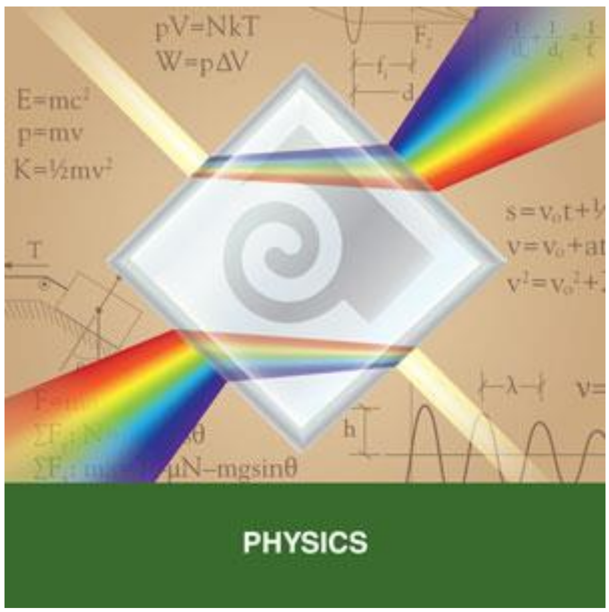
PHYSICS PROGRAM REVIEW



4/24/2015

Portland Community College

Physics Program Review

PORTLAND COMMUNITY COLLEGE

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We would also like to thank the one year temporary full-time faculty and the all the part time faculty for their contributions. They all participated enthusiastically in collecting assessment data and made numerous other contributions to this program review.

1. PROGRAM/DISCIPLINE OVERVIEW

A. Educational goals or objectives of this program

Physics is the root discipline of science that describes the natural universe at its most fundamental level. Physics is relevant to a broad range of academic pursuits including chemistry, biology, engineering, medicine, and liberal arts. Physics allows students to view the world with a new understanding and appreciation of its order and beauty.

Although the technological resources available to us have changed somewhat since the last Physics discipline review, our primary goals and objectives have not fundamentally changed in the last five years, nor do we expect them to change in the next five years.

The AAPT (American Association of Physics Teachers), in its "Guidelines for Two-Year College Physics Programs" states that:

> *The quality of a two-year physics program is determined in part by the quality of the preparation and the overall workloads of its faculty, as well as the adequacies of departments' budgets, facilities, and support services.*
>
> *If the college administration or its Board of Trustees has a narrow view of physics, or if there is not an awareness of the need for a broadly prepared physics faculty who are active as professional physicists, the physics program cannot remain strong, regardless of its other assets. New technology and physics education research are constantly changing the way introductory physics is taught. Two-year college physics programs have been in the forefront of improving introductory physics education because of the focus on student learning at two-year colleges.*
>
> *"Diversity" most aptly describes the physics courses offered in two-year colleges. The need for a wide variety of courses arises from the service role of the physics department. Two-year colleges offer several levels of transfer courses including courses for students pursuing careers in the physical sciences and engineering; courses for students pursuing careers in life science, medicine, and other professional programs; and courses*

for nonscience majors including students who are preparing to be elementary school teachers. Specialized courses in physics are often offered for students in specific two-year vocational and technical programs.

Physics is an experimental science. Therefore, laboratory experiences should be an integral part of the physics curriculum. Excluding experimental learning experiences in physics is analogous to the elimination of physical training from the physical education curriculum or the de-emphasis of practice on a musical instrument in a music program. Students have more difficulty understanding the relationship between physical theory and experimental evidence without the personal experience of designing and conducting experiments.

Physics courses at PCC are designed and implemented in accordance with these guidelines.

- Faculty members stay up to date on the latest Physics teaching research and methodologies.
- We offer a wide variety of physics classes (for non-majors, with algebra, with calculus and an introductory astronomy series).
- We have integrated new technologies into both our lectures and labs.
- Laboratory exercises play a key role in instruction, and comprise half of all hours spent in the classroom. Labs are carefully designed to complement material presented in the lecture, thereby enhancing student learning.

Additionally, we have established a more detailed set of outcomes, shared by all of our Physics courses.

After completion of any Physics course at PCC, students will

1. have an increased awareness of the Physics behind phenomena observed in everyday life, including an understanding of our natural and technological environments.

2. be able to <u>apply</u> abstract mathematical and physical principles to specific problems such as those presented in the homework and on tests, and to reason both qualitatively and quantitatively.

3. be able to apply these same principles when confronted with similar situations in the real world, taking into account factors such as reasonable approximation and limitations due to uncertainty.

4. have strengthened mathematical skills due to the constant application of mathematics in Physics.

5. be able to design experiments and acquire data with the goal of verification of physical principles.

6. have the ability to communicate experimental procedures and results clearly and effectively through a written lab report.

7. have an appreciation for the historical advancement of Physics, and its relation to other disciplines.

B. Changes since the last program review

Enrollment

We compared data from the academic year of our last review 2009/10 with the latest complete academic year (2013/14) which is shown in Table 1.1 below.

Student FTE	2009/10	2013/14	% change
District wide	293.4	394.1	**34%**
Sylvania	129.1	196.7	**52%**
Cascade	74.4	121.9	**64%**
Rock Creek	89.9	75.5	**-16%**

Table 1.1: Physics enrollment (FTE) for the 2009/10 and 2013/14 academic years, both district wide as well as by campus.

The Physics program continues to grow robustly. Over the four year period shown our overall growth rate was 34%. This does not include the new physics program at Southeast campus which started offering classes during the current 2014/15 academic year and which will bolster this number still further. It is likely that the 5 year growth number including Southeast campus will be comparable to the growth we reported in our last program review (42%) which was over a much longer 9 year period!

As in the last program review Cascade has shown the most overall growth at 64%. This growth was primarily driven by the addition of the PHY121 Astronomy series and strong growth in PHY101 and the PHY201 series. Sylvania saw strong growth in the PHY121 series and moderate growth in the PHY211 series. Rock Creek's enrollment declined primarily due to budget cuts which resulted in a PHY101 class (taught every quarter) and an entire PHY211 series being cut. We hope that with improved budgetary conditions these classes can be added back into the schedule in the near future. Unfortunately the robust growth at Cascade and Sylvania has not been accompanied by any new full time faculty members.

New Department

We are excited to have added a new Physics department at Southeast campus. As suggested in the Administrative Response to our 2010 Program review we worked closely with the Southeast campus administration to design and equip a new physics lab facility at the Southeast campus. We have just completed the process of hiring a new full time Physics faculty member to head up the Southeast Physics department. This is our first full time hire in 15 years! Lee Collins has done a great job as a one year temporary full-time instructor to get the ball rolling and we are pleased to welcome him as our new full-time Physics faculty member.

New Courses

During this last review period we have greatly enhanced our distance learning hybrid class. PHY101 is taught with an online lecture component and an on-campus laboratory at Rock Creek campus. The class is team taught by Vicki Schroeder (online) and Laura Fellman (lab). The class had just been introduced at the time of our last review. Since then the class has been moved over to the new D2L online platform (it was developed under the old Blackboard platform). The quality of the class has been enhanced and online office hours have been added.

Laboratories

All campuses continue to add new equipment and write new laboratory exercises to utilize the new equipment.

New Technology and Teaching Techniques

Rock Creek campus has added a Classroom Response System ("clickers") to their classroom. These are used by students to answer interactive questions during lectures which help to keep students engaged and give them immediate feedback on their understanding of important topics. While "clickers" are not used on other campuses the majority of instructors are now using interactive questions during their lectures.

Combined Lecture-Lab format

PCC has often utilized a class format in which a class meets for two 3 hour time blocks per week. Traditionally that has meant a 3 hour lecture and a 3 hour lab. This format has been particularly popular for the PHY101 series. As mentioned in our previous program review Rock Creek campus pioneered splitting these 3 hour class periods into a combined lecture and lab format in which the first half of the class is lecture, followed by a "mini" lab. So instead of a single 3 hour lab the class has two "mini" labs per week. Sylvania campus has recently moved over to this format for their PHY101 classes. The experience at Rock Creek shows that students overwhelmingly favor this format. This format has also been adopted by the General Science classes at Rock Creek campus.

Textbooks

In keeping with the PCC wide effort to reduce the cost of textbooks for our students we have introduced a new set of custom textbooks for our PHY101/102/103 series. Working with the publisher we created three separate textbooks, one for each class. Many of the students take only one class in the series and before this year they were required to purchase the full textbook which costs over $180. The new custom texts are under $60 and can be resold back to the bookstore. This represents a large savings for our students. Rock creek campus is the only campus that offers the full series and even students taking the whole sequence pay slightly less for the three custom texts than for the single full text. As a SAC we are proud of this effort to reduce costs for our students.

C. Changes as a result of the last program review

Two of the areas marked as needing improvement in our last review have been addressed.

- Sylvania has made some progress with class size limits. They now offer more classes with a 24 person limit and a reduced number of large (double) sections. The American Association of Physics Teachers (AAPT) recommends a class size of 24 as ideal and we will continue to strive for classes in a range of 24 – 28 students for ***all*** our sections.

- We recommended that a full time instructor be hired to build the Physics department at Southeast campus and we are thrilled to welcome Lee Collins as our new full-time faculty member at Southeast campus.

2. OUTCOMES AND ASSESSMENT

The Course Content and Outcome Guidelines (CCOG's) of all Physics courses contain a set of common intended outcomes which are outlined below:

Students completing a Physics course at PCC should:

1. have an increased awareness of the Physics behind phenomena observed in everyday life, including an understanding of our natural and technological environments.
2. be able to apply abstract mathematical and physical principles to specific problems such as those presented in the homework and on tests, and to reason both qualitatively and quantitatively.
3. be able to apply these same principles when confronted with similar situations in the real world, taking into account factors such as reasonable approximation and limitations due to uncertainty.
4. have strengthened mathematical skills due to the constant application of mathematics in Physics.
5. be able to design experiments and acquire data with the goal of verification of physical principles.
6. have the ability to communicate experimental procedures and results clearly and effectively through a written lab report.
7. have an appreciation for the historical advancement of Physics, and its relation to other disciplines.

