California State Polytechnic University, Pomona

Academic Program Review - Self-Study
College of Science
Department of Physics & Astronomy
B.S. Physics

AY 2023-2024

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1 INTRODUCTION

1.1 Program Overview

Cal Poly Pomona (CPP) is one of 23 campuses of the California State University (CSU) system. It is the largest university system in the US, and was created in 1960 under the California Master Plan for Higher Education to focus on instruction and granting of baccalaureate and master's degrees. The CSU system now serves approximately 450,000 students annually, providing more than half of all undergraduate degrees conferred to the state's Hispanic/Latinx, African American, and Native American students combined.

CPP opened in 1938 as an all-male branch campus of Cal Poly San Luis Obispo. It enrolled its first female cohort of 329 students in 1961, formally separated from San Luis Obispo in 1966, gained WSCUC accreditation in 1970, was granted university-status in 1972, and converted from quarters to semesters in 2018. CPP is a regional comprehensive state university with over 2,600 faculty and staff serving approximately 26,000 students (Fall 2023). CPP's student population is diverse with 53% self-identifying as Hispanic/Latino, and only 13% identifying as White. Fifty-five percent of our students are first generation, and 42% are Pell-recipients,

The College of Science's mission is to educate, mentor, and inspire students through scientific inquiry and hands-on learning. There are seven academic departments that combined offer 15 undergraduate degree programs and six Master's degree programs. The College of Science has approximately 150 full-time faculty, 45 staff, and 4,600 active majors and strives to embody the teacher-scholar model by blending scholarship with education.

This is a review of the Bachelor of Science Degree in Physics, offered by the Department of Physics and Astronomy. The degree has three Options:

- General Physics Option
- Biophysics Option
- Integrated Science Option

There is one Emphasis available to students under the General Physics Option:

1) Astrophysics Emphasis

In addition, we offer three Minors:

- General Physics Minor (39 units)
- Astronomy Minor (41 units)
- Biophysics Minor (47 units)

1.2 Mission, Vision & Values

UNIVERSITY[1]	**Mission** - We cultivate success through a diverse culture of experiential learning, discovery, and innovation.
	Vision - Cal Poly Pomona will be the model for an inclusive polytechnic university that inspires creativity and innovation, embraces local and global challenges, and transforms lives.
	Values • **Academic Excellence** – We demonstrate academic quality, relevance, and excellence through our teaching, learning, scholarship, and creative activities with student centered faculty in an evidence-based culture. • **Experiential Learning** – Our polytechnic identity fosters an integrative approach to education through collaboration, discovery, learn-by-doing, and innovation. Our approach encourages reflection, informed risk-taking, and continuous learning. • **Student Learning and Success** – We are deeply committed to educational experiences and supportive services that engage our students, enhance personal well-being and growth, provide career opportunities, and foster ethical citizenship. • **Inclusive** – Our diversity across multiple dimensions reflects and enhances our community. We are welcoming and respectful, and we value diversity. • **Community Engagement** – We nurture mutually beneficial and meaningful relationships with community partners and stakeholders. • **Social and Environmental Responsibility** – As global citizens, our individual and collective actions reflect our commitment to one another, society, and the environment.
COLLEGE OF SCIENCE[2]	**Mission** – Educate, mentor, and inspire students through scientific inquiry and hands-on learning.
	Vision - Fostering curiosity and a culture of scientific discovery.
	Values – Curiosity, Integrity, Collaboration, Inclusivity, and Innovation.
Department of Physics & Astronomy	**Mission** - The mission of the Department of Physics and Astronomy is to provide rigorous education in Physics and Astronomy and to propagate the joy of physics through its diverse faculty who are active teacher-scholars contributing to their respective research fields. We create and maintain programs that many times transcend disciplinary boundaries and provide active classroom and laboratory experiences for our students to have successful research, industrial, and teaching careers.

The Department has not formulated Vision and Values statements, but is active in teaching, mentoring and research activities consistent with the above-listed statements. Much of what follows describes various hands-on, experiential approaches to student learning and success, in

[1] Source: https://www.cpp.edu/~aboutcpp/calpolypomona-overview/mission-and-values.shtml

[2] Source: https://www.cpp.edu/sci/about/index.shtml

keeping with the University's values and the College's mission statement, The department has not formulated such statements because the best way to infer an organization's values is to look at the actions that people undertake, not the verbiage that they produce.

1.3 History

1.3.1 Recent Program Review

The most recent Program Review took place in 2016-2017, with the External Review team visiting May 18-19, 2017. The reviewers were from the University of Southern California and California State University Long Beach.

In our departmental Self Study document for the 2017 site visit, the Department of Physics and Astronomy identified several suggestions for action, summarized here:

1) Space: The department identified significant needs for more space, including research space for experimental work and large classrooms suitable for flipped instruction and other modes of interactive engagement.
2) Faculty hiring: The department needs to hire more tenure-track faculty hires to compensate for retirements, respond to growth in the major, and maintain a heavy tenure-track (TT) presence in the service courses.
3) Improve and sustain the quality of undergraduate education: Besides a reaffirmation of our ongoing commitment to excellence in undergraduate education, there was a discussion of increasing the use of recitation/discussion/activity sections in courses, particularly introductory courses. There was also some mention of possible "common tests" for majors at various stages.
4) Alumni relations: Deepen ties with alumni to help current students prepare for careers.

The external evaluators' response to the departments' suggestions for action is summarized here:
1) The evaluators agreed with the department's need for additional space and recommended that the department develop requests specifying the purpose and size of additional spaces.
2) The evaluators stated that the pace of new faculty hires would only relieve short-term pressures, but not fix high student/faculty ratios. They suggested developing a multiyear tenure-track hiring plan to address concerns about student/faculty ratios.
3) The evaluators agreed with our plan for improving and sustaining quality undergraduate education and suggested we work with administration to build a plan for support.
4) The evaluators agreed with our plan for improved alumni relations.

The External Evaluators suggested several additional actions:

1) Valuing Research: The administration should continue to value and recognize the faculty's scholarly achievements, as faculty research benefits undergraduate education at Cal Poly Pomona. The reviewers suggested support in the following ways:

    - Sufficient start-up funds for new faculty
    - Adequate research space
    - Dependable and sustained sources of reassigned time for research

2) Deeper Engagement with the Lecturers: The evaluators suggested that the department coordinate the lower division classes with the goal of reducing DFW rates and improving student learning, with reassigned time for faculty coordinators, whether lecturer or tenure-track.
3) Job satisfaction: Suggestions for improving TT faculty, lecture, and staff job satisfaction included:

   - Recognition and awards for lecturers' achievements.
   - Tangible rewards for success in teaching and research, including teaching release and appropriate research space allocations.
   - Include staff in decision-making process when appropriate.

4) Learning Assistant Program: The evaluators suggested appropriate and sustained support for Learning Assistant (LA) salaries as well as reassigned time for faculty members operating the program.
5) Departmental Discretion in Financial Planning: The department has a proven track record of using discretionary funding responsibly and effectively. The administration should allocate appropriate discretionary funding to the department in recognition of efficient scheduling and planning. The college administration should provide more transparency in budgeting.
6) Stronger Communication: The evaluators state that the administrators' ideas should be clearly communicated with the faculty, with effective channels for faculty to deliver constructive feedback.
7) Appropriate Metrics of Evaluation: The department and administrators should discuss discipline-specific metrics in evaluating the department and student outcomes, including how growth in the major affects resource needs, or how our lab-intensive instructional needs affect space needs in the face of growing enrollment.

1.3.2 Changes Made in Response to the Program Review and Remaining Concerns

Our department has made efforts to follow up on the reviewers' "suggestions for action." However, many factors, particularly regarding space and other resources, are beyond our control. Here is an itemized summary of progress:

1) Space: The department has not gained any new research or instructional labs since 2017. We have lost time slots in some of our classrooms, particularly 8-4 (used for many introductory classes). Renovation of instructional lab spaces to accommodate more students (e.g. 4-3-567, used for upper-division labs) has been stymied by university procedures and space rules On a positive note, we have at least managed to renovate 3-2011 (used for many electives and discussion classes) with new furniture more suitable for computational activities and group problem-solving.

2) Faculty Hiring: This remains a major challenge. Since 2017, we have managed to hire four TT faculty members). However, one TT faculty member accepted a job at another college, another passed away, three finished FERPing (part-time teaching while in a semi-retired status) and another has begun FERPing. Our net loss is one TT faculty member.

Our current majors-to-TT-faculty ratio is 162:13=12.5:1, and in Spring 2023 our ratio of introductory lecture enrollment to TT faculty was the third worst among the 18 CSU campuses that provided data for a survey. Overall, our staffing situation is dire.

3) Quality of Undergraduate Education: Undergraduate education remains our top priority. Our work in that area cannot fit in this short summary, and occupies many sections in the rest of this report. Here we will just note that we have followed through on plans to expand the use of activity/discussion/recitation sections, but common tests remain an elusive goal.

4) Alumni Relations: This is one of our areas of greatest improvement since 2017. Both students and faculty now interact frequently with alumni via annual department events like the Alumni Career Panel and Women in Physics Seminar & Luncheon, College of Science events like the annual Research Symposium, Professor for a day, as well as guest lectures in many classes. Alumni also serve on our new Industry Advisory Board.

5) Valuing Scholarly Activities: There has also been some progress here.
   - Start-up funding: All new faculty continue to receive start-up funds, and start-ups for the two most recent experimental hires have been particularly generous, approximately $100k for each.
   - Research space: There has been no increase in the Department's research space. There has been some amount of reallocation of space, e.g. the growing astronomy group traded with the theoretical physics group.
   - Reassigned time: All new faculty in the College currently teach half-loads (6 weighted teaching units, AKA WTUs) in each of their first two years. After these two years, some research-active faculty receive up to 3 WTUs/year (out of a 24 WTUs/year load) through the institution's Teacher-Scholar Support Program.

6) Learning Assistant Program: We have maintained an active Learning Assistant Program and are beginning to incorporate LAs into some upper-division classes. The program is currently administered by a Lecturer, who is compensated for her time. However, the money comes from general funds rather than a dedicated source, and recent budgetary concerns delayed administrative action on LA hires.

7) Job satisfaction:

   - Recognition and awards for lecturers: Lecturer-specific awards are unlikely to increase engagement. Most lecturers have other jobs and time-demands outside our department; only tangible compensation for additional involvement could sustain greater engagement. Also, lecturer-specific awards would reinforce the two-tier nature of the faculty ranks.

     However, we often nominate lecturers for teaching awards, and in 2021 Svetlana Stouklova (now retired) won the College of Science Distinguished Teaching Award. Additionally, 3 lecturers currently receive reassigned time for service tasks in the department, coordinating the Learning Assistant Program , assessment activities, and instructional lab practices for faculty.

Also, Nathan Tung, a lecturer, has received considerable support (including a stipend for his time and internal grant for lab equipment) to revamp the experiments and lab manual for PHY 1050L: Physics of Musical Sound. We hope to find more opportunities for lecturers to take ownership of classes and spearhead innovations.

- Staff engagement: Staff are consulted on many departmental decisions. In particular, the stockroom staff provide input in all matters involving equipment and schedules for lower-division labs. The department recognizes that there is always room to improve in this area. Engagement with office staff in department decisions is more *ad hoc*, due to the daily working relationship between the department chair and the office staff.

8) Discretion in Financial Planning: We have seen little progress since 2017. We are not given a budget at the start of the year. Room and furniture upgrades require close consultation with the Dean's office. Hiring of student assistants at the start of the semester encounters bottlenecks in the Dean's office. Much of this is due to a campus-wide trend toward greater centralization of budget matters.

9) Stronger communication between faculty and the administration: The Dean conscientiously attends at least one department meeting per semester and hears concerns. However, many decisions that affect the department are beyond the Dean's control, and there is a general concern among faculty across campus that department-level concerns are not heard or valued. Since 2017, there have been major changes to class scheduling procedures, student registration (e.g. permission numbers for prerequisites), and TT hiring processes, among other areas. All of these changes have reduced department-level discretion, often in ways that make it harder for departments to achieve goals ostensibly shared by both the faculty and the administration (e.g. student success, operational efficiency).

10) Evaluation Metrics for Departmental Resource Allocations: There has been little explicit communication from the administration about what sorts of metrics would enable us to better communicate and justify our resource needs. Space allocations have not improved in discipline-appropriate ways. However, we have been able to argue for new TT faculty hires by noting that introductory courses for non-majors normally comprise the bulk of a physics department's efforts, and the TT faculty footprint in this vital endeavor needs to expand. Unfortunately, hiring has barely kept pace with attrition, a problem more of campus resources and priorities than lack of discipline-specific metrics.

    The department has also gained recognition and goodwill from the administration for its focus on career preparation and industry ties, as discussed below.

1.3.3 Major Changes to the Program

1.3.3.1 Semester conversion

The transition from a quarter system to semesters in fall 2018 was the most significant change in our department over the past seven years, necessitating a complete curricular overhaul. This overhaul was undertaken as a conscious effort to implement **item 3** from our last self-study, **improvement of undergraduate instruction**.

Format changes associated with semester conversion forced many hard choices. Replacing 10-week quarters with 15-week semesters allows more in-depth exploration of subjects in standalone

classes but involves tradeoffs when converting courses that were previously 2 quarters. We mostly converted 2-quarter core sequences to 1-semester courses with both a 3-unit lecture and a 1-unit (2 hours/week) recitation/activity section. For example, PHY 308 and PHY 309 (Mathematical Methods Physics) were converted to the PHY 3600 lecture and accompanying PHY 3600A activity course. As discussed below, these recitation/activity classes provide more opportunities for active learning approaches, and individualized attention as needed.

1.3.3.2 Addition of activity/recitation classes

Both of our sophomore-level lecture/lab courses (4 quarter units) were converted to lecture/activity/lab courses (4-semester total: 2 in lecture and 1 each in activity and lab). These courses are:

- PHY 2530/L/A- Introduction to Electromagnetic Radiation and Special Relativity
- PHY 2540/L/A - Introduction to Thermal and Quantum Physics

Recitations in the sophomore sequence provide dedicated time to reinforce and solidify understanding via discussions and guided problem-solving, in keeping with one of our goals from the previous self-study. Moreover, recitations help integrate students into the department as they interact with peers. This can be particularly beneficial for transfer students, who generally come in with one semester of 2000-level physics rather than two, and thus place into PHY 2540.

We have also added required recitations to the following core upper division courses:

- PHY 3600/A - Mathematical Methods of Physics I
- PHY 4010/A - Quantum Mechanics I
- PHY 4140/A - Electricity and Magnetism I
- PHY 4330/A - Thermal and Statistical Physics

Adding recitations to these core classes provides opportunities for students to revisit and reinforce their understanding of key concepts through additional practice and problem-solving exercises. Furthermore, recitations facilitate a project-based learning approach when appropriate, as avenues for hands-on projects, group work, or other interactive learning experiences.

For instance, activity sessions in PHY 4140A (Electricity and Magnetism) often include numerical simulations in COMSOL Multiphysics using AC/DC, RF, and wave optics modules. COMSOL Multiphysics is widely used in many industries for simulations and analysis.

Additionally, we have added accompanying recitation/activity courses to the following elective courses for a more project-based approach.

- PHY 3440/A - Applied Optics
- PHY 4090/A - Computational Physics
- PHY 4510L/A – Advanced Laboratory Physics – Advanced Instrumentation Laboratory
- PHY 4520L/A – Advanced Laboratory Physics – Contemporary Experiments Laboratory
- AST 3240/A- Observational Astronomy and Data Analysis
- AST 4240/A - Astrophysics I: Stars and Planetary Systems
- AST 4250/A - Astrophysics II: Galaxies and the Universe

Examples of how recitations are used in some classes:

- PHY 4510 and 4520: Lab time is mostly used to perform experiments, while activity time is mostly used to discuss relevant physics concepts and data analysis skills.
- AST 3240/A: Students analyze astronomical data using Python and astronomical software packages such as SAOImage, ds9, and TOPCAT. At the end of the semester, students produce a photometry catalog (data table) of stars that they extract from near-infrared imaging data previously obtained using the 3.5-m WIYN telescope and present a set of color-color and color-magnitude diagrams (plots) made from their catalog data. The lecture and activity are integrated seamlessly in this course pairing.
- PHY 3440/A: Students use Zemax, a professional-grade simulation package for modeling lens systems.
- PHY 4090/A: Students write simulation code (usually in Python) to solve physics problems. Class time is divided between discussion of relevant theory, algorithms, code development, and troubleshooting.

1.3.3.3 Optional Recitation Classes

In addition to classes listed above, we offer ***optional*** recitation classes for students in the introductory calculus-based physics courses:

- PHY 1510/L/A*- Introduction to Newtonian Mechanics
- PHY 1520/L/A* - Introduction to Electromagnetism and Circuits

Our goal in offering elective activity/recitation classes (i.e. PHY 1510A and PHY 1520A) is to address the high DFW rates (D/F/Withdraw grades) in introductory courses. The hope is that 2 hours/week of additional problem-solving in a group setting, with more opportunities to interact with the instructor and learning assistants, will lead to greater success.

We recruit heavily at the beginning of the semester, encouraging all students to enroll in recitations. These efforts were revitalized in the 2022-2023 academic year, the first fully in-person year since 2018-2019, with a heavy focus on PHY 1510A, since PHY 1510 is the foundation for success in all subsequent physics courses. After two semesters of strong enrollment (topping 40 students in Spring 2023) the Department is committed to offering multiple sections of PHY 1510A and reviving PHY 1520A in Fall 2023.

In addition, as evidenced by performance on the Force Concept Inventory (a standardized assessment instrument in physics), students who enroll in PHY1510 demonstrate better gains in knowledge of Newtonian Mechanics. We will elaborate on this further on in this document.

1.3.3.4 New Hires

Since 2017, we have managed to hire four TT faculty members, with another search for two more faculty going on this year. Each new faculty member has brought unique expertise and broadened the research experiences available to students. The areas of expertise are:

- Observational Astronomy, specifically an expert who studies the birth and death of massive stars in the Milky Way and nearby galaxies. This work uses multiwavelength observations to study X-ray binaries-star systems with a black hole or neutron star gravitationally bound to a normal companion star - to better understand their formation and evolution. Students involved

in this work have investigated black hole binaries, supernova “impostors,” and the remains of binary merger events. There are collaborations with other CPP faculty to study massive star clusters and H II regions. One student participant in this work represented Cal Poly Pomona at the CSU Student Research Competition in April 2023.

- Experimental biophysics: This research group emphasizes single-molecule experiments. The research is interdisciplinary, addressing problems in biomedical sciences with state-of-the-art physics-based apparatus. The focus is on dynamics and interactions of membrane proteins in native lipid environments. One goal is to address fundamental problems in membrane biophysics and eventually facilitate innovative approaches for new drug development.
- Theoretical condensed matter physics: This work uses *ab initio* electronic structure simulations to study the properties of different materials. Computational tools like Density Functional Theory and systematic crystalline structure search algorithms allow explorations of matter in settings not directly accessible to experiments. This investigator has previously published in journals like Nature Communications and Angewandte Chemie, including research with undergraduate students.
- Theoretical Cosmology: This work focuses on how low-mass galaxies can help answer fundamental questions about the Universe. The high dark matter content and shallow potential wells of these objects make them excellent testbeds for differing theories of galaxy formation. These investigations use simulations of dwarf galaxies at high enough solution to test the end of galaxy formation physics, investigate challenges to our current cosmological paradigm, and improve galaxy formation models.

The incorporation of a new experimental biophysics group into the department upgraded and expanded our experimental facilities, acquiring a state-of-the-art Atomic Force Microscope (AFM). This instrument can image individual biological molecules, measure distances in the sub-Angstrom range, and measure forces of order picoNewtons. Students use the AFM to study membrane protein structure and protein-membrane interactions in physiologically relevant settings.

These new faculty members have supervised 47 students in total since their hiring. New faculty also offer courses directly related to their specialties, providing students with diverse educational opportunities, including:

- Our new experimental biophysicist has taught biophysics (PHY 4100), directly relevant to his research. Dr. Sigdel has also taught Advanced Instrumentation lab (PHY 4520L), befitting his expertise in experimental physics.
- Our new observational astronomer has taught the upper-division astrophysics lecture series (AST 4240/A and 4250A), Observational Astronomy (AST 3240/A), and two general education astronomy courses (AST 3420H & AST 1010). This faculty member has also taught Computational Physics (PHY 4090) and Mathematical Methods (PHY 3600/A.
- Our new condensed matter theorist has taught Computational Physics (PHY 4090/A) and Advanced Classical Mechanics (PHY 3210/A).
- Our new theoretical cosmologist has taught the upper-division astrophysics lecture series (AST 4240/A and AST 4250/A). She will teach PHY 4090 (Computational Physics) in the fall of 2023. .

1.3.3.5 Industry Ties

Since last program review, our department has made concerted efforts to strengthen and expand our industry ties, to better connect students with employers, and ensure that our ongoing efforts to improve our curriculum will also improve students' career readiness. To organize and expand these efforts, in 2021 our department formed an Industry Advisory Board (IAB) consisting primarily of representatives from organizations that have hired our alumni. This work is synergistic with **item 4** from our last self-study, **alumni relations**.

Current IAB members are:

- Gasia Bedrosian, Integration and Test Manager for the Coronagraph Instrument on the Nancy Grace Roman Space Telescope, NASA JPL (CPP alumna)
- Tom Chrien, Optical Engineering Team Leader, Millennium Space Systems
- Dan Denison, Director of Sales and Marketing, OptoSigma Corporation
- Sara Gill, Medical Dosimetrist, Loma Linda University Medical Center
- Adrian Godina, Owner & General Manager, Supply Chain Optics
- Gerald Hung, Deputy DSP SOS Technical Director, Northrop Grumman (CPP alumnus)
- Vincent Kong, Systems Director, EO/IR Sensing and Tactical Surveillance Directorate, Aerospace Corporation (CPP alumnus)
- Lam Luu, Thin Films Process Engineering Manager, Skyworks Inc. (CPP alumnus)
- Lute Maleki, CEO, OEWaves
- Miraflor C. Medina, Procurement Financial Analyst, Boeing Defense Systems (CPP alumnus)
- Tom Persico, CEO, Advanced Spectral Technology
- Michael Thoresen, Director of Application Integration, Kaiser Permanente Corporation
- Souzan Maleki Thoresen, Manager of Program Management, Crane Aerospace & Electronics

While many IAB members have physics degrees, the key trait they all have in common is leadership experience in organizations that hire our graduates. The Department has formed an Industry and Alumni Relations Committee to coordinate all departmental efforts involving the IAB. We actively engage with the board to discuss plans and seek valuable feedback on areas of strength, areas for improvement, and the key skills and competencies required by our graduates in the workforce.

We have conducted two review meetings with our IAB, in April 2022 and April 2023, with plans for an ongoing series of April meetings. These meetings focused on comprehensive updates on our efforts to enhance students' workforce readiness. In return, we received invaluable feedback that guided our continuous improvement, and opportunities to deepen relationships that improve students' access to career opportunities. In particular, at the spring 2023 meeting, we presented the board with 9 project-based assignments from a variety of upper-division courses and received IAB feedback. For instance, the feedback on assignments for PHY 3440 (Applied Optics) led to a complete course redesign, and the hiring of an industry scientist with experience in optical engineering to teach the course in Spring 2024.

The IAB interacts directly with students in a number of ways, ranging from guest lectures in courses and the department's seminar series (e.g. Lute Maleki in November 2022, Sara Gill in April 2023), to attending the Women in Physics Luncheon (Miraflor Medina and Lam Luu in March 2023) to attending student poster sessions at both the April 2022 and April 2023 meetings. One IAB member company (Advanced Spectral Technologies) hosted a lab tour for CPP physics students in October 2022, and more such tours are tentative planned at other IAB member companies in the future.

Figure 1: Students receiving resume critiques from an IAB representative at the September 2022 event.

Perhaps the most in-depth interaction between IAB members and CPP students has been the September 2022 and 2023 resume events. IAB members met with students to critique resumes a few days prior to the campus career fair. The first event was a tremendous success, with all IAB members agreeing that it should be repeated in September 2023. The 2023 event expanded to include mock interviews and "elevator pitch" coaching, where students learn how to give oral presentations introducing themselves, their skills, and their career goals. Much of the preparation for this work was conducted in close collaboration with the Career Center.

Figure 2: Students receiving resume critiques from IAB members at the September 2022 event.

Figure 3: Students, IAB members, and faculty at the September 2022 IAB Resume Critique Event.

Another industry-focused tradition that has taken root in the Department is the Alumni Career Panel, held annually since the 2012-2013 Academic Year. This is a panel discussion with 3-4 alumni, generally held in February or March just before the Career Fair, so that students can get expert advice before interacting with recruiters. The 11th panel in the series, held February 24, 2023, featured career advice from the following alumnae:

- Sara Margala (Hopkins Applied Physics Laboratory)
- Bianca Cruz (Northrop Grumman)
- Courtney Wilt (HRL)

Our students also organized an additional Alumni Career Panel for the Society of Physics Students (SPS) Zone Meeting held at CPP in February 2023 to bring together more than 50 physics students from around California. The alumni presenting at that event were:

- Felice Hyppolite (Loma Linda University Radiation Oncology)
- Nicholas-Tyler Howard (Millennium Space Systems)
- Victoria Patterson (Northrop Grumman)
- Jerry Turner (Supply Chain Optics)

Figure 4: CPP Physics and Astronomy alumni discussing their careers at the February 2023 SPS Zone Meeting.

Another common practice in the department is alumni guest lecturers in various classes. While comprehensive lists of all alumni visits are difficult to obtain, visitors in the 2022-2023 academic year included:

- Kyle Haddock (OptoSigma, visit to Applied Optics, PHY 3440)
- David Vega (Ansys, visit to Applied Optics, PHY 3440)
- Vincent Kong (Aerospace Corp, visit to Advanced Laboratory Physics, PHY 4520L)

Finally, we are working to increase the representation of industrial scientists alongside academic scientists in our department's regular seminar series. Industry presenters in the 2022-2023 academic year included:

- Lute Maleki (OEWaves)
- Sara Gill (Loma Linda University Radiation Oncology)
- Jack Latchinian (4D Technologies)
- Dylan O'Connell (UCLA Radiation Oncology)

Our goal is to ensure that every student graduating from our department has had multiple productive interactions with physics-trained and/or astronomy-trained scientists in non-academic careers.

1.4 Credit Hour

As of July 1, 2011 federal law (Title 34, Code of Federal Regulations, sections 600.2 and 600.4) requires all accredited institutions to comply with the federal definition of the credit hour. For all CSU degree programs and courses bearing academic credit, the "credit hour" is defined as "the amount of work represented in intended learning outcomes and verified by evidence of student achievement that is an institutionally established equivalency that reasonably approximates not less than:

- *One hour of classroom or direct faculty instruction and a minimum of two hours of out-of-class student work each week for approximately fifteen weeks for one semester or trimester hour of credit, or ten to twelve weeks for one quarter hour of credit, or the equivalent amount of work over a different amount of time; or*
- *At least an equivalent amount of work as required in paragraph (1) of this definition for other academic activities as established by the institution, including laboratory work, internships, practica, studio work, and other academic work leading to the award of credit hours."*

A credit hour is assumed to be a 50-minute period. In courses in which "seat time" does not apply, a credit hour may be measured by an equivalent amount of work, as demonstrated by student achievement.

Currently, the primary mode of instruction in our department is face-to-face classes that adhere to conventional norms, i.e., one hour of in-person, direct faculty instruction each week per unit of lecture classes for approximately fifteen weeks, with the expectation that students will also engage in at least two hours of out-of-class work and study per unit. Laboratory classes, in accordance with university policy, have 3 hours of in-person laboratory work per week per credit hour, with a similar expectation that students spend at least two hours per week studying and preparing outside of class time. Activity classes, again in accordance with university policy, have two hours of in-person activity work per week per credit hour, again with an expectation of at least two hours of out-of-class work per week per credit hour.

Online classes were only used extensively during COVID-19 pandemic from spring 2020 to spring 2201. From fall 2021, we started gradually to transition back to face-to-face classes, by starting from recitation classes, laboratories, and some upper-division classes. From spring 2022, however, the primary mode of instruction has been face-to-face. By resuming traditional teaching methods, we aim to provide students with enhanced opportunities for direct engagement, interactive discussions, hands-on practical experiences, and personalized guidance. In a typical semester we have offered only a low-single-digit number of online or hybrid courses (“hybrid” meaning a mix of in-person and online instruction). Most of these online or hybrid courses are part of mixed lab/activity or lecture/activity combinations, i.e. students in these courses still experience a significant portion of the course in-person.

2 PROGRAM EVALUATION – UNDERGRADUATE

2.1 Curriculum and Pedagogy – Undergraduate

Curriculum sheets and roadmaps:
Biophysics: https://catalog.cpp.edu/preview_program.php?catoid=65&poid=17192&print
https://catalog.cpp.edu/preview_program.php?catoid=65&poid=17263&print

General Physics: https://catalog.cpp.edu/preview_program.php?catoid=65&poid=17154&print
https://catalog.cpp.edu/preview_program.php?catoid=65&poid=17260&print

Integrated Science (aimed at teacher prep):
https://catalog.cpp.edu/preview_program.php?catoid=65&poid=17191&print
https://catalog.cpp.edu/preview_program.php?catoid=65&poid=17264&print

In this section, we delve into an analysis of our department's curriculum. As we discuss specific elements such as the LA program's impact, the unique sophomore sequence, and our project-oriented curriculum, we also highlight opportunities for improvement. These opportunities encompass strategies for fostering more research opportunities, continuous curriculum review, and potential enhancements to specialized introductory courses for physics majors.

Our main takeaway revolves around our commitment to refining our curriculum, ensuring it remains aligned with evolving industry expectations while nurturing a dynamic and engaging learning environment for our students.

In section 1.3.3 we described a number of curricular changes. We revisit a few of them here with additional information on impact.

2.1.1 Recitation Classes and other supports for Introductory Students

As discussed above, we have made a concerted effort to encourage students in the introductory calculus-based physics courses to enroll in elective, pass/fail recitation courses that offer extra opportunities for structured practice. After an enrollment dip during COVID, we have revitalized these classes, focusing initially on mechanics, but now expanding to the electromagnetism course.

One way to evaluate the efficacy of recitations is via the Force Concepts Inventory (FCI), a widely-adopted multiple-choice conceptual diagnostic test that was developed by physics education researchers. Its validity and reliability have been verified repeatedly in the literature, and a widely-cited study (Hake, *American Journal of Physics*, 1998) has established a link between FCI scores and effective instructional methods. Our assessment coordinator reaches out to every introductory mechanics instructor each semester and provides a Canvas version of this diagnostic test that all students are strongly encouraged to take. We then compare FCI performance for students in the recitation class with the performance of the wider cohort of introductory physics students.

We focus on a measure called “normalized gain” (<g>), the difference in pre-test and post-test scores, normalized to the improvement that would be possible if students scored perfectly on the post-test. It has been found in the literature that gains exceeding 30% are unusual, especially in more traditional lecture classes. Recent data in our department (Table 1) shows that recitation

students exhibit significantly higher gains on the FCI when compared with peers in the various lecture sections:

	Recitation students	PHY 1510 lecture sections
Fall 2022	<g> = 44%	<g> = 27% to 38%
Spring 2023	<g> = 50%	<g> = 27% to 38%

Table 1: FCI (Force Concept Inventory) Data comparing students who only take regular lecture classes and students who take both the lecture and the elective recitation.

