on an NSF-funded supercomputer. Jensen received funding from campus and system programs to support his research.

Commendation 2.8: The faculty is dedicated to scholarship and research and have received substantial grant, contract, and project funding for a small department.

Dept.	14/15	15/16	16/17	17/18	Total

Biology	550,172	30,013	317,936	0	898,121
Chemistry	24,771	152,750	95,681	880,093	1,153,295
Geology	240,587	1,286,010	1,075,979	144,192	2,746,768
Geography	0	0	11,000	75,080	86,080
Math	182,057	185,839	308,512	155,987	832,395
Physics	**0**	**240,000**	**407,680**	**381,162***	**1,473,204**
MASE*	1,125	207,072	30,000	438,603	676,800

Figure 9

6.6.2 Staff

Faculty, lecturers, and students recognize the invaluable role that Yamazaki, Administrative Support Coordinator II, and Tom Scarry, Instructional Support Tech II, play in the efficient operation of the Department and curricular support. Helgren recommended hiring an additional staff person (2018 p 12). Dean Mott is aware of the Department's request and informed Amata that she is reviewing Yamazaki's responsibilities and in discussion with Chair Taylor to determine whether or not her workload is comparable with similar size departments (Geography and Geology) in the College. Also Mott and Chair Taylor are aware that the new planetarium will most likely require an additional staff person.

6.6.3 Space

Helgren recommended that the Dean allocate an additional laboratory in order to have the optimal enrollment of 24 students. To meet the demand in PHYS 5A and 5B, enrollment remains at 30 students in lab sections. There is no opportunity in the current lab room schedule to add additional lab sections to reduce enrollment. Technician Scarry has systematically organized all demonstration and laboratory equipment and trained his student lab assistants to maximize efficiency in setting up labs for courses. Dean Mott is aware of the situation and has plans to provide the Department with an additional lab. Also her goal is to house almost all Department faculty in offices on the same floor in Sequoia Hall when some of the College faculty relocate to the new science building and planetarium. Unfortunately, there is a lack of funding to renovate laboratories in Sequoia, a limiting factor.

6.6.4 Potential Master's

The faculty have been researching the possibility of offering a degree. They will submit a proposal if they agree that it meets regional educational needs, there are adequate resources (faculty supervision, labs, etc.), and it wouldn't detract from the undergraduate program. Dean Mott is waiting for the faculty to submit a report on the viability of offering a master's program and understands that if the Department receives University approval that it would most likely require an additional future faculty member.

6.6.5 Student/Faculty Diversity

The Department's undergraduate population is 82.9% male and 18.2% female. Students are predominately white 51.2% with the remaining under-represented minorities (URMs) (African American 3.7%, Asian 11%, Hispanic 20.7%, multiracial 7.3%, and unreported 1.2%) and 3% foreign. Nationally the number of URMs earning physics degrees has risen from 8% in 1997 to 13% in 2017 (https://www.aps.org/programs/education/statistics/minorityphysics.cfm). Students from low income families make up 37.8% and 18.1% are first generation. Women earning bachelor's degrees in physics has risen from 6% in 1967 to 20% in 2017. The Department's enrollment of female students is close to the national average. (https://www.aps.org/programs/education/statistics/womenstem.cfm).

The Department's faculty are predominantly male 81.8% and female 18.2%. The majority are white 68.2% with the remaining consisting of African-American 4.5%, Asian 4.5%, Latino 4.5%.

The Team concurs with Helgren's commendation (2018 p 8): "Commendably, as compared to the national average (statistics from AIP) the department has a large proportion of underrepresented minority majors, well above the national average. The representation of women in the program is low, but close to the national average; this is a well-documented, serious problem in Physics. The department is aware of and working to address this issue." Furthermore Helgren (2018 p 9) recommended that the "The department should continue utilizing APS, AAPT, and

other resources to support underrepresented students in the program." These include APS programs such as CUWIP (Conference for University Women in Physics), STEP UP 4 Women, Minority Bridge, and Mentoring.

Commendation 2.7: The Department has a large proportion of underrepresented minority majors (42%), well above the national average.

Recommendation 3.13: The Department should continue utilizing American Physical Society (APS) and American Association of Physics Teachers (AAPT) resources to support underrepresented students in the program.