In addition the PHY201 series also requires that students:

8. be prepared for future study in pre-medicine, biology, geology, or related fields.

For the PHY211 series the additional requirement is that students:

8. be prepared for future study in engineering, chemistry, advanced Physics, or related fields.

In the following sections we will discuss how these outcomes intersect with PCC Core outcomes and also how these outcomes are assessed.

A. Course Level outcomes

In order to demonstrate the improvement in student performance for our last program review we designed and administered a simple test consisting of 6 questions that covered the key topics taught during the first course in all of our Physics series. The test was also to be used as a benchmark that we could use in future years to measure our performance against. We decided to administer the test again in 2014 as it had been 5 years since we had last administered it.

The design criteria were that the test:

1. could be taken by all three series (PHY101, PHY201 and PHY211).
2. should have minimal impact on instruction time.
3. would show whether student knowledge and problem solving abilities improved as a result of attending their Physics classes at PCC.

The nationally administered Force Concept Test and the Mechanics Baseline Test offered the opportunity to compare with national data bases but did not meet the first two criteria for our tests. As a result we decided to design our own test which covered key topics in mechanics. The test can be found in Appendix B.

During Fall 2009 and Winter 2010 the tests were administered at the beginning of the quarter (pre-test) to 315 students across the district in PHY101, PHY201 and PHY211 classes . The same test was then administered at the end of the quarter (post-test) to a total of 203 students. During Fall 2014 the same pre-test used in 2009 was administered at the beginning of the quarter (pre-test) to 504 students across the district in PHY101, PHY201 and PHY211 classes. The same test was then administered at the end of the quarter (post-test) to a total of 358 students.

The pre-test and post test scores of our students both declined by a small amount in 2014 compared with the 2009 results. However, the post-test result percentage improvement was slightly higher in 2014 (64%) compared with that of 2009 (60%).

Both pretest graphs (2009 and 2014) show something close to a normal distribution with most students getting 2 or 3 correct answers. The post-test data for both years shows a large improvement. The curve is now clearly skewed towards a higher number of correct responses. No students got all the answers wrong in the post- test.

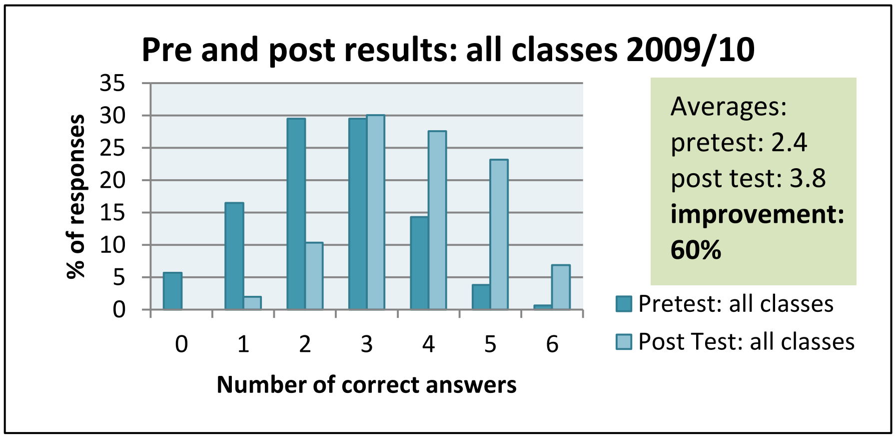


Fig 2.1: Pre and post test results for all physics classes in the 2009/10 test period.

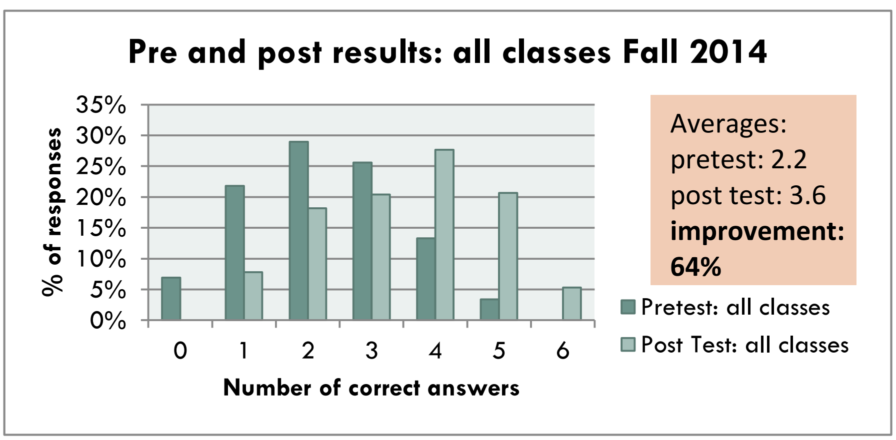


Fig 2.2: Pre and post test results for all physics classes in the 2014 test period.

The pre and post test results were also broken down by courses. We have three major series, each of which begins with a course in mechanics (description of motion, forces and Newton's Laws of Motion, momentum, energy and rotational motion). The PHY101 series has the lowest level of math requirement with students required only to meet the general education math prerequisite. The PHY201 series requires algebra and the PHY211 series requires calculus.

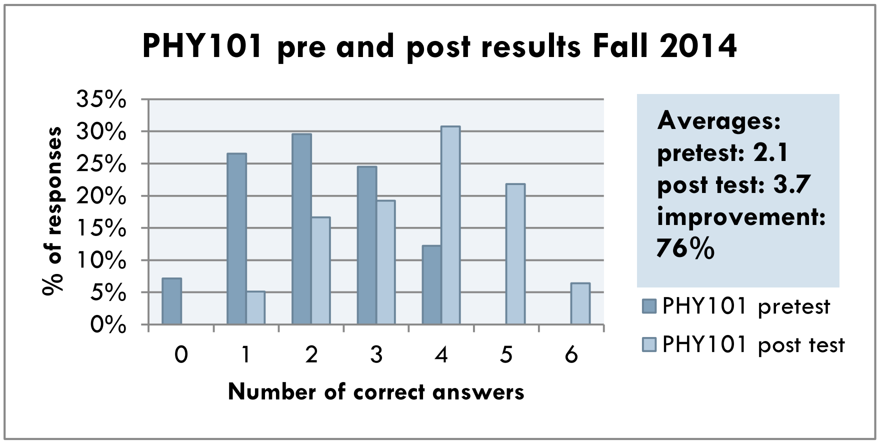


Fig 2.3: Pre and post test results for PHY101 in the 2014 test period.

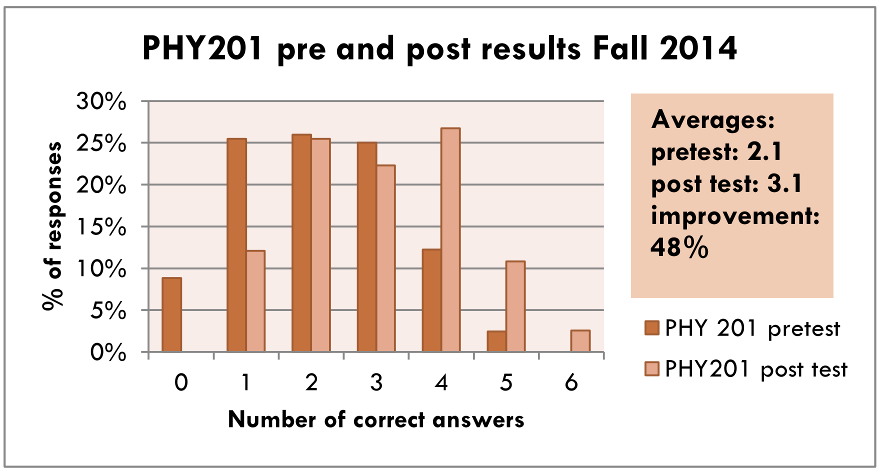


Fig 2.4: Pre and post test results for PHY201 in the 2014 test period.

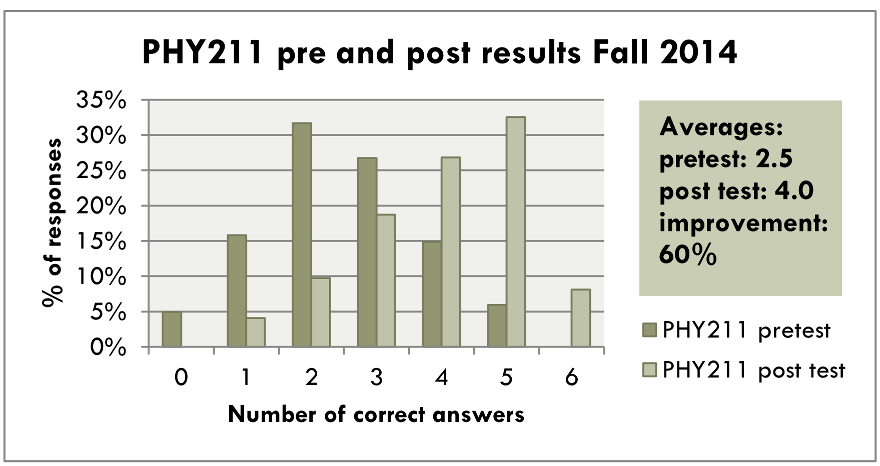


Fig 2.5: Pre and post test results for PHY211 in the 2014 test period.

Unlike the results in 2009 where all three classes showed an improvement of between 60% to 70% between the pre-test and post-test scores, the 2014 results showed a much larger variation. As in 2009, the 2014 PHY101 class showed the largest improvement, with a 76% improvement between the pre and post test scores. A very pleasing result was that, while 37% of students had zero or one correct response in the pre-test, there were no students who scored zero and only 5% who scored one in the post test.