As a result of the FCI assessment data in Table 1, we have 'closed the loop" on our findings by strongly promoting the recitation classes to all students in PHY 1510 lectures. The results of this effort are shown in Figure 4.

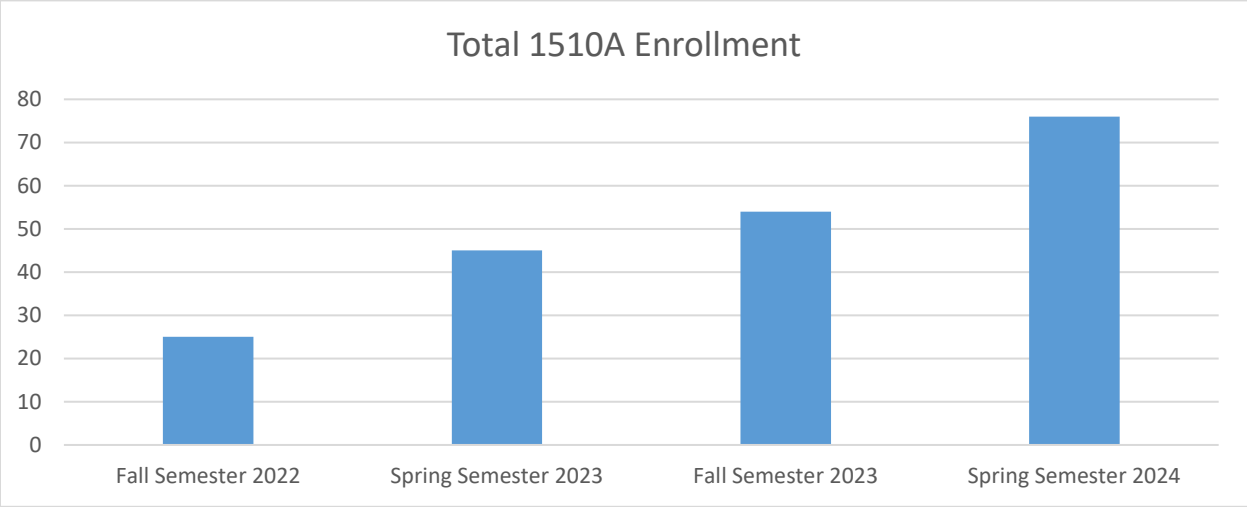


Figure 4: Enrollment in PHY 1510A recitations since Fall Semester 2022.

We do not report data for earlier semesters because (1) it is only in the past few years that we systematized the administration of the FCI to all students in PHY 1510, and (2) during the pandemic enrollments in recitations dropped significantly, leaving us with small, unrepresentative samples.

Another effort that we have implemented recently (Spring 2023) is a weekly homework help session that is open to all PHY1510 students. Learning Assistants help students with homework, and pizza is available as an attendance incentive.

2.1.2 Sophomore Sequence:

One area of distinctiveness is our sophomore sequence, which spreads optics, relativity, quantum mechanics, and thermal physics over two semesters instead of the more common one-semester format:

- PHY 2530/L/A- Introduction to Electromagnetic Radiation and Special Relativity
- PHY 2540/L/A - Introduction to Thermal and Quantum Physics

We chose this format for two reasons. First, so that students' first exposure to each topic is more in-depth than it might otherwise be. Also, we see benefits for transfer students. Many transfer

students have taken a semester of sophomore-level physics, but the emphasis in sophomore-level physics courses varies widely among institutions. By individually counseling each student during orientation, we ensure placement into the course with material in which they most need enrichment.

2.1.3 Structure of Core Theory Courses: Lecture + Recitation (Discussion)

Many schools offer core courses like Quantum Mechanics (QM) and Electromagnetism (E&M) as 2-semester lecture sequences. However, our department has decided to only require one semester of each core theoretical subject, but combine the lecture with a recitation class. Recitation courses are typically smaller group sessions or tutorials that provide students with an opportunity to engage in active learning and reinforce the concepts taught in the main lecture.

Our rationale for choosing a different path than many peers was two-fold: First, we felt that the intensive structure of the lecture+recitation model at least partially compensates for the lack of a second semester in core theory areas. Second, we wanted to make room for students to pursue project-oriented electives, as discussed next.

2.1.4 Project-Oriented Curriculum

In keeping with Cal Poly Pomona's "Learn By Doing" pedagogical philosophy, every physics major is required to take at least 7 units of upper-division electives from the following list of project-oriented courses:

- Observational Astronomy (AST 3240/3240A, 2 units of lecture, 1 unit of activity)
- Electronics for Scientists (PHY 3040/3040L, 2 units of lecture, 1 unit of lab)
- Computational Physics (PHY 4090/4090A, 2 units of lecture, 1 unit of activity)
- Wave Optics (PHY 4170/4170L, 2 units of lecture, 1 unit of lab)
- Internship in Physics (PHY 4410, 1-2 units)
- Advanced Laboratory Physics—Advanced Instrumentation (PHY 4510L/4510A, 1 unit of lab, 1 unit of activity)
- Advanced Laboratory Physics—Contemporary Experiments (PHY 4520L/4520A, 1 unit of lab, 1 unit of activity)
- Senior Project (PHY 4610/4620, 1-2 units)

All of these courses have analogues at other CSU schools, as well as UC schools and private undergraduate institutions. Though we have not done a systematic survey of peer curricula in recent years, based on the data collected during semester conversion planning in 2014-2015, and conversations with peers in subsequent years, we can safely say that we do not require fewer such courses than peers.

Additionally, while these are the designated project-oriented electives from which all students must take a minimum number of courses, many other courses, both core and elective, have a heavy focus on projects and applications beyond traditional textbook theory. For instance, students in Applied Optics (PHY 3440) use Zemax and Python for simulations, students in electromagnetic theory (PHY 4140 and 4150) often use COMSOL for finite-element solutions of Maxwell's equations, student in Biophysics (PHY 4100) make use of many simulations and databases, and students in the AST 4240/4250 astrophysics theory courses often do assignments that require comparing literature data with theory.

Almost all lower-division service courses, including the year-long algebra-based (PHY 1210/1220) and calculus-based (PHY 1510/1520) sequences also have laboratory components that include data collection, data analysis, and report-writing. Our emphasis on lab work in introductory courses is not limited to courses for STEM majors; the Department has recently secured $16,000 in University funds to upgrade the lab in PHY 1050L-Physics of Musical Sound, a course taken primarily by Music majors. This course redesign is being spearheaded by Dr. Nathan Tung, a lecturer, in keeping with the **2017 external reviewers' recommendations to integrate lecturers** into more of the department's work.

2.1.5 Learning Assistant (LA) program:

Learning Assistants (LAs) are undergraduate students who assist faculty with various class activities, including group problem-solving/discussion during lectures and recitations, assisting students with lab work, and performing various demonstrations under instructor supervision. They are chosen from among students who previously completed the course with a grade of B or better. LAs receive modest stipends for working 5-10 hours per week, including 1-2 office hours to tutor students in the classes that they are assisting with. Besides financial compensation, LAs get the opportunity to explore teaching as a possible career path, and deepen their understanding of physics by explaining it to others. The principal benefit to other students is a more interactive instructional model, and the opportunity to seek assistance from more experienced peers. The program is coordinated by a Lecturer who is compensated for her time.

Our department has used the following number of LAs during the past four years:

AY	Fall	Spring
2019-2020	8	10
2020-2021	6	2
2021-2022	2	2
2022-2023	5	6

These classes span all levels, from introductory mechanics to upper-division electromagnetism.

2.1.6 Some Opportunities for Improvement include:

In this section we discuss areas we believe the department could focus on for improving students learning.

- **More research opportunities, and earlier research opportunities:** The learning opportunities afforded by in-depth research projects are invaluable preparation both for careers and graduate study. From Fall 2017 to Spring 2023, 155 students took PHY/AST 2000, 4000, 4610, or 4620. The overwhelming majority of these students were physics majors. Given that we graduated approximately 200 physics majors in that time frame, this means that more than 2/3 of our students have some sort of supervised research experience.

  However, 86% of these registrations were in the upper-division (400/4000 level) supervisory courses, normally taken by juniors and seniors. Giving students earlier opportunities to explore research fields would help students hone their academic and career plans sooner, but would ***require an improved TT faculty to student ratio***.

- **Continuous Curriculum Review:** Regularly reviewing the curriculum in consultation with industry experts is important for staying relevant and up-to-date. We have established an Industry Advisory Board to provide valuable insights and guidance in aligning our curriculum. At the moment our conversations have focused on helping students with networking and presentation skills, and getting a general sense of which aspects of our existing curriculum students should emphasize to employers. The next time we undertake a redesign of an upper-division lab, however, we are likely to see in-depth IAB input.

  We also plan to engage in more in-depth consultation with other departments at CPP, to ensure that introductory courses are relevant to the needs of all students, not just our majors. As a significant step in that direction, we have studied student outcomes in engineering courses that have introductory physics as a prerequisite, to see if there is a correlation between physics grades and subsequent engineering performance. We have also surveyed engineering faculty for recommendations regarding introductory physics topics, emphases, skills, and expectations. This data is discussed in Section 2.2.

- **Specialized introductory courses for physics majors:** One possible improvement for the department is the addition of specialized counterparts to the introductory physics lectures courses (PHY 1510 Newtonian mechanics or 1520 Electricity and Magnetism), aimed specifically at the needs of physics majors. This is a common but far from universal practice at peer institutions. For instance, we might create a PHy 1610/1620 sequence that covers the same physics topics as 1510 and 1520, but in a manner more targeted at the needs of our majors.

  One key rationale for a majors-specific sequence would be that many students emerge from the introductory calculus-based courses unprepared for the phase transition to more intense expectations in sophomore and junior classes. Some of this is due to inevitable differences between courses for majors and non-majors. However, there are also certain preparation deficits that are not necessarily unsurmountable obstacles in introductory courses (e.g. comfort solving problems entirely with symbols instead of a mix of symbols and numbers) but are major issues later in the curriculum. Smaller classes that emphasize relevant skills earlier could help us address preparation deficits.

  Before committing to such a curricular change, we need to weigh this against the downsides of diverting attention from improving PHY 1510 and 1520 for all students. We also need to consider the impact on students who switch their majors from engineering to physics after taking the standard introductory courses for engineers, and how we would help them succeed in the subsequent courses.

Table 2 provides a list of GE courses taught by the department and Table 3 provides a list of honors courses taught by the department. If your department teaches honors or service-learning courses, please add them below in a separate table.

Table 2 – General Education Courses[3]

Course	Course Title
PHY 1020	Fundamentals of Physics
PHY 1050	The Physics of Musical Sound
PHY 1050L	Physics of Musical Sound Laboratory
PHY 1210	Physics of Motion, Fluids, and Heat
PHY 1210L	Physics of Motion, Fluids, and Heat Laboratory
PHY 1510	Introduction to Newtonian Mechanics
PHY 1510L	Newtonian Mechanics Laboratory
PHY 2120	Physical Science for Elementary Educators
PHY 2120L	Physical Science for Elementary Educators Laboratory
PHY 3010	Energy and Society
PHY 3020	Physics for Future Presidents
PHY 3060	History of Physics

Table 3 – List of Honors Courses[4]

Course	Course Title
PHY 122H	College Physics Honors
PHY 132H	General Physics Honors
PHY 133H	General Physics Honors
PHY 461H	Senior Project Honors
PHY 1510H	Intro To Newtonian Mechanics Honors
PHY 1520H	Introduction to Electromagnetism and Circuits Honors
PHY 4000H	Special Study for Upper-Division Students Honors

The table below provides data associated with high non-passing rates. It is important to note that the numbers reported below are based on filtering the data by major, so only students enrolled as a Physics major are included in the counts.

[3] Source: Catalog https://catalog.cpp.edu/preview_program.php?catoid=36&poid=9591
[4] Source: Tableau https://analytics.cpp.edu/#/site/production/views/ClassSchedule/CourseAttribute?:iid=1

Table 4 – List of Courses with high non-passings rates[5]

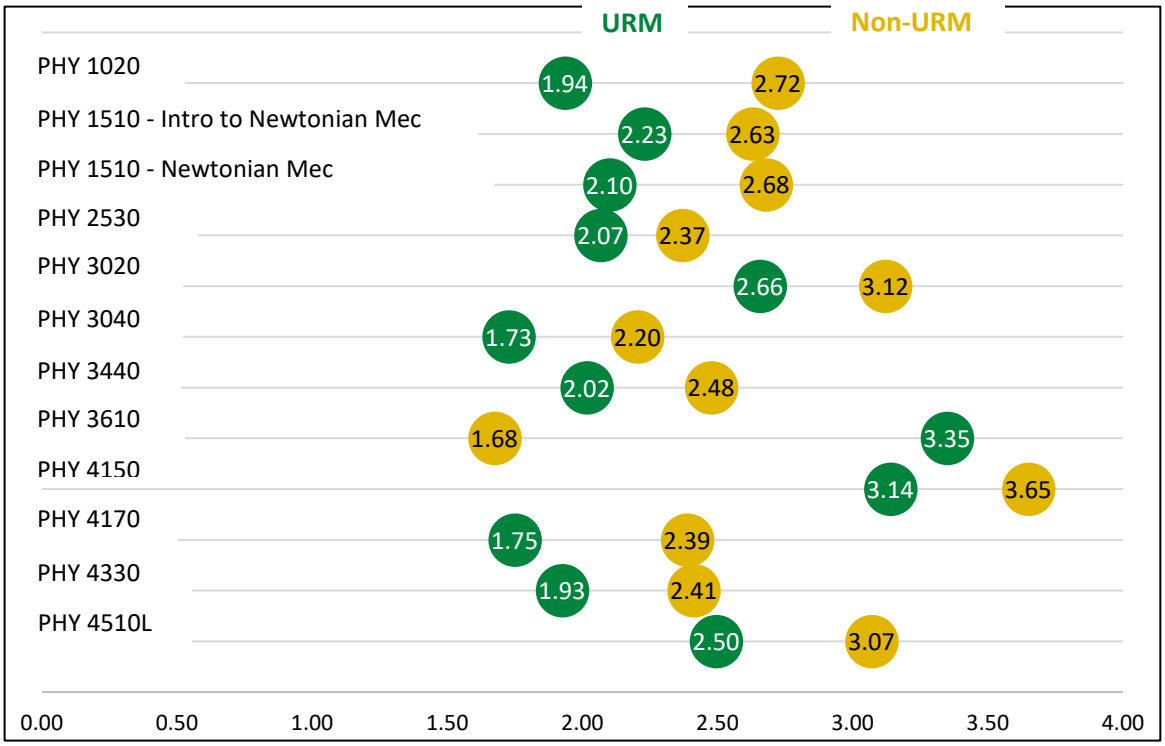
Non-Passing					
Year Term	**Course Code**	**Course Title**	**Enrollment**	**Non-passing Rate**	**Number of students not passing**
2017-2018 - Quarters	PHY314	Physics Elec and Mag Phenomena	221	33%	73
	PHY304	Electronics For Scientists	126	31%	39
	PHY131A	General Physics Recitation	16	31%	5
	PHY315	Physics Elec and Mag Phenomena	191	30%	58
	PHY333	Thermal Physics	249	29%	71
	PHY235	Elementary Modern Physics	244	25%	62
	PHY321	Mechanics	223	24%	54
	PHY322	Mechanics	211	23%	49
	PHY417	Optics	164	22%	36
	PHY426	Relativity, Grav and Black Hol	115	22%	25
	PHY131	General Physics	291	21%	61
	PHY234	General Physics	239	21%	50
	PHY133	General Physics	266	20%	52
	PHY430L	Advanced Physics Laboratory	212	20%	43
	PHY424	Astrophysics	90	19%	17
2018-2023 - Semesters	PHY3040	Electronics For Scientists	91	36%	33
	PHY3210	Advanced Classical Mechanics	172	27%	47
	PHY1510*	Intro To Newtonian Mechanics*	113	27%	30
	PHY3210A	Adv Classical Mech Rec Act	172	26%	44
	PHY2530	Intro Elcmgntc Rad Spec Rel	147	25%	37
	PHY4330A	Thermal Stat Physics Rec Act	133	23%	31
	PHY4330	Thermal Statistical Physics	134	23%	31
	PHY3040L	Electronics For Scientists Lab	87	22%	19
	PHY4140	Electricity and Magnetism I	170	21%	35
	PHY4100	Biophysics	46	20%	9
	PHY3600	Mathematical Methods Physics I	175	19%	33
	PHY2530L	Intro Lab Elcmgt Rad Spec Rel	124	19%	23
	PHY3600A	Math Meths of Phys I Rec Act	170	18%	30
	PHY3440	Applied Optics	61	18%	11
	PHY3440A	Comp Activities App Optics Act	61	18%	11
	PHY4170L	Wave Optics Laboratory	61	18%	11

**GE Courses*

[5] CSU Dashboard "In Which Courses Do They Struggle" Report https://csusuccess.dashboards.calstate.edu/public/faculty-dashboard/where-do-they-struggle

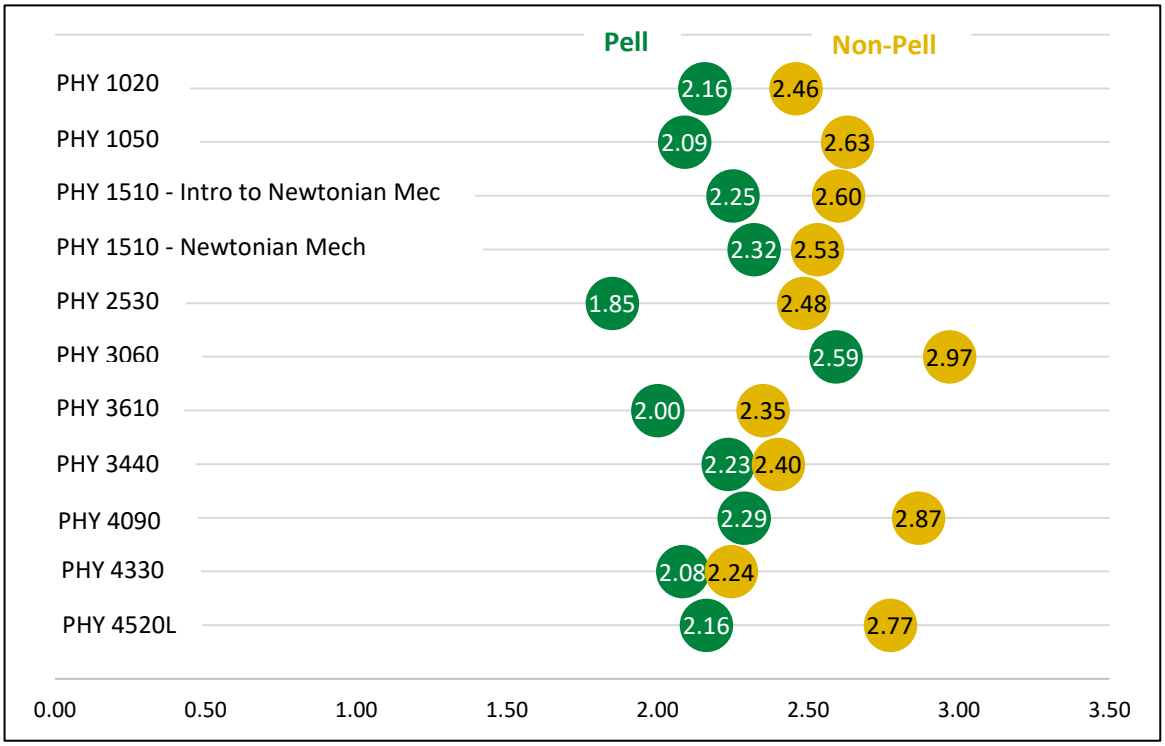
The next two figures depict 1) the Physics courses with the largest equity gaps for URM and non-URM students, and 2) the Physics courses with the largest equity gaps for Pell recipients and non-Pell recipients. The scale uses grades (*1 = D; 2 = C; 3 = B; 4 = A*).

Figure 5– Courses with the Largest Equity Gaps by URM Status for Physics[6]



[6] Source: Tableau https://analytics.cpp.edu/#/site/production/views/CourseEquityGaps/EquityGaps?:iid=1

Figure 6– Courses with the Largest Equity Gaps by Pell Status for Physics[7]



2.1.7 General Perspective on DFW Rates and Equity Gaps

We will focus our attention here on semester courses listed in Table 4, as the majority of the evaluation period involves semester courses, and semester courses were designed with some of the distinctive approaches outlined above in Section 1.3.3 and Sections 2.1.2 through 2.1.5.

Physics courses inevitably have highly structured and hierarchical content—a strong foundation in prerequisite concepts is absolutely essential for success in subsequent courses. Nonetheless, many faculty indicate in informal discussions that some students are passing courses with skills that enable them to solve some basic problems at the level of the course, but do not suffice to perform well in more advanced classes that often require mastery of foundational skills and knowledge, not just rudimentary acquaintance with basic material. It is the widespread (but not necessarily unanimous) view of the faculty that high DFW rates thus reflect weaknesses of foundational preparation. When we work closely with students on material for advanced classes, generally their greatest struggles are less about the nuances of new concepts from advanced classes but rather with more foundational mathematical concepts, and their lack of comfort with symbols and abstraction.

Regarding equity gaps, we note two things. First, unconscionable inequities in access to educational resources prior to college will have inevitable effects on preparation. ***Our department works hard to provide resources for students who need to catch up in introductory courses, e.g. the Learning Assistant program, or recitation courses for 1510 and 1520 students.*** We make serious efforts to assign excellent instructors to introductory lecture courses

[7] Source: Tableau https://analytics.cpp.edu/#/site/production/views/CourseEquityGaps/EquityGaps?:iid=1

and support them and their students with Learning Assistants and other resources. Nonetheless, there are limits to what we can do and what we can push independent adult students to avail themselves of.

Second, economic disadvantage means that many of our students work long hours at jobs outside of school. The department offers a few on-campus employment opportunities (e.g. department office assistants, stockroom assistants, Learning Assistant program) and a few scholarships courtesy of generous donors. However, our capacity to financially support needy students is limited, and physics courses that provide good preparation for technical work and/or graduate study are inevitably time-intensive.

All of this is to say that we are working under tight constraints. One question we can nonetheless ask is whether we worsen the problems via unfairly high demands placed on students. As we will show below, there is significant evidence that if we have erred it is NOT on the side of unduly harsh demands.

2.1.8 Analysis of Data on PHY 1510 Performance

Of all the courses flagged for equity gaps and DFW rates, by far the highest-enrollment and most pivotal course is PHY 1510, the first physics course taken by physics majors and also most engineering majors. In a typical semester 600 to 800 students take this course. From an assessment standpoint, one unique aspect of PHY 1510 is that it is the prerequisite for the Engineering Statics courses (ARO 2041, CE 2041, and ME 2141) taken by more than 500 students per year. Though offered by three different departments, the instructors for these courses coordinate closely. We thus have an opportunity to evaluate how well our PHY 1510 course prepares students for other courses that draw on the material. Moreover, while looking at courses outside of our department means that we are not examining data on our majors, it does mean that we get to look at a much larger cohort of students than our own majors can provide, and faculty judgments are not biased by narratives internal to the department.

We analyzed data from 562 students who took an Engineering Statics course in the 2022-2023 academic year. We chose this time period because most of the students would have taken PHY 1510 after or near the end of the pandemic. If a student took statics more than once we only looked at the grade in their second attempt. We divided this cohort of 562 students into groups based on PHY 1510 grade, and for each physics grade cohort we looked at 3 measures of statics performance:

1. Mean statics grade. (On a 4.0 GPA scale.)
2. Median statics grade.
3. DFW rate, i.e. percentage of students who either got a D or F or Withdrew from statics.

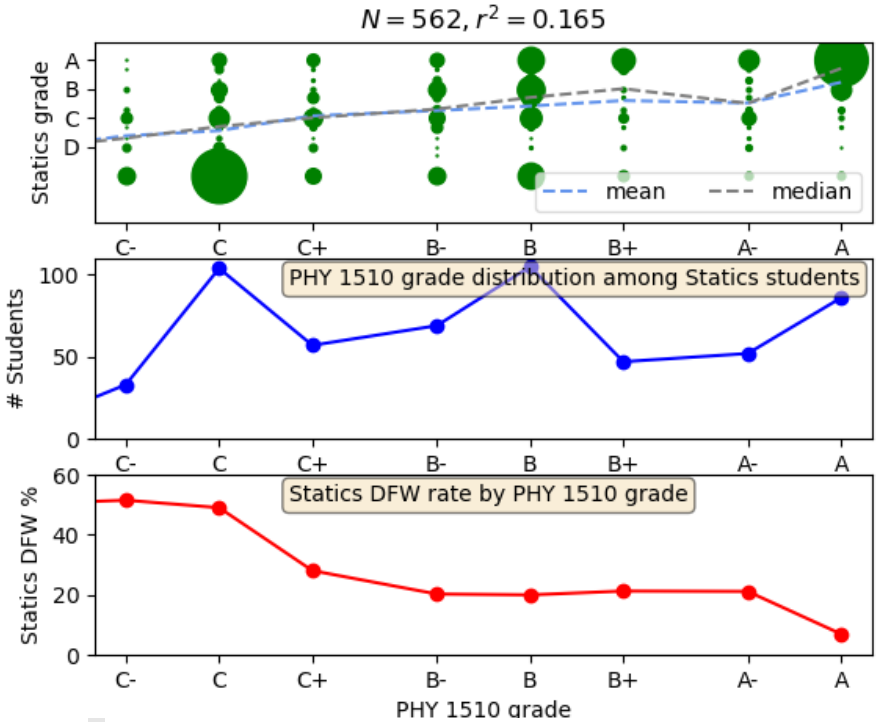


Figure 7– Top: Mean and median Statics grades vs PHY 1510 grade. Middle: PHY 1510 grade distribution among Statics students. Bottom: DFW rate in Statics vs PHY 1510 grade.

Figure 7 shows our results. The key finding is that students who receive a C- or C in PHY 1510 have roughly a 50% chance of receiving a D, F, or W in Statics, while students with a B or better in 1510 have roughly a 20% chance of receiving a D, F, or W in Statics. This data suggests that we are not being overly stingy with good grades; ***if anything, we are passing along too many students rather than requiring them to repeat the material for better mastery***.

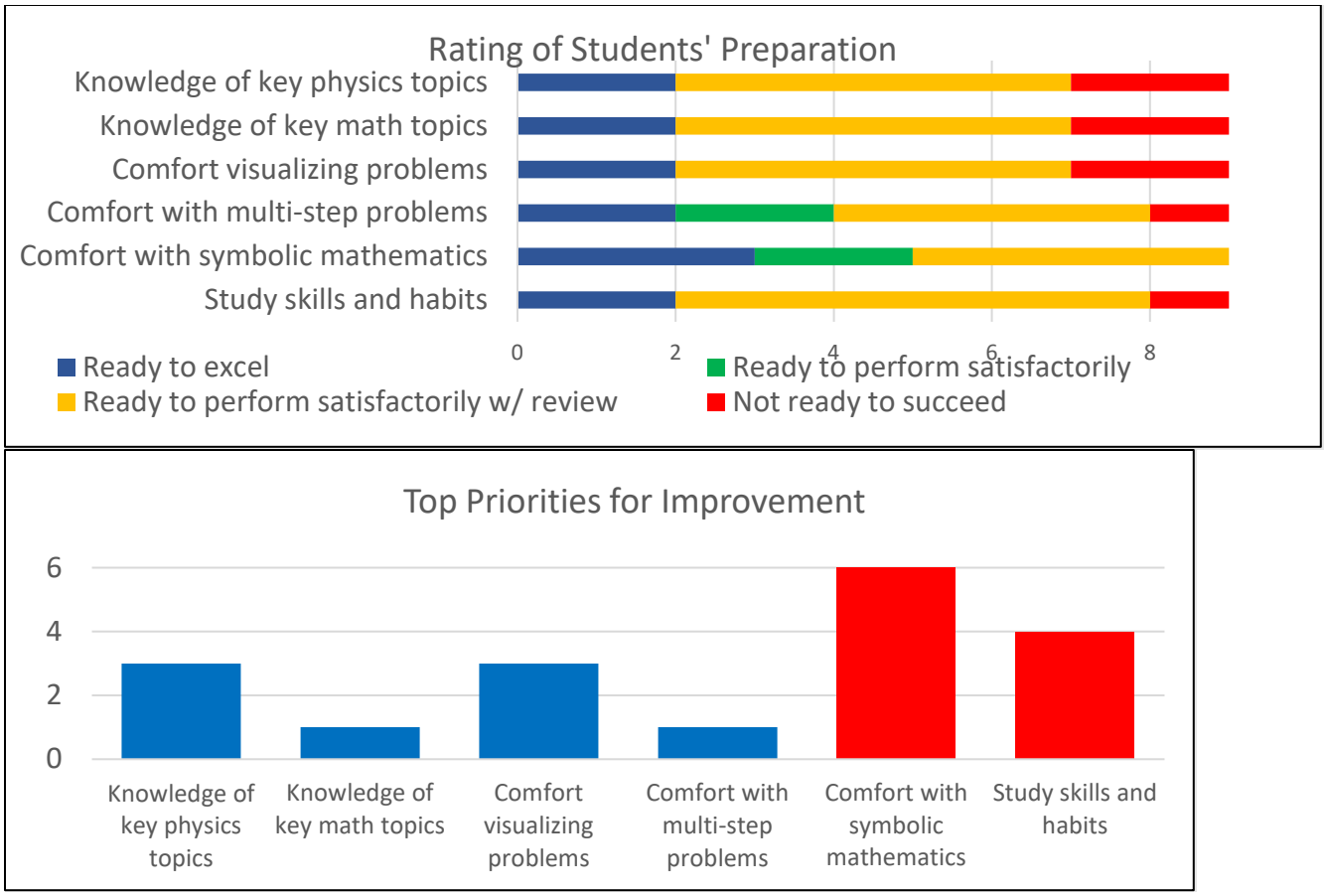


Figure 8– Engineering faculty ratings of Statics students' preparation (top) and priorities for improvement (bottom). Most common priorities in red.

To further explore the strengths and weaknesses of students we surveyed engineering faculty who taught Statics courses in 2022-2023. The first question we asked was for faculty to think of the typical student at the start of their Statics class and rate preparation in several key areas. We also asked them to indicate 1-2 top priorities for improvement. Figure 8 shows their responses.

Overall, engineering faculty are not satisfied with students' math and physics preparation, and also their problem-solving skills and study habits. All of these topics are emphasized in PHY 1510, further reinforcing that DFW rates in introductory physics are not simply artifacts of unreasonably high expectations.

We also surveyed engineering faculty on students' preparation in specific physics topics. Full results are in Appendix 2 but in brief the key area of weakness noted by engineering faculty is vectors, consistent with anecdotal observations from physics faculty observing our students in upper-division classes. (See discussion of PHY 4140, upper division electromagnetic theory, in the next section) Closing the loop to address these weaknesses is an ongoing area of effort, but key components of our work include the aforementioned recitations and Learning Assistant program.