The Team commends Morris who formed the Women in Physics (WiP) group in fall 2018 to meet regularly to discuss issues relevant to female physicists, including every day concerns and larger social matters, such as impostor syndrome. It received an American Physical Society grant to host events aimed at recruiting additional members and networking with the Society of Women Engineers (SWE) at the University. WiP sponsored a shadow day together with SWE in spring 2019 and created a competitive Research Experience for Undergraduates applications to national programs. Morris wrote letters of recommendation that will result in several of the group being accepted to strong graduate programs. Three of the WiP members attended a recent Conference for the Undergraduate Women in Physics (CUWiP) conference at UC Davis; they attended several grant writing and other professional development workshops geared towards helping students find productive paths to graduate schools (including securing funding). The Department sponsored the registration fees for the students to attend CUWiP.

Commendation 2.16: Dr. Morris formed the Women in Physics (WiP) group in fall 2018 to mentor and support women, an underrepresented minority.

6.7 Communication

Although not mentioned in the Self-study, DeGraffenreid told Amata that the Department utilizes social media to connect with its students and alumni. It was an early adopter of creating a Facebook page (available only for students and alumni) and using Twitter. The Team commends the Department's efforts to share department information, research, and interesting developments in physics and astronomy with students and alumni and uses email to share information with current students and lecturers.

Commendation 2.17: The Department utilizes social media to communicate with its students and alumni.

Lecturers are invited to attend Departmental meetings but rarely do because of time conflicts and other teaching jobs. They would like to have a summary of meetings (excluding issues that it can't share such as personnel matters).

Both adjunct faculty and some students expressed a desire to attend colloquiums but can't because of scheduling conflicts.

Recommendation: 3.14: The Department should provide a summary of faculty meetings with information that is appropriate to share (excluding personnel, etc.).

Recommendation: 3.15 The faculty should consider recording some of the colloquia sessions for lecturers and students who cannot attend but could still view or listen at a later time.

6.8 Student Physics Society

From 2002/3 to 2017/18, the Club has received over the last 16 years, 10 outstanding and 3 distinguished chapter awards. It also allows the students an opportunity to perform outreach and community service (civic engagement).

Commendation 2.12: The Society of Physics Students has recognized the Department's club as a "Distinguished" or "Outstanding" chapter for 13 out of 16 years.

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8. Appendix I

MORRIS Fall 2018- Exceptional Assigned Time Activity Report
Enhancing Student Support Architecture through Integrated Class Structure
Physics 11A, Calculus Based Introductory Physics

Thanks to the generous support awarded from the Faculty Senate and the Exceptional Assigned Time Committee I was able to implement a pilot program integrating three lab sections and one lecture section of Physics 11A. As mentioned in the initial application, Physics 11A is the first general physics course that a majority of calculus-based STEM majors will encounter here at Sac State. It serves as a pre-requisite for many science and engineering courses and can prove an early roadblock for many students, leading to long graduation times for students in STEM majors in both the College of Natural Sciences and Mathematics, as well as Engineering. The integrated lab/lecture format was developed and introduced in Fall 2018. I recognize that this is a pilot program, and in need of additional testing and refinement, but the initial results are quite promising.