The PHY201 class showed the weakest improvement (48%) between the pre and post-tests. This was also a decrease compared to the 2009 data where PHY201 students improved by 60% between pre and post-tests. In the 2014 pre-test 60% of students scored zero, one or two out of six. However, this figure did drop dramatically to 37% of students in the post test results. Unfortunately the fraction of PHY201 students who scored 5 or 6 out of 6 in the post test was not as high as in the other two classes (14% versus 28% and 41% for PHY201, PHY101 and PHY211 respectively). This may be a result of the fact that the incoming PHY201 students had weaker preparation but also points to an area that needs improvement. We clearly need to do more research in order to understand why the PHY201 class has a much weaker improvement rate than PHY101 and PHY211 classes.

The PHY211 class had the highest pre-test average score. In our experience these students are more likely to have had some prior Physics experience which is consistent with their higher pre-test scores. In spite of this higher starting level these students still managed to improve on average by 60% from pre to post test, giving them the highest post-test average score of 4.0 out of 6.

It was interesting to compare our 2014 results with our baseline study of 2009/10. The decrease in pretest scores in 2014 indicates that our students are entering our classes with weaker backgrounds. The promising news is that the students' improvement over the course of the term was slightly higher (60% in 2009 vs 64% in 2014). However even with this increased improvement rate, the post test scores were still slightly lower in 2014 than in 2009. This is concerning.

We plan to use these pre and post-tests again in the future in order to monitor our students' progress and to compare with our growing database of results.

B. College Core Outcomes

i. How College Core Outcomes are aligned with Course Outcomes

Below we map Physics Intended Outcomes onto the PCC Core outcomes. The numbers for the Physics Intended Outcomes refer to the numbers outlined at the beginning of Section 2.

Communication

Communicate effectively by determining the purpose, audience and context of communication, and respond to feedback to improve clarity, coherence and effectiveness in workplace, community and academic pursuits.

Physics Intended Outcomes 1, 3 and 6 all address the requirement that students be able to effectively communicate what they have learned in their Physics classes in both technical environments as well as to the general public. Written lab reports in the 200-level classes require students to develop strong technical writing skills which we feel is important preparation for students going to work in technical disciplines.

Community and Environmental Responsibility

Apply scientific, cultural and political perspectives to natural and social systems and use an understanding of social change and social action to address the consequences of local and global human activity.

Physics Intended Outcomes 1, 3 and 7 emphasize that students should understand how Physics fits within wider social and historical contexts. In addition, Toby Dittrich (Physics, Sylvania) offers a community education course on Global Climate Change sponsored in part by the Oregon NASA Space Grant program.

Critical Thinking and Problem Solving

Identify and investigate problems, evaluate information and its sources, and use appropriate methods of reasoning to develop creative and practical solutions to personal, professional and community issues.

Critical thinking and Problem Solving is a ***key skill*** that we seek to develop in Physics. This outcome is essentially addressed in all of our outcomes but most specifically in Physics Intended Outcomes 2, 4 and 5. Constant work on complex homework problems as well as dealing with more real world, less clearly defined problems encountered during lab experiments gives students exposure to many different problem solving skills. All courses strongly emphasize developing a process for solving problems. Physics questions the very nature of everything in our universe and requires students of the subject to think critically about every aspect of our world.

Cultural Awareness

Use an understanding of the variations in human culture, perspectives and forms of expression to constructively address issues that arise out of cultural differences in the workplace and community

The Physics SAC has decided that the limited amount of cultural material in our physics classes does not allow us to address this outcome in any meaningful way. However, it is partially addressed in Physics Intended Outcomes 1 and 7. An appreciation of the history of Physics places the science in a wider social context. For example, the historical interaction between physical sciences and religion brings up many cultural issues.

Professional Competence

Demonstrate and apply the knowledge, skills and attitudes necessary to enter and succeed in a defined profession or advanced academic program

All of our intended outcomes address issues of professional competence but Physics Intended Outcomes 3, 6 and 8 specifically call for the demonstration of professional conduct.

Self-Reflection

Assess, examine and reflect on one's own academic skill, professional competence and personal beliefs and how these impact others.

Again, all our outcomes broadly cover this self-reflection outcome. Physics Intended Outcome 3 requires students to process the concepts they learn and then re-apply them to the more complex problems they are faced with in the real world. Outcome 5 requires students to setup experiments, gather data, analyze the data and reflect on how the results relate to physical principles. Several of the Physics Intended Outcomes require students to reflect on what they have learned and place this new knowledge within the context of history and the world around us.

ii. Core Outcomes Mapping Matrix

Below is our updated mapping matrix. The key is shown below the table.

Course #	Course Name	CO1	CO2	CO3	CO4	CO5	CO6
PHY 101	Fundamentals of Physics 1	3 */**	2 *	4 */**	0	2 *	2 *
PHY 102	Fundamentals of Physics 2	3 */**	2 *	4 */**	0	2 *	2 *
PHY 103	Fundamentals of Physics 3	3 */**	2 *	4 */**	0	2 *	2 *
PHY 201	General Physics	4 */**	2 *	4 */**	0	3 */**	1 *
PHY 202	General Physics	4 */**	2 *	4 */**	0	3 */**	1 *
PHY 203	General Physics	4 */**	2 *	4 */**	0	3 */**	1 *
PHY 211	General Physics (calculus)	4 */**	2 *	4 */**	0	4 */**	1 *
PHY 212	General Physics (calculus)	4 */**	2 *	4 */**	0	4 */**	1 *
PHY 213	General Physics (calculus)	4 */**	2 *	4 */**	0	4 */**	1 *

Core Outcomes key:

1. Communication.
2. Community and Environmental Responsibility.
3. Critical Thinking and Problem Solving.
4. Cultural Awareness.
5. Professional Competence.
6. Self-Reflection.

Mapping Level Indicators:

0: Not Applicable.
1: Limited demonstration or application of knowledge and skills.
2: Basic demonstration and application of knowledge and skills.
3: Demonstrated comprehension and is able to apply essential knowledge and skills.
4: Demonstrates thorough, effective and/or sophisticated application of knowledge and skills.

* A single asterisk indicates courses in which these outcomes have been intentionally assessed as part of the SACs annual assessment work.

** A double asterisk indicates courses in which these outcomes are expected to be a part of every faculty member's routine student evaluation/grading.

*/** indicates courses in which both apply.

C. Assessment of College Core Outcomes

The Physics SAC has completed one full round of Learning Assessment Council (LAC) Outcome assessments and this academic year we begin our first re-assessment cycle. As mentioned previously (in Section 2Bi above) we assess all the Core Outcomes with the exception of Cultural Awareness. What follows is brief summary of the methodologies used and the results we obtained. For a more detailed look at our work on this please see Appendix A which includes the full reports submitted to the LAC each year.

i. Assessment Design and Process

Communication

This outcome was assessed in 2010/2011. Two instructors evaluated five separate classes (PHY 201, PHY 202, PHY 203, and two PHY 101 classes). The 200 level courses were evaluated by collecting written lab reports. The 100 level courses were evaluated by collecting answers to conceptual homework problems. In each case, the assessment was evaluated using an appropriate rubric (see Appendix A for details).

Community and Environmental Responsibility

The Physics SAC assessed Environmental Awareness in 2012/2013 by developing a survey of student environmental awareness and how participation in physics courses has influenced that awareness. An online environmental awareness survey was created by the SAC using Survey Monkey and consisted of 10 multi-part questions. The questions developed for the survey were focused on the following:

- Which physics course were they currently enrolled and at which campus?
- A series of ranked questions inquired whether participation in the course had:
  1. Developed new awareness of previously unknown (to student) environmental issues?
  2. Improved breadth of understanding of environmental issues, both global and local?
  3. Influenced student's previously held understanding and opinions on specific environmental issues?
- A ranked question was also developed to inquire how students felt regarding the effectiveness of the laboratory component in providing effective tools to evaluate and assess environmental data.
- Respondents were also requested to share their opinions as to how the course might be improved to further improve their sense of environmental awareness.
- Lastly, the respondents were asked about how previous physics courses they may have taken, either at PCC or elsewhere, had influenced their environmental awareness perspectives.

The URL to the Survey Monkey questionnaire was distributed to all SAC members across the district and faculty members were requested to encourage their students to respond to the survey. Completed survey responses were received from students from all PCC campuses, representing all physics courses offered during the 2013 winter term. Survey responses were analyzed and summarized using Survey Monkey

Critical Thinking and Problem Solving

This was the first outcome to be assessed by our SAC and was assessed in 2009/2010. In order to demonstrate the improvement in student performance we designed and administered a simple test consisting of 6 questions that covered the key topics taught during the first course in all of our Physics series. We have three major series, each of which begins with a course in mechanics (description of motion, forces and

Newton's Laws of Motion, momentum, energy and rotational motion). The test is included in the full LAC report in Appendix A.

Professional Competence

We chose to assess Professional Competence in 2009/10 by polling our students to see what they had learned in their Physics courses that would be useful in their profession. Three instructors evaluated five separate classes (PHY 101, PHY 201, PHY 202, PHY 211, and PHY 212). These courses were evaluated by asking students for written answers to the following question at the beginning of the term, and then again at the end of the term:

"How do you think studying physics will help you in your professional life?"

The end-of-term answers were compared and contrasted with the beginning-of-term answers for detail and breadth. Ideally, it was hoped that students would go from perceiving the course as simply a requirement for their degree, to seeing it as containing valuable and relevant information directly related to their profession. The results were quantitatively judged by comparing the number of responses citing the course as a requirement vs. the number of responses citing specific course topics that related to a student's particular field.