2.1.9 DFW Rates and Equity Gaps in Courses for Majors

While there are a number of other classes with high DFW rates and/or equity gaps, some of them are seldom-offered GE classes (e.g. PHY 3020: Physics for Future Presidents) or low-enrollment specialty electives for which valid statistical conclusions may be elusive (e.g. PHY 4100: Biophysics). We will focus our discussion here on 2 classes, one of which (PHY 4140) has a high DFW rate and the other of which (PHY 3600) has not been flagged but is crucial for success in subsequent courses:

- PHY 3600, Mathematical Methods of Physics. This junior-level course is a crucial prerequisite for many other core theory courses, and is pivotal in the development of students' mathematical skills.
- PHY 4140, Electricity and Magnetism 1: This course draws on skills developed in both of the previous courses. Also, many students take it in the last semester of senior year, making success or failure in this course a particularly high-stakes matter.

Mathematical Methods (PHY 3600/3600A)

This course is intended for student in either the second semester of sophomore year or first semester of junior year. It has two corequisites: PHY 2540 (second semester of sophomore-level physics, emphasizing quantum and thermal physics) and MAT 2250 (linear algebra and differential equations). The physics prerequisite is largely to ensure some level of familiarity and sophistication in physics, so that the instructor can freely draw on a wide range of applications and examples. The math class would, ideally, be a prerequisite rather than a corequisite, but we are bound under state law (SB 1440) to ensure a 2-year path to graduation for any student who enters with an Associate's degree in physics, and California's standard Associate's degree curriculum in physics does not include a course on linear algebra and differential equations. Consequently, the math course is a corequisite.

We prioritize assigning this course to faculty who have extensive experience with other upper-division courses, so that they are familiar with our students' typical skills and areas for improvement. Instructors maintain a demanding but highly structured pace in the course, usually with multiple weekly assignments that build off of each other as well as the Friday recitation activities. (As discussed above, the structure of this course is 3 hours of lecture split between Monday & Wednesday and 2 hours of group activities on Friday, with the students split between two sections on Friday to ensure more individualized attention.)

Given the DFW rates in this class, we place a strong emphasis on a course structure that's conducive to developing skills and study habits. Two recent instructors for this class (Prof. Small and Prof. Binder) try to motivate students to study homework solutions (made available on the course website after the due date) by assigning short follow-up problems (due a few days later) that are extensions of problems on the longer problem sets, and are easily solvable if students reviewed the available solutions. Additionally, ***starting in Fall 2023 we assign Learning Assistants to help in the Friday recitation activities***, so that students get more support and opportunities to ask questions during class.

One natural question is whether course structure is actually as supportive as hoped. One way to gauge this is to ask whether the various lower-stakes assignments adequately prepare students for higher-stakes tests. In the fall of 2021, Dr. Small analyzed data from PHY 3600 (Mathematical Methods of Physics I). He computed correlations between each assignment type and the final exam grade, and between each midterm and the final exam. The results are shown in Table 5.

Assignment	**Correlation w/ final** (*r*, not r^2)
Weekly warm-up assignments	0.76
Long problem sets	0.79
Follow-ups to problem sets	0.74
Midterm 1	0.49
Midterm 2	0.66
Midterm 3	0.75

Table 5: Correlation between final exam grade and various supportive assignments in PHY 3600.

The best predictors of final exam grade were the various weekly assignments. To some extent this probably reflects the fact that the final exam was cumulative, just like the assignment averages. However, it also suggests that the course structure aligns the weekly tasks with the final learning goals. ***Efforts to improve this course and reduce DFW rates should thus focus on helping students to stay on-task with weekly assignments.*** Promisingly, the correlations also grow from the first to the third midterm, suggesting that some degree of catch-up is possible.

Electricity & Magnetism 1 (PHY 4140/4140A)

This course is offered in spring semester and can be taken by either juniors or seniors. It is a challenging course, requiring that students recall and utilize all of their prior preparation in electromagnetic phenomena (primarily covered in the freshman and sophomore-level classes, though referenced in other courses), vectors (used in virtually every course), and vector calculus (introduced in the third semester of calculus and revisited in the Mathematical Methods course). Many students struggle to recall, synthesize, and apply these concepts to the course material, often resulting in high DFW rates (Table 6).

Year	**UD E&M DFW Rate**
2021	17.54%
2022	39.39%
2023	68.18%

Table 6: DFW rate in upper-division electromagnetic theory (required course), recent years.

Instructors commonly attribute the DFW rates to weak preparation that leads to poor retention of prerequisite knowledge. As one piece of evidence for this explanation, in Spring 2023 Prof. Ertan Salik conducted an in-depth examination of student responses to a quiz administered early in the semester, covering basic facts about the field of a point charge and vector notation. He noted numerous errors reflecting basic misunderstandings of mathematical operations, such as:

- The gradient of a scalar function was somehow written to include terms like $\frac{\partial}{\partial x}\hat{x}$, i.e. the derivatives of unit vectors. This indicates a basic misconception about the nature of a gradient.
- The partial derivative of $\frac{1}{\sqrt{(x-1)^2+(y-2)^2+(z-3)^2}}$ with respect to x was written as $\frac{1}{2(x-1)^{1/2}}$. This reflects a profound misconception about partial derivatives.

It is important to note that this quiz was administered AFTER the following supportive measures to prepare for a quiz on material covered in prerequisite courses:

- Students had done a homework assignment with similar problems.
- Students had been given solutions to that homework assignment a few days prior to the quiz, so that they could study for the quiz (which they were told would resemble the homework).
- Students had participated in an in-class interactive group activity on similar problems (with instructor and Learning Assistant support) prior to the quiz.
- In Spring 2023 the instructor identified students in need of extra support (based on their quiz performance) and offered them dedicated office hours with other faculty who had volunteered to provide additional tutoring. Besides the dedicated one-on-one time, the opportunity to review with someone who would not be assigning their grade was intended to lower the stakes of the conversation.
- The course structure has also been modified to afford students opportunities to earn credit for making and uploading YouTube videos in which they explain, in detail, the steps of key problems, in recognition of the fact that the best way to learn something is to explain it.

In other words, the course structure affords ample opportunity for review. In spite of this, not only do we see many students make mistakes such as those noted above, we also see that performance on this course quiz is an excellent predictor of final course grade. As noted in Figure 9, the correlation between this first quiz (which tests foundational skills from previous courses) and the final course grade is R^2=0.48. Even the review opportunities afforded are not sufficing to help significant numbers of students catch up.

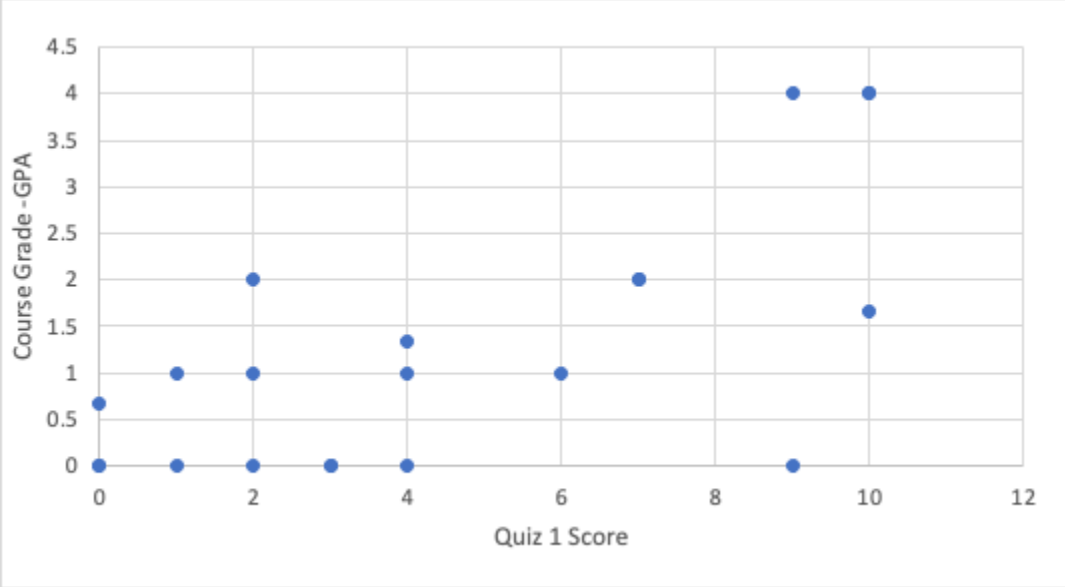


Figure 9: Course grade vs score on first quiz for students taking upper-division electromagnetic theory (PHY 4140) in Spring 2023.

Other instructors for PHY 4140 have also engaged in extensive assessment and data analysis. As an expert in Physics Education Eesearch (PER), Dr. Ryan used research-based materials, including “preflight” questions before class, think-pair-share (clicker) questions during class, tutorials during recitations. Additionally, Dr. Ryan used a research-based assessment to evaluate

students' learning gains: CUE-CMR (Colorado Upper-Division Electrostatics Diagnostic - Coupled Multiple Response[8]). Using research-based assessment tools allows us to compare across different institutions and further inform the instructor's efforts.

Course	Assessment	Term	Pre	Post	Gain <g>=(post-pre)/(100-pre)	R1 Universities (N=3)	Private PUI (N=2)
PHY4140	CUE-CMR	Spring 2019	18%	37%	0.23	0.12-0.40	0.18-0.34

From the pre and post assessment scores collected in spring 2019, we can see even though the pre- and post-score averages are low, given that this test is very hard and pre and post-scores are also low for other universities, learning gains reflected by this assessment are considered on par with other institutions. Since this instrument hasn't been given as widely, Dr. Ryan provided data for five other institutions, 3 of which are R1 universities and 2 are small private colleges with only 3,000 to 4,000 students. The normalized gains for the courses taught at 3 R1 universities (all of which are at least partially transformed by PER-informed pedagogy) are 0.12, 0.25, 0.40. The gain for the two other courses from private bachelor granting universities (pedagogy is unknown) are 0.18 and 0.34. We can see students' learning outcome here at CPP is on par with the gain for PER-)informed classes at other institutions.

2.2 Assessment of Student Learning - Undergraduate

[8] Wilcox, B. R. and Pollock, S.J., Phys. Rev. ST Phys. Educ. Res 11, 020130 (2015).

Table 7– Curriculum Matrix (Last updated 2021)

Student Learning Outcome	Course Number																										
	PHY 1510: Newtonian Mechanics	PHY 1510L: Newtonian Mechanics Lab	PHY 1520: E&M	PHY 1520L: E&M Lab	PHY 2530: EM waves & relativity	PHY 2530L: EM waves & relativity lab	PHY 2540: Thermo & QM	PHY 2540L: Thermo & QM lab	MAT 2010: Numerical Methods	PHY 3040: Electronics	PHY 3040L: Electronics lab	AST 3240: Observational Astronomy	AST 3240A: Observational Astronomy Computer Activity	PHY 3210: Mechanics	PHY 3440: Applied Optics	PHY 3440A: Applied optics computational activity	PHY 3600: Math methods	PHY 4010: Quantum	PHY 4090: Computational	PHY 4140: E&M	PHY 4170: Wave optics	PHY 4170L: Wave optics lab	PHY 4330: Thermo	PHY 4510 A/L: Adv. Lab 1	PHY 4520 A/L: Adv. Lab 2	PHY 4630: Seminar
SLO 1: Apply equations and foundational theories when	I		I		D		D			M		M		M	M		M	M	M	M, A	M		M			
SLO 2: Predict qualitative behaviors in real world systems	I	I	I	I	D	D	D	D		M, A		M	M	M	M	M		M	M	M	M	M	M	M	M	M
SLO 3: Solve common equations in situations relevant to the real world	I		I		D		D			M, A		M		M	M			M		M	M		M			
SLO 4: Develop laboratory techniques		I		I		D		D			D		D						M			M		M, A	M	
SLO 5: Interpret experimentally obtained data		I		I		D		D			D		D			D			M			M		M, A	M	M
SLO 6: Written communication		I		I		D		D			D		D			D			M			M		M	M	M, A
SLO 7: Spoken communication		I		I		D*		D*			D*		D*			D*			M*			M*		M*	M*	M, A

I = introduced; D = developed and/or practiced; M = demonstrated mastery; A = Assessed, *=*When applicable; instructor-dependent

Table 8 – Alignment Matrix

Program Learning Outcome	PLO/SLO Alignment	Student Learning Outcome	Core Competencies					Strategic Vision		
			Critical Thinking	Information Literacy	Oral Communication	Written Communication	Quantitative Reasoning	Innovation and Creativity	Civic Engagement	Problem Solving
PLO 1: Graduates will be able to apply the basic principles of fundamental theories of physics to construct models of fundamental phenomena and technologically relevant processes in the real world	PLO 1	SLO 1: Students will be able to apply equations and foundational theories when modeling a system with quantitative reasoning	X			X	X			X
PLO 2: Graduates will be able to use common mathematical and computation techniques to obtain quantitative predictions from models	PLO 1, 2	SLO 2: Students will be able to predict qualitative behavior in real world systems. Examples may include energy issues, medical devices, and information technology.	X				X			x
PLO 3: Graduates will be able to work with experimental apparatus to make accurate physical measurements, will be able to identify limitations of various measuring devices, and will be able to quantify the systematic and statistical uncertainties in their experimental results	PLO 1, 2	SLO 3: Students will be able to solve common physics equations in situations relevant to the real world using analytical techniques					X			X

Program Learning Outcome	PLO/SLO Alignment	Student Learning Outcome	Core Competencies					Strategic Vision		
			Critical Thinking	Information Literacy	Oral Communication	Written Communication	Quantitative Reasoning	Innovation and Creativity	Civic Engagement	Problem Solving
PLO 4: Graduates will be able to communicate an understanding of fundamental physics principles, of problem-solving strategies, and of analyses of experimental data and the inherent uncertainties in both written and oral forms	PLO 3	SLO 4: Students will develop laboratory techniques (set-up, troubleshooting, perform experiments)	X			X	X			X
PLO 5 Physics majors, upon graduation, will be prepared for careers in teaching, research industry, or public service, as well as advanced study in physics and related fields.	PLO 3	SLO 5: Students will be able to interpret experimentally obtained results	X			X	X			
	PLO 4, 5	SLO 6: Students will be able to write professional-quality reports that describe the methods, results, and interpretation of the experimental or computational investigations of physics problems		X		X				

Program Learning Outcome	PLO/SLO Alignment	Student Learning Outcome	Core Competencies					Strategic Vision		
			Critical Thinking	Information Literacy	Oral Communication	Written Communication	Quantitative Reasoning	Innovation and Creativity	Civic Engagement	Problem Solving
	PLO 4, 5	SLO 7: Students will be able to give verbal presentations on physical principles, application of physical principles, and the results of physics investigations, at a level understandable by an audience of novices. These presentations may include visual aids.		X	X					

Table 9 – Overall assessment plan

PLO/SLO Alignment	SLOs	Courses where each SLO is addressed.	Assessment activity (signature assignment) used to measure each SLO.	Assessment tool used to measure outcome success	How assessment data will be reported as evidence SLO performance criteria have been met	Designated personnel to collect, analyze, and interpret student learning outcome data for the program	Student learning outcome data disseminatio n schedule	Closing the loop strategies
PLO 1: Graduates will be able to apply the basic principles of fundamental theories of physics to construct models of fundamental phenomena and technologically relevant processes in the real world	SLO 1: Students will be able to apply equations and foundational theories when modeling a system with quantitative reasoning	*PHY 4140*	Exam problems	Quantitative rubric	Percentage - exceeded, met, fails	*Collection: Course Instructor; Analysis: Assessment committee*	*Department presentations as needed (at least once a year)*	*Changes to curriculum, course content, pedagogy*
PLO 2: Graduates will be able to use common mathematical and computation techniques to obtain quantitative predictions from models	SLO 2: Students will be able to predict qualitative behavior in real world systems. Examples may include energy issues, medical devices, and information technology.	*PHY 4010 (*originally 3040 in spring, we moved data collection to fall)*	Short answer assignment	Rubric	Percentage - exceeded, met, fails			
PLO 3: Graduates will be able to work with experimental apparatus to make accurate physical measurements, will be able to identify limitations of various measuring devices, and will be able to quantify the systematic and statistical uncertainties in their experimental results	SLO 3: Students will be able to solve common physics equations in situations relevant to the real world using analytical techniques	*PHY 4010 (*originally 3040 in spring, we moved data collection to fall)*	Exam problems	Quantitative rubric	Percentage - exceeded, met, fails			

PLO/SLO Alignment	SLOs	Courses where each SLO is addressed.	Assessment activity (signature assignment) used to measure each SLO.	Assessment tool used to measure outcome success	How assessment data will be reported as evidence SLO performance criteria have been met	Designated personnel to collect, analyze, and interpret student learning outcome data for the program	Student learning outcome data disseminatio n schedule	Closing the loop strategies
PLO 4: Graduates will be able to communicate an understanding of fundamental physics principles, of problem-solving strategies, and of analyses of experimental data and the inherent uncertainties in both written and oral forms	SLO 4: Students will develop laboratory techniques (set-up, troubleshooting, perform experiments)	*PHY 4510L*	Formal laboratory report	Lab rubric	Percentage - exceeded, met, fails			
PLO 5 Physics majors, upon graduation, will be prepared for careers in teaching, research industry, or public service, as well as advanced study in physics and related fields.	SLO 5: Students will be able to interpret experimentally obtained results	*PHY 4510L*	Formal laboratory report	Lab rubric	Percentage - exceeded, met, fails			
	SLO 6: Students will be able to write professional-quality reports that describe the methods, results, and interpretation of the experimental or computational investigations of physics problems	*PHY4510A/L or PHY4520A/L (*originally PHY 4630, but we thought it is better assessed in advanced lab)*	Scientific paper	Rubric	Percentage - exceeded, met, fails			
	SLO 7: Students will be able to give verbal presentations on physical principles, application of physical principles, and	*PHY 4630*	Oral presentation	Rubric	Percentage - exceeded, met, fails			

PLO/SLO Alignment	SLOs	Courses where each SLO is addressed.	Assessment activity (signature assignment) used to measure each SLO.	Assessment tool used to measure outcome success	How assessment data will be reported as evidence SLO performance criteria have been met	Designated personnel to collect, analyze, and interpret student learning outcome data for the program	Student learning outcome data disseminatio n schedule	Closing the loop strategies
	the results of physics investigations, at a level understandable by an audience of novices. These presentations may include visual aids.							

Table 10– Assessment Data Collection Timeline

Student Learning Outcome	Academic Year					
	AY 20-21	**AY 21-22**	**AY 22-23**	**AY 23-24**	**AY 24-25**	**AY 25-26**
SLO 1: Students will be able to apply equations and foundational theories when modeling a system with quantitative reasoning				Self-study year, we will resume our regular assessment activities next year.		
SLO 2: Students will be able to predict qualitative behavior in real world systems. Examples may include energy issues, medical devices, and information technology.	X (completed)					X
SLO 3: Students will be able to solve common physics equations in situations relevant to the real world using analytical techniques		X *Moved to this year 21-22 from yr 19-20				
SLO 4: Develop laboratory techniques (set-up, troubleshooting, perform experiments)		X *Moved to this year 21-22 from yr 20-21				
SLO 5: Interpret experimentally obtained results					X	
SLO 6: Students will be able to write professional-quality reports that describe the methods, results, and interpretation of the experimental or computational investigations of physics problems					X	
SLO 7: Students will be able to give verbal presentations on physical principles, application of physical principles, and the results of physics investigations, at a level understandable by an audience of novices. These presentations may include visual aids.			X *Moved to this year 22-23 frm yr 19-20 (The data needs to be collected in the advanced lab course, due to the recent years of online teaching, we move this to yr 22-23).			

2.3 Annual Assessment Reports

Apart from the various grass-roots, assessment efforts mentioned previously, responsive to specific ground-level observations and concerns, this section summarizes our formal annual assessment reports which we submit to the Office of Assessment and Program reviews every year. This work is led by our department assessment committee, which usually consists of three tenure track faculty who collect data from various classes and compile the results.

During our formal annual assessment work, we rotate through different Student Learning Outcome (SLO) from year to year and our plan to do periodic evaluations on all of the SLOs are laid out in the Table 10. Here we summarize work conducted over the past 7 years, highlighting actions and recommendations for changes in light of the SLO assessment results, as well as discussing needed resources .

From 2017 to 2022, the assessment committee performed reports on all but one (SLO 6) of the department's SLOs. SLO#6 (Students will be able to write professional-quality reports that describe the methods, results, and interpretation of the experimental or computational investigations of physics problems) was evaluated during AY 22-23 and is therefore not included in this program review period. We have always been on track to carry out our assessment plan, and we believe that the SLOs are well formulated properly, align with our goals, and don't currently require any changes. Here we list our most up-to-date student learning outcomes (noticing that we revised our SLOs in 2018, and the academic year 2017-2018 and 2018-2019 were referring to older versions of SLOs and 2018 and later were referring to the new SLOs):

1) SLO 1: Students will be able to apply equations and foundational theories when modeling a system with quantitative reasoning.
2) SLO 2: Students will be able to predict qualitative behavior in real world systems. Examples may include energy issues, medical devices, and information technology.
3) SLO 3: Students will be able to solve common physics equations in situations relevant to the real world using analytical techniques.
4) SLO 4: Develop laboratory techniques (set-up, trouble-shooting, perform experiments).
5) SLO 5: Interpret experimentally obtained results.
6) SLO 6: Students will be able to write professional-quality reports that describe the methods, results, and interpretation of the experimental or computational investigations of physics problems.
7) SLO 7: Students will be able to give verbal presentations on physical principles, application of physical principles, and the results of physics investigations, at a level understandable by an audience of novices. These presentations may include visual aids.

2.3.1 Annual Assessment Report 2017-2018:

Goals evaluated: Physics majors, upon graduation, will be prepared for careers in teaching, research, industry, or public service, as well as advanced study in physics and related fields. (note this is an older version of SLOs)

Method: Indirect evidence.

Artifacts: We are encouraged by the indirect evidence that we can derive from our annual alumni career panels, our senior seminar requirements, and visiting alumni such as those who participate in the annual "Professor for a Day" program, those participating in the Industry Advisory Board, and those visiting classes on the invitation of faculty.

Results: Our department website serves as a showcase of success for dozens of students who have found successful careers as physicists.
http://www.cpp.edu/~sci/physicsastronomy/people/student-testimonials.shtml

Reflection: As pointed out in the assessment report, we do not have a numerical way to assess students' success upon graduation. We can only provide indirect evidence. What we have learned thus far indicates that many of our project-oriented classes (e.g. labs, computational physics, observational astronomy) are very significant for future success, and to the extent that we can officially "close the loop" on this, we have continued to put much time and resources into such classes (e.g. raising funds to purchase equipment for Applied Optics).

Also, based on the suggestion we received, we have later consolidated our student learning outcomes to seven, that with a more focused number of SLOs, we can make more rigorous assessments.

2.3.2 Annual Assessment Report 2018-2019:

Goals evaluated:

- Students will develop laboratory techniques (set-up, trouble-shooting, perform experiments) (note this is from an older version of our SLOs).
- Students will be able to interpret experimentally obtained results (note this is an older version of SLOs).
-

Method: Direct evidence: average score

Artifacts: Formal laboratory reports.

Results:

Students can successfully describe the background and relevance of a given experiment and details an experimental setup. Students were able describe their data collection.

Students' analysis of data was satisfactory. Improvements are possible for students who did not provide descriptions of their variables or calculations or describe the context for choices made during analysis. Very few students discussed the uncertainty in their data or limitations of techniques and instruments.

Reflection: We received a good suggestion that we should report the distribution of student scores instead of only reporting the averages. An average doesn't convey as much information as a distribution, i.e. it doesn't convey how many students are better or worse than average. We have incorporated this suggestion in later years, closing the loop on that feedback.

2.3.3 Annual Assessment Report 2019-2020:

Goals evaluated:

- SLO #4. Students will develop laboratory techniques (setup troubleshooting, perform experiments)
- SLO #5: Students will be able to interpret experimentally obtained results.
- SLO #7: Spoken Communication: Students will be able to give verbal presentations on physical principles, applications of physical investigations, at a level understandable by an audience of novices. These presentations may include visual aids.)

Method: Analytical rubric (scale 0-3)

Artifacts: Lab reports (N=8) on 5 labs for SLO4 and 5; Oral zoom presentation (N=3) for SLO 7

Results:

SLO#4: Students' description of the setup was generally very clear and easy to follow. These descriptions listed all the necessary equipment, settings, and relevant connections (i.e. wires, tubes, etc. connecting pieces of equipment). Only a few lower scores were given, primarily when students provided no detail about the experimental set up and instead only stated what measurements were being taken.

SLO#5: Students' analysis of data was satisfactory, on average. All students compared the data to predicted values or to results in the scientific literature. The average score for uncertainty or discussion of limitations was below expectations. This is because half of the analyzed students did not use uncertainty in their calculation or discuss limitations of the experimental technique.

SLO #7: Students perform well on the “Etiquette and Presentation Delivery” category. They perform especially well on time management and making the slides easy to follow. They speak with a clear voice and speakers smoothly. The category in which students need the most improvement is “appropriate styles for the slides”, it seems like students could do more to make sure their slides are professional in terms of using appropriate font sizes, colors, texts, size of images. Students perform relatively well on the “structure and organization” category, but relatively less well compared with their performance on the previous category. The best parts of the presentations are the introductions, in which the purpose and goals are clear. The category that needs the most improvement is “summary or conclusions and brings the closure effectively”.

Reflection:

SLO#4**:** We reflected on whether SLO#4 is best assessed by using lab reports. Just because a student doesn’t describe a task in their lab report, it does not follow that they cannot perform the task. This skill of troubleshooting might be best captured by a lab practical exam, or by using some kind of in class observation.

SLO#5: We reflected on the fact that the use of uncertainty in measurement often doesn’t show up as an explicit activity in upper-division labs. Now doing self-study, we do believe

that the low score is largely due to the absence of directly relevant information, i.e. activities dedicated to uncertainty analysis, rather than weaknesses in that type of analysis. For the future, we can try collecting from a different lab, or selecting the types of reports which will allow us to more directly assess this learning outcome.

2.3.4 Annual Assessment Report 2020-2021:

Goals evaluated:

- SLO #1. Students will be able to apply equations and foundational theories when modeling a system with quantitative reasoning.
- Other goal: Evaluating the online teaching modality (as this assessment was done during the pandemic) and students' perceptions of online teaching.

Method: Analytical rubric (scale 0-3) for SLO 1, Survey for other goal.

Artifacts: Students exam solution (N=29) for SLO1; Online survey responses(N=331).

Results:

- SLO#1: The average score of all four categories is somewhere around 2 points on a 3-point scale (minor mistakes). More than a third of the students got 3s (highest score) in all categories. Scores oin the reflection category are somewhat lower.
- Overall, students were positive and appreciative about the efforts the faculty made to accommodate them in this most unusual semester. Students rated the most useful strategies as: Use of multimedia such as short films / Youtube videos /Working with a study group /Personal check-ins from the instructor outside of assignments /Synchronous, online lectures/Working in small groups in “zoom break out rooms” / Use of web-based interactive assignments /Use of polls or clicker-type questions within lectures.

Reflection: Students scored lower on "reflection" skills, and this does require more deliberate practice and we encourage that instructors prompt students to do that as much as possible in the class. We reflect to rotate to assess this skill in a different class or evaluate another aspect of quantitative reasoning (which was done in the subsequent year).

2.3.5 Annual Assessment Report 2021-2022:

Goals evaluated:

- SLO# 2: Students will be able to predict qualitative behavior in real world systems. Examples may include energy issues, medical devices, and information technology.
- SLO# 3: Students will be able to solve common physics equations in situations relevant to the real world using analytical techniques.

Method: Analytical rubric (scale 0-3).

Artifacts: Students exam solution (N=48).

Results:

- SLO#2: the average score across all 3 categories is 2.18 on a 0-3 scale. For the counts in each bin (total N=48), we have 4 zeros , 8 ones, 11 twos, and 25 threes. More than 50% of the students scored 3s, and more than 20% scored 2s. We consider this result

satisfactory.

- SLO #3: the average score across all 3 categories is 1.44. For the counts in each bin (total N=48), we have 14 zeros , 9 ones, 15 twos, and 10 threes. Close to 30% of the students scored 0s, and close to 20 % scored 1s. We consider this result unsatisfactory.

Reflection: We see that students do well with qualitative predictions but struggle with quantitative analysis. Doing quantitative calculations in real-world contexts is particularly challenging because students need to apply mathematical models to a more messy physical world. This skill requires more deliberate practice and we consequently recommended that instructors prompt students to do that as much as possible in the class.

3 STUDENTS – UNDERGRADUATE

3.1 Student Profile at Admission and Enrollment - Undergraduate

The data in Tables 11 and 12 were compiled using data requested from the Office of Academic Resources. Tables 11 and 12 show admission trends. Some of the data may be missing due to students not reporting information or we were not able to locate it.

Table 11 – Admission trends for first-time freshmen[9]

	Fall 2022	Fall 2021	Fall 2020	Fall 2019	Fall 2018
Applied	**263**	**258**	**292**	**272**	**274**
Gender					
Female	92	77	78	75	66
Male	170	179	214	197	208
Not Reported	1	2	0	0	0
URM Status					
Non-URM	171	167	158	166	142
URM	92	91	134	106	132
Not Reported	0	0	0	0	0
1st Generation Status					
1st Generation	87	82	146	123	142
Not 1st Generation	176	176	146	149	132
Not Reported	0	0	0	0	0
Admitted	**224**	**208**	**266**	**232**	**215**
Gender					
Female	82	66	72	69	56
Male	141	140	194	163	159
Not Reported	1	2	0	0	0
URM Status					
Non-URM	153	137	141	149	122
URM	71	71	125	83	93
Not Reported	0	0	0	0	0
1st Generation Status					
1st Generation	68	65	135	99	102
Not 1st Generation	156	143	131	133	113
Not Reported	0	0	0	0	0
Enrolled	**19**	**17**	**48**	**29**	**50**
Gender					
Female	6	6	12	6	12
Male	13	11	36	23	38
Not Reported	0	0	0	0	0

[9] Source: Tableau https://analytics.cpp.edu/#/site/production/views/ApplicantProfile/AdmissionsCustomTable?:iid=1

URM Status					
Non-URM	12	10	17	21	19
URM	7	7	31	8	31
Not Reported	0	0	0	0	0
1st Generation Status					
1st Generation	5	9	31	13	26
Not 1st Generation	14	8	17	16	24
Not Reported	0	0	0	0	0

*Note: Students who did not report their demographics or are nonbinary are counted as "Not Reported"

Table 12 – Admission trends for transfer students[10]

	Fall 2022	Fall 2021	Fall 2020	Fall 2019	Fall 2018
Applied	**77**	**81**	**100**	**86**	**95**
Gender					
Female	18	20	24	16	25
Male	59	60	76	70	70
Not Reported	0	1	0	0	0
URM Status					
Non-URM	40	39	65	42	50
URM	37	42	35	44	45
Not Reported	0	0	0	0	0
1st Generation Status					
1st Generation	34	40	63	55	57
Not 1st Generation	43	41	37	31	38
Not Reported	0	0	0	0	0
Admitted	**45**	**42**	**80**	**79**	**78**
Gender					
Female	14	10	21	14	23
Male	31	31	59	65	55
Not Reported	0	1	0	0	0
URM Status					
Non-URM	25	20	56	38	41
URM	20	22	24	41	37
Not Reported	0	0	0	0	0
1st Generation Status					
1st Generation	22	20	52	49	48
Not 1st Generation	23	22	28	30	30
Not Reported	0	0	0	0	0
Enrolled	**13**	**17**	**23**	**21**	**32**
Gender					

[10] Source: Tableau https://analytics.cpp.edu/#/site/production/views/ApplicantProfile/AdmissionsCustomTable?:iid=1

Female		4	6	3	8
Male		13	17	18	24
Not Reported		0	0	0	0
URM Status					
Non-URM		9	15	8	21
URM		8	8	13	11
Not Reported		0	0	0	0
1st Generation Status					
1st Generation		7	15	14	16
Not 1st Generation		10	8	7	16
Not Reported		0	0	0	0

*Note: Students who did not report their demographics or are nonbinary are counted as "Not Reported"
*Note: A demographic breakdown is not provided for cohorts with less than 15 students.