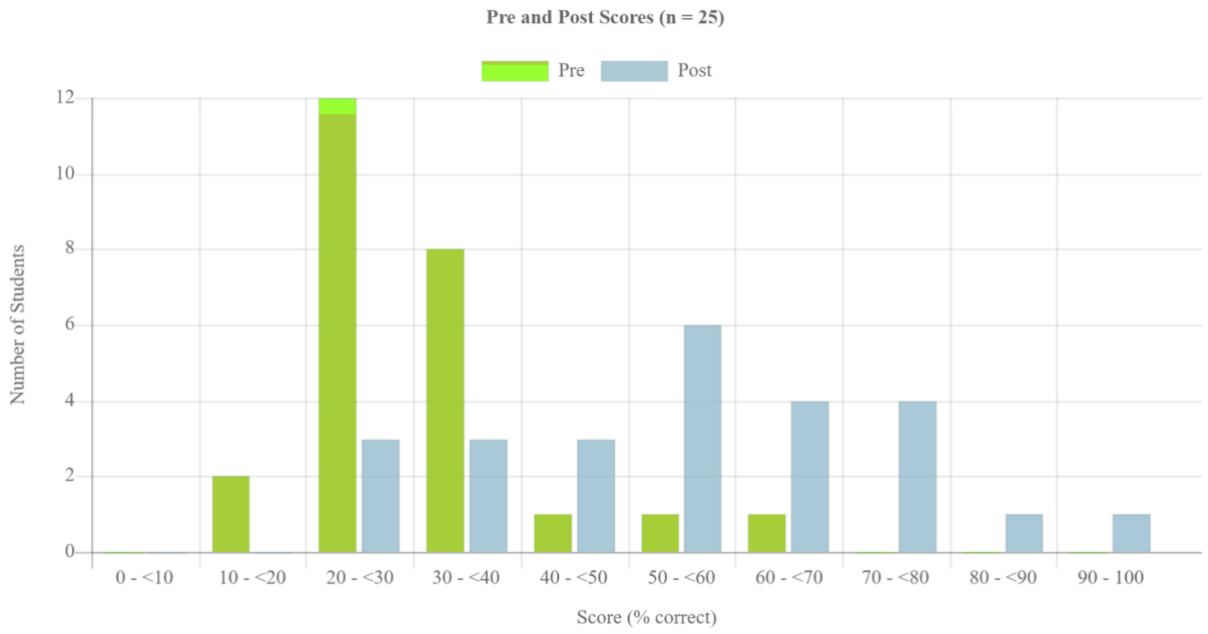
Currently, students in Physics 11A enroll in a lecture/discussion section with 81 students as well as a laboratory section with 27 students. The two sections are often taught by different instructors, and are taught as separate (though related) sections. The integrated course structure was implemented as a pilot program with one third of students in a Physics 11A lecture also attending the same laboratory section in Fall 2018, allowing for enhanced interplay and coordination between the sections. A cursory look at performance indicates success rates far higher than those in the traditionally structured sections. However, these results need to be reproduced and properly analyzed and quantified.

I have applied for a Pedagogy Enhancement Award together with the co-director of this pilot program, Dr. Mikkel Jensen (Physics & Astronomy), and a math education faculty member, Dr. Sayonita Ghoshhajra (Mathematics & Statistics) to analyze the data from the fall, and design and administer a follow up survey for those who participated in the Fall 2018 integrated class. Formative assessment, done using the standard Force Concept Inventory, were well above normal levels, with normalized Hake gains of 31-37% for the 3 lab sections (typical rates at CSUS are 20-25%). This also manifested in the DFW rates; only 4 students out of 80 ended up with grades of D, F, or W (typical rates are on the order of 15-20%). We are looking to gather additional data and ultimately publish the results.

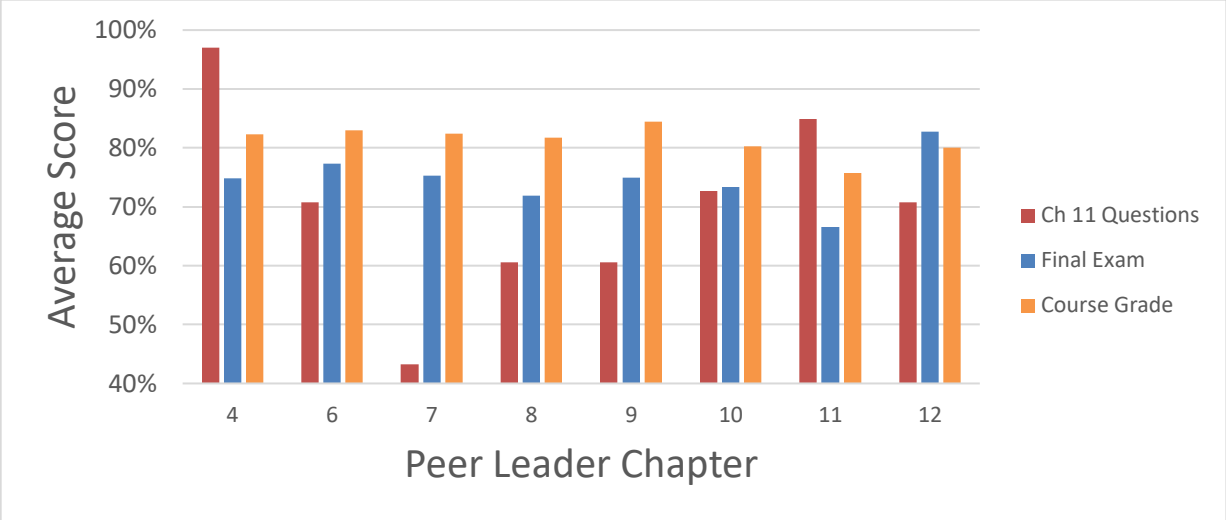
Throughout the semester students worked in the same groups in both lecture/discussion and laboratories, allowing for stronger peer-assisted learning in the classroom. To take advantage of the integrated structure, I facilitated a "student support network" in the class, in which students were assigned as peer mentors to other students in the class on a rotating basis. Students were designated "leaders" for one chapter and took a guiding role in their group when this chapter was