Self-Reflection

Our self-reflection assessment took place in 2013/14. We looked at student study habits and their own assessment of what went well, or what went wrong, after a midterm exam. Each student did a pre and post exam reflection. We used a mix of paper and online surveys. The aspect we chose to focus on this year was how students assess their own study habits and skills before taking their exams. The SAC felt this was important because over the last 5 years or so we have collectively noticed that students sometimes are disengaged from their classes. In speaking with faculty in other departments we have realized that this is a common theme. Many students have very full lives with jobs, families and school. It became clear to us that many students were doing too much and that this made succeeding in their classes very difficult, especially in time intensive science classes. We wanted to see if students were aware of this and what they were doing to cope.

ii. Summary of Assessment Results

Communication

The improvement in evaluated lab reports was significant with 73% of students receiving perfect scores on the lab report rubric scoring by the end of the term compared to 44% at the beginning of the term. Perhaps the most notable improvement was the decrease in students who went from scores of 2 or below on the rubric at the beginning of the term (32%) to those receiving scores of 2 or below at the end of the term (7%). As far as scoring the individual lab components, the most improvement was seen in the writing of conclusions, and the least improvement was seen in describing experimental procedures.

The results for Conceptual Homework Questions also showed significant improvement. However, only about half of the students were achieving perfect scores by the end of the term. A notable improvement was the decrease in students who went from scores of 2 or below on the rubric at the beginning of the term (43%) to those receiving scores of 2 or below at the end of the term (16%). As far as scoring individual components, the most improvement was seen in students' presentation of the reasoning they used in arriving at an answer, and the least improvement was seen in providing correct and complete answers.

Community and Environmental Responsibility

Greater than 50% of all student respondents indicated that by taking their current physics course they gained a significant increase (ranked score of 3 or greater out of 5) in their awareness and breadth of understanding of environmental issues. Predictably, students attending 100-level physics courses indicated the largest number of 3 or greater scores.

Only 43% of all student respondents indicated that their previous environmental opinions were significantly influenced (ranked score of 3 or greater) by taking their current physics course (question 3). Notably, for students taking a 100-level physics course, this percentage is 92%.

A total of 88% of all student respondents indicated that participation in the laboratory activities for their current physics course provided significantly more techniques with which to effectively evaluate environmental data.

Of the 30 students that offered examples, roughly 90% provided in-class or in-lab suggestions, 73% made outside of class/lab suggestions. Review of the specific responses implied that the vast majority of the students felt in-class and in-lab class content, such as more “real-life” examples and labs focused more specifically on an environmental issue, would improve their understanding and awareness of environmental issues.

Critical Thinking and Problem Solving

The test was administered at the beginning of the quarter (pre-test) to 315 students across the district in PHY101, PHY201 and PHY211 classes during Fall 2009 and Winter 2010 quarters. The same test was then administered at the end of the quarter (post-test) to a total of 203 students. The results of our pre and post mechanics test analysis were significant. The average score on the pre-tests was 2.4 out of 6. This score improved by 60% to 3.8 out of 6 in our post-tests. For more detail on these results please see the LAC report in Appendix A as well as section 2A which includes the data from our most recent administration of this test in Fall 2014.

Professional Competence

For the 128 students polled and asked to answer: "How do you think studying physics will help you in your professional life?" , the results are summarized in the following table:

	Beginning of Term	End of Term
Percentage of students citing their Physics course as a requirement*	78%	51%
Percentage of students citing specific topics within the course related to their field*	33%	69%

*Note that percentages do not necessarily total 100% since some students mentioned both or neither aspects.

The results were pleasantly surprising, considering that more than twice as many students mentioned specific course topics in their end-of-term answers. Although many students still referred to the course as a requirement, they were far more likely to include information on specific course topics in their responses. The results of this type of survey cannot fully be expressed by numbers alone. Several examples of student comments can be found in the full report in Appendix A.

Self-Reflection

Here are some key results from each of the pre and post self-reflection surveys conducted in our Self-Reflection assessment.

Pre Exam reflections: Students studied mostly alone (89.0%) and while the majority studied at least 2 days before the exam (73.8%) an alarming number still try to cram everything into one session before the exam (18.3%).

Post Exam reflections: The number one reason for success listed by the students who did well (Regularly attended lecture and lab sessions, 92.5%) does not appear in the top four reasons for those who did not do well. In fact only 5.6% of those unhappy with their results thought that not regularly attending lecture might have prevented them from succeeding. Doing and understanding the homework was the third most popular reason students who succeeded sited while again only 5.6% of those who did not do well thought that this was an issue.

iii. Changes made as a result of our assessments

Communication
It was suggested that in order to help students answer homework questions correctly, more in-class examples should be presented. A significant number of these examples should not simply be solved for the class by the instructor, but instead first be attempted by students in class in order to engage them in the process. As a SAC we have encouraged instructors to improve the quantity and quality of examples done in class.

Community and Environmental Responsibility
The Physics SAC adopted the following guidelines for all physics courses taught at PCC:

- Physics SAC does not, and individual physics instructors should not, in any way promote a specific environmental bias in the classroom or lab.
- Overtly promoting an instructor's personal opinions/philosophies on environmental issues and politics under the guise of objective science is highly discouraged.
- The role of physics instructors at PCC is to appropriately inculcate the application of scientific methodologies, based on accepted modern scientific approaches, to effectively analyze, evaluate and critique data used to support or disprove presented environmental models and claims.
- To the extent that the discipline of physics is a vehicle for the establishment of student environmental awareness and understanding, this important student learning outcome can and should only be achieved by demonstrating and supporting application ***scientifically based analysis*** to credible environmental data. Teaching students to understand the distinction between what data actually objectively tells us, versus what an individual subjectively wants it to, must be emphasized as well.

Critical Thinking and Problem Solving
The primary goal of this assessment was to see how our students were improving their knowledge and skills during each course and to provide a **benchmark** for us. We used this test again during the 2014/15 academic year so we could compare how our students are improving compared to students 5 years ago. A comparison of these results can be found in Section 2A.

Professional Competence
As a result of this assessment the Physics SAC adopted the following guidelines:

- Physics instructors should continue to integrate more examples involving applications to specific professions to show how relevant Physics is to our everyday lives.
- In addition to offering interdisciplinary examples, instructors should also stay informed as to which PCC degree programs require Physics courses so that we can offer pertinent information and examples in our courses. Currently, these programs include Mechanical Maintenance, Aviation Science, Bioscience, Electronic Engineering, Facilities Maintenance, and Microelectronics.

Self-Reflection
The main area in which we decided that we could make changes to align students who underachieved in exams with students who attained their potential was in the area of instruction of study skills. Overall 18.3% of students listed a cram session as the way they expected to implement their study time. In Physics cramming is close to useless so we need to do a better job explaining to students that this is not an effective way to prepare for their exams. Many of us already address this issue but when we discussed this as a SAC we agreed that we need to explain this to students more clearly. Many of the underachieving students did not realize the importance of regular class attendance and of doing their homework. Again this is an issue we all address but we concluded that we must stress these important steps to success more because some of our students are still not aware of just how important this is.

3. CURRICULAR ISSUES

A. Distance Learning

PHY 101 (Conceptual Physics) has been offered as a Distance Learning hybrid course which utilizes an on-campus weekly lab since 2009. The PHY 101 course material was originally developed by Vicki Schroeder, and adapted for the online platform. In 2010/2011the course was transitioned from the Blackboard platform to the D2L platform. Here are several pieces of valuable information that have been gathered so far from our experience with offering Physics in the DL format:

- Students have readily accepted the hybrid nature of the class and enjoy the face to face lab experience. Furthermore, after interacting online, students enjoy meeting each other face-to-face for the labs.
- The on-campus exams solve the academic integrity issues that many online classes struggle with.
- Because of the combination of both the conceptual and mathematical nature of Physics, explicit online resources with step-by-step solutions to problems are extremely helpful to students.

For the last 4 years we have monitored the success of our DL students as compared to the on-campus PHY101 students. Each Fall quarter Vicki Schroeder teaches both an on-campus PHY101 class as well as the lecture portion of the distance learning class (PHY101DL). In order to compare student success we administer the same exams to both classes. There was some variation year to year between the classes but averaging the on-campus PHY101 and PHY101DL results over the four years shows that there is very little difference in the student success rates. The average grades for each exam were within 3% of each other.

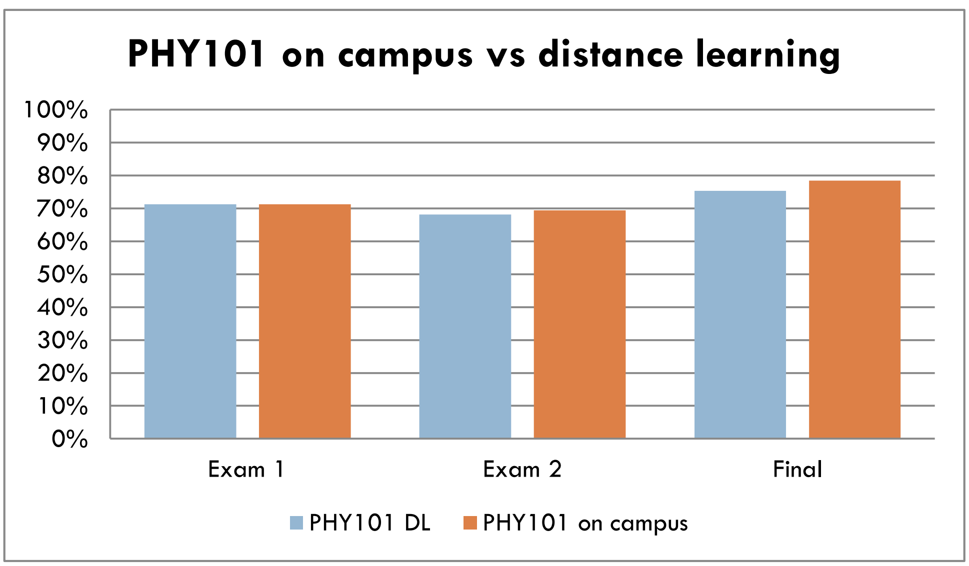


Figure: 3.1: Comparison of PHY101 on-campus and distance learning exam results.

Each exam is made up of two components: the first section has students solving numerical problems and showing all their work while the second section is multiple-choice with a mixture of conceptual and numerical questions. We also compared how students from each group (PHY101 and PHY101DL) did on the multiple choice part versus the problem solving section. As shown in the table below there was once again virtually no difference between how each group did (within 2%) in the four year averaged data.