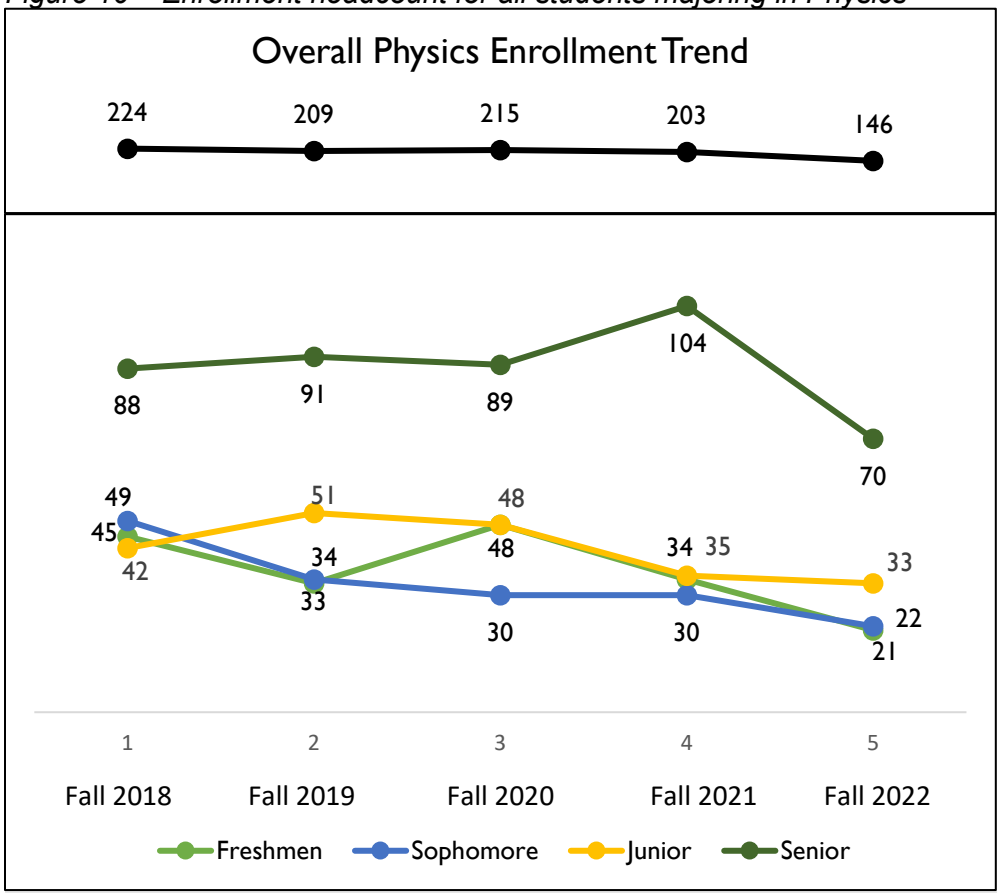
Table 13 and Figure 6 provide enrollment trends for the program.

Table 13 – Enrollment trends for all students[11]

Enrollment Trends					
Term	**Overall Program**	**Freshmen**	**Sophomore**	**Junior**	**Senior**
Fall 2018	224	45	49	42	88
Fall 2019	209	33	34	51	91
Fall 2020	215	48	30	48	89
Fall 2021	203	34	30	35	104
Fall 2022	146	21	22	33	70

[11] Source: Tableau https://analytics.cpp.edu/#/site/production/views/EnrollmentTrend/EnrollmentTrend?:iid=1

Figure 10 – Enrollment headcount for all students majoring in Physics



Enrollments are relatively stable, despite a small but not drastic downward trend. Also, though Fall 2023 is not part of the review period, we enrolled more than 50 freshmen in fall 2023. Furthermore, Table 11 shows an upward trend for enrolled freshman admits, despite a downward trend for freshman enrollment in Table 13; we can likely attribute this discrepancy to freshman admits having more Advanced Placement (AP) credits, and hence advancing to sophomore standing mid-year. This suggests admission of more studious freshman cohorts.

The biggest difficulty we face is that students are not graduating in 4 years, as evidenced by the significantly higher number of seniors relative to other academic standings. Students are staying past their 4th year because they have not yet completed requirements.

As noted previously, in section 2.1.9, upper-division students struggle with mathematical concepts. Whether this means that students are suited to the program (per the question prompt) or the program is suited to meet the needs of students is one of the hardest Rohrschach tests in academia. All that we can say about the issue before us is that (1) we hope that more studious freshman admits will eventually translate into stronger upper-division performance, and (2) all of the curricular and pedagogical improvements and efforts described in Section 2 are aimed (at least in part) to address our students' mathematical struggles (among other issues).

Supporting enrollment has two components: Supporting enrolled students so that they can persist, and attracting new students. Regarding the first issue, all of the department's efforts to help

students succeed in classes and other endeavors, described particularly in Section 2 above, are relevant.

Regarding attracting enrollment, the department has been active in campus recruitment events aimed at persuading admitted students to choose Cal Poly Pomona. As noted above, although Fall 2023 is outside the review period, a particularly vigorous department effort at a recent recruitment event for admitted high school students resulted in a record-setting 50+ incoming freshmen in Fall 2023. We aim to have a vigorous presence at all future recruitment events as well, ***emphasizing two key strengths of the department: Student research opportunities and career preparation (e.g. our Industry Advisory Board events and related efforts)***.

Admission and Students Preparedness

Though the Physics and Astronomy major at CPP had been designated as impacted, due to challenges in meeting student demand for research projects and specialized labs with our current tenure-track faculty numbers, the number of applicants to our program has not significantly exceeded the available spots. In practice this means that we have little to no flexibility in setting admissions standards. For our local area, we admit any students who have met the minimum eligibility standards for CSU. We thus anticipate (and accept) that our designation as “impacted” might soon be revoked.

However, in the absence of higher admission standards, we are still faced with he weaknesses in foundational preparation noted repeatedly above, e.g. in the discussion of vector errors in PHY 4140. Vector mistakes are, admittedly, mistakes with college-level material, but faculty have noted many weaknesses with high school algebra material, and such weaknesses surely impede skill development in college-level classes. For instance, many faculty have encountered errors like:

$$\frac{1}{a}+\frac{1}{b}=\frac{1}{a+b}$$

It is quite evident that additional efforts need to be directed toward student preparation and the improvement of their mathematical skills at the junior and sophomore levels. For instance, the discussion/activity sections in our sophomore-level courses are excellent places to spot and address algebraic misconceptions. However, the time available is not always adequate, and students do not always recognize the gravity of the problem. Many will correct one line in the calculation in front of them, but will not fundamentally rebuild their understanding of algebra, leading to more problems in subsequent classes.

Recognizing the magnitude of the challenge we face with our incoming students, we prioritize addressing these gaps by focusing on introductory courses and strengthening students' mathematical foundations. By striving to help students acquire the essential tools before progressing to upper-division classes, we hope to create a level playing field and enhance students' readiness for advanced coursework.

Enrollment and diversity: URM students

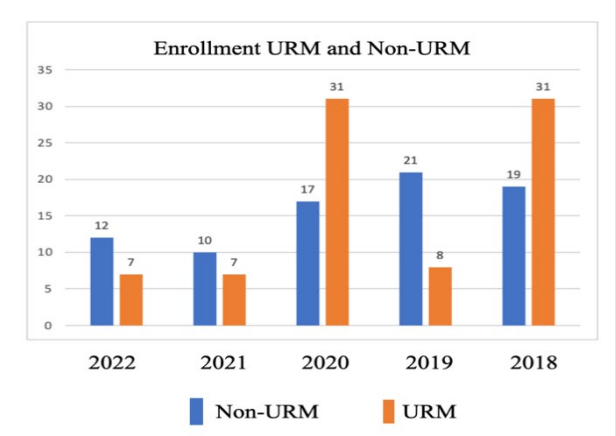
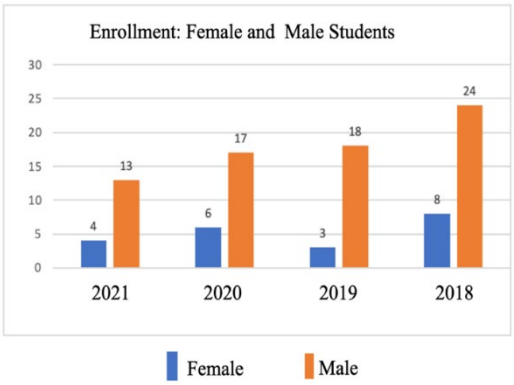


Figure 11. Freshmen Enrollment for URM and non-URM students (bar graph generated based on data in Tables 11-12)

In every year shown, at least 27% (and sometimes a majority) of our enrolled freshman physics majors were from under-represented minority (URM) backgrounds. National data from the American Institute of Physics (AIP) shows that in the years 1994-2019, bachelor's degree recipients in physics were never more than about 14% URM[12], indicating that ***with good retention strategies simply graduating our incoming freshmen will yield a more ethnically and racially diverse class than the national average***.

Enrollment and diversity: Female students

Figure 12. Freshmen Enrollment for male and female students (bar graph generated based on data in Tables 11-12)



[12] AIP Statistical Research Center, "The Proportion of Physics Bachelor's Degrees Awarded to African Americans and Hispanic Americans, Classes 1994 to 2020", October 1, 2021. https://ww2.aip.org/statistics/the-proportion-of-physics-bachelors-degrees-awarded-to-african-americans-and-hispanic-americans-classes-1994-to-2020

From 2018 to 2022, the proportion of women in the incoming class ranged from 14% to 26%, neatly averaging to 22.6%, roughly the proportion of women receiving all bachelor's degrees in physics nationally in recent years (21%)[13]. In other words, ***with good retention efforts, simply graduating a cohort that matches our entering student body will result in representation of women that is at least no worse than national averages***.

Regarding the fairness of our admission processes, during the time period in question a total of 968 male students applied to our program. A total of 797 were admitted, and a total of 121 enrolled in the program. In that same time, a total of 388 female students applied to the physics and astronomy program; a total of 345 were admitted, and a total of 42 enrolled in the program. The ratio of female to male applicants is 0.4, which is better than the ratio of female to male undergraduate physics students nationally (0.25). This indicates that the applicant pool is not the main obstacle to greater gender diversity in our department. Likewise, the acceptance rate for female students is 90%, which is higher than the acceptance rate for male students, which stands at 82%. This suggests that admissions processes are not biased against female students. However, the enrollment rate for female students is 12%, compared to 15% for male students. Evidently, female students may have chosen other campuses or other majors for various reasons, and comparing 12% of a smaller cohort to 15% of a larger cohort will lead to issues of statistical noise. If we assume that the fluctuations of students who enter will be proportional to the square root of the mean (per common statistical observations) then the percentages will fluctuate as $1/\sqrt{N}$, which is 15% for the 42 women who entered, and 15% of a 12% rate of offer acceptance is about 1.9%. For the 121 men, the fluctuation will be 9%, and 9% of the 15% rate of offer acceptance is about 1.4%. Summing these expected fluctuations gives 3.3%, comparable to the difference in the rates at which men and women accept our offers of admission.

We further note that we make especial efforts to recruit women students, inviting every female student offered admission to the program to attend our spring "Women in Physics Seminar and Luncheon", an annual department tradition that showcases our efforts to foster a climate supportive of female students. In other words, the (thankfully small) disparities between enrollment rates cannot be ascribed to lack of effort or attention from the department.

3.2 Student Retention and Graduation Rates – Graduation Initiative 2025

Figure 13 provides graduation data for students entering the Physics major as First-Time Freshmen only. Any on-campus transfers who started in another major as a freshman are not accounted for in the First-Time Freshmen Graduation Rates for Physics. The figure below shows that 46% of student who started in 2010 graduated in six years or less, 36% of students who started in 2010 graduated in five years or less, and 13% of students who started in 2011 graduated in four years or less.

[13]Anne Marie Porter and Rachel Ivie, "Women in Physics and Astronomy, 2019" (March 1, 2019). https://ww2.aip.org/statistics/women-in-physics-and-astronomy-2019

Figure 13 – First-time Freshmen Graduation Rates for Physics[14]
Note: Label along bottom indicates the entering cohort year

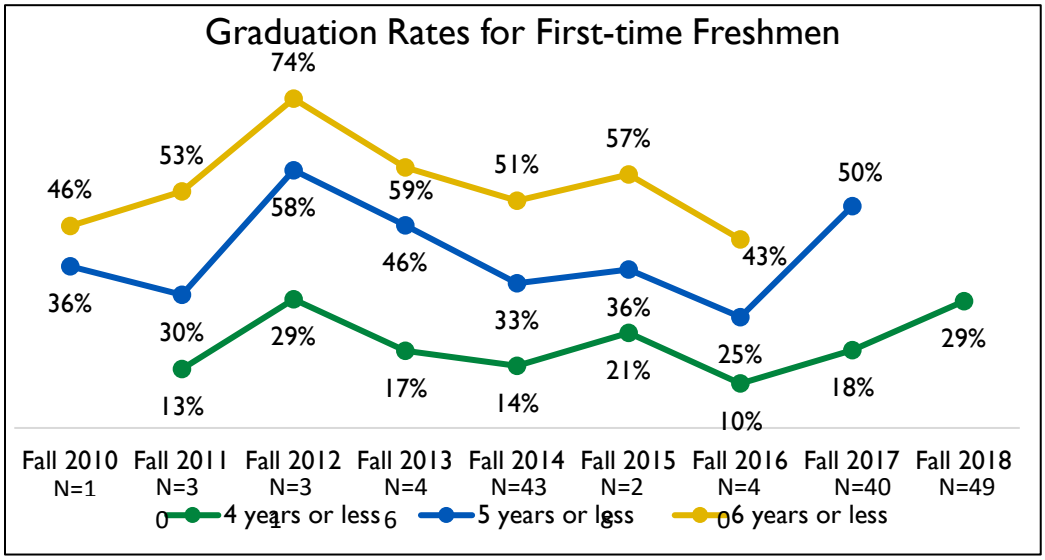
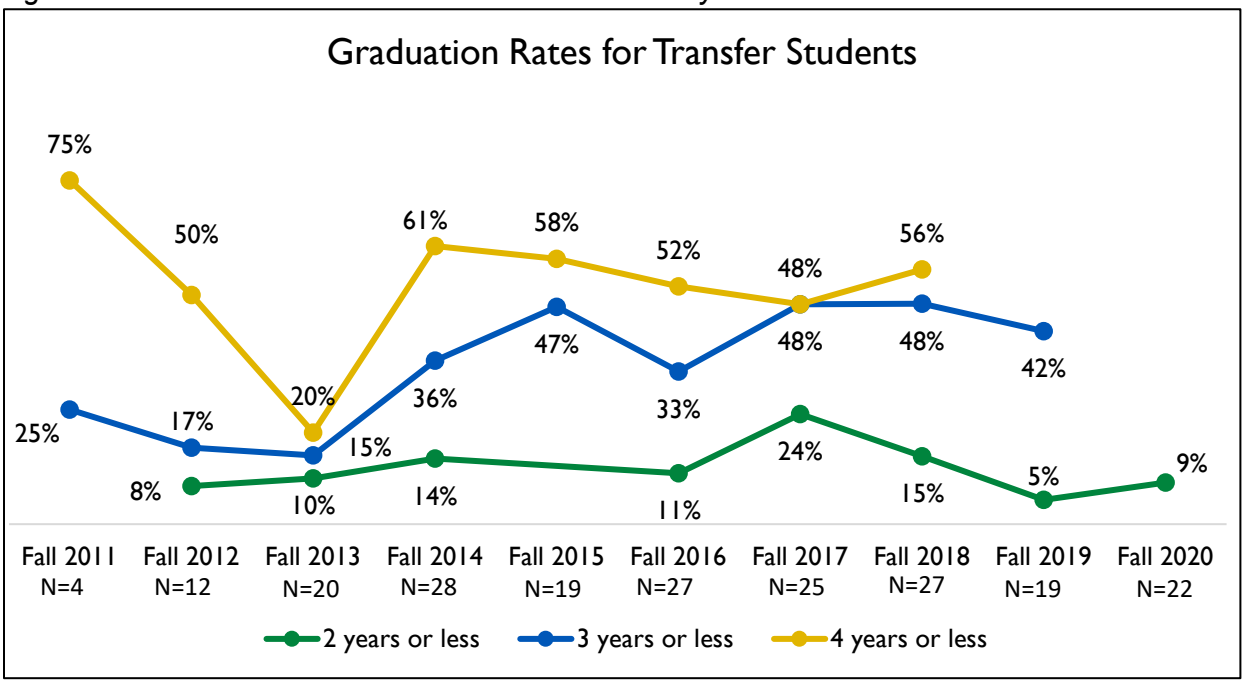


Figure 14 provides graduation data for students entering as a Physics major as off-campus fall term Transfers. Any transfers entering in a term other than fall or are on-campus transfers are not accounted for in the Fall Entering Transfer Graduation Rates for the Physics program. The figure below shows that 8% of transfer students who started in 2012 graduated in two years or less and 75% of those who started in 2011 graduated in four years or less.

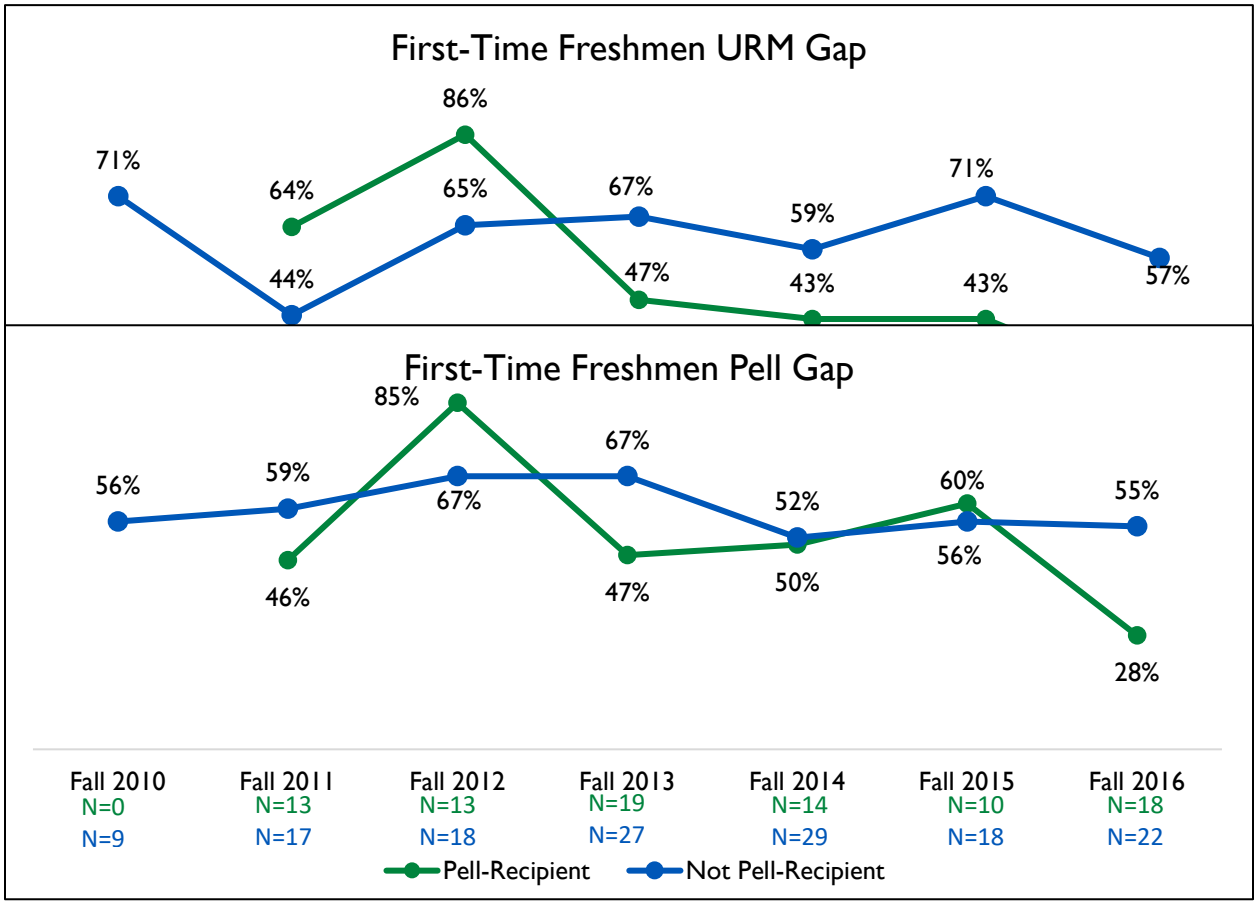
Figure 14 – Transfer Student Graduation Rates for Physics[15]



[14] Source: Tableau https://analytics.cpp.edu/#/site/production/views/GraduationRatesDashboard/FTFGradRates?:iid=2
[15] Source: Tableau https://analytics.cpp.edu/#/site/production/views/GraduationRatesDashboard/FTFGradRates?:iid=2

The figures below depict six-year graduation rates for underrepresented minorities (URM) and Pell-eligible First-time freshmen majoring in Physics. Figure 15 indicates that 64% of URM students and 44% of non-URM students who started in 2011 graduated in six years or less. Figure 16 below indicates that 46% of students who receive the Pell Grant and 59% of students who do not who started in 2011 graduated in six years or less.

Figure 15 – First-time Freshmen graduation rate gap between URM ad non-URM students[16]



[16] Source: Tableau https://analytics.cpp.edu/#/site/production/views/GraduationRatesDashboard/FTFGradRates?:iid=2
[17] Source: Tableau https://analytics.cpp.edu/#/site/production/views/GraduationRates_0/FTFPellGap?:iid=2

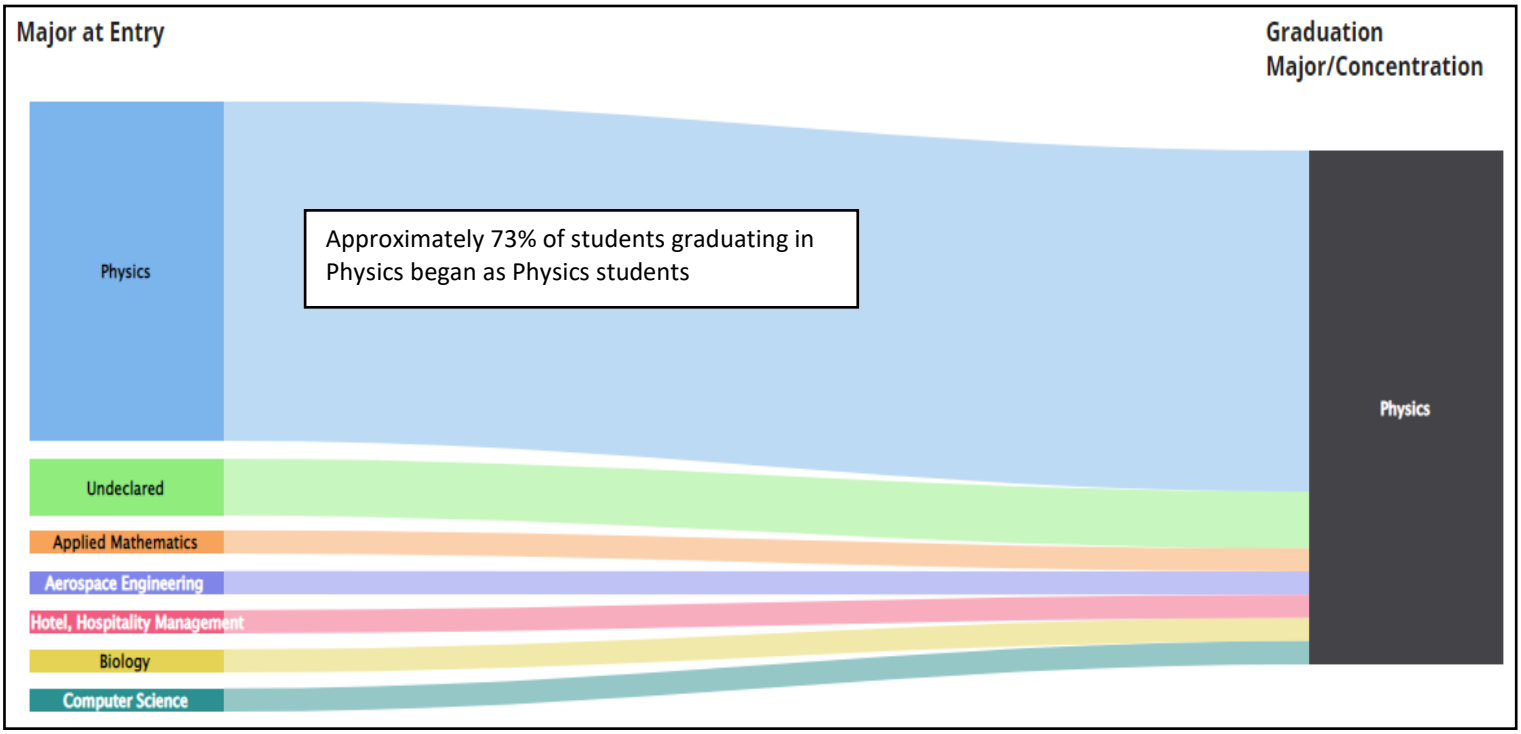
Table 11 and Figure 17 provide a snapshot of starting degree vs graduation degree.

Table 11 – Snapshot of Starting Degree for Student Population[18]

Major at Entry	Major at Graduation	# Students
Physics	Physics	36
Undeclared	Physics	6
Applied Mathematics	Physics	2
Aerospace Engineering	Physics	2
Hotel, Hospitality Management	Physics	1
Biology	Physics	1
Computer Science	Physics	1
Physics	Physics	36

**The information above is for first-time full-time freshmen who graduated in 2020, 2021, or 2022*

Figure 17 – CSU Major Migration for all First-Time Freshmen Who Graduated in 2020, 2021, 2022[19]



Students' Persistence and Graduation Rates

[18] CSU Dashboard "What Paths Do They Follow" Report https://csusuccess.dashboards.calstate.edu/public/db-what-paths-do-they-follow
[19] CSU Dashboard "What Paths Do They Follow" Report https://csusuccess.dashboards.calstate.edu/public/db-what-paths-do-they-follow

Figures 13 and 14 depict six-year graduation rates for first-time freshmen and transfer students, respectively, in our department. The horizontal axis represents the cohort based on their year of admission and goes to 2016. Figure 15 depicts the six-year graduation rate gap between underrepresented minorities (URM) and non-URM students majoring in physics. Figure 16 depicts the six-year graduation rate gap between Pell and non-Pell recipients.

The gap between URM and non-URM students' graduation rates is more consistent than the gap between Pell and non-Pell recipients. From 2013 to 2016, the graduation rates for non-URM students is consistently around 20-30% higher than non-URM students. However, interestingly, the two data points priori to 2013 show the opposite, where graduation rates for non-URM students is higher. We are certainly interested in investigating further to see any insights that can be gained about the changed, and possibly use it to improve bridging the gap in the future.

While gaps are evident and persistent, we note two points: First, the gaps are of order several percent, and the numbers of URM and non-URM students entering each year is of order 20, so the expected percentage fluctuations are of order $1/\sqrt{N}=1/\sqrt{20}=22\%$. None of the gaps that we observe are terribly large, in statistical terms. However, the fact that the gaps are persistent and consistent with known inequalities in access to resources (including preparation prior to college, role models during college, and sufficient financial resources to devote one's full time and effort to college) suggests that the gaps are real effects, not just statistical flukes.

To the extent that the core issues are prior preparation and current time demands, every single supportive practice outlined in this self-study, whether curricular structures that include more discussion/recitation/activity, learning assistants, peer tutoring, hands-on research experiences, more attention to introductory foundational courses, etc., should be at least somewhat helpful in addressing these equity gaps.

Below are a few efforts particularly worth highlighting in the context of equity gaps:

- Enhanced Academic Advising: Once enrolled, the department provides comprehensive academic advising and support services to help students navigate their academic journey. This includes regular check-ins with academic advisors who assist students in selecting appropriate courses, creating academic plans, and addressing any academic challenges or concerns. Tenure-track faculty serving as academic advisors also help students explore opportunities for research, internships, and other experiential learning opportunities that can enhance their engagement and persistence.

  The University has recently shifted most advising duties from faculty in the discipline to advising specialists outside the discipline, in keeping with university-level efforts to shift efforts and resources away from the people most familiar with ground-level, discipline-specific challenges. However, we continue to assign faculty advisors and strongly encourage students to meet with them.

- Building a Sense of Community: The program fosters a sense of community among students through social events, study groups, and extracurricular activities. This community-building approach helps students develop connections with their peers, faculty, and staff, creating a supportive environment where they feel valued, engaged, and motivated to persist in their academic pursuits.

- In spring semester 2023 the Department of Physics and Astronomy held special homework help sessions with pizza every week, targeted at PHY 1510 (Introduction to Newtonian Mechanics) students. The sessions were on Thursdays from 6 pm to 8 pm. At least two Learning Assistants were present at these sessions, to help students with homework. While students from any class were welcome to come and ask for help and work with others, the LAs were focusing on PHY 1510 homework which is one of the major bottleneck courses in the department. In addition, all PHY 1510 students had access to a special canvas site with homework help sessions and helpful study material that students in any 1510 lecture could benefit from were posted.

- In our department, we have a designated room for the Physics Club which provides students with a dedicated space where they can come together, collaborate, and engage in various activities related to their physics studies.

- Our department provides a variety of opportunities for informal student/faculty interactions, including near-weekly seminars with refreshments and discussion beforehand, the annual Women in Physics seminar and luncheon, the Alumni Career Panel with an informal social component prior to the panel discussion, social events in collaboration with the Physics Club, and an annual party for our graduating seniors.