covered in both lab and lecture/discussion. These chapter leaders were encouraged to attend a special out of class office hour to help prepare them to lead their groups in class. They were also in charge of facilitating a canvas discussion on their chapter. Every week during the chapter quiz 2 or 3 particularly difficult questions were identified, based on class performance. These questions were posted to the discussion forum as a starting point for conversations. Each peer leader discussed optimal answers with classmates and then posted their "top response" to the discussion thread. This peer-assisted learning in the classroom helped to maintain an active learning environment in the large classroom setting (81 students). On the final exam I added in 3 multiple choice questions specifically targeting Chapter 11 content in order to test the impact of being a Peer Leader on chapter specific performance. Preliminary results suggest that there is some added benefit from time spent as a Peer Leader.

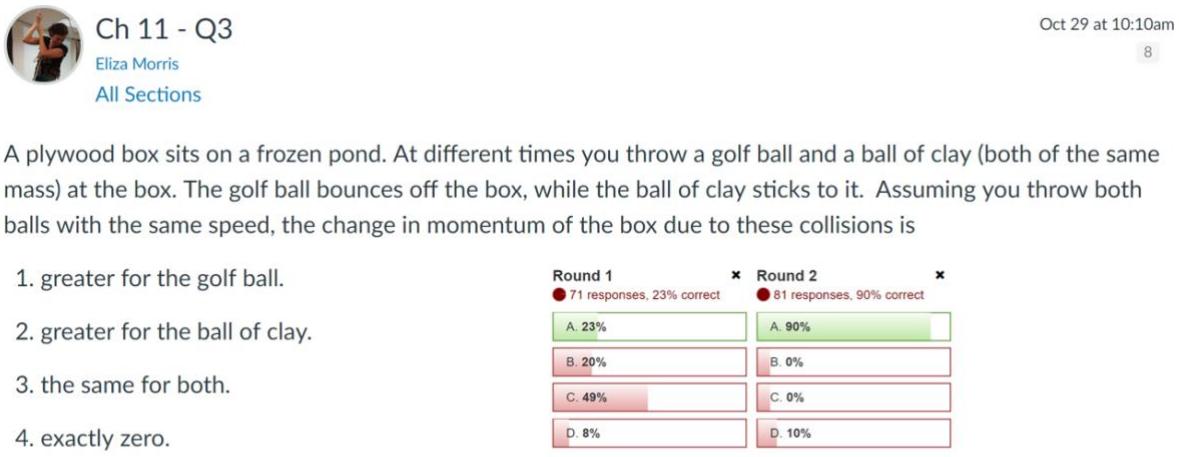
Overall the integrated class structure seems to be highly beneficial. We will continue exploring this new methodology, as time allows, and hopefully, if the Pedagogy Enhancement Award is granted, we can continue to analyze the results of this pilot program to continue enhancing the course structure.



The Force Concept Inventory results from Laboratory Section 03 are shown above. The Pre distribution refers to the test taken before the start of the course (mean 29%). The Post distribution refers to the test taken in week 11 of the semester (mean 54%). The normalized gain, taken as the amount gained relative to the maximum potential gain, was 35% for this section.