	PHY101 DL	PHY101 on campus
Exam 1	71%	71%
Exam 1 MC	67%	67%
Avg. Sample Size	17	26
Exam 2	68%	69%
Exam 2 MC	73%	73%
Avg. Sample Size	16	26
Final	75%	78%
Final MC	76%	78%
Avg. Sample Size	16	26

Table 3.1: Detailed exam score comparison for the distance learning class (PHY101DL) and the on-campus PHY101 class averaged over 4 years. For each exam we compare overall score as well as the scores for just the multiple choice (MC) section of the exam. The sample size represents the 4 year averaged class size.

At this point there are no immediate plans to expand our non-astronomy online physics offerings beyond our PHY101 hybrid class. Delivering a significant lab experience "at home" for physics courses is an enormous challenge particularly for the algebra and calculus based classes. To the best of our knowledge there is only one accredited physics course of this type offering an "in home" lab experience (at a private for profit university in New York). The professor teaching this course described the "in home" lab kit that is sold to students (for nearly $1000) to perform this series of labs at a recent physics conference. Even this professor admitted that the lab experience he is offering "at home" students is not of high quality, definitely not sufficiently rigorous to satisfy our faculty. This hurdle must be overcome before an academically acceptable "at home" lab experience can be performed and before a truly distance learning physics course is delivered online at PCC.

Efforts have been undertaken by our Physics SAC members to develop such a lab based on the use of a miniature lab interface device (called informally "The Little Blue Box") which has been created by Dr. Mat Selens of the University of Illinois. He also created the commonly used system called the Classroom Clicker. This device is useful but limited in the number of labs that can be performed with it. Future work will perhaps improve this device by adding additional external input devices. For example, the thermometer is inside of the box which is the size of a pack of cigarettes. It can therefore not be used to measure the temperature inside of a small container, and many thermodynamic experiments require this. By adding an external thermometer probe, this could be accomplished. Many physicists around the country, including our physics faculty are working to further implement the Mini-IO device for distance labs. Perhaps by the next Program review, a true distance lab set of experiments will have been developed. It remains a serious goal of PCC Physics to offer an academically rigorous lab based online general physics set of courses, but this goal today remains elusive.

However, our sequence in Astronomy, Physics 121-122-123, is currently being developed for online delivery beginning with Physics 121 in Fall 2015. Recently, Toby Dittrich received a grant from Oregon NASA Space Grant funding the development of this physics sequence. The grant also hired a two year temporary fulltime astronomy instructor, and at the present time this position is filled by Rod Lee. The plan is to have Mr. Lee trained in online course delivery in Spring term 2015 and he will complete the creation of the online course in Summer 2015. It will be offered for the first time in Fall 2015, and it will have an "in home" set of labs which has been approved by the Physics SAC as academically acceptable. Thus, we will have fulfilled our goals as specified in the grant application to Oregon NASA Space Grant at the end of the two year term of the grant. It is expected that the online astronomy sequence will be very popular and many sections of this course will need to be opened. This will create a need for a permanent additional fulltime position in Physics at the Sylvania campus (moving the temporary fulltime position into a permanent new faculty position).

B. Curricular Changes

The largest curricular change we have made has been the expanded use of Inquiry based learning. The majority of instructors are now using interactive questions during their lectures. Many instructors are using questions developed by Eric Mazur at Harvard (*Peer Instruction: A User's Manual*) as well as writing many of their own questions. In PHY101 Paul Hewitt (author of our required text) also has a large database of conceptual interactive questions.

Rock Creek campus has added a Classroom Response System ("clickers") to their classroom. These are used by students to answer interactive questions during lectures which help to keep students engaged and give them immediate feedback on their understanding of important topics.

C. Dual Credit Courses

We currently offer PHY101and PHY103 as Dual Credit with Liberty High school in Hillsboro. Rock Creek maintains ties with the high school instructor at Liberty High. Laura Fellman recently visited his classroom and did a teaching observation and evaluation.

D. Dual Credit agreements

There are plans to develop a Dual Credit agreement for an Astronomy class. This will be developed by the NASA grant two year temporary astronomy appointee. We would like to expand the PHY101 dual credit offerings. The two largest barriers to this expansion are finding high school instructors that meet the Physics instructor qualifications and finding schools that have sufficient equipment to offer a comparable lab experience for their students. The SAC has talked about exploring the option of writing a grant with local high schools to help them obtain funds for equipment.

E. Course Evaluations

We do not have any specific SAC questions on the Course Evaluations. However, several instructors have utilized the instructor specific questions to help learn more about their classes. For example several Rock Creek instructors have asked students why they chose Rock Creek campus in particular. This helps us understand our demographic better. Other instructor specific questions include things such as rating how useful posted PowerPoint notes are, whether the use of interactive questions have contributed positively to their learning experience, whether the instructor explains concepts well and whether the instructor used enough worked examples during class time.

F. Significant Curricular Changes

Another curricular change has been the expansion of combined lecture-lab classes. This format has been particularly popular for the PHY101 series. Rock Creek campus pioneered splitting the traditional 3 hour class periods into a combined lecture-lab format in which the first half of the class is lecture, followed by a "mini" lab. So instead of a single 3 hour lab the class has two "mini" labs per week. Sylvania campus has recently moved over to this format for their PHY101 classes.

4. STUDENT AND COMMUNITY NEEDS

A. Student demographics

In order to better understand the demographic we serve the PCC Physics program compared our students' ethnic backgrounds and genders with the demographics of the Portland Metro area and the overall PCC student population.

According to the PCC Core Themes our target is to "Reflect the diversity of the area community" with an acceptable result being "within 5% of service area".

We were pleased to find that our students' ethnic backgrounds match that of the Portland Metro area very closely and we feel that we have an acceptable result according to the PCC Core Themes target. Most groups reflect the Metro population very closely with the exception of the Asian/Pacific Islander group (PCC physics population is higher than Metro population) and the White (Non-Hispanic) group (PCC physics population is lower than Metro population).

Ethnicity	PCC Physics	Portland Metro
Multi-racial	**4.4 %**	**3.2 %**
African American	**2.5 %**	**2.7 %**
Asian/ Pacific Islander	**13.4 %**	**6.4 %**
American Indian/Alaska Native	**0.6 %**	**0.7 %**
Hispanic	**9.1 %**	**11.2 %**
White, Non-Hispanic	**70 %**	**75.7 %**

Table 4.1: PCC and Portland Metro demographic data.

We also studied the gender distribution in our physics classes and what we found was somewhat alarming. Women were extremely underrepresented in all of our classes, particularly in our highest level series (PHY211). Table 4.2 below shows the average percentage of female students in each course during the period from 2011 to 2014.

The PHY201 series has the largest proportion of female students although this proportional is still 10% below the general PCC student population. The PHY201 series attracts a higher proportion of students in medical and life science majors which tend to have a higher proportion of female students.

The PHY211 series has a very low proportion of female students at only 16.4%. This series is a prerequisite for engineering and computer science majors. Clearly we have a lot of work to do attracting more female students to this series. This is a project that would have to be undertaken with the engineering and computer science programs because very few of our students are physics majors.

The area in which we can make the most impact is the PHY101 series. This class is typically taken as an elective science class and we clearly need to do a better job marketing this class amongst female students in order to increase the diversity in this class.

Course	Average % Female	Average % Female	PCC overall student body
PHY101	28.1%		
PHY102	29.4%	30.6%	53.7%
PHY103	34.4%		
PHY201	45.8%		
PHY202	41.9%	43.8%	53.7%
PHY203	43.7%		
PHY211	17.6%		
PHY212	15.4%	16.4%	53.7%
PHY213	16.2%		

Table 4.2: Average percentage of female students by Physics course compared with PCC student body between 2011 and 2014.

B. Changes in instruction due to changes in demographics

There have been no significant changes in the demographics of students since the last review. The gender and ethnic distributions in classes have not changed significantly over the last 5 years. In addition our classes continue to have a large mixture of ages ranging from high school students to seniors citizens.

C. Current and predicted enrollment patterns

The Physics program continues to grow robustly. Over the four year period shown our overall growth rate was 34%. This does not include the new physics program at SE campus which has come online during the current 2014/15 academic year which will bolster this number still further. It is likely that the 5 year growth number including SE campus will be comparable to the growth we reported in our last program review (42%) which was over a much longer 9 year period!

Student FTE	2009/10	2013/14	% change
District wide	293.4	394.1	**34%**
Sylvania	129.1	196.7	**52%**
Cascade	74.4	121.9	**64%**
Rock Creek	89.9	75.5	**-16%**

Table 4.3: Physics enrollment (FTE) for the 2009/10 and 2013/14 academic years, both district wide as well as by campus.

As in the last program review Cascade has shown the most overall growth at 64%. This growth was primarily driven by the addition of the PHY121 Astronomy series and strong growth in PHY101 and the PHY201 series. Sylvania saw strong growth in the PHY121 series and moderate growth in the PHY211 series. Rock Creek's enrollment declined primarily due to budget cuts which resulted in a PHY101 class (taught every quarter) and an entire PHY211 series being cut. We hope that with improved budgetary conditions these classes can be added back into the schedule in the near future.

As described in Section 3A, we expect that once the online astronomy sequence (PHY121, 122, 123) is up and running that it will be very popular and that many sections of this course will need to be opened.

We believe that the robust past growth and large projected growth at Cascade and Sylvania campuses creates an urgent demand for **additional new full time faculty members at these two campuses.**

D. Access and diversity

Our PHY101 hybrid class has improved the access to this course for many students who have fulltime jobs. With only one class meeting on campus per week this helps students with busy work schedules and also students with limited transport options. Access will be further expanded by the planned addition of a PHY121-122-123 series Astronomy series in Fall 2015. As noted in Section 3A faculty members are also working on the development of home labs for regular physics classes which is a very challenging task.