- Extended Integration Opportunities in Sophomore Classes: As mentioned previously, two-semester physics courses for sophomore students are offered with the goal of giving students more time to develop certain fundamental skills, spread out the transition from lower-division to upper-division material, and get to know each other in the first courses taken primarily with other physics majors. This is also beneficial for community college students, as the third semester that they take at community college is not as standardized as the first two semesters.

  While the benefits of this curricular structure extend to all students, those in need of support because of inequitable k-12 preparation can particularly benefit.

- Discussion/Activity Required in Core Courses: As discussed above, we have structured our curriculum to include recitation activities in all core theory courses at the sophomore, junior, and senior levels. This gives more time for group work while receiving guidance from the instructor, and the instructors work with small group or work individually with students as needed. We are also making more frequent use of Learning Assistants in these activity courses, with an eye toward giving more attention students who need the most support. We are also going to increase the frequency of offering Mathematical Methods (PHY 3600) from once a year to twice-yearly, so that students who need to repeat the course do not have to wait a year. While we of course want to improve pass rates on the first attempt, we also recognize the importance of expanding access to second attempts.

In general, in the Physics and Astronomy Department, we firmly believe that strengthening students' mathematical foundations and knowledge of the core physics concepts is crucial for their success. By focusing on these areas and trying to address preparation gaps, the department aims to improve students' persistence and graduation rates by providing a solid educational foundation.

3.3 Student Support, Satisfaction and Services - Undergraduate

3.3.1 Co-Curricular

Student organizations

Active Student Club and the Club Room: In our department, we have a dedicated room for the Physics Club, where they can come together, collaborate, and engage in various activities related to their physics studies. Students gather in this room to discuss their homework assignments, share insights, and work through challenging problems together. It creates an environment conducive to intellectual exchange and encourages active learning and problem-solving among students. Discussions in this space allow students to clarify concepts, seek help, and gain different perspectives on physics topics. Thus, the physics club provides an ideal setting for students to form study groups. Having a designated physics room fosters a sense of community among students. Regular interactions in this space can lead to the formation of strong bonds and a supportive network of peers who share similar academic goals and challenges. The physics room offers an opportunity for students to seek advice from both their peers and more senior students. Older students who have already completed specific courses or faced similar academic obstacles can provide guidance, share their experiences, and offer strategies for success. This peer-to-peer support system can be invaluable in helping students navigate their coursework, understand difficult concepts, and overcome academic hurdles. In addition to academic support, the physics room can also serve as a platform for students to share information and provide guidance regarding career opportunities in the field of physics. Students discuss internships, research positions, and job openings, sharing insights, tips, and resources related to career development. This exchange of information can be particularly helpful for students who are exploring their future paths in physics and seeking guidance on career options and professional development.

One of the most significant achievements of the Physics Club in recent years was organizing the 2023 SPS (Society of Physics Students) Zone Meeting on campus, bringing together more than 50 students from several universities throughout California, along with several alumni and other friends of the department.

Women in Physics Group: The women physics students have their own group which holds regular social events, some of them with alumni and also with newly-admitted physics majors, as a recruitment effort.

The department faculty also organize an annual Women in Physics Seminar and Luncheon in March or April, which includes a woman scientist giving a research talk, women alumni and friends of the department (e.g. former staff, and emerita faculty) and a luncheon bringing together all visitors with women students.

Telescope Operators: The astronomy faculty, as part of their outreach efforts, train students to operate telescopes for outreach events that bring in the campus community and local community. While not formally registered with Student Affairs as a student organization, it is a valuable extracurricular activity for students.

Research: The full range of research activities undertaken by students in the department is broad, encompassing the full range of research specialties represented among the faculty and their close collaborators and partners. Since 2017 (the date of our last review), ***70 students have been presenters or co-authors on conference presentations with department faculty, and 49 have been authors or co-authors on peer-reviewed journal articles with department faculty!***

3.3.2 Academic Advising

Academic advising practices have been in flux during the review period. Initially, advising on course selection was primarily a faculty task. Student participation in advising was enforced by the fact that students could not register until a faculty member had signed an advising form, and upon receipt of this form the Registrar would lift a hold that barred the student from registering for classes. However, by the time of the pandemic this requirement was largely phased out. In recent years, the university has invested in increasing the number of formal academic advisors in the College Advising Centers. The faculty role in course selection is now largely informal, with students seeking out advice from faculty whom they know, especially their research advisors or faculty with whom they developed a good working relationship in a class.

The department's working relationship with the College of Science Advising Center has deepened in recent years, but has not fundamentally changed in character. Even when faculty advised every student prior to registration, we would refer students to the College of Scicence Advising Center regarding complicated issues such as academic probation, challenges with transfer credit, and petitions to handle complex prerequisite issues and elaborate chains of course substitutions. We still refer students to the Advising Center for such issues. In addition, we work closely with the Advsing Center during summer orientation, as they have a better understanding of issues such as placement tests, freshman writing course sequences, and which set of rapidly-evolving General Education requirements apply to a student.

One area in which faculty continue to have important advising roles is preparation for careers and/or graduate study after completing their BS. This role resides with us because of our expertise, and in particular our working relationships with colleagues in graduate institutions and companies on our Industry Advisory Board. However, these roles are not assigned, i.e. students seek out faculty for this sort of advice based on their prior relationships with faulty, and based on the faculty member's reputed expertise, e.g. their research focus, or their industry collaborations. It has always been the case that even when faculty advisors were assigned to students, students would still seek career advice from faculty with relevant expertise, often based on a referral from their formally assigned advisor. In other words, we have never assumed that the person assigned to advise a student on when to take Lagrangian Mechanics is the best person to advise on internships in a very particular field.

One of our greatest advising challenges is how to steer students with deep deficits of mathematical preparation. As noted above in section 2.1.9, many students in upper-division courses like Electromagnetic Theory have profound misunderstandings of basic material in calculus and vectors (a point noted by Engineering Statics instructors in the survey findings in Appendix 2). Obviously we hope to address many of these issues by improving our pedagogical

practices in freshman and sophomore classes. However, it may be advisable for some students to consider different majors if they have no yet achieved proficiency with foundational material by the end of their sophomore class. Changing major after sophomore year could significantly delay graduation, while a change during freshman year may be premature, as there is still time to improve. ***The hard question is how to develop fair and predictive criteria for flagging students who would benefit from changing major, and when to flag these students and how to compassionately advise on changing path.***

3.3.3 Student Satisfaction

We conducted a survey of current students, and received up to 38 responses on some of the questions. Detailed information is included in Appendix 3; here we summarize key findings.

Data indicates that the majority of students actively engage in academic or career discussions with faculty members. However, a significant portion of students who do not participate cite the challenge of finding an appropriate time to do so as a primary obstacle.

Moreover, an overwhelming majority of students perceive these discussions with faculty as highly valuable. They recognize the immense significance of these interactions in shaping their academic trajectory and future career prospects.

Additionally, majority of respondents have actively participated in research alongside faculty members. Notably, a majority of these students have established consistent, weekly interactions with their research supervisors. They not only acknowledge the critical importance of research but also believe that it significantly contributes to their academic pursuits and personal growth.

These findings emphasize the critical need for adequate support systems to facilitate and encourage academic, career, and research-related engagements beyond traditional classroom settings. Both students and faculty members can benefit greatly from initiatives that enable and promote these interactions, fostering a more comprehensive and enriched educational experience. Such support systems could include dedicated mentorship programs supported by administration, or institutional structures that prioritize and facilitate research for both students and faculty. The significance of these interactions extends beyond mere academic learning, playing a pivotal role in shaping students' educational journeys and fostering a culture of lifelong learning and academic excellence.

3.4 Stakeholders

We emailed a survey to all alumni with addresses on file, and received few/no responses. However, our general observation on alumni satisfaction is that we have maintained very strong ties to alumni, evidenced by high participation in the 2022 and 2023 alumni reunions at the College of Science spring research symposium. In 2022 we had ***more alumni attendees than any other department in the College of Science***, despite having many fewer graduates over time than departments like Biology, Computer Science, and Kinesiology and Health Promotion. Alumni participating in departmental efforts like our above-mentioned Alumni Career Panels and Industry Advisory Board give remarkably consistent verbal feedback on the lasting value of our lab classes, research projects, and extracurricular activities.

4 INCLUSIVE POLYTECHNIC EDUCATION

The vision of Cal Poly Pomona is to be the model for an inclusive polytechnic university that inspires creativity and innovation, embraces local and global challenges, and transforms lives. This vision is lived-out through the eight elements of inclusive polytechnic education, as shared in Cal Poly Pomona's Academic Master Plan.

Here, we discuss how departmental and program activities are aligned with these eight elements. We proceed by providing representative examples.

Application of knowledge:

At Cal Poly Pomona, we use multiple modalities of teaching to facilitate student learning of theory, followed by reinforcement of theoretical knowledge through active, hands-on application of principles to address opportunities and challenges of the modern world.

In our department we realize this goal via many methods, including (but not limited to):

- Culminating projects in many classes.
- Student research projects in all areas of physics and astronomy.
- Real-world, data-driven projects and modeling projects.
- Numerical simulations in COMSOL Multiphysics.
- Data analysis using Python.
- Simulations of optical systems in Zemax, a professional-grade simulation package widely used in industry.

Critical thinking and problem-solving:

- *At Cal Poly Pomona, we emphasize the development of critical thinking and problem-solving skills, and integrate active and immersive experiential pedagogies in curricular and co-curricular learning experiences.*

To the extent that physics is all about solving problems that require deduction of unknown quantities from given information, and trouble-shooting in laboratory activities, it is self-evident that physics teaches problem-solving skills. To the extent that our curriculum has a heavy project-oriented element, as discussed above in section 2.1.4, it is self-evident that we have active and immersive experiential pedagogy

Creativity, discovery, and innovation:

At Cal Poly Pomona, our academic programs connect theory, practice, and research, and are focused on creativity, discovery, and innovation.

In our department we realize this goal via many methods, including (but not limited to):

- Active encouragement of undergraduate participation in Off-campus summer research programs and industrial internships, and on-campus research projects.
- Project-oriented classes.

Diverse and multidisciplinary perspectives:

At Cal Poly Pomona, we value diversity, diverse perspectives, and inclusivity, all of which are integral to multi-disciplinary and collaborative teaching, learning, discovery, and innovation.

Our department strives to expose students to a very wide range of perspectives and applications, both in the classroom and in collaborative research experiences. Some examples are:

- Research experiences in collaboration with other departments and institutions, including the Aerospace Engineering Department, NASA JPL, faculty in Biology and Chemistry.
- Cal- Bridge, a program that explicitly prepares students for admission to graduate programs in the UC system and eight non-UC Cal-Bridge partners.
- Explicitly interdisciplinary courses, including AST 3050 – Archeoastronomy (co-taught with an Anthropology faculty member), PHY 1050 -Physics of Musical Sound (recently redesigned in close consultation with the Music Department), PHY 3010--Energy and Society (taught by a faculty member who also works at the AQMD), and PHY 4100—Biophysics (cross-listed with Biology).
- Applications of science to all areas of life and technology throughout our curriculum, including many industry-relevant examples developed in consultation with our Industry Advisory Board.

Integration of technology:

> *At Cal Poly Pomona, we use evidence-based approaches to integrate technology in support of excellence in curricular and co-curricular pedagogies.*

Our students develop facility with a wide range of technologies relevant to STEM careers, including:

- Hands-on experience with laboratory equipment from their first introductory physics courses to 4000-level lab courses required for all physics majors.
- Coding in modern languages and packages such as MATLAB, Mathematica, Python, and LabView in various courses.
- Numerical simulations in COMSOL Multiphysics, an industry-grade simulation suite for modeling a range of physical phenomena.
- Simulations in Zemax, industry-grade simulation software used to model optical systems.
- Use of spreadsheet software from the very first laboratory classes.
- Use of LaTeX to prepare reports with professional typesetting in the same style as research journals.

Collaborative learning:

> *At Cal Poly Pomona, we embrace team approaches to foster collaborative teaching, learning, discovery, and innovation.*

In our department we realize this goal via many methods, including (but not limited to):

- Collaborative group work in a wide variety of settings, from lab experiments, to debugging code in courses that use simulations, to group problem-solving in recitation/activity courses.
- Flipped instruction models in some classes.
- Group work is standard in lab classes.

Community and global engagement:

At Cal Poly Pomona, we are engaged with our community, link our academic programs to local and regional stakeholders, and have an understanding of global perspectives and trends.

Many of our students participate in outreach activities with astronomy faculty. Our physics student club is active in collaborating with counterparts at other institutions.

Professional and career readiness:

At Cal Poly Pomona, our curricular and co-curricular learning experiences optimize students' professional and career readiness.

Our department emphasizes career readiness both in and out of the classroom. Besides above-mentioned items concerning Application of Knowledge and Integration of Technology, some distinctive aspects of our department include:

- Annual Alumni Career panels that bring together alumni in diverse career paths to offer advise to students.
- Regular integration of industry speakers into our research seminar series.
- Frequent opportunities for students to interact with our Industry Advisory Board.

5 FACULTY

5.1 Overview of Faculty

The tenure-line faculty in the Department of Physics and Astronomy have disciplinary areas in Astronomy/astrophysics, biophysics and optics, solid-state physics, physics education research, and relativity.

Astronomy/astrophysics:

- Dr. Breanna Binder (associate professor): Dr. Binder studies the births and deaths of massive stars, both in our own Milky Way and in nearby galaxies. She uses multiwavelength observations to study X-ray binaries. Students working with Dr. Binder have investigated black hole binaries, supernova "impostors," and the remains of binary merger events.

- Dr. Mathew Povich (full professor): Professor Povich studies the formation and evolution of massive star clusters/associations and their H II regions in our Milky Way Galaxy. He is a core member of the GLIMPSE and MYStIX research collaborations and lead scientist for the Milky Way Project. He is the Associate Director of CAMPARE.

- Dr. Alexander Rudolph (full professor): Professor Rudolph provides numerous research opportunities for students as the Principal Investigator and Director of the CAMPARE summer research program.

- Dr. Coral Wheeler (assistant professor): Dr. Wheeler's research focuses on how the study of low-mass galaxies can be used to answer fundamental questions about the Universe. She uses simulations of dwarf galaxies at high enough resolution to test the extreme end of galaxy formation physics, investigate challenges to our current cosmological paradigm, and improve galaxy formation models.

Optics and biophysics:

- Dr. Nina Abramzon (full professor): Professor Abramzon uses optical emission spectroscopy to study different plasma characteristics, such as composition and temperature. Dr. Abramzon studies surface modification using gas discharge plasma.

- Dr. Ertan Salik (full professor): Professor Salik develops fiberoptic biosensors for detection of proteins, viruses, and bacteria for applications in medical diagnosis, food safety, environmental monitoring, and biodefense. Dr. Salik's lab is a truly interdisciplinary place filled by students majoring in various disciplines, such as, Physics, Biology, Electrical Engineering, and Mechanical Engineering.

- Dr. Krishna Sigdel (assistant professor): Professor Sigdel uses Atomic force microscopy to probe the biomolecules in single molecule level. He studies the structure and dynamicsof membrane proteins in near native environment and at physiological condition.

- Dr. Alex Small (full professor): Professor Small studies the fundamental limits to superresolution microscopy, a family of fluorescence techniques that enable imaging of cells at nanometer resolution, revealing details not accessible to a conventional light microscope. As a theorist, Dr. Small's work is mostly focused on understanding the theory that replaces Abbe's diffraction limit, understanding the ways in which image analysis algorithms work with superresolution, and developing and benchmarking computational tools for superresolution.

Solid state Physics:

- Dr. Jorge Botana Alcaldec (assistant professor): Dr. Alcalde is a theoretical physicist. His research interests revolve around the study of the properties of different materials, calculating their electronic structure through ab initio simulations. Computational tools like Density Functional Theory codes and systematic crystalline structure search algorithms allow us to explore configurations of matter where experiments have difficulty reaching.
- Dr. Kurt Vandervoort (full professor): Professor Vandervoort has been involved in several aspects of solid state research. He and student have studied the magnetic properties of high temperature superconductors. More recently, he has pursued investigations in the field of nanotechnology. He uses scanning probe microscopes, instruments with atomic resolution that work by rastering a small probe across the surface of a sample.

Physics education research:

- Dr. Homeyra Sadaghiani (full professor): Professor Sadaghiani has a broad range of research interests including:

    - Studying student difficulties in upper level quantum physics in two paradigms: Spin First vs. position first
    - Development and validation study of research-based assessments in upper-level quantum mechanics
    - Measurement of scientific reasoning ability and conceptual understanding of physics content.
    - Effectiveness of different range of scientific inquiry approaches in preparation of prospective and practicing k-12 teachers.
    - Conceptual and mathematical barriers to students learning quantum mechanics.
    - Design and implementation of web-based instructional technologies and study of Hybrid-online and flipped classroom formats.
    - Effectiveness of different curricula, course transformations, and pedagogical strategies.

- Dr. Qing Ryan (associate professor): Professor Ryan has the following research interests:
    - Development of web-based computer coaches to improve students' physics problem-solving skills, at both the high school and college level.
    - Studying student difficulties in upper-level physics courses.
    - Understanding student difficulties of using mathematics in junior level E&M problem-solving.
    - Development of research-based assessments in junior level E&M.
    - Effectiveness of different range of scientific inquiry approaches in preparation of prospective and practicing k-12 teachers.

General Relativity

- Dr. Shohreh Abdolrahimi (associate professor): Dr. Abdolrahimi works on theoretical gravitational physics. Some of Dr. Abdolrahimi's favorite topics include classical and quantum gravity, black hole physics, large extra dimensions and black hole production at the Large Hadron Collider (LHC), quantum field theory in a curved spacetime, and quantum effects in accelerated frames.

Faculty in our department have been very successful in recent years in obtaining funding from a variety of external sources. Only a small portion of the faculty currently have active grants, however.

Faculty in the Department of Physics and Astronomy work to accomplish learning outcomes, including quantitative reasoning, modeling physical systems, laboratory techniques, interpretation of experimentally obtained results. Faculty help students to communicate mathematical and physical knowledge orally, visually, and in writing in a variety of settings. Faculty provide experiences for students to use a variety of technological tools. The faculty use computer-mediated homework systems as appropriate, but in most cases the assessment is very time-intensive. Examples of such learning experiences include assignments, projects, and oral presentations.

Due to the time-intensive nature of assessment in Physics and Astronomy courses, student graders could provide significant service and relief to faculty. ***However, in recent years, the funding and hiring of student graders has been reducing, which has caused challenges to faculty in planning for the learning experiences and assessment practices that are vital for their classes***.

In spring 2023, only six faculty received graders' support for 8 sessions of PHY 1510 and PHY 1520, with a total enrollment of 824 students. This was provided by 30 hours per week of work for graders.

In contrast, in spring 2020, fifteen faculty received graders' support for 26 sessions of various lower-division and upper-division classes with a total enrollment of 1712 students. This was provided by 73 hours per week of work for graders.

In recent years, hiring of graders has been almost entirely shifted to university funds tied to large classes, reducing overall expenditures. However, although this has resulted in

some reduction of expenditure, the cost reduction is equivalent of less than $9 per student and in our opinion, it is not the best strategy.

Physics problem-solving is as much about the process as the result. Online homework is popular in large introductory classes because it requires little human effort for grading and gives students immediate feedback. That rapid feedback is a genuinely good pedagogical feature. However, the obvious drawback in comparison to written homework is that feedback focuses entirely on outcomes, not processes, which hinders learning of key aspects of physics problem-solving.

The Department of Physics and Astronomy has 13 tenured/tenure-track faculty as well as a very large pool of 17 or more part-time temporary faculty. Temporary faculty teach most introductory lecture and lab sections in our department. The Department recognizes the tremendous work done by departmental temporary faculty and has substantial concerns regarding the department's long-term tenure density issues. Right now, we have 13 TT faculty, ?? full-time adjunct faculty, and 17+ temporary adjunct faculty.

Due to low tenure density, most lower-division course sections in the Department of Physics and Astronomy are being taught by temporary faculty. For physics majors, this means that students often do not meet a tenure-stream faculty member until their second year. Students' success, particularly in terms of equity and lower DFW (Drop, Fail, Withdrawal) rates, heavily relies on regular interaction with faculty. Unfortunately, due to insufficient tenured faculty, effective engagement with students, both in upper and lower division, becomes challenging. Consequently, academic advising, information about opportunities like summer research, and support for graduate school preparation may be lacking or delayed until senior years. Addressing this issue is vital to improve student success, ensure equitable access to resources, and enhance overall learning outcomes. As much as our lecturer faculty work hard and engage in students, many high-impact practices outside the classroom (e.g. tutoring sessions, or the Learning Assistant Program) require time and access to university resources, and working-relationships with people in various university-level offices, as opposed to just department-level work and resources.

In addition, most of the tenure-stream faculty are now teaching schedules that regularly consist entirely of multiple upper divisions, creating workload issues due to the time-intensive nature of the courses. Improving the tenure density in our department is surely a top priority, perhaps the top priority, for our department. For Fall 2024, the Department is hiring two new Assistant Professor in theoretical physics.

Figure 18 to Figure 21 provide data over 5 years on the historical Full Time Equivalent-Faculty (FTEF), Full Time Equivalent-Student (FTES), Student to Faculty Ratio (SFR), and Major to Faculty Ratio (MFR).

In comparison in 2008 our department had 81 physics majors, while we had 16 (+3 in FERP program). Our program is likely to be one of the highest numbers in the nation for a Physics Baccalaureate program. The dramatic increase in FTES, this has created a situation in which our department has grown steadily more reliant on Temporary Faculty than does the campus as illustrated by data in Table 12.

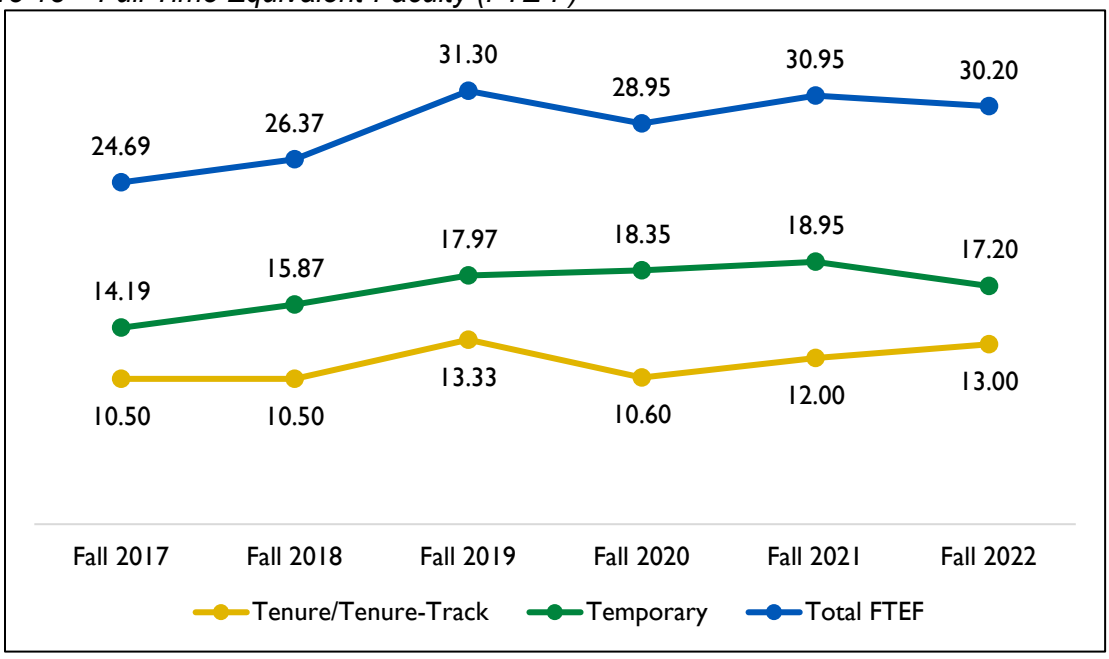
According to the data we have collected the physics and astronomy department at Cal Poly Pomona has a higher major to faculty ratio compared to other Physics/Astronomy departments at CSU, where the average for other campuses is 7.8, while Figure 20 shows that our ratio has fluctuated in the high teens.

Table 12: Major/Faculty ratio at CSU Physics & Astronomy Departments.

Bakersfield	16.0
Channel Islands	17.0
East Bay	4.5
Fresno	7.3
Fullerton	4.6
Humboldt	12.0
Los Angeles	7.3
Northridge	2.7
Sacramento	7.7
San Bernardino	6.6
San Francisco	8.3
San Luis Obispo**	7.3
Sonoma	8.4

Figure 18 to Figure 21 provide data over 5 years on the historical Full Time Equivalent-Faculty (FTE-F), Full Time Equivalent-Student (FTE-S), Student to Faculty Ratio (SFR), and Major to Faculty Ratio (MFR). The following definitions are from the Office of Academic Resources. Full Time Equivalent-Faculty is an aggregate measure of faculty workload based on payroll appointment fractions. Student to Faculty Ratio is an aggregate measure of students served based on units in course sections and student level. For FTE-S reporting, graduate student (master or doctoral) is considered full-time with 12 units; all others are considered full-time with 15 units. Student Faculty Ratio is FTE-S divided by FTE-F. Lastly, Major Faculty Ration is the number of stateside degree-seeking students enrolled at census by the FTE-F for tenure-line faculty in the department.

Figure 18 – Full Time Equivalent-Faculty (FTE-F)[20]



[20] AR "FTE-Faculty with Status Detail Tenure-Track and Temporary Faculty", Falls 2011-2022 Report https://www.cpp.edu/arar/campus-data/fte_faculty_with_status_detail-tenured_tenure-line_and_temporary_faculty_falls_2011_to_2020.pdf

The Office of Academic Resources were unable to break down the FTE-S data for Tenure/Tenure-track and Temporary faculty at the time they provided our office with the data.

Figure 19 – Full Time Equivalent-Student (FTE-S)[21]

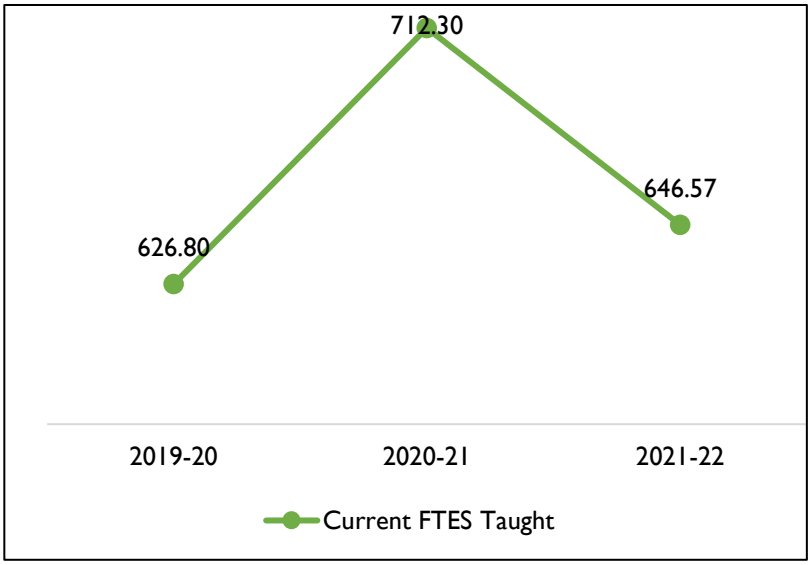
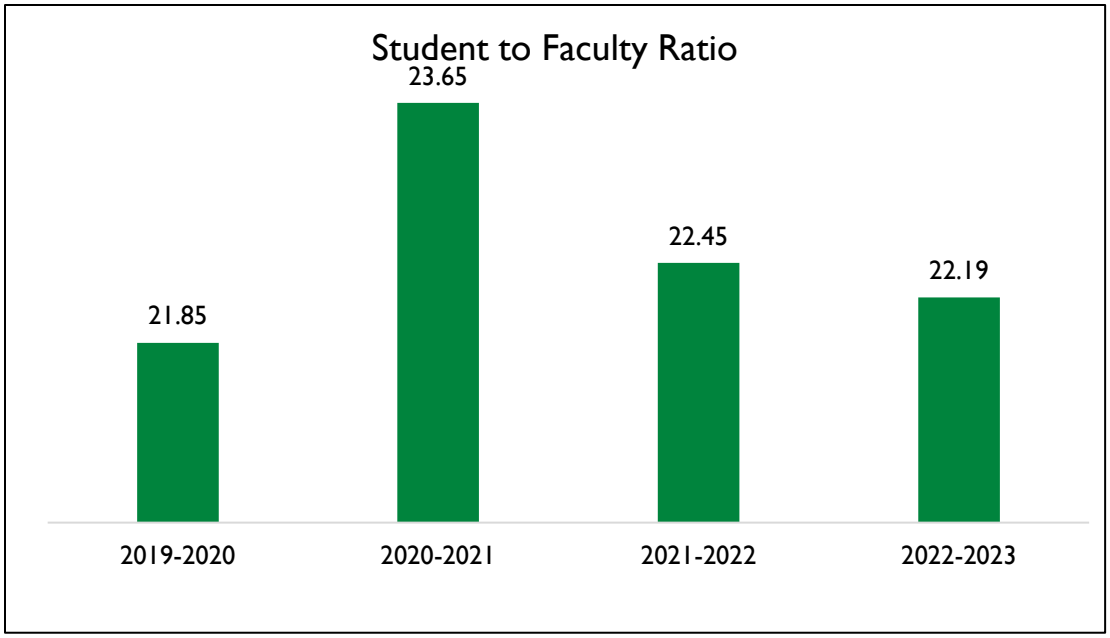
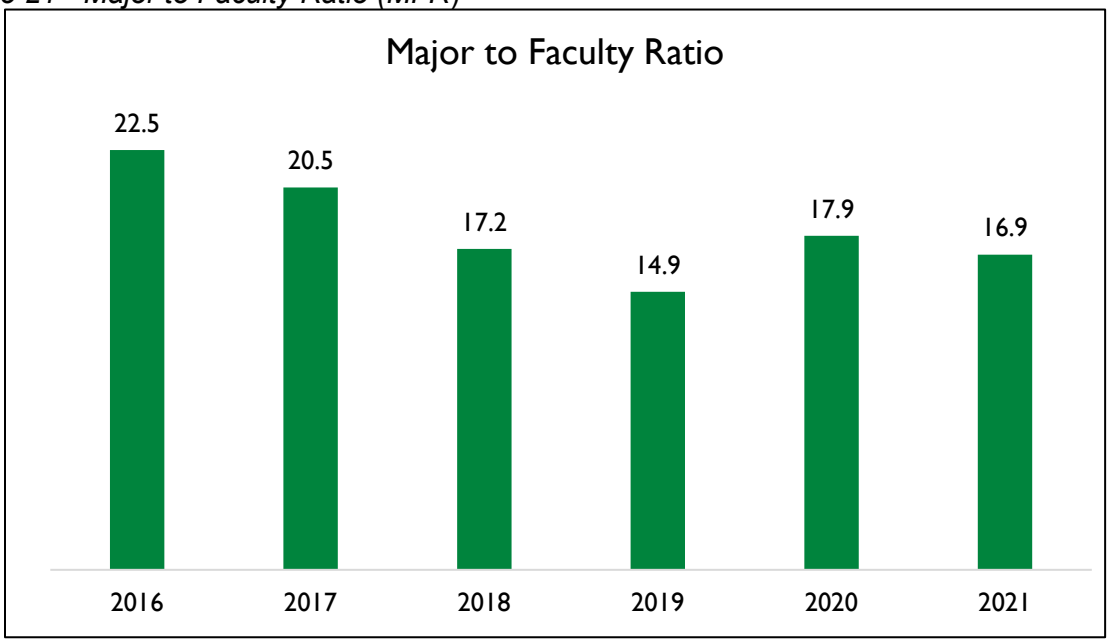


Figure 20 – Student Faculty Ratio (SFR)[22]



[21] Tableau https://analytics.cpp.edu/#/site/production/views/FacultyAssignmentsbyDepartment/SFRbyCY?:iid=1
[22] Tableau https://analytics.cpp.edu/#/site/production/views/FacultyAssignmentsbyDepartment/SFRbyCY?:iid=1

Figure 21 - Major to Faculty Ratio (MFR)[23]

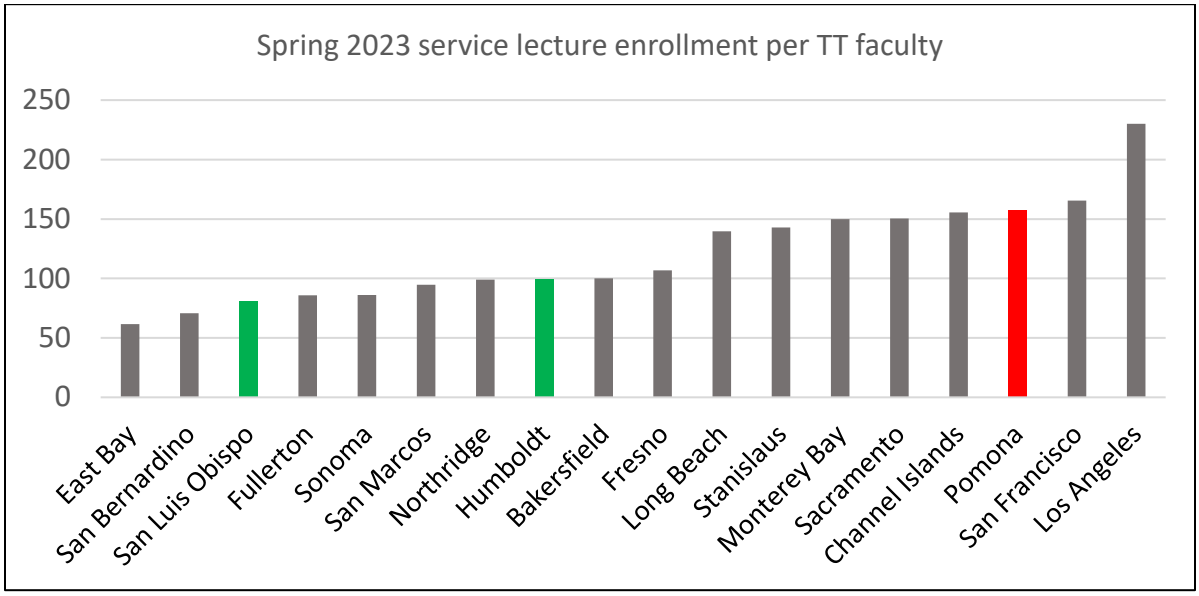


Of greatest significance for the campus-wide emphasis on student success, though, is the ratio of enrollments in introductory courses to tenure-track faculty numbers. As noted in the discussion above, high-impact practices outside the classroom (e.g. advising, mentored research projects, peer tutoring sessions) require faculty with the status and support to leverage campus resources and make things happen. And as shown in Figure 7, success in introductory Newtonian Mechanics (PHY 1510) corelates with success in key bottleneck engineering classes like Statics. Given the importance of tenure-track faculty for student success in introductory classes, it is worth looking a the ratio of introductory enrollments to tenure-track faculty numbers, shown in Fig. 22, using numbers for

Fig. 22 makes clear that we have the third-wors ratio in the CSU, and significantly worse than the 2 other designated Polytechnic campuses in the system (San Luis Obispo and Humboldt). ***The need for additional tenure-track faculty to serve our introductory physics students is urgent.***

[23] ARAR "Major to Faculty Ratio", Falls 2011-2021 Report https://www.cpp.edu/arar/campus-data/headcount-ftef-ftes-mfr.shtml

Fig. 22, Ratio of introductory Physics enrollments (courses equivalent to CPP courses PHY 1210, 1220, 1510, & 1520) in Spring 2023, collected in a survey of 18 CSU physics chairs in summer 2023.