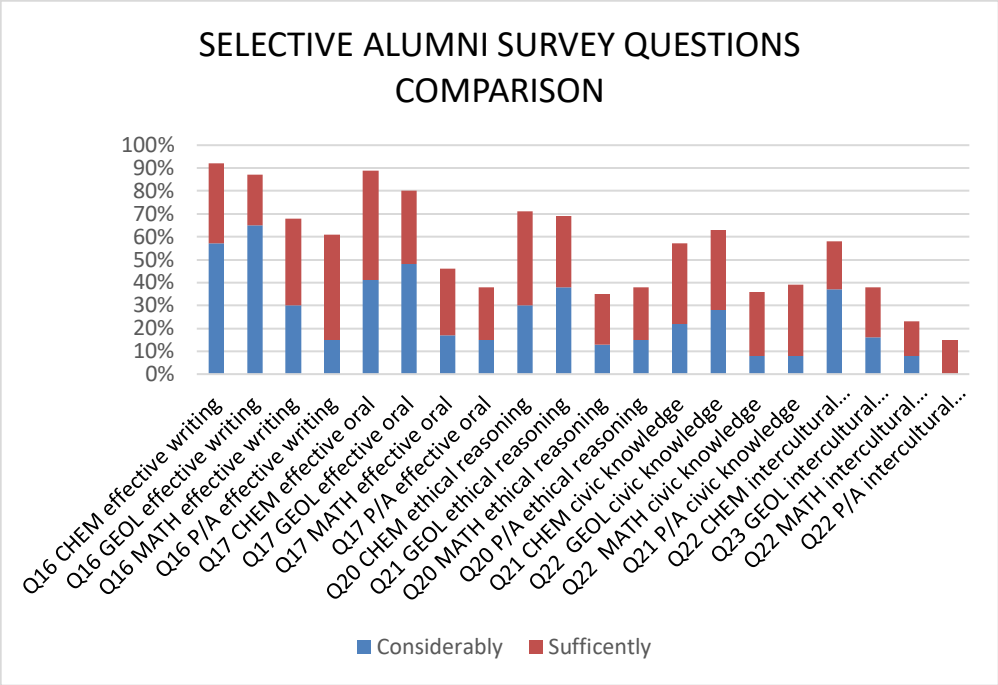
The Chapter 11 exam question results are shown above, as a function of the peer leader chapter assignment. Chapter 4 peer leaders performed best on the Chapter 11 questions, followed by the Chapter 11 peer leaders, other chapter peer leaders scored lower on the Chapter 11 questions. Note the overall final exam score and course grade was lower for Chapter 11 peer leaders when compared to other chapters.



An example discussion post is shown above. This question was given during the Chapter 11 quiz and proved particularly difficult for the students. The quiz results are shown at the bottom right of the post. Round 1 is the individual round, where only 23% answered the question correctly. Round 2 is the team round, where by their 3rd attempt 90% of the teams answered the question correctly. As a result, it was later assigned as a peer leader discussion. These responses were useful for the peer leaders, who often gained a deeper understanding of the material while generating their responses, as well as others, who used the chapter discussions as study tools for exams.

The On To the Future Program (OTF) is a grassroots initiative of the Geological Society of America (GSA) that addresses the organization's overall strategic commitment to building a diverse geoscience community by engaging groups traditionally underrepresented in the geosciences. The OTF Program awards partial travel scholarships to undergraduate and graduate students, and recent graduates studying in the geosciences, to attend their first GSA Annual Meeting. https://www.geosociety.org/GSA/Education_Careers/Grants_Scholarships/otf/GSA/OTF/Home.aspx?hkey=03114bd9-a31c-4478-a604-9df109a5acbb

Appendix II



9. Resources Consulted:

Undergraduate Students

Tenure track/tenured Faculty and Adjunct Faculty

Dr. Chris Taylor, Interim Department Chair & Dr. William DeGraffenreid (Chair from 2011 – 2018)

Heidi Yamazaki, Administrative Support Coordinator II, and Tom Scarry, Instructional Support Technician II

Dean Joanna Mott interviewed by Dr. Erik Helgren October 22, 2018 and Ben Amata November 2018

Undergraduate Dean Dr. James German by Erik Helgren October 22, 2018.

Physics and Astronomy Department Self Studies 2018 and 2010

Physics and Astronomy Department Fact Book 2017

Alumni Survey 2017 https://www.csus.edu/oir/surveyreports/alumni/2017/physics-and-astronomy-alumni-survey-report.pdf

Dr. Erik Helgren, External Consultant Report, October 19, 2018

Assessment reports/OAPA responses (http://www.csus.edu/programassessment/annual-assessment/2016-17assessment.html)

Assessment plans http://www.csus.edu/programassessment/assessment-plans/geology.html

Department Web page.

Society of Physics Students web page