Most of our students are taking physics classes because they are pre-requisites for their major. This makes changing the demographics of our students very difficult. As noted earlier in Section 4A our biggest challenge is gender diversity. Our full-time physics faculty at PCC does include two female instructors out of 5 instructors so we are providing female students with role models.

E. Working with Disability Services

The Physics SAC has discussed making PowerPoint notes used in classes accessible. Vicki Schroeder (SAC Chair) has taken the training course for making distance learning documents accessible and has presented the key points from this training to the SAC during a meeting. We have been working on upgrading the PHY101 online class notes to make them accessible. This is an ongoing project. All Physics faculty regularly work with Disability Services to facilitate the needs of our students.

F. Feedback and instructional changes

Changes have been made to our instructional delivery as a result of both student feedback as well as based on the results from research on teaching physics. As discussed in Section 3B we have expanded the use of Inquiry based learning. The majority of instructors are now using interactive questions during their lectures.

Based on student feedback Rock Creek campus pioneered splitting 3 hour class periods into a combined lecture-lab format in which the first half of the class is lecture, followed by a "mini" lab. So instead of a single 3 hour lab the class has two "mini" labs per week. This new format received very positive student feedback.

5. FACULTY: COMPOSITION, QUALIFICATIONS & DEVELOPMENT

A. Faculty composition and needs

i. Quantity and quality of the faculty needed to meet the needs of the program/ discipline.

Physics courses are currently being offered at all four campuses of PCC. As shown in Table 5.1, full-time instructors are currently employed at Sylvania, Rock Creek and Cascade. Sylvania and Rock Creek Campuses each have two full-time Physics instructors, while Cascade still has only one. Aside from the planned hiring of a full-time Physics instructor at the new Southeast Campus, the number of full-time Physics faculty, both district-wide and individually at the other three campuses, has not changed during the last 14 years.

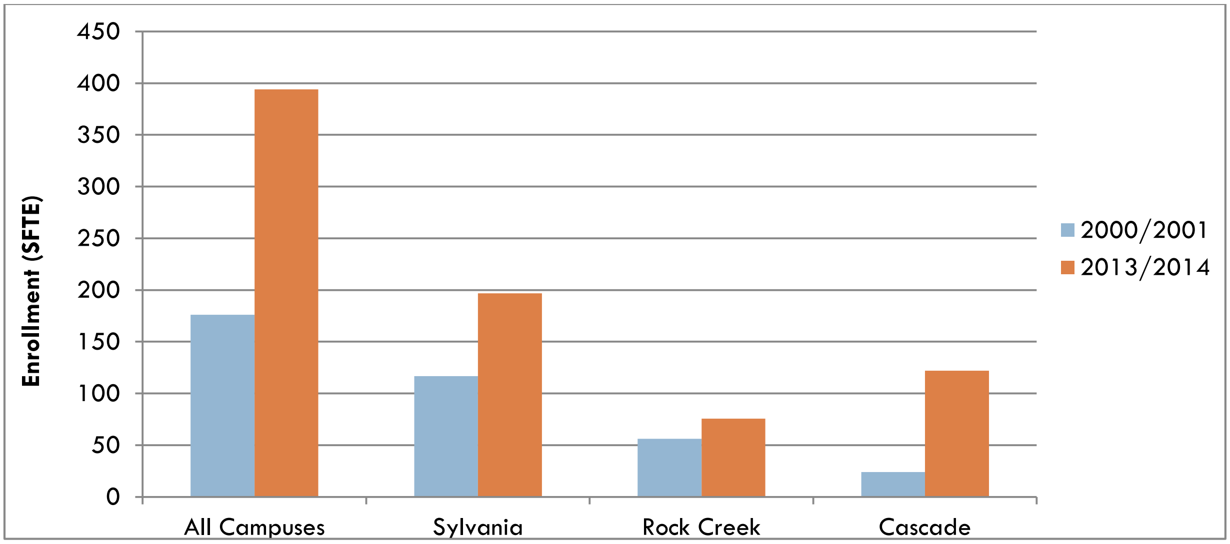
The full-time Physics faculty is comprised of 3 PhDs and 2 Master's Degree recipients. Among these are 2 theoretical physicists and 3 experimentalists. This balance between degree levels and field emphasis has enabled PCC to provide our students diverse perspectives on the field and study of Physics.

			Highest Degree Obtained		
Location	**Total FT Faculty**	**Avg # Years of FT PCC Service**	**PhD**	**MS/MA**	**Other**
Sylvania	2	21	1	1	0
Rock Creek	2	16	1	1	0
Cascade	1	17	1	0	0
District-wide	***5***	***18***	***3***	***2***	***0***

Table 5.1: Physics Full-time faculty distribution by campus, years of service and educational background.

As Physics enrollment continues to rise, additional full-time instructors are needed to meet the increasing demand. Since our last Program Review, enrollment in Physics courses at PCC has increased by 34% while enrollment in Lower Division Transfer courses in general has increased by a more modest 12%. Most notably, during this time period the enrollment in Physics courses at the Cascade Campus has increased by 64%. Considering that Cascade has just one full-time Physics instructor, this highlights the necessity of another full-time position at Cascade.

Since the number of full-time, district-wide Physics faculty has not changed during the past 14 years, it is helpful to look at enrollment data over a longer period of time. Graph 5.1 shows the increase in Physics enrollment (both college-wide and by campus) since the last full-time instructor was hired.



Graph 5.1: Increase in Enrollment (SFTE) since Last Physics Full-Time Faculty Hire.

At the time of our last Program Review, the observed student enrollment growth trends and the inclusion of Physics offerings at Southeast Center underlined the immediate need for new full-time faculty positions at both Cascade and Southeast. We are pleased that a search is underway for a new full-time position at the Southeast Campus, since this faculty member will be instrumental in nurturing the growth and development of the new Physics department, as well as oversee the hiring of future adjunct instructors. However, our primary appeal from the previous Program Review remains unchanged:

- As shown above, Cascade Campus Physics enrollment has continued to grow at a significantly faster pace than Sylvania and Rock Creek. In fact it has increased by over *400%* during the past 14 years. ***The allocation of a single faculty member at Cascade is no longer adequate for the current and future student demand.***

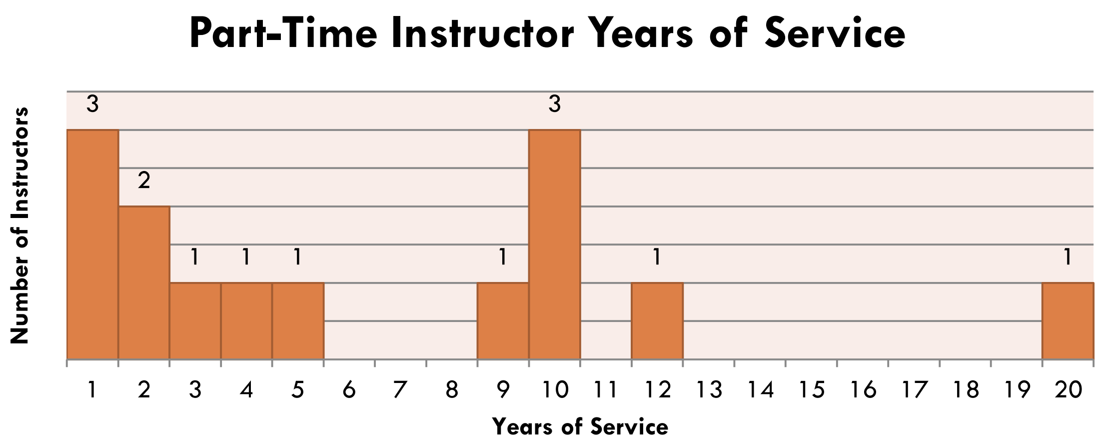
- The campus with the next greatest need for a new full-time Physics position is Sylvania, which has experienced an enrollment increase of 69% during the past 14 years. The most recent full-time faculty hire at Sylvania was 17 years ago, and the ***most recent new Physics position at Sylvania was created 22 years ago.***

In addition to enrollment increases over so many years, the need for new faculty positions arises out of a desire to bring fresh perspectives and new ideas into our Physics departments.

ii. Faculty turnover and changes anticipated in the next five years.

As indicated above, the full-time Physics faculty has consisted of the same five instructors for the last 14 years. Since there has been no full-time faculty turnover, the average length of employment at PCC for these instructors is 18 years. We have been very fortunate to have retained all of these competent physicists.

Given the economic climate of the past several years, the part-time Physics faculty employed by PCC has remained relatively stable as well. Half of the current part-time Physics instructors have been with PCC for at least 5 years, and of those, over 70% have been teaching classes at PCC for 10 years or more (see Graph 5.2 below).