5.2 Faculty Support

The department supports professional development in a number of distinct ways. First, besides a trend of increasing start-up packages funded in collaboration with the College over the past several years (most recent experimental hire receiving $120k), we are often able to support basic supplies purchases (e.g. compressed gas). All faculty also receive reassigned time to develop their research programs (half-time teaching for two years) and research space appropriate to their research needs. Conference travel is usually supported above the $1500 baseline allocated by the college. The department is usually able to provide space and other resources for grant-related activities (e.g. a 2023 summer workshop to introduce undergraduates to skills for astronomy research as part of Dr. Breanna Binder's NSF grant activities). Faculty often teach specialty courses synergistic with their research interests, e.g. astronomy, biophysics, computational physics, optics.

Additionally, faculty are encouraged to participate in campus-level professional development activities. What follows is a list of workshops provided by the Center for the Advancement of Faculty Experience (CAFÉ). The image depicts the number of faculty, department chairs, and teaching assistants who attended events.

The following professional development information is a list of workshops provided by the Center for the Advancement of Faculty Experience (CAFÉ). The image depicts the number of faculty, department chairs, and teaching assistants who attended events.

Year	Event	Count of Event
2018-2019		
2018-2019	5 Week Dash	1
2018-2019	ACUE Course on Effective Teaching Practices	1
2018-2019	ACUE Pinning	2
2018-2019	Black Board Wrangling Workshop	2
2018-2019	Blackboard workshop for New Faculty	1
2018-2019	Course Redesign Institute	8
2018-2019	CSU Symposium	2
2018-2019	EDSI	1
2018-2019	EDSI - Semester Conversion Bootcamp	1
2018-2019	Every Semester Needs a Plan Workshop	1
2018-2019	Faculty Day	16
2018-2019	Faculty Inclusion Luncheon	3
2018-2019	Flipping the Classroom	3
2018-2019	MATLAB/SimuLink Lunch n Learn	2
2018-2019	Motivate Students through "Belonging" -- Part 2	2
2018-2019	New Faculty Follow Up	3
2018-2019	New Faculty Orientation	2
2018-2019	New Faculty Welcome Week	1
2018-2019	New Lecturer Orientation	7
2018-2019	PolyTeach	2
2018-2019	Quality Matters": Invest in Excellent Hybrid & Online Course Design	1
2018-2019	Saddle Up for Semesters	1
2018-2019	Steps Create H/OL Courses	1
2018-2019	Write on Site	1
2018-2019	YourLife@CPP	1
2019-2020		
2019-2020	ACUE Kick Off	2
2019-2020	ACUE: August	1
2019-2020	ACUE: Microcredential October	1
2019-2020	CAFE Remote Course Design: August	6
2019-2020	CAFE Remote Course Design: July	19
2019-2020	CAFE Remote Course Design: June	4
2019-2020	EDSI 2020: Enhancing Inclusion & Student Motivation	1
2019-2020	How to Do a Peer Observation of Teaching	2
2019-2020	Improve your Online Course	6
2019-2020	Introduction to Teaching Online Using the QLT Instrument for Summer(QLT1-S)	1
2019-2020	New Department Chair Dinner	1

2019-2020	Organization & Navigation for Remote & Online	2
2019-2020	PolyTeach - Main	1
2019-2020	Remote Course Design	1
2019-2020	The Ripple Effect Keynote Speaker	3
2019-2020	Variation of Activities in Remote Courses	1
2020-2021		
2020-2021	Introduction to Teaching Online Using QLT June 7 June 27	1
2020-2021	ACUE Micro H - Promoting Active Learning - Robert Nyenhuis	1
2020-2021	ACUE Micro M - Creating an Inclusive & Supportive Learning Environemnt - Payam Parsa	2
2020-2021	CAFE Inclusive & Equitable Hybrid & Flipped Course Design	7
2020-2021	Cal Poly Pomona Spring 2021 Lecturer Orientation	1
2020-2021	Canvas Course Tools	1
2020-2021	CANVAS week May 24, 2021 - May 28, 2021	3
2020-2021	CHAI Workshops with Zahra Sotoudeh	1
2020-2021	Communicating in Canvas	1
2020-2021	EDSI - What's in a Grade June 1 - June 30	2
2020-2021	EDSI: What's in a Grade ?	2
2020-2021	Facilitator - ACUE Micro J Cohort	1
2020-2021	Facilitator - Intro to Teachning CANVAS	1
2020-2021	Improve Your Online Course (QM) July 26 - Aug 15	2
2020-2021	Intro to Teaching Canvas - 5 of 25	1
2020-2021	Intro to Teaching CANVAS - Cynthia Sanchez	1
2020-2021	Intro to Teaching CANVAS - Ekaterina Chernobai July 19 - August 2	1
2020-2021	Intro to Teaching CANVAS - Killick June 14 - June 28	3
2020-2021	Intro to Teaching CANVAS - Maha Ghosn	1
2020-2021	Intro to Teaching CANVAS - Nissenson Group June 1 - June 15	1
2020-2021	Intro to Teaching CANVAS - Phan Group June 1 - June 15	4
2020-2021	Intro to Teaching CANVAS - Tamayo June 14 - June 25	2
2020-2021	Intro to Teaching CANVAS - Trembley June 7 - June 21	2
2020-2021	Intro to Teaching CANVAS Summer 2021	1
2020-2021	Introduction to Teaching Online Using QLT July 5-25	1
2020-2021	Lecturer Faculty Evaluation	6
2020-2021	New Tenure Track Faculty	1
2020-2021	Part 2: Asynchronous & Synchronous Strategies for Engaged Learning	2
2020-2021	Peer Review & Student Ratings	1

2020-2021	Teaching Online: Best Practices for Asynchronous & Synchronous Delivery	3
2020-2021	Tech Tuesday - Virtual Software Lab	1
2021-2022		
2021-2022	First Day of Face to Face Class	2
2021-2022	Learning Fridays - Go React	1
2021-2022	Learning Fridays - Grading in Canvas	1
2021-2022	Learning Fridays - Spruce Up Your Canvas	1
2021-2022	The Lecturer Evaluation Packet	1
2021-2022	Wall of Cool & Jose Bowen - Zoom	1
2022 - 2023		
2022 - 2023	Building a Publishing Pipeline: Increase Your Writing Productivity	1
2022 - 2023	New Lecturer Orientation	1
2022 - 2023	Peer Coaching	3
2022 - 2023	Summer Institute Thursday Workshop	2
2022 - 2023	Summer Institute Thursday Workshop - H Holmgren	1
2022 - 2023	Summer Institute Thursday Workshop - P Vieira	1
2022 - 2023	Summer Institute: Anti Racist Teaching & Learning	2

5.3 Faculty Satisfaction

We conducted a survey of all faculty (tenured, tenure-track, and lecturers) to determine their degree of satisfaction with working conditions and support (both from the department and the administration). Full results are shown in Appendix 4. The responses are unsurprisingly complex and varied. Department leadership needs to reflect on the particulars, and we encourage the external review team to review them and offer their own take-aways in light of their interactions with faculty during the site visit.

6 UNIVERSITY SUPPORT AND RESOURCES

6.1 Personnel

The Department has 4.5 staff: Two office staff (one of them shared with Chemistry and Biochemistry, working 2.5 days/week in Physics and Astronomy) and three technical staff. All of these staff are crucial to student success.

Our technical staff put most of their effort into supporting laboratory instruction, which in AY 2022-2023 consisted of 169 sections (84.5 class sections per semester) enrolling 3,593 students (nearly 1,800 students per semester). Our highly skilled technical staff are responsible for setting up and taking down lab apparatus, maintaining and repairing apparatus, and maintaining the checkout system that students use to obtain supplies not available in the lab rooms. This system operates from 8am to 10pm Monday through Thursday, and 8am to 4pm Fridays. **Without skilled, well-organized staff working hours that start at 7:30am and run to 10pm most days, we would not be able to meet student demand within our existing facilities, as we would have to run more parallel lab sessions during a shorter time frame.** The classes that these staff support are mostly introductory labs taken by a wide range of STEM majors, and the students in these classes match profiles common to CPP students: First-generation, economically disadvantaged, often non-traditional students who need classes in evening time slots so that they can work during the day. Navigating college is not easy for some of these students, and **our well-organized, efficient system of lab operations is crucial for helping students succeed in these bottleneck introductory STEM courses**. Any reduction in staffing would severely hinder our ability to meet student demand and help them complete challenging bottleneck courses. **We are grateful to the College for continuing to support Alternative Work Schedules that keep our lab operations well-staffed until 10pm Monday-Thursday, and we strongly urge that our technical staffing levels be maintained**.

Our office staff likewise play a pivotal role in helping introductory STEM students navigate college. Physics courses have some of the tightest prerequisite and co-requisite chains on campus, which creates many headaches for students trying to register, especially transfer students whose previous coursework might yet have articulated. Our staff work hard to help students understand the requirements and the registration system, and to help them obtain permission number workarounds when they have met the requirements for a class but the registration system is not recognizing their prior or current coursework. **A well-staffed department office is absolutely crucial during registration, in order to ensure that all students get the help they need to register for classes required for graduation. Sharing a staff member with Chemistry means that our office is often overwhelmed during registration periods**, especially on days when one of the staff is out of the office for various reasons. **We strongly request that our staff numbers in the Department Office be augmented to two full-time staff!**

6.2 Facilities and Space

Roster of Rooms primarily controlled by the department.

Room Type	Sub-Type	Number	Notes
Dedicated Lecture Rooms		1	Building 8, Room 241 is the only lecture room in which we have priority for ALL days/times during the week. All other rooms shared.
Instructional Labs	Introductory Service Labs	7	3 of our 4 service courses are served by a pair of lab rooms to run parallel sessions. The 7th room serves the lowest-enrollment course, and through careful scheduling serves a majors course as well.
	Multi-purpose lab	1	Computational classes, Physics of Musical Sound, Discussion/Activity Classes, and Physics for Pre-Service Teachers
	Upper-Division Labs	2	Each room serves 2 different courses/semester, usually with multiple sections. Multi-week set-ups are complicated.
Faculty Offices	Tenure-Track (single occupant)	14	Includes Chair office in main department office area
	Lecturers (shared)	6	Average of 4.5 lecturers per office
Research Rooms		9	4 of these rooms are shared by multiple faculty (theory, astronomy, wet lab, and educational research)
Equipment stockrooms	Lower-Division Labs	1	Serve 84 lab sections/week, with 1800 students
	Demonstrations, Upper-Division Labs, other technical functions	1	11 course sections in Spring 2023, including labs with multiple class meetings/week, necessitating multiple equipment setup/takedown cycles per week.
Department administrative office		1	Used by 1.5 staff, 2 student assistants

Classrooms: The department only has one dedicated lecture classroom (Building 8, Room 241, capacity 52) in which we get first priority during all days and time slots. In all other rooms we only get priority during selected days and times. Consequently, we often prioritize scheduling into other rooms, and reserve this room as our backup, as we know that we can safely hold a time slot to open last-minute sections in response to last-minute changes in student demand. In fall 2023 we have 12 distinct physics course sections meeting in this room, and 9 of them meet multiple days per week. While there are unused time slots in this room, reserving time slots with tentative classes is absolutely crucial to meet unexpected demand for bottleneck introductory courses that students need to make academic progress.

Since our 2017 review we have lost time slots in other rooms, including Building 8 room 4 (capacity 60), which we often use for introductory classes as it is larger than 8-241, and Building 3, Room 1637 (capacity 48) which we would often use for Tuesday-Thursday classes, as we lost time slots in other mid-sized rooms.

Lab Rooms for Service Courses: Pressures on instructional lab space are an ongoing problem for the department. As noted above, we offer 2 high-enrollment introductory lecture course sequences (calculus-based and algebra-based) with accompanying labs. These are each 2 semesters, resulting in 4 different high-enrollment lab sequences. The two calculus-based labs have sufficient enrollment that even when using every available time slot from 8am to 10pm we need to double-up labs during some time slots, running parallel sessions in multiple rooms. To make efficient use of equipment budgets the students alternate experiments, i.e. one lab section will do experiment A this week while the other section does experiment B, then they'll switch rooms the following week.

For some time we were able to avoid running parallel sections of the labs for the algebra-based course. However, enrollments in the first-semester of the algebra-based sequence have now reached the point where we usually need parallel sections. Starting in Spring 2022 we decided to dedicate 2 rooms to this course (PHY 1210L). While this means there are often unused time slots, ***without a second room it is simply impossible to offer sufficient courses to meet student demand in the available time slots***, even running from 8am to 10pm Monday through Thursday and 8am to 4pm Friday.

To understand this resource situation, start from the fact that with our current staffing we have 18 available lab time slots in the week (starting at 8am, 1pm, 4pm, and 7pm on MTuTWTh, and just 8am and 1pm on Friday). We can only use at most 17 time slots per week, and typically 16, because we have to leave time for stockroom staff to take down old experiments and set up new ones. However, since Fall of 2018, ***we have had to run more 17 or more 1210L sections in 5 of 10 semesters***. Moreover, running ***parallel sections is a more nimble approach to student demand***, doubling up lab sections during time slots when no sections of the accompanying lecture courses conflict, and run 1 or 0 labs during time slots that have large lecture sections.

Finally, we are only able to offer labs in 18 time slots per week because we have a staff member who enjoys working 4 days/week for 10 hours/day late into the evening, in exchange for not having to work Fridays and missing the morning commute. However, we have often faced hassle in getting this work schedule approved by the administration each year. If, at any point, we were to lose our staff member and/or face a new administrative situation, we would probably lose 7pm labs and then only have 13 usable time slots/week, further underscoring the need to run PHY 1210L in multiple lab rooms.

Finally, if the administrative and/or staffing situation with regard to evening labs were to ever change, we would need an additional lab room for PHY 1510L. To wit, if we had only 13 time slots/week then we could offer no more than 26 sections of PHY 1510L. However, since Fall 2018 we have run 27 or more sections of PHY 1510L in 8 of 11 semesters. Without staffing flexibility we would need a third lab room.

In summary, our current space allocated to introductory labs allows us a certain amount of slack, which we use to nimbly meet student demand, but ***the viability of our situation is contingent on administrative allowance for flexible evening staffing. If that situation should ever change, we would be unable to meet students' needs our current space***.

The one place in which we had a bit of excess capacity is in the second semester of the algebra-based sequence which has lower enrollment (primarily because some majors, e.g. architecture, do not require it), so we are able to meet demand while running labs in one room just 3 days/week. (Monday through Wednesday) However, even ***this slack has been taken up***

to meet other needs. On Thursdays we use this room (Building 3, Room 2628) to run one of our sophomore labs for physics majors (PHY 2530L, mostly waves and optics). Setups are done Wednesday evening and Friday afternoon. ***This sharing of space between courses only works because one of our technical staff is willing to work an evening schedule. Without staffing flexibility we could not make efficient use of this room.***

Also, if at any point we have a significant increase in biology majors then we will need to expand the number of PHY 1220L situations and the PHY 2530L class (required for our majors to graduate) will need a new room. In short, what little slack we have in the system is highly contingent and could be under threat with changes in staff, administration policy, or biology enrollments.

Lab Rooms for Majors Courses: Besides the aforementioned dual use of 3-2628, we have 3 rooms primarily used to teach courses for physics majors at the sophomore level and above. Two of them (Building 8, Room 211 and Building 4, Room 4-3-567) are specialized lab spaces that typically host 2 courses (1-2 sections per course) each semester. We run courses in these rooms with capacities of 14 students due to a combination of square footage, number of work stations (particularly constraining in 4-3-567), and available equipment.

It would be challenging to expand the number of courses in these rooms because of the time needed for equipment setup/takedown between courses. However, we have occasionally used the room with the more open configuration (4-3-567) for discussion/seminar classes, and we would be happy to do this in the future as feasible.

We also have one other general-purpose room (Building 3, Room 2011) that gets used for various laboratory, computational, and discussion classes. This room was upgraded in Fall 2022 to include new furniture more conducive to discussion courses and computational activities, and we also purchased 16 new laptop computers (stored in a cart but used in particular in this room). In Spring 2023 we ran 11 course sections in this room, including 2 labs with twice-weekly meetings that required a total of setup and takedown efforts per course.

Expanding the use of this room beyond a few incremental changes in the number of discussion classes would be quite challenging, requiring (at a minimum) investments in staffing to handle the more frequent lab setups/takedowns and/or more flexible equipment that is easier to set up.

The courses taught in this room include:

- PHY 1050/1050L (Physics of Musical Sound)
- PHY 2120/2120L (Physical Science for Elementary Educators)
- AST 3240/3240A (Observational Astronomy, a computation-heavy course)
- PHY 3440/3440A (Applied Optics, heavy on computation and/or experiments, depending on the instructor's focus)
- PHY 4090/4090A (Computational Physics)

In addition, we regularly use this room for the recitation activity portions of our upper-division theory courses (PHY 3210A, 3600A, 4010A, 4140A, 4330A, and sometimes AST 4240A and 4250A) in this room, and sometimes the presentation-focused Senior Seminar class (PHY 4630). The flexible configuration of the furniture works well for this purpose.

Improving Efficiency: In the past 7 years we have already made considerable strides in efficiency despite losing classroom access. As noted above, we have re-organized our introductory labs so that we are running two distinct classes (PHY 1220L and 2530L) in one room, while we run the other introductory labs in pairs of rooms so that we can nimbly meet student demand. However, our ability to use this space efficiently depends on staff and administrative arrangements that are subject to change.

We have one room that is used quite flexibly for a variety of courses. We have upgraded the furniture to make it more flexible, but we are reaching the limits of what can be done in this room as long as we are sometimes using it for experiments that require equipment setup/takedown.

Our more specialized advanced lab rooms might well accommodate more sections as enrollment grows (e.g. one class could meet there Monday/Tuesday and the other Thursday/Friday, with setup/takedown on Wednesdays and Friday afternoon). Expanding enrollment in one room (8-211) should be feasible in current space, subject to equipment availability.

Our hardest constraint on expanding specialty lab room use is the number of stations in Building 4 room 4-3-567. The room is set up with benches secured to the floor, and the desk space is ample. As a result, the room can only be used by 14 students at a time, and the safety paperwork for the room likewise rates it as holding no more than 14 students. We have explored the possibility of reconfiguring the room with different tables that allow more people to work there, and also provide more room for safe exit in an emergency.

However, we have received hard pushback from Facilities, who insist that the square footage would still be insufficient to expand enrollment. This is puzzling in light of the fact that if we use our introductory labs as a baseline (24 students in in roughly 900 square feet) then the 728 square feet in this room should be sufficient for 18-19 students. When we presented this information to Facilities we were told that our introductory labs would not be rated for 24 students if they were refurbished today, even though they each have at least 2 exits and easy pathways for evacuation. Nonetheless, Facilities has taken a hard line on this matter, and their statements about reducing the rated capacity in the event of an upgrade effectively forecloses the possibility of improvements to the rooms. ***Until administrative changes lead to a more collaborative stance from Facilities***, we are greatly hindered in making more efficient use of lab space.

6.3 Library

Subject Librarian

The University Library assigns specific librarians to support specific disciplinary areas. For the BS Physics program, the assigned library faculty member up until April of 2023 was Ariel Hahn. Following her departure from the University Library, the position is currently vacant. Subject librarians provide the following services:

- Design and deliver library-related course-integration instruction at the request of teaching faculty;
- Develop online tutorials and guides for specific courses or projects as well as more general online research guides for the disciplinary area;
- Available on a by-appointment basis to meet with individual students or with small groups of students for personalized research consultations in-person, via Zoom or

chat, or by phone or email. https://www.cpp.edu/library/reference-instruction/contact-subject-librarian.shtml

Outreach Efforts

As the statistics that follow illustrate, outreach toward the BS program in Physics has been minimal over the past 5 years. This was due, in part to the Librarian assigned to the College of Science also having the functional role of the Data Management librarian, and found it difficult to cover both areas of responsibilities effectively. In light of this experience, it would probably be advisable to hire a research and instruction librarian focused solely on the College of Science to begin outreach efforts.

Research Assistance

Research assistance is available in a variety of ways– in-person, via online chat, by telephone, or via email. Library faculty provide reference service (this includes assistance that is 15 minutes or less) and offer one-on-one research consultations (by appointment consultations that generally run longer than 15 minutes). The chart below outlines the number of reference questions and research consultations conducted in the specific disciplinary area over the last five fiscal years:

	AY 2022-23	AY 2021-22	AY 2020-21	AY 2019-20	AY 2018-19
Reference Questions	1	3	1	6	0
Research Consultations	1	3	0	3	0
Total	1	3	1	6	0

Course-Related Instructional Statistics

The chart below outlines the number of course-integrated instructional sessions offered by library faculty at the request of teaching faculty teaching specific credit courses in the academic program. Total number of attendees and contact hours are also provided. These statistics cover sessions offered for specific credit courses over the last five fiscal years:

- AY 2018-19
  - SCI 1010
- AY 2022-23
  - SCI 1010 (2 Sections)

	AY 2022-23	AY 2021-22	AY 2020-21	AY 2019-20	AY 2018-19
Number of Course-Integrated Instructional Sessions	2	0	0	0	1
Total Number of Attendees	54	0	0	0	24
Total Number of Instructional Contact Hours	45.0	0.0	0.0	0.0	16.0

Library Workshop Instructional Statistics

The chart below outlines the number of library-sponsored workshops designed and delivered by library faculty. Total number of attendees and contact hours are also provided. These statistics cover the following workshops offered over the last five fiscal years:

	AY 2022-23	AY 2021-22	AY 2020-21	AY 2019-20	AY 2018-19
Number of Workshops Offered	0	n/a	n/a	n/a	n/a
Total Number of Attendees	0	n/a	n/a	n/a	n/a
Total Number of Instructional Contact Hours	0.0	n/a	n/a	n/a	n/a

Online Research Guides

Library faculty created online research guides for specific courses and disciplines. The full list is available on the library website here: https://libguides.library.cpp.edu/

For this subject area, the subject librarian has developed and maintained the following research guides listed below. The chart also includes the number of views by fiscal year which indicates usage.

Online Research Guide Title + Link	AY 2022-23	AY 2021-22	AY 2020-21	AY 2019-20	AY 2018-19
Physics & Astronomy	42	56	134	10	0

Online Tutorials & Modules

Library faculty create online tutorials and modules for specific courses and disciplines. Listed below are the relevant tutorials and modules for this academic program and the number of views which indicates usages.

Online Research Guide Title + Link	AY 2022-23	AY 2021-22	AY 2020-21	AY 2019-20	AY 2018-19
APA Citation	9	0	0	0	0
Bronco Scholar Accessibility	N/A	0	1	0	1
Interlibrary Loan	0	0	0	2	0
Engineering Tutorial	0	0	0	1	0
EZ Research	N/A	3	1	4	9
Finding Books in OneSearch	0	0	0	2	0
Finding Masters Theses & Projects	0	0	0	2	0

Finding Bibliographic Information	0	2	0	0	0
MLA Citation	0	2	0	0	0
Research 101, Part 1	4	0	0	4	8
Research 101, Part 2	3	9	13	3	7
Research 101, Part 3	5	8	14	3	5
Research 101, Part 4	3	6	15	3	6
Research 101, Part 5	3	3	13	3	5
Research 101, Part 6	0	1	0	0	0

Library Resources

For this program area, there are 2 electronic resources that support the disciplinary area. These resources include both journals and databases. These resources and the number of searches are indicated in the charts below.

Electronic Resource Titles	AY 2022-23	AY 2021-22	AY 2020-21	AY 2019-20	AY 2018-19
AIP Journals	1332	1489	1572	2904	2255
Web of Science	n/a	10804	11893	n/a	n/a

Regarding library resources, we just note that the library got little mention in the faculty survey. On that basis we believe that the library's resource needs are best determined via comparisons with peer libraries, and that a rising tide will lift all boats. In other words, we will surely benefit from anything that benefits the library and leads to collaborative efforts between the library and all other academic units.

6.4 Other Campus Resources

Our strong collaborative relationship with the College of Science Advising Center was discussed above, as well as some of the successes of our Physics Club, which is a registered student organization under the Division of Student Affairs.

6.5 Budget

We currently have no budget, per se. Department Chairs in the College of Science have started receiving more training on fiscal matters, however, and we hope that if the campus moves towards a de-centralized operating mode then the resulting Glasnost and Perestroika moves might lead to some genuine budgetary autonomy and flexibility.

7 CONCLUSION

Pedagogical improvements desired:

1) Greater TT involvement in introductory courses, particularly the foundational PHY 1510 (Newtonian Mechanics) course, leading to more widespread adoption of high-impact practices that improve students' study and problem-solving habits..

   Evidence for success: Improved FCI scores, stronger relationships between PHY 1510 grades and Engineering Statics grades. In particular, the DFW rate for students with a C in PHY 1510 would be much lower than 50%.

2) Improvements in the foundational math skills of students who have advanced from our sophomore-level classes to upper-division courses. Some v in the department have visited the idea of summer "boot camps" to help motivated students voluntarily develop core math skills involving vectors, calculus, and algebraic manipulation.

   Evidence for success: Fewer errors of the sort noted in PHY 4140 assessment efforts. Feedback from engineers would indicate more facility with vectors among the Statics students.

Resource Goals:

1) More TT faculty to achieve pedagogical goal 1, and also mentor more student projects.
2) A second full-time office staff member, to help students during critical registration periods.
3) Given that so many of our students need to work in order to support themselves and their families, more scholarship funds would be nice. We currently as a department award 3 scholarships per year, a number that we would like to increase. Conversations with alumni indicate that there are potential donors interested in expanding this number, especially via scholarships targeting certain under-represented groups (e.g. women). Close collaboration with our College Development Officer is needed, and perhaps judicious outreach to our industry partners.
4) More instructional lab space for sophomore and upper-division lab classes that can accommodate larger cohorts of incoming students.
5) More research lab space to involve more students in experimental research with faculty.
6) Greater success rates in acquiring external funds for research. This will require careful support and mentoring for new faculty who are most connected to the current directions of their fields.

More external funds.

More lab space for classes and experimental research.