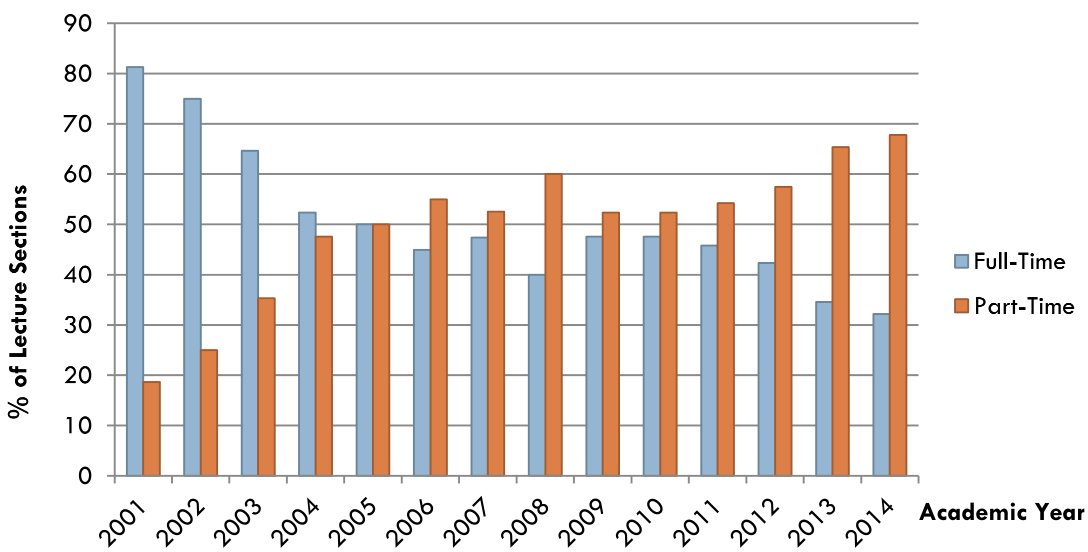


Graph 5.2: Part-time Instructors Years of Service

Over the past few years, PCC has been extremely fortunate to have identified and hired a number of extremely talented Physics educators. These instructors receive great student evaluations and contribute prominently in the activities of the Physics departments on their respective campuses. The Physics SAC is fully supportive of our valuable part-time faculty and their professional development, and would like to see these individuals have the opportunity to compete for full-time employment at PCC. Moreover, as the economic climate improves, academic and high-tech employment will inevitably become more available. Undoubtedly, PCC will lose many of our prized part-time Physics instructors to other academic institutions and/or the private sector. This loss will ultimately be our students' loss.

iii. Part-time faculty reliance and backgrounds

The Physics departments on all campuses rely heavily on the time and efforts of our part-time instructors. The following graph illustrates the increasing percentage of Physics lecture sections being taught by part-time instructors college-wide over the last 14 years.



Graph 5.3: Percentage of Physics Lecture Sections Taught by Full-Time and Part-Time Instructors

Our adjunct faculty is highly dedicated to their students. They have the minimum education level of a Master's Degree in Physics, Engineering or a related field. Many are former private sector engineers and scientists, and bring a wealth of outside the classroom perspective to our students. In summary, our current adjunct faculty is educationally and professionally comparable to their full-time colleagues.

Since the previous graph reflects the percentages of the college as a whole, it should be noted that Cascade currently has the smallest percentage (25%) of Physics lecture sections being taught by a full-time instructor.

The falling percentage of full-time to part-time faculty has meant substantially greater burdens on the full-time faculty to both support the larger number of part-time faculty as well as deal with the ever rising administrative demands on the Physics SAC.

iv. How the faculty composition reflects the diversity and cultural competency goals of the institution.

As illustrated in Tables 5.1 and 5.2, the full-time Physics faculty represents a diverse and balanced collection of academically successful professionals. The district-wide female to male ratio is 2:3.

Although 80% of the faculty composition is technically "white", 50% of those individuals' country of origin is outside the USA. In fact, our group of full-time faculty members includes those of Native American, Asian, Eastern European and African heritage. This distribution reflects a unique academic and cultural diversity that serves our students well.

	Gender		Ethnicity			Country of Origin	
Location	**Male**	**Female**	**White**	**Asian**	**Other**	**USA**	**Other**
Sylvania	2	0	2	0	0	1	1
Rock Creek	0	2	2	0	0	1	1
Cascade	1	0	0	1	0	1	0
District-wide	***3***	***2***	***4***	***1***	***0***	***3***	***2***

Table 5.2: Faculty Composition

B. Changes to instructor qualifications

In February 2014, the Physics instructor qualifications were changed to read as follows:

PHY 101, 102, 103, 201, 202, 203, 211, 212, 213 -- Lecture and Lab

Master's degree in physics OR
Master's degree in related area plus 30 quarter hours graduate credit in physics;

The Physics SAC has established the following disciplines to be considered approved "related areas":

- Engineering (civil, mechanical, electrical, chemical, etc.)
- Math or any science other than physics
- Math education
- Physics (or other science) education
- Secondary science education

PHY 121, 122, 123 -- Lecture and Lab

Master's Degree in any one of the following subject areas: Astronomy, Physics, Science Education, Earth/Space Sciences, Planetary Sciences, Secondary School Science Education, Geology; OR

Bachelor's Degree in any one of the above subject areas PLUS 30 graduate hours in astronomy, earth/space sciences, planetary sciences, physics, general science, or any combination thereof; OR

Bachelor's Degree in any one of the above subject areas PLUS a background in astronomy as demonstrated by academic coursework, teaching experience, "industrial" (non-teaching) experience, research, grants, professional experience, or any combination thereof.

Provisional Approval

PHY 101, 102, 103, 201, 202, 203, 211, 212, 213-- Lecture and Lab

For an individual who does not currently meet the necessary Instructor Qualification Requirements, the following criteria are considered acceptable for consideration of Provisional Approval to teach physics courses:

- Currently in good standing in a graduate degree program in Physics, or in a Physics-related field *(see Instructor Qualifications Requirements above for the list of SAC-approved Physics-related programs)* AND
- Is within 1 year of completing the graduate degree program, as verified by candidate's graduate advisor; AND
- Has already earned at least 30 graduate credit hours in Physics course work.

The instructor qualifications were changed only because a prior clerical error had erroneously removed the qualifications for PHY 101, 102, 103, 201, 202, 203, 211, 212 & 213 when an update was made to the instructor qualifications for PHY 121, 122 & 123.

C. Professional development activities

Both full-time and part-time members of the Physics SAC engage in professional development activities in order to stay current in our discipline, to maintain excellence in teaching, and to serve the community at large. Below are several examples of the professional development activities undertaken by our Physics Faculty since our last Program Review.

Professional Associations, Conferences, Workshops and Trainings

- Membership, Leadership Positions, and Presentations for organizations such as AAPT (American Association of Physics Teachers), PNACP (Pacific Northwest Association for College Physics), and Oregon NASA Space Grant Consortium
- Participation in Teaching Excellence Workshops presented by the CAE (Center for Astronomy Education) in Seattle
- Attendance of PCC's annual Anderson Conference with a focus on collaborating with Chemistry and Math instructors to show students the overlap between various STEM subjects
- PCC Desire2Learn Online Instructor Training, in addition to Distance Learning Accessibility Training

Mentoring and Community Outreach

- Mentoring students in the UCORE program (Undergraduate Catalytic Outreach & Research Experiences) in association with the University of Oregon
- Engaging students from around the world in glaciological research through the Juneau Icefield Research Project (JIRP) in Alaska each summer
- Participating in the annual Hermanas (sisters) conference designed to attract high school Latinas to careers in science, technology, engineering and math
- Coordinating summer star parties at Timberline Lodge (public astronomy viewing sessions with telescopes, usually attended by several hundred people)
- Presenting lectures and workshops at local grade schools, high schools, and community events
- Participating in the annual SMILE workshops which introduce underrepresented and educationally underserved 4th and 5th grade students to STEM subjects
- Volunteering to be judges at many local and state science fairs
- Working with OMSI and OPT (telescope supplier) to organize the national and international educational response to the upcoming American Eclipse of the Millenium (August 21, 2017)

Research and Publications

In addition to serving on editorial boards of peer reviewed journals, members of the Physics SAC are actively involved in scientific research. The following is a list of papers published since our last program review, in which PCC faculty have authorship:

- W. Dittrich. *Drop Tower Physics*. The Physics Teacher. vol. 52, 415-417, (2014)
- R. Drosd, L. Minkin, A.S.Shapovalov. *Interference and the Law of Energy Conservation*. The Physics Teacher. vol. 52, 428-430, (2014).
- W. Dittrich, L. Minkin, A.S. Shapovalov. *Mechanical Parametric Oscillations and waves*. The Physics Teacher. vol. 51, 163-165, (2013).
- W. Dittrich, L. Minkin, A.S. Shapovalov. *Measuring the Specific Heat of Metals by Cooling*. The Physics Teacher. vol. 48, 531-533, (2010).
- A.S.Shapovalov, L.M.Minkin, S.A.Shapovalov. *About one coefficient of the collective transformation of noises of the multidiode microwave oscillator*. J.Appl. Physics. *20*, 35-38, (2013)
- A.S.Shapovalov, L.M.Minkin, S.A.Shapovalov. *Spectral analysis of frequency fluctuations of the collective transformation coefficient of multidiode microwave generator*. J.Appl. Physics. ***19***, 44-48, (2012)
- A.S.Shapovalov, L.M.Minkin, S.A.Shapovalov. *Spectrum analysis of transformation of amplitude and amplitude-frequency modulation fluctuations of multidiode microwave generator*. J.Appl. Physics. ***18***, 29-33, (2011)
- A.S.Shapovalov, B.B.Mashnikov, L.M.Minkin, S.A...Shapovalov. *Coefficients of Transformation of Fluctuations of a Multidiode Microwave Generator*. J.Appl. Physics. ***17***, 33-38, (2010)

6. FACILITIES AND SUPPORT

A. Impact of classroom space and technology and laboratory space and equipment on student success

Since the 2010 Physics Program Review, the Physics departments across the district have undergone numerous updates to existing facilities and support personnel. The significant facility improvements have been updates and additions to physics lab equipment. These lab improvements have significantly and positively impacted the physics learning environment for students at each of the campuses, respectively. Moreover, our improved lab equipment has resulted in increased and more direct opportunities for students to engage in hands-on learning of physics concepts. Therefore, the improvements to Physics facilities across the district have had a positive impact on student success. In addition, the establishment of a Physics program at Southeast Campus has both significantly increased our capacity to serve our students and provided a locus for the study of physics in SE Portland, which has been a traditionally underserved region in the district.

Classroom space & Technology

Since the 2010 Physics Program Review, there have been no significant changes or increases in the classroom teaching space at the Cascade, Rock Creek and Sylvania Campuses, respectively. However, the latter two campuses have received updated classroom presentation equipment. Rock Creek Campus has added a Classroom Response System, i.e. student clickers, to their existing equipment whereas the Sylvania Campus now has a new overhead camera display system. However, the most significant improvement to classroom facilities has occurred at Southeast Campus, which now has a new physics classroom, equipped with complete A/V presentation equipment and internet access.