8 APPENDICES

Appendix 1
2017 External Reviewers Report Physics & Astronomy Cal Poly Pomona

Stephan Haas, Department of Physics and Astronomy, University of Southern California
Chuhee Kwon, Department of Physics and Astronomy, California State University Long Beach

- We wish to thank the students, faculty, staff, and administration at Cal Poly Pomona for hosting our visit on May 18 – 19, 2017. It was a pleasure to meet dedicated faculty, supportive staff, enthusiastic students, and administrators who are eager to listen.
- The Department of Physics and Astronomy at Cal Poly Pomona is commendable for increasing the number and diversity of its majors in recent years. Based on the national statistics by the American Institute of Physics (AIP), the Department belongs to the top 2% of the U.S. Physics departments in number of bachelor's degrees awarded (28 in AY 2015-16 compared to the national median of 5 among Physics Baccalaureate programs), and 46% URM in the major represents an exceptional diversity (the national average is 9%). The notable achievements in the Department are the PhysTEC to increase qualified high school physics teachers, CAMPARE and Cal-Bridge to broaden the participation and success of URMs, NSF CAREER and RUI grants, and hosting the 2018 APS Conferences for Undergraduate Women in Physics (CUWiP).
- The faculty are passionate about student success and engaged in it through multiple levels. As a department with a large portion of FTES from service courses, they have been engaged in the innovative teaching practices and research in student learning, introducing innovative approaches such as flipped classrooms and learning assistants. The DFW rate in PHY service courses is quite low as "gateway" courses, and the faculty are committed to maintain and improve the student experience in those courses after the semester conversion. The Department upper division curriculum for the semester conversion is a standard physics curriculum, and the SLO and Assessment plan appear to be aligned with discipline standard. The faculty are also dedicated providing Learning-by-Doing experience for majors via on- and off-campus research opportunities, upper division laboratory courses, and senior projects. Students are highly motivated, and many have been successful in obtaining external research and career opportunities.
- The Department's mission and actions are aligned with campus objectives to focus student experience, success, and placement. We sense that the constituents of the Department are dynamic and have a good working relationship. Also the Department Chair, Prof. Hector Mireles, is effective and enjoys the support of faculty.
- The Department has four Suggestions for Action in the self-study. (1) Space issue: We support the need of more space, and we suggest the Department to develop specific requests for the purpose and size of the space to discuss with the administration. A large (> 100 seats) classroom dedicated for a flipped instruction was mentioned several times during our visit as well as research laboratory space for new experimental faculty. (2) Faculty hiring: The Department conducted one TT faculty search in AY 2016-17 which will continue into the AY 2017-2018. A second search, was approved for 2017-2018 AY to replace one TT faculty who took a job elsewhere this year. These two hires will relieve the short-term pressure, but they do not stem the student to faculty ratio. , We suggest that the Department develop a new multiyear TT hiring plan. (3) Improving and sustaining quality of undergraduate education: We agree with the plan and suggest the Department to work with the administration to build a concrete plan and support. (4) Alumni relation: We agree with the plan.

Suggestions for Action

- Research support by the University: many of the department's full-time faculty members are research active and highly visible in the scientific community. The University administration should continue to assign value and recognition to the scholarly achievements of the faculty, and to the benefits that these activities give to the quality of education at Cal Poly Pomona. This means allocating start-up funds for new faculty that are commensurate with those of other CSU campuses, providing research space, and creating dependable and sustained sources of reassigned time for activities that enhance the scholarship of the faculty.
- Deeper engagement of TT faculty with lecturers: the department should make further efforts to coordinate the lower division classes with the intent of reducing DFW rates and improving student learning. This will likely require additional resources such as reassigned time for the coordinating faculty members and compensation of lecturers for work that goes beyond their instructional duties. Senior lecturers may also be tasked with coordination duties when appropriate.
- Job Satisfaction: While the faculty, lectures, and staff have expressed a generally high level of satisfaction, there are some suggestions to improve this even further:
- a) Lecturers: expand their level of engagement and participation through recognition and awards.
- b) Faculty: reward successes in teaching and research by tangible measures such as teaching release and appropriate allocation of research space.
- c) Staff: engage in decision making processes when appropriate.
- The Learning Assistant (LA) program should be placed on firm financial grounds as part of the campus effort to improve student success. The administration should provide appropriate and sustained support for LA salaries, and for the reassigned time of faculty members associated with the operation of this program.
- Departmental Discretion in Financial Planning: the department has established a proven track record of responsibly creating activities that support and enrich student learning, using discretionary funds that are derived from efficient scheduling and planning. Savings to the university through the efficient scheduling at the department level should be rewarded by appropriate discretionary funding to the department for the purpose of supporting strategic and creative efforts that improve the student learning in the department. The department should be able to decide to use this budget for activities such as providing reassigned time for coordinating lower-division instruction or to send junior faculty to professional development workshops and conferences.
- The new dean enjoys strong support by the faculty. An important part of her role will be to continue promoting and advocating the value (academic rigor, scholarly visibility, inspiration of underrepresented talented students) and specific challenges (tough subjects, expensive start- up) of basic science to the central administration. The dean and the department should engage in a conversation about appropriate space allocations for research and teaching.
- The portion of department FTES taught by the TT faculty should be increased in order to optimize student learning/outcomes.
- The administration's ideas and objectives should be clearly communicated to all faculty, and an effective channel for constructive feedback from the faculty to the administration should be readily available.
- The department faculty desires more transparency in resource decisions and allocations for the new centralized budget. Specifically, it would be helpful for the department chair to meet with the College administration annually to discuss the projected departmental budget before allocation decisions are made.

- The department and administration need discussion about various metrics applied to evaluate the department and student outcomes. While the metrics appear to be generally in agreement, there are some discipline specific metrics that should be taken into account by the administrations. For example, because of laboratory experiences for the students, the spatial footprint for physics & astronomy departments is typically larger than in other disciplines.
- Growth in numbers of physics & astronomy majors needs to be taken into account when allocating resources.
- Need for long term planning, including faculty hiring, cross department initiatives: the department should formulate a strategic plan to improve its undergraduate program as well as student outcomes, and request resources from administration to implement these. There needs to be a clear path where to go with these ideas.

Appendix 2
Feedback from Engineering Statics Instructors.

Key feedback from Engineering Statics instructors was already shown above in Figure 8, but here we append their feedback on specific physics topics, and their free-response comment.

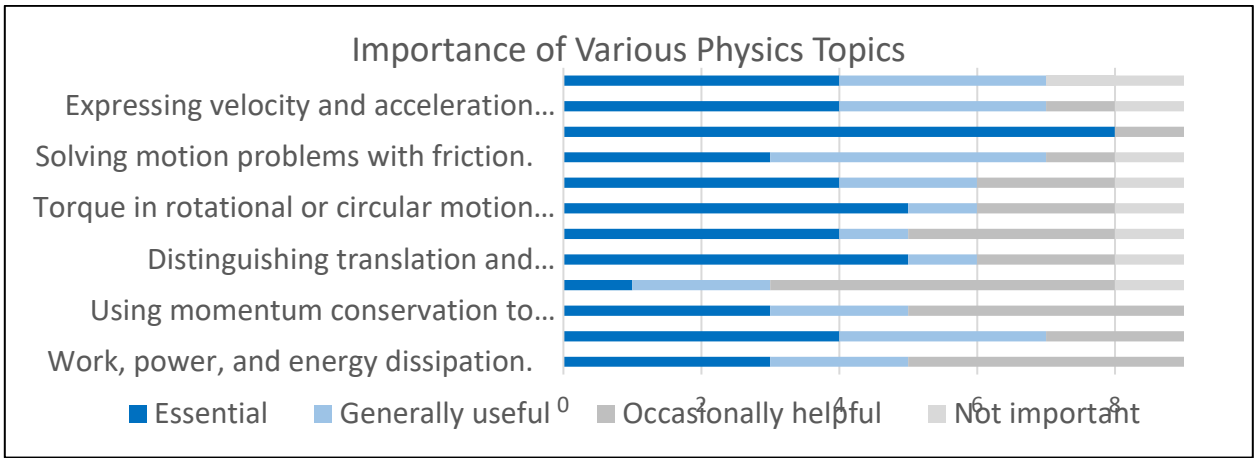


Figure A2.1: Engineering faculty ratings of significance and relevance of common physics topics as preparation for statics.

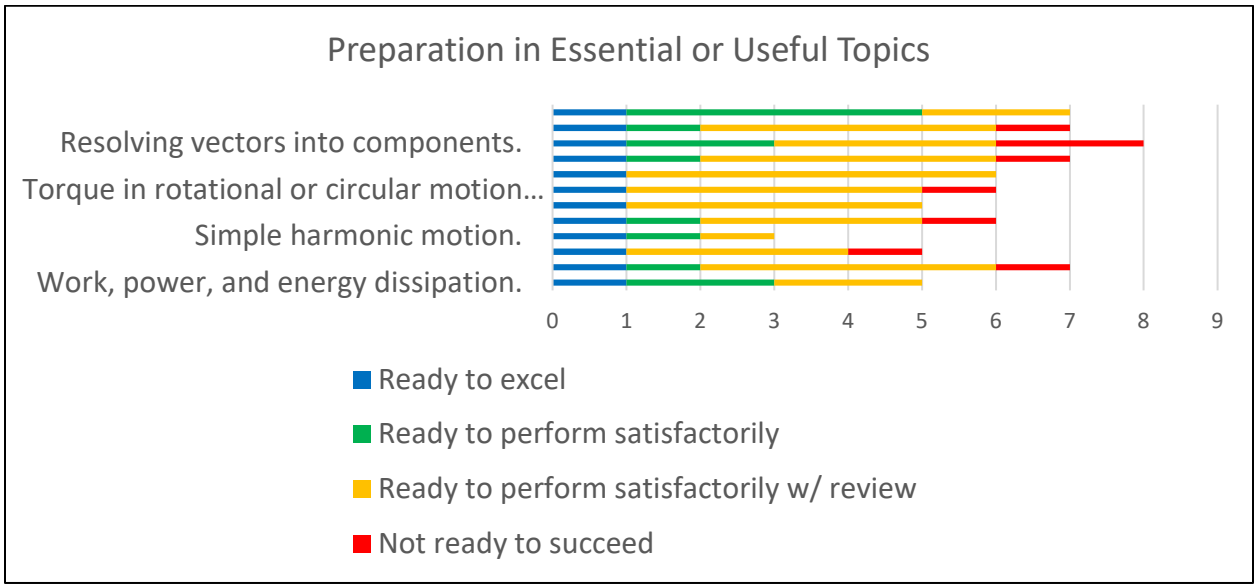


Figure A2.2: Engineering faculty ratings of students' preparation in key topics.

Table A2.1: Free-response feedback from surveyed Engineering statics instructors.

If you could offer one or two suggestions/requests for PHY 1510 instructors, to help make your job easier in teaching engineering statics and/or dynamics, what would you say?
- Make students understand what a vector really is as opposed to "a quantity that has a magnitude and direction". In my dynamic classes, the students often add velocity or acceleration as scalars, especially during rigid body motion of the class.
- Be strict on grading while students make simple mistakes so they will learn from their mistakes
- My students' knowledge and understanding of vectors is horrible. Even worse, they are not willing to learn. They just don't know and don't see the importance of it.
- Please make sure that the students are engaged in the classroom.
- Use of 3D vector math such as dot and cross products was a weakness in Vector Statics. More time spent on 2D and 3D vector mathematics would be helpful.
- Study habits are essential. Many students do not get this yet. HW is essential. There needs to be sufficient HW solved by each student to ensure the concepts trickle in. Tests and quizzes need to be frequent enough and comprehensive enough to ensure grades reflect mastery.
- Do not pass students that cannot resolve forces and moments into their components. Have a preparatory course that reviews this for those that are about to take statics.

Appendix 3
Student Survey

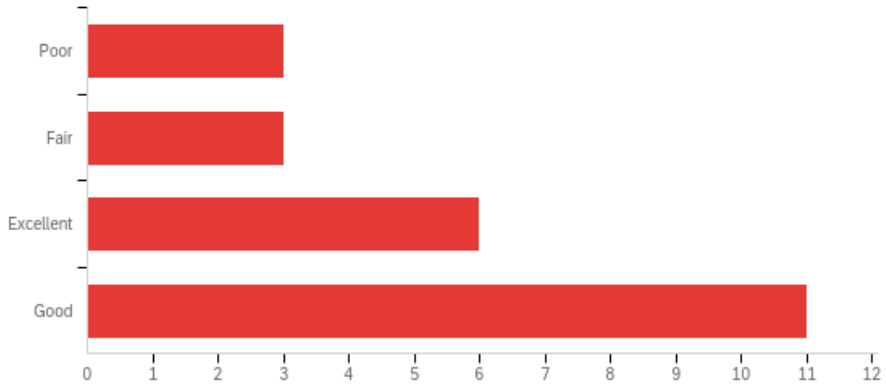
Students were asked:

Q1: Academic Discussion with Physics and Astronomy Faculty 1. On average, how often do you interact with faculty in our department (Physics and Astronomy) to discuss your academic plans? (This could include discussing course selections, degree requirements, getting feedback on your performance, discussing academic challenges, etc.)

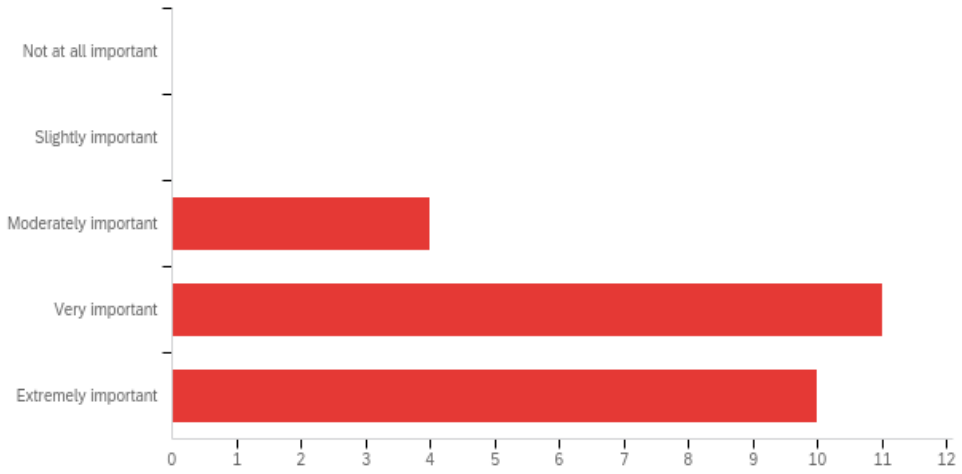
Q2: Career Di - Section III: Career Discussion with Physics and Astronomy Faculty 1. On average, how often do you interact with faculty in our department to discuss your career plans? (This could include discussions of possible career paths, internship opportunities, or more specific guidance on resume preparation, etc.).

	Q1		Q2	
	Percentage	Number	Percentage	Number
Never or rarely	10.7%	3	8.7%	2
Occasionally	35.7%	10	52.2%	12
Regularly	28.6%	8	8.7%	2
Frequently	25%	7	30.4%	7

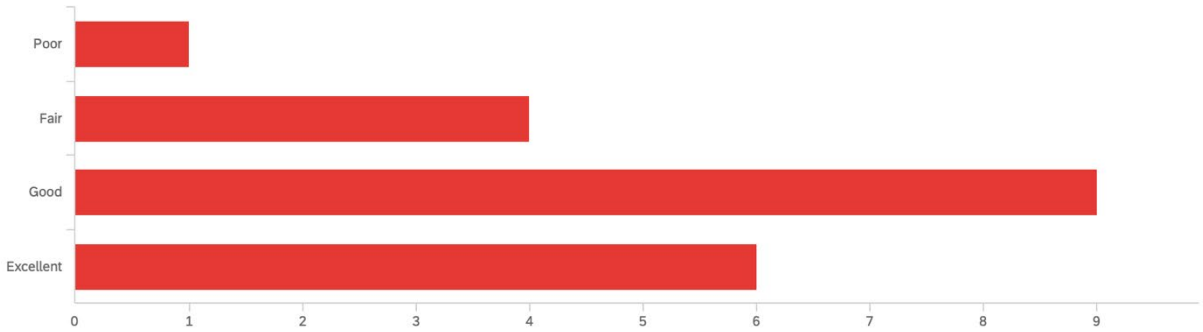
Q: How would you rate the quality of the discussions you had with faculty in the department for your academic plans?



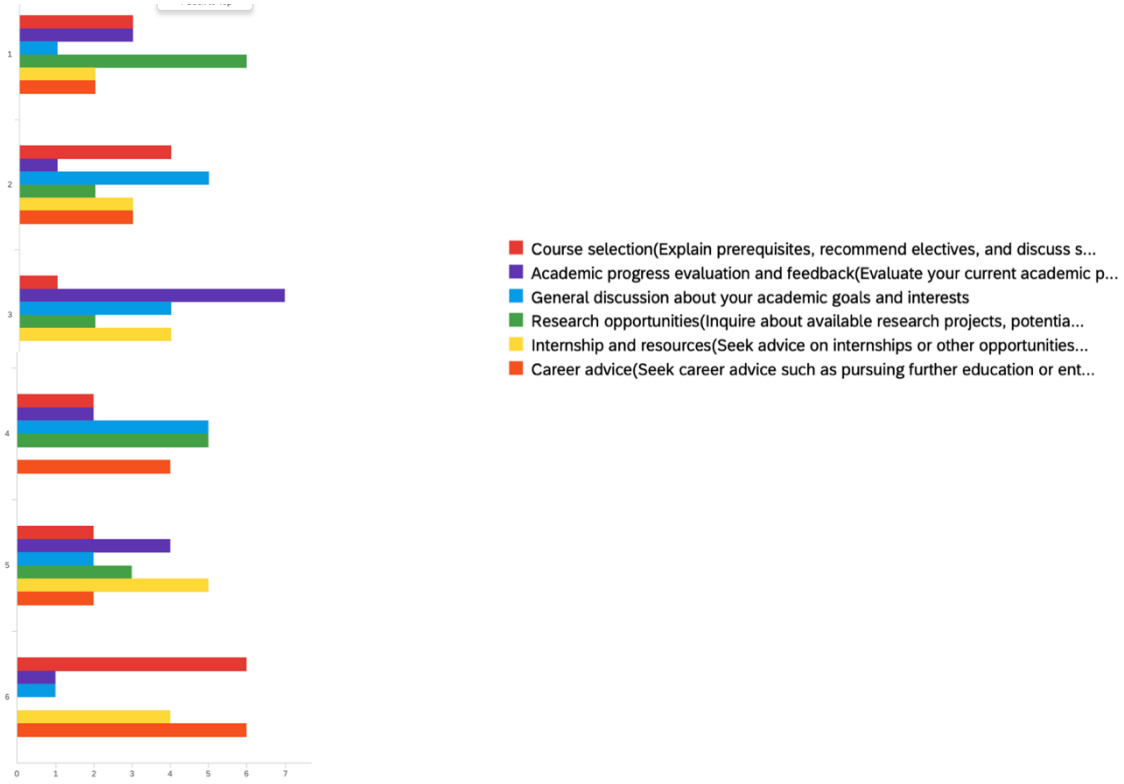
Q: How important do you think it is for students to engage in discussions about their academic plans with faculty members?



Q: How would you rate the quality of the career discussions you had with the Physics and Astronomy faculty regarding your career?



Q: Academic and Career Discussion with the Physics and Astronomy Faculty Which aspects of the academic/career discussions that you had with faculty did you find most important? Please rank them from 1 (least important) to 7 (most important).



70% of 20 responders have participated in research with a faculty advisor.

Students were asked how often they have interacted with their research advisor. The responses are summarized as follows:

Answer	%	Count
Once or twice a month (or less)	7.69%	1
Two or three times a month	23.08%	3
Once a week	53.85%	7
More than once a week	15.38%	2
Total	100%	13

Students have rated the significance of participating in research with the faculty as follows:

Answer	%	Count
Not at all important	5.26%	1
Slightly important	0.00%	0
Moderately important	15.79%	3
Very important	21.05%	4
Extremely important	57.89%	11
Total	100%	19

Students were asked to rate which field of physics/Astronomy they are interested in.

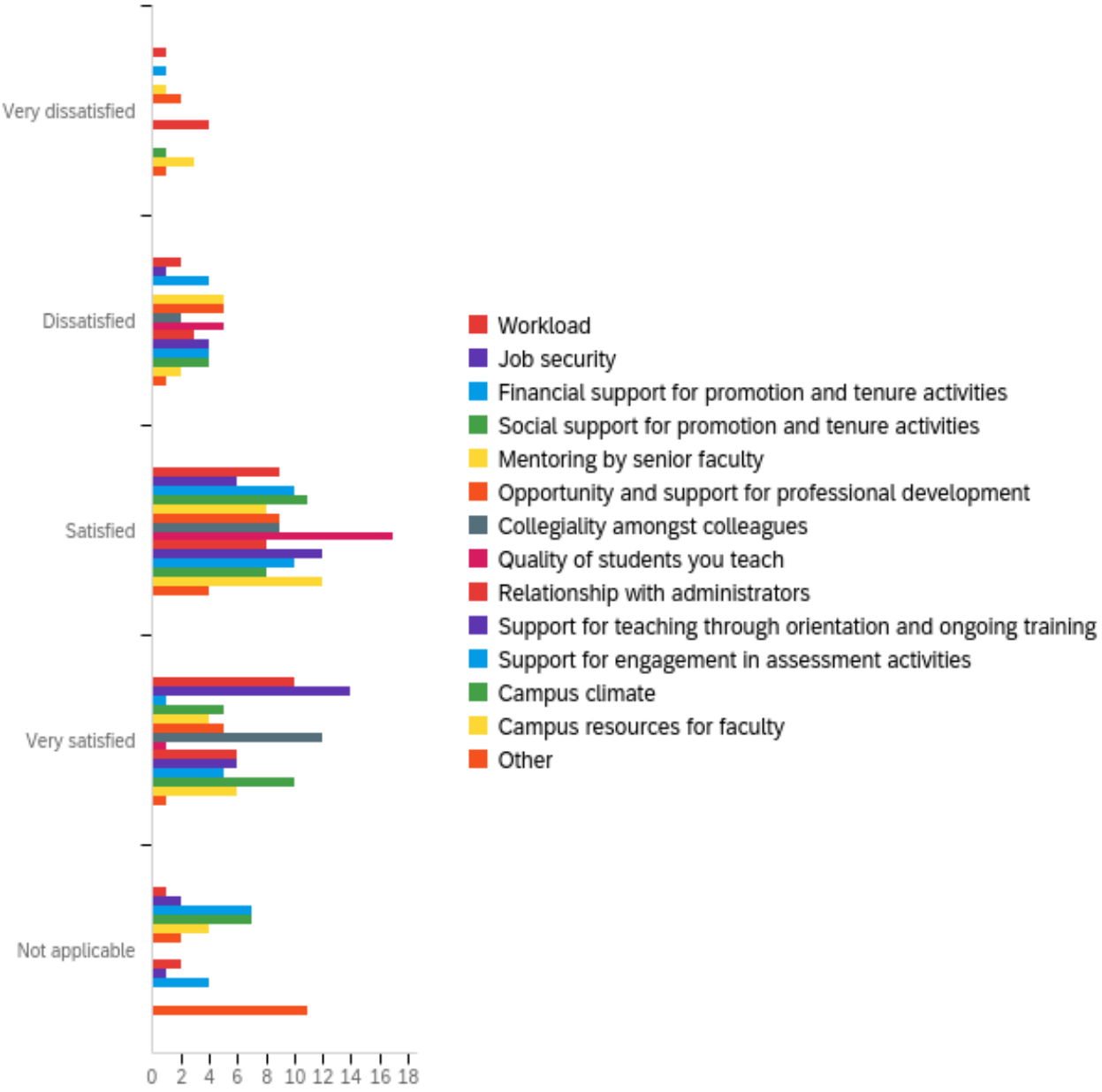
Q: Here are some subfields in physics and astronomy (note this is not an exhausted list). Please select a few sub-fields that you are interested in and rank them (drag them to the right-side column and rank them in the order of most interested on top). By "interested in" we mean that you wish to explore further that subfield by either doing undergraduate research or pursuing graduate study in that subfield.

The summary of student's rating are as follows. Total number of participants in the survey was 28 students. Based on this result the fields that students are most interested in are: High energy physics/particle physics (11); Nuclear physics(10); optics, condensed matter physics and material sciences (9), Gravitational physics and Quantum information (8).

Appendix 4
Faculty Survey

BS Physics Program Review Faculty Survey

Q3 - How satisfied are you with Cal Poly Pomona's employment conditions?



Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
Workload	1.00	5.00	3.35	0.87	0.75	23
Job security	2.00	5.00	3.74	0.67	0.45	23
Financial support for promotion and tenure activities	1.00	5.00	3.39	1.21	1.46	23
Social support for promotion and tenure activities	3.00	5.00	3.83	0.87	0.75	23
Mentoring by senior faculty	1.00	5.00	3.23	1.13	1.27	22
Opportunity and support for professional development	1.00	5.00	3.00	1.06	1.13	23
Collegiality amongst colleagues	2.00	4.00	3.43	0.65	0.42	23
Quality of students you teach	2.00	4.00	2.83	0.48	0.23	23
Relationship with administrators	1.00	5.00	2.96	1.20	1.43	23
Support for teaching through orientation and ongoing training	2.00	5.00	3.17	0.76	0.58	23
Support for engagement in assessment activities	2.00	5.00	3.39	0.97	0.93	23
Campus climate	1.00	4.00	3.17	0.87	0.75	23
Campus resources for faculty	1.00	4.00	2.91	0.93	0.86	23
Other	1.00	5.00	4.11	1.24	1.54	18

Question	Very dissatisfied	Dissatisfied	Satisfied	Very satisfied	Not applicable	Total
Workload	4.35%	8.70%	39.13%	43.48%	4.35%	23
Job security	0.00%	4.35%	26.09%	60.87%	8.70%	23
Financial support for promotion and tenure activities	4.35%	17.39%	43.48%	4.35%	30.43%	23
Social support for promotion and tenure activities	0.00%	0.00%	47.83%	21.74%	30.43%	23
Mentoring by senior faculty	4.55%	22.73%	36.36%	18.18%	18.18%	22
Opportunity and support for professional development	8.70%	21.74%	39.13%	21.74%	8.70%	23
Collegiality amongst colleagues	0.00%	8.70%	39.13%	52.17%	0.00%	23
Quality of students you teach	0.00%	21.74%	73.91%	4.35%	0.00%	23
Relationship with administrators	17.39%	13.04%	34.78%	26.09%	8.70%	23
Support for teaching through orientation and ongoing training	0.00%	17.39%	52.17%	26.09%	4.35%	23
Support for engagement in assessment activities	0.00%	17.39%	43.48%	21.74%	17.39%	23
Campus climate	4.35%	17.39%	34.78%	43.48%	0.00%	23
Campus resources for faculty	13.04%	8.70%	52.17%	26.09%	0.00%	23
Other	5.56%	5.56%	22.22%	5.56%	61.11%	18

Q4 - Since you selected "Other" in the question regarding employment satisfaction, please specify below.

Since you selected "Other" in the question regarding employment satisfaction, please specify below.
The security of employment is very, well, insecure.
proximity
Our Chair, Dr. Alex Small, is doing a great job.
Overall I am very satisfied with the climate in the department. My only concerns relate to the university climate/policies.
accountability for faculty as well as administrators.

Q5 - What could the program/department do to improve faculty satisfaction? (Limited to 200 words)

I think that the department does very well. Continuing the questionnaires about our teaching preferences is helpful.
They are doing fine.
I think that this is a question of resources. The program needs more resources for development. All other problems are secondary.
Allowing lecturers to attend physics/teaching conferences for professional development.
Overall I think that the climate and structure in the department is excellent.
The lengthy bureaucratic process for anything to happen on this campus is unbearable. 1) Anything we want to do with the IT/ studio 6 is hard. Eric from studio 6 is the only person who knows how to do things. I tried to install MathType , they asked me to do 2 rounds of permissions (accessibility review and etc), then send me to procurement even when it doesn't need to be purchased. It took more then six months. 2) anything with HR is hard. They got my payment wrong several times. 3) anything with grant submission is hard, it takes forever for internal approval to go through, and it takes forever to get a letter of support from the dean. But I guess I grow used to this system. It's just not efficient, that's all. But our department chair is extremely efficient, that's probably the only fast link in this process.
I have been here many years, but for new adjunct faculty in my department, it would be advisable for more senior faculty to be paired with new adjunct faculty for guidance. This would encourage more consistency within courses.
This complaint is not the result of decisions made directly by my department, but by dictates imposed upon the department. There is too much emphasis on assessment that detracts from other key priorities, including (and especially) research. There is generally not sufficient support for extramurally funded research or professional service obligations, such as participation in professional societies, serving as a peer reviewer for grants or as a referee for professional journals. The vision of a teacher-scholar is not being adequately realized due to a lack of support for the "scholar" component.
The department is very supportive of the faculty activities in teaching as well as in research. Even though all faculty are open to the questions of new faculty members in the department it would be better if the department assigns a senior faculty as a mentor to the new incoming faculty.
I don't believe that the program/department can do much. However, the university doesn't value research sufficiently. There is very little time left for faculty to devote to research. In addition, there is very little budget for conferences.
Realize that we don't need to have as many committees as we do.
I feel I have plenty of resources and do not have something to add to that at this moment.
More support to provide collaboration between faculty who teach the same course especially in introductory Physics courses.
The problems stem from higher up.
The department could continue to improve support and respect for faculty with diverse interests and expertise (intellectually and professionally). We are not all the same, and we do not all fill the same roles and needs.
Provide more space for research, and more funds for research costs.

Q7 - How satisfied are you with the availability of resources at Cal Poly Pomona?

Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
Physical instructional facilities (e.g., classrooms, labs, etc.)	1.00	4.00	3.04	0.75	0.56	23
General instructional equipment (e.g., audio-visual, instructor classroom computer and projector, etc.)	2.00	4.00	3.26	0.61	0.37	23
Specialized tools and software	1.00	5.00	2.96	1.12	1.26	23
Technical support for remote/virtual instruction	1.00	5.00	3.65	1.00	1.01	23
Faculty pedagogical resources from the Center for the Advancement for Faculty Excellence (CAFE)	2.00	5.00	3.61	0.77	0.59	23
Library	1.00	5.00	3.26	1.11	1.24	23
Research and grants support from the Office of Research, Innovation, and Economic Development (IRB, Sponsor Programs, Internal Funding Opportunities, etc.)	1.00	5.00	3.43	1.38	1.90	23
Office of Assessment and Program Review	1.00	5.00	3.82	1.23	1.51	22
Bronco Advising Center academic advisors	2.00	5.00	4.04	1.04	1.09	23
College professional staff advisors	2.00	5.00	3.86	1.14	1.30	22
Disability Resource Center	1.00	5.00	3.39	1.09	1.19	23
Learning Resource Center	2.00	5.00	3.86	0.97	0.94	22
Academic Research and Resources (ARAR)	1.00	5.00	4.09	1.14	1.30	23
Institutional Research, Planning and Analytics	1.00	5.00	4.14	1.18	1.39	22
Counseling and Psychological Services (CAPS)	1.00	5.00	4.14	1.32	1.75	22
Career Center (within Student Affairs)	3.00	5.00	4.18	0.94	0.88	22
Support for the program and classes from the Dean and other administrators	1.00	5.00	3.13	1.08	1.16	23
Other	3.00	5.00	4.87	0.50	0.25	15

Question	Very dissatisfied	Dissatisfied	Satisfied	Very satisfied	Not applicable
Physical instructional facilities (e.g., classrooms, labs, etc.)	4.35%	13.04%	56.52%	26.09%	0.00%
General instructional equipment (e.g., audio-visual, instructor classroom computer and projector, etc.)	0.00%	8.70%	56.52%	34.78%	0.00%
Specialized tools and software	17.39%	4.35%	52.17%	17.39%	8.70%
Technical support for remote/virtual instruction	4.35%	0.00%	47.83%	21.74%	26.09%
Faculty pedagogical resources from the Center for the Advancement for Faculty Excellence (CAFE)	0.00%	4.35%	43.48%	39.13%	13.04%
Library	4.35%	17.39%	47.83%	8.70%	21.74%
Research and grants support from the Office of Research, Innovation, and Economic Development (IRB, Sponsor Programs, Internal Funding Opportunities, etc.)	8.70%	17.39%	34.78%	0.00%	39.13%
Office of Assessment and Program Review	4.55%	9.09%	31.82%	9.09%	45.45%
Bronco Advising Center academic advisors	0.00%	4.35%	39.13%	4.35%	52.17%
College professional staff advisors	0.00%	13.64%	31.82%	9.09%	45.45%
Disability Resource Center	8.70%	8.70%	30.43%	39.13%	13.04%
Learning Resource Center	0.00%	4.55%	40.91%	18.18%	36.36%
Academic Research and Resources (ARAR)	4.35%	0.00%	34.78%	4.35%	56.52%
Institutional Research, Planning and Analytics	4.55%	4.55%	22.73%	9.09%	59.09%
Counseling and Psychological Services (CAPS)	9.09%	4.55%	13.64%	9.09%	63.64%
Career Center (within Student Affairs)	0.00%	0.00%	36.36%	9.09%	54.55%
Support for the program and classes from the Dean and other administrators	8.70%	13.04%	47.83%	17.39%	13.04%
Other	0.00%	0.00%	6.67%	0.00%	93.33%

Q9 - What additional resources do you wish were available to you through Cal Poly Pomona? (Limited to 200 words)

More up to date laptops for lecturers. Every other state university I've worked at has provided up to date laptops for lecturers. In particular at CalPoly SLO they told us we were given university laptops precisely so that student data could (and should) not be stored on any personal device, for the obvious reason of student privacy. Possibly travel grants for lecturers to attend conferences, although I get this is a stretch.

Printing services, especially for large lectures.

I believe that the times of chalk on board are over. It is time to move to new tools like Smartboard. I used it, and I like it very much. Once again, this is a question of resources.

CAFE is amazing for both support and a sense of welcoming and community.

I find that most resources that students need are not responsive to communication. I rarely recieve a response from the DRC, for example, when a student needs an accomodation.

Grants administration is woefully inadequate. I have experienced egregious delays (often of multiple months) in supporting funding for students. I secured extramural funding in the hopes that I would support our students and advance my research program, but my impression is that administration sees external funding as an inconvenience rather than a direct benefit to Cal Poly Pomona's reputation. The department could be more proactive in allocating departmental resources, such as ICR funds, to support scholarly activities instead of relying entirely on individual faculty members to ask for individual support. Requests for support (such as page charges or travel funding) have, in the past, been met with some hesitance, and I am pleased to see departmental attitudes shifting to be more supportive of scholarly and research activity in recent years.

Cal poly pomona has very little support for research. Cal Poly Pomona doesn't provide simple things that could greatly enhance the life of faculty, although other universities provide those. For example, discount on gym membership on campus for the faculty. In general, anything that is not about teaching and enhancing students' life is not concerned of cal poly. For example, although students have accommodations for a disability, faculty with a disability get nothing. Cal Poly does not understand that happier faculty, well-paid faculty, and active research faculty would be essential for better teaching. They think that teaching is only about the classroom. However, a lot has to happen for a faculty to be effective on the campus.

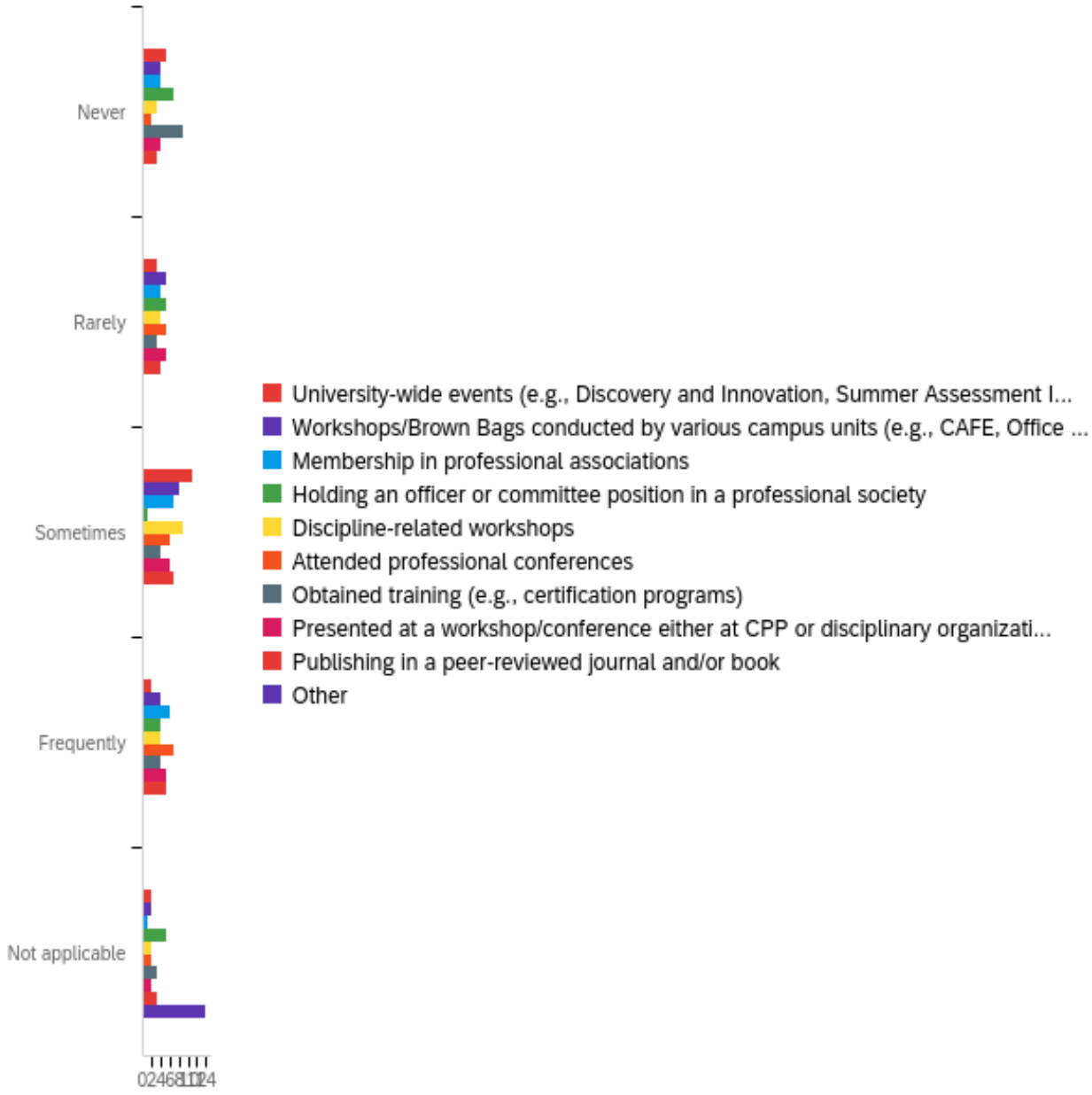
The departments should be more independent in their use of the allotted budget. The decisions by the Dean need to be made on time to provide student services (such as approving learning assistants) and for hiring documentation approval. I do not see much value in advising center and their activities.

a faculty club, a decent social place for faculty of various disciplines to casually and informally meet and share ideas - while able to buy coffee, lunch etc. A "faculty club."

Cal Poly Pomona lacks adequate physical space for large lecture courses and research labs. Many current classrooms are too small and in disrepair. Faculty office space is insufficient, with TT faculty offices too small and lecturers needing to share offices. Cal Poly Pomona expects faculty to perform research to earn tenure or promotion (or in the case of lecturers, to compete for tenure-track openings in their field). Research support is very limited unless faculty are able to secure their own external funding, and teaching loads are too high. Faculty salaries struggle to remain competitive, with compensation in "academic" disciplines such as Physics and Astronomy lagging significantly behind "professional" ones such as Computer Science and Business.

More research-grade and industry-grade software, e.g. the same suite of tools as engineering.

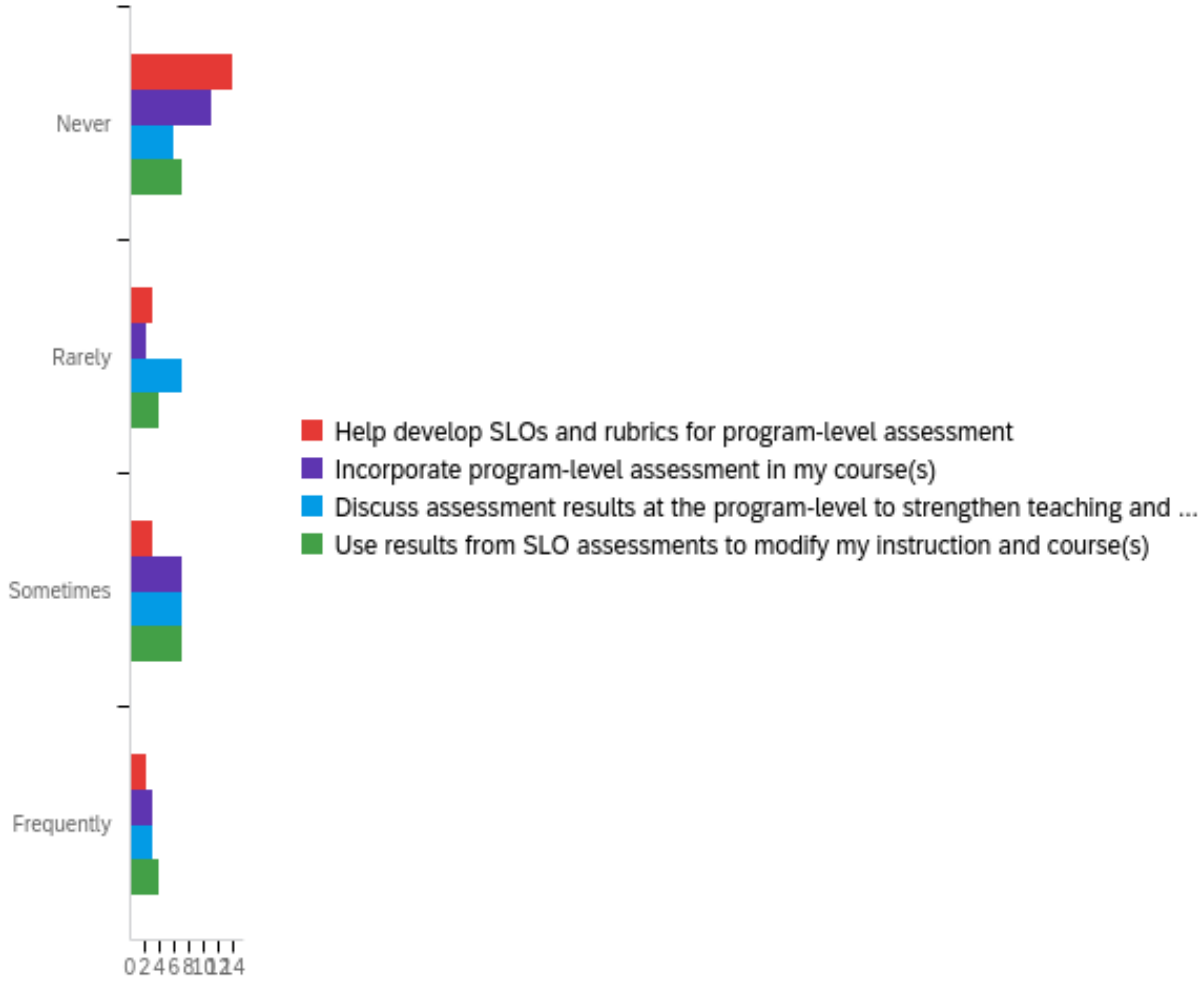
Q11 - To what extent in the last 5 years did you participate in professional development opportunities on- or off-campus?



Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
University-wide events (e.g., Discovery and Innovation, Summer Assessment Institute, Stories of Successful Learning, Faculty Zoom Sessions)	1.00	5.00	2.70	1.16	1.34	23
Workshops/Brown Bags conducted by various campus units (e.g., CAFE, Office of Assessment and Program Review, library, et.)	1.00	5.00	2.78	1.18	1.39	23
Membership in professional associations	1.00	5.00	2.82	1.15	1.33	22
Holding an officer or committee position in a professional society	1.00	5.00	2.77	1.59	2.54	22
Discipline-related workshops	1.00	5.00	2.91	1.12	1.26	22
Attended professional conferences	1.00	5.00	3.09	1.12	1.26	22
Obtained training (e.g., certification programs)	1.00	5.00	2.52	1.47	2.16	23
Presented at a workshop/conference either at CPP or disciplinary organization	1.00	5.00	2.82	1.23	1.51	22
Publishing in a peer-reviewed journal and/or book	1.00	5.00	3.05	1.22	1.50	22
Other	5.00	5.00	5.00	0.00	0.00	14

Question	Never	Rarely	Sometimes	Frequently	Not applicable	Total
University-wide events (e.g., Discovery and Innovation, Summer Assessment Institute, Stories of Successful Learning, Faculty Zoom Sessions)	21.74%	13.04%	47.83%	8.70%	8.70%	23
Workshops/Brown Bags conducted by various campus units (e.g., CAFE, Office of Assessment and Program Review, library, et.)	17.39%	21.74%	34.78%	17.39%	8.70%	23
Membership in professional associations	18.18%	18.18%	31.82%	27.27%	4.55%	22
Holding an officer or committee position in a professional society	31.82%	22.73%	4.55%	18.18%	22.73%	22
Discipline-related workshops	13.64%	18.18%	40.91%	18.18%	9.09%	22
Attended professional conferences	9.09%	22.73%	27.27%	31.82%	9.09%	22
Obtained training (e.g., certification programs)	39.13%	13.04%	17.39%	17.39%	13.04%	23
Presented at a workshop/conference either at CPP or disciplinary organization	18.18%	22.73%	27.27%	22.73%	9.09%	22
Publishing in a peer-reviewed journal and/or book	13.64%	18.18%	31.82%	22.73%	13.64%	22
Other	0.00%	0.00%	0.00%	0.00%	100.00%	14

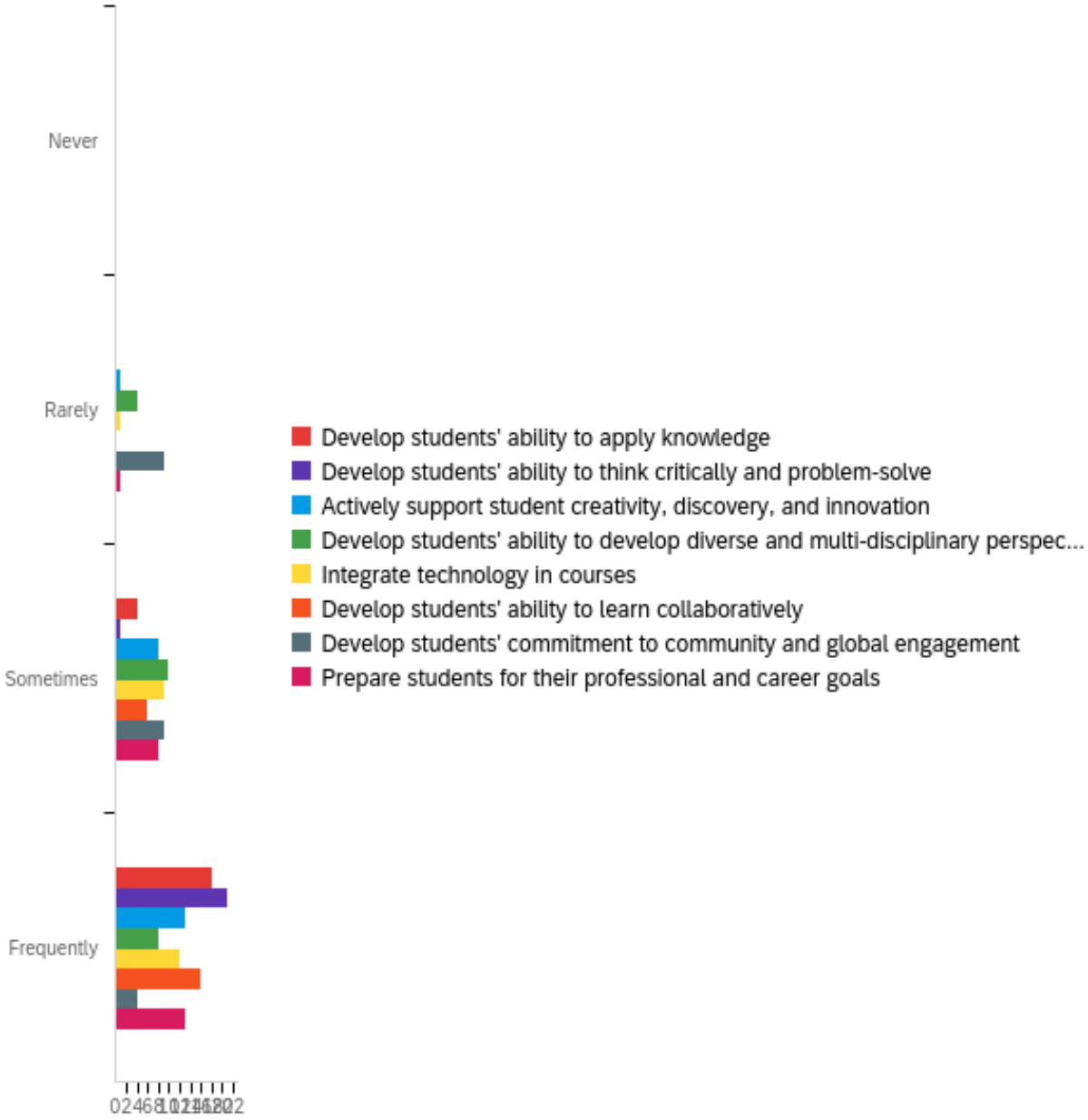
Q14 - In the last 5 years, to what extent have you participated in assessment activities at Cal Poly Pomona?



Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
Help develop SLOs and rubrics for program-level assessment	1.00	4.00	1.68	1.02	1.04	22
Incorporate program-level assessment in my course(s)	1.00	4.00	2.09	1.14	1.30	23
Discuss assessment results at the program-level to strengthen teaching and learning	1.00	4.00	2.30	1.00	0.99	23
Use results from SLO assessments to modify my instruction and course(s)	1.00	4.00	2.36	1.11	1.23	22

Question	Never	Rarely	Sometimes	Frequently	Total
Help develop SLOs and rubrics for program-level assessment	63.64%	13.64%	13.64%	9.09%	22
Incorporate program-level assessment in my course(s)	47.83%	8.70%	30.43%	13.04%	23
Discuss assessment results at the program-level to strengthen teaching and learning	26.09%	30.43%	30.43%	13.04%	23
Use results from SLO assessments to modify my instruction and course(s)	31.82%	18.18%	31.82%	18.18%	22

Q16 - To what extent do you contribute (teaching, research, service) to helping students develop CPP's inclusive polytechnic university identity?



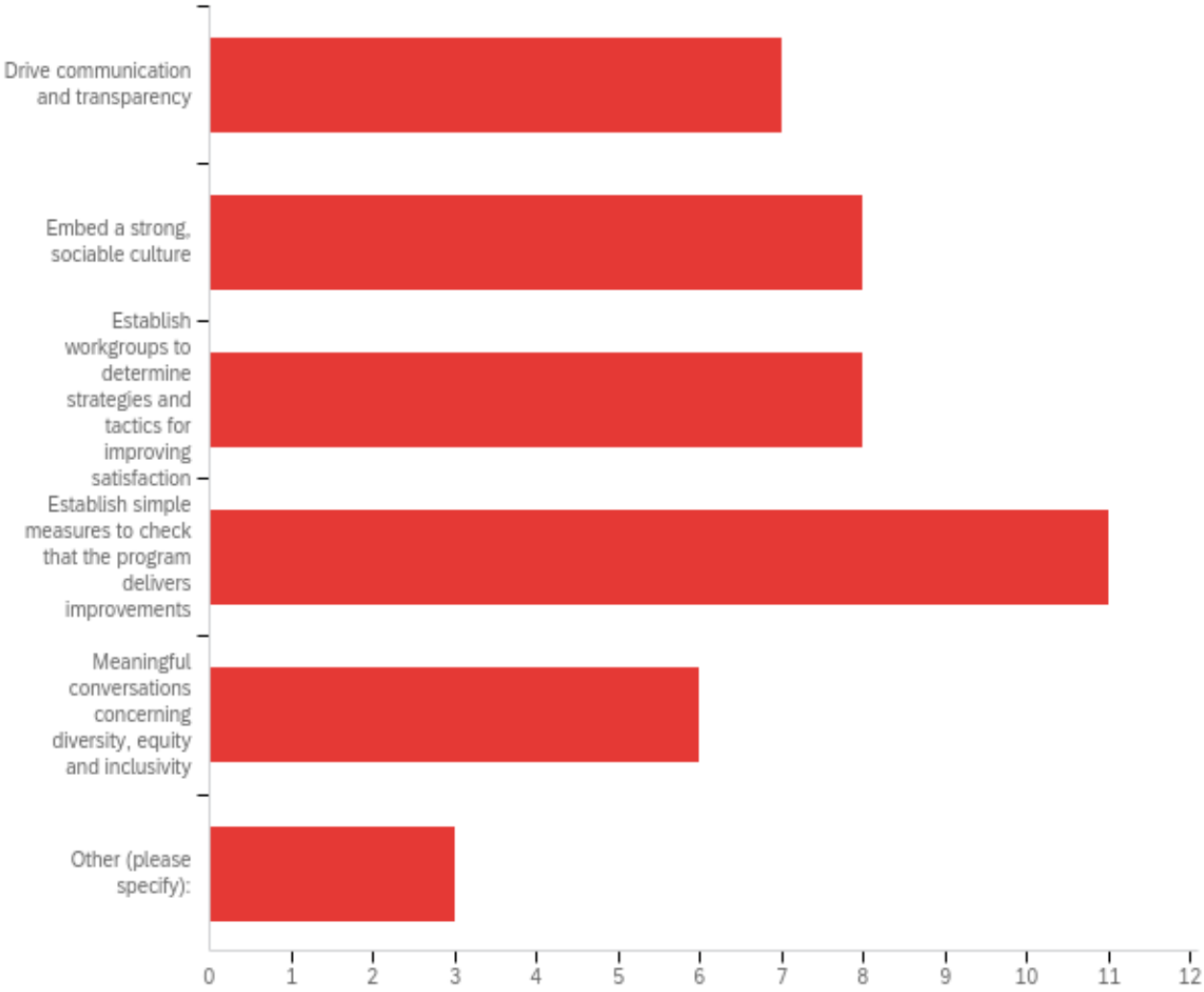
Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
Develop students' ability to apply knowledge	3.00	4.00	3.82	0.39	0.15	22
Develop students' ability to think critically and problem-solve	3.00	4.00	3.95	0.21	0.04	22
Actively support student creativity, discovery, and innovation	2.00	4.00	3.55	0.58	0.34	22
Develop students' ability to develop diverse and multi-disciplinary perspectives	2.00	4.00	3.18	0.72	0.51	22
Integrate technology in courses	2.00	4.00	3.50	0.58	0.34	22
Develop students' ability to learn collaboratively	3.00	4.00	3.73	0.45	0.20	22
Develop students' commitment to community and global engagement	2.00	4.00	2.77	0.73	0.54	22
Prepare students for their professional and career goals	2.00	4.00	3.55	0.58	0.34	22

Question	Never	Rarely	Sometimes	Frequently	Total
Develop students' ability to apply knowledge	0.00%	0.00%	18.18%	81.82%	22
Develop students' ability to think critically and problem-solve	0.00%	0.00%	4.55%	95.45%	22
Actively support student creativity, discovery, and innovation	0.00%	4.55%	36.36%	59.09%	22
Develop students' ability to develop diverse and multi-disciplinary perspectives	0.00%	18.18%	45.45%	36.36%	22
Integrate technology in courses	0.00%	4.55%	40.91%	54.55%	22
Develop students' ability to learn collaboratively	0.00%	0.00%	27.27%	72.73%	22
Develop students' commitment to community and global engagement	0.00%	40.91%	40.91%	18.18%	22
Prepare students for their professional and career goals	0.00%	4.55%	36.36%	59.09%	22

Q17 - Provide an example of how you have contributed to helping students develop CPP's inclusive polytechnic university identity. (Note: our department and the university can use this information to replicate best practices) (Limited to 200 words)

I do everything I can to introduce the students to how to use technology in their studies; this can include something as simple as showing students how to use a spreadsheet to plot a graph in a lab or how to code in high level languages. Collaboration is a natural part of teaching in lab situations, and it seems that our students are good at collaborating that way already. I do what I can to assist them.
Students end each session with a reflection of Gots and Needs. They are encouraged to include all types of needs, not just content based. It allows me to adjust for disabilities and cultural differences so long as the course objectives are still met.
I implement hands-on activities in lectures and recitations in class. I always ask my research students to explore their own interest and develop their own project.
In a course I instruct, I have an option for my students to conduct community based research. My department encourages this and provides resources contacts for small grants.
I frequently mentor students in research, and I make clear that I expect their work to be of high enough quality that their results could be suitable for a presentation at a national conference or incorporated into a peer-reviewed publication. I further implement disciplinary knowledge into all courses that I teach, and demand that students regularly demonstrate critical thinking skills on class activities. These activities frequently involving coding, data analysis, giving presentations, and writing papers in the style of professional peer-reviewed journals.
By explaining the students how physics relate to the real world. For example, Physics underlies the fundamental principles governing the forces, motion, and energy that shape our everyday experiences. Whether you're behind the wheel of a car, delivering a powerful kick to a football, or simply using a smartphone.
I believe I have been helping students develop inclusive polytechnic identity in various ways. I provide tutorials and worksheets in class and ask students work in a group that will be helpful to develop critical thinking and problem solving skill. I encourage them to collaborate with friend while solving problems that supports collaborative learning. I also engage students in research projects where they learn various skillset via learn through discovery which prepares them for professional and carrier readiness.
Stress the importance and explain the reasoning behind peer-learning activities. Pressure them to actually work as a team in group activities, explaining in their future workplace their work will almost always be as part of a group.
Just trying my best to be a good teacher that also wants my students to learn and appreciate their subject and how it involves everything around them
I ask difficult questions in my exams. They are challenging and make students study more. I do not collect HW any more, as all the solutions to typical HW problems are available. I rather quiz students on the HW questions. These quizzes are frequent assessments and make students study regularly. In the classes I taught in this fashion, I receive quite favorable ratings in the student evaluations. Students like being challenged. They feel they learn something. I make students write papers based on their experiments or simulations. These take a lot of time to grade, but they are very useful for students to develop as professionals.
Learning about them, their backgrounds and challenges. Explicitly stating values and acceptance of views in class.
Research mentoring of students who have presented at professional conferences and authored papers in leading peer-reviewed journals.
I organize events that bring together students and industry professionals (including alumni). I incorporate industry-grade simulation software into many of my class assignments.

Q19 - What could the program/department do to improve the success of the program? (select all that apply)



Answer	%	Count
Drive communication and transparency	16.28%	7
Embed a strong, sociable culture	18.60%	8
Establish workgroups to determine strategies and tactics for improving satisfaction	18.60%	8
Establish simple measures to check that the program delivers improvements	25.58%	11
Meaningful conversations concerning diversity, equity and inclusivity	13.95%	6
Other (please specify):	6.98%	3
Total	100%	43

Q19_6_TEXT - Other (please specify):

Other (please specify): - Text
Less bureaucracy and more efficiency
Avoid busywork, please do not create more committees. We can enhance success by living our values instead of performatively checking boxes.
No more group please, only tangible things.

Q20 - What could the program do to improve student success? Please consider actionable items and provide examples of what could/should be implemented. (Limited to 300 words)

Include more social activities in the first years and include the faculty in those social events to create a tighter community from the start. We have talks but it’s not the same as getting together and doing a non academic activity.
Encourage instructors to advertise our tutoring labs for students.
Faculty are working at capacity; adding more extraneous obligations detracts from faculty members' ability to devote time and energy to their classes and research. The department should be supporting faculty members in "protecting" their time. More time spent on class preparation will lead to better classes, and more time spent on scholarship will lead to better and more meaningful student projects. We should be actively providing learning assistant and grader positions for students. They greatly assist the faculty member with their workload, help students enrolled in classes master the material more efficiently, and provide valuable work experiences for students.
I think the department is doing really good jobs for students success by bringing in the programs such as homework help, LA program and industry advisory board meetings. Department could plan for some workshops where students can learn strategies for professional readiness.
Focus on the sucess of faculty to improve the success of students.
Professors must challenge the students while providing help. Many students are underprepared for our curriculum, which should not make us more lenient. On the contrary, we need to make courses challenging. Students will develop their skills when they are challenged. Yes, we can provide help for struggling students, but not at the expense of education rigor. One thing we can do for better uniformity in quality of instruction is to have common final exams. We need to make sure students learn the same level. We already do good things such as providing undergrad research opportunities, programs that link the students with industry leaders and our alumni, and we should keep doing them.
Be more sympathetic and compassionate and not hard ass about absolute deadlines, lateness etc., at the same time clearly stating boundaries and limits of acceptable work and work ethic.
Faculty in our program rarely, if ever, discuss issues of diversity, equity, and inclusion in a constructive fashion. There is an aversion to acknowledging that students' experiences based on their racial/ethnic backgrounds may impact their perceptions of the department. We are a bit more forthright acknowledging and supporting issues of gender underrepresentation, and we are more sensitive to economic/class issues that create challenges for CPP students.
High, consistent standards in introductory courses.

Q22 - Faculty tenure status

Answer	Count
Currently hold tenure/ on tenure-track	10
Not on tenure-track	12
Total	22

Q23 - Please indicate the amount of time spent on the following activities (must sum to 100%)

Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
Teaching (including prep)	13.00	100.00	71.27	26.35	694.20	22
Research	0.00	51.00	12.82	14.94	223.33	22
Service	0.00	31.00	9.45	9.80	95.98	22
Administrative (Department Chair, Faculty Director, Faculty Fellow)	0.00	54.00	5.77	14.46	209.18	22
Other (please specify)	0.00	10.00	0.68	2.28	5.22	22

Q23_5_TEXT - Other (please specify)

Other (please specify) - Text
Directing students to resources within the department and across the university.
I frequently participate in service activities to professional societies. I would like to be more involved in the leadership roles of professional societies, but I refrain from doing so because I do not know if the department or college would support these activities in terms of reassigned time, or if I would have to sacrifice even more research time (since that is the only activity that I could chose to spend less time on without penalty).

Q27 - What is your gender identity?

Male = 8
Female = 4
Don’t wish to specify = 2