The lecture rooms and lab space required for the PCC Physics program are integrally linked to the educational philosophy regarding class size and growth in both the Physics program and other sciences. As previously presented in the 2010 Physics Program Review, the inconsistency of class size between the Sylvania Campus and all of the other campuses remains in place and continues to be a concern to the Physics SAC. Physics classes at Sylvania continue to be regularly offered with class sizes (maximum) of 48 students. In contrast, all Physics classes offered at Cascade and Rock Creek campuses allow no more than a maximum class size of 24 to 28 students. The latter is consistent with the class size recommendations by the American Association of Physics Teachers and the American Physical Society, based on nation-wide institutional data suggesting that Physics class sizes no larger than 25 to 30 students improve learning, retention and success.

Therefore, it is the Physics SAC's intention to **once again** bring this matter to the attention of the PCC Administration. The Physics SAC will continue to do so until this situation is recognized, addressed and ultimately rectified by Administration.

Laboratory space and equipment

All of the campuses across the district have updated their laboratory facilities, to various extents, and have all acquired new physics lab equipment to improve their respective lab offerings as well as to further our physics students' learning experience. Most significantly is the construction of the new physics lab and classroom at Southeast Campus and the purchase of all new lab equipment to get the new lab fully operational to begin the 2014-2015 academic year. In addition, both Cascade and Rock Creek Campuses have also updated older existing lab equipment. A summary of Physics Lab updates since 2010 (by campus) is provided below.

Cascade Campus:

- New lab equipment
- Updated lab equipment
- Updated lab computers

Rock Creek Campus:

- Updated classroom presentation equipment
- New lab equipment
- Updated lab equipment

Southeast Campus:

- New and/or additional classroom(s)
- New and/or additional physics lab(s)
- New lab equipment
- New lab computers

The Southeast Campus expansion and construction of 2 new physics labs has significantly increased PCC's capacity to serve our students. Both labs have been designed to be interdisciplinary-use teaching spaces, Physics/Engineering and Physical Science/Astronomy, respectively. Both new labs feature six 4-student work stations and are fully equipped with laptop computers and Vernier-based computer data acquisition technology. These Physics labs appear to be sufficient to accommodate existing and future expansion of the Physics program at SE Campus.

Sylvania Campus:

- New computer-based lab equipment
- New lab computers
- New and/or updated lab A/V equipment

Since 2010, the Sylvania Campus has received new Physics lab computers, with internet access, and upgraded its Physics equipment to new PASCO-based computer data acquisition technology, similar to the technology in use at Cascade and Rock Creek Campuses. In addition, through IIP funding, the Sylvania faculty have also rewritten their Physics Lab Manuals, adapting this new technology to most of their Physics lab materials and course outcomes.

Student impacts

The positive impacts associated with the establishment of computer-based data acquisition technology for Physics labs at all campuses and the adaptation of pre-computer based Physics lab materials to this technology cannot be overstated. At this time, Physics students across the district enjoy comparable laboratory learning environments utilizing the most up-to-date research-based educational lab technology. Computer-based data acquisition technology provides more direct and immediate observation of physical data and corresponding graphical representation, where applicable. In addition, this equipment allows for performing video motion analysis of data which is quite compelling. Published Physics Education Research (PER) reports have identified many benefits toward student learning can be achieved using this type of technology.

Although observations of student success in current PCC Physics labs have not been scientifically quantified, it has been consistently observed at each campus and across all levels of PCC Physics course offerings that our students favor using computer-based technology in the labs versus the more traditional approaches used in the past. Students appear to be more engaged in their lab work, more involved as lab teams and more directly connected with their learning outcomes. Moreover, our students' abilities to make both observations and perform measurements are more efficient and reliable using computer-based technology, resulting in higher levels of confidence in the Physics labs, as well. Our observations at PCC, albeit anecdotal, are highly consistent with the national consensus within the Higher Education community that student-centered computer-based data acquisition technology has a significantly positive impact on student learning and success in Physics lab courses.

B. Students use of library and other information resources.

There is no uniform districtwide policy for student use of library or outside-the-classroom information resources in Physics courses at PCC. However, most of our Physics faculty, part-timers as well as full-time instructors, are encouraged to and do utilize web portals such as MyPCC and D2L to organize and provide Physics course materials for PCC students. In addition, our Physics faculty encourage the use of credible and well-vetted internet sources for obtaining reliable and credible scientific information, whether that information is obtained for Physics-related assignments or otherwise unrelated usage.

C. Clerical, technical, administrative and/or tutoring support

The ability of Physics faculty to provide a topnotch educational environment for our students and the quality of our students' learning outcomes in the laboratory is strongly reinforced when effective lab support resources are available. At each of the respective PCC campuses, the Physics programs have been fortunate to have excellent lab support. Cascade, Rock Creek and Southeast Campuses all have at least one designated lab support technician with a net time allocation of at least 5 hours per week. The exception is Sylvania campus, which has a lab support technician that is responsible for multiple science departments and is not specifically assigned to Physics labs. Moreover, both Cascade and Rock Creek campuses also have regular work-study students that also assist with Physics lab support. The Physics SAC has been pleased with the commitment of Administration to provide Physics Lab Support.

Campus	# of Lab Support Techs	Hours Budgeted	Student Help
Cascade	1	5-10 hrs	Yes
Rock Creek	2	5-10 hrs	Yes
Southeast	1	>10 hrs	No
Sylvania	1	N/A	No

Table 6.1: Physics Lab Support Staff Summary (by campus)

A key resource for Physics students at PCC is the Campus Tutor Center. The Campus Tutor Center at the Cascade, Rock Creek and Southeast campuses, respectively, communicates with its campus Physics Program on a regular basis to assess student needs. Each campus has at least one designated (non-faculty) Physics tutor available for students at its Campus Tutor Center. All campuses offer Physics tutoring at least 2 days a week. In addition, Cascade and Sylvania faculty also participate in Physics tutoring at the Tutor Centers. A summary of the Physics Tutor resources by campus shown in the following table:

Campus	# Tutors	Days (per week)	Hours (per week)	Evenings	Weekend	Faculty Tutor Participation
Cascade	1	3	5-10	No	No	Yes
Rock Creek	>3	>3	>10	Yes	Yes	No
Southeast	1	2	0-5	No	No	No
Sylvania	1	>3	5-10	No	No	Yes

Table 6.2: Physics Tutor Support Summary (by campus)

D. Impact of Advising, Counseling, Disability Services and other student services on students

We have worked closely with Disability Services providing feedback on systems such as exam scheduling. These systems have improved a lot over the time period of this review particularly the use of electronic contracts and being able to upload exams electronically to a centralized system, allowing students to take their exams on any campus.

We have worked with advising to promote physics classes particularly the PHY101/102/103 series which have only the general education math and writing prerequisites. This has helped both our enrollment in these classes as well as many students who had not considered taking physics.

E. Patterns of scheduling in the program and the needs of students

At the present time, the primary modality of physics course offerings at PCC is the traditional lecture and lab format. At Cascade and Rock Creek Campus, lecture and lab sessions are taught in their respective Physics Labs. At these campuses, the physics labs have been designed to be multipurpose, serving both lecture and lab needs. The flexibility of these physics learning spaces has been highly successful, allowing Physics instructors to arrange their course materials for both lecture and lab sessions in a more integrated format, where distinctions between lecture and lab experience is less delineated. The downside to this format is the scheduling constraints of using the Physics Labs for both lecture and lab sessions, effectively limiting the overall number of Physics courses that can be offered at these campuses. At Sylvania and Southeast Campus, lecture and labs are taught in different teaching spaces, to accommodate larger numbers of students in lecture than lab.

The Physics SAC has consistently offered physics courses that attempt to meet the needs of our students, including evening and weekend class sections, in addition to traditional morning and afternoon time slots. During the Fall-Winter-Spring quarters, lecture classes are typically scheduled with meeting times either once a week or twice a week. For once a week sections, the classes are held in 3-hour time blocks for 4 credit hour courses or 4-hour blocks for 5 credit hour courses. For twice weekly course sections, the classes are held in in two 1.5-hour time blocks for 4 credit hour courses or two 2-hour blocks for 5 credit hour courses. For both class schedules, lab sessions are 3-hours per week and offered during a separate time block on a separate day, with the exception of weekend class sections where lecture is scheduled as a single 3-hour or 4-hour time block followed by a 3-hour laboratory session with a lunch break in between.

Regarding class sizes, in spite of the fact that in previous Program Reviews, as well as specific recommendations to the Administration from the Physics SAC that Physics classes be no larger than 24 to 28 students, as stated above, attempts convince the Sylvania Administration to comply with this recommendation have been unsuccessful. This large class size puts additional stress on classroom and lab space at Sylvania, and provides a disadvantage to students in Physics courses at Sylvania through overcrowding. This overcrowding is made more severe when the growth of all other sciences utilizing the facilities forces the use of the Physics lab at Sylvania for other programs for both lecture and lab. Moreover, the large class sizes compromise the ability of the Physics Instructor to effectively engage with students on a more direct, one-on-one, level.

8. RECOMMENDATIONS

1. New Faculty

Due to the tremendous enrollment growth at both Cascade and Sylvania we propose that **two new full-time faculty positions** in Physics be added as soon as possible, one for each of the above mentioned campuses.

2. Class size

A key strength of Physics at PCC is the small size of ***most*** of our courses. This is an advantage for students in that it is a primary factor in both student success and retention. Class limits of 24 - 28 allow for the pairing of lecture and lab sections under a single instructor, which follows the recommendation of the American Association of Physics Teachers (AAPT). As proposed in our last program review, it would be best if ***all*** Physics courses at PCC were offered in this manner. Therefore we again stress that **class size limits should be set at 24-28 students at all campuses** including Sylvania which still offers much larger sections and has lectures and labs taught by different instructors.

3. Distance Learning

We currently offer a successful hybrid PHY101 class and will soon be expanding our distance learning offerings to include the PHY121/122/123 Astronomy series. We ask for support and funding to help us perform research into the development of affordable physics labs that could potentially be done at home while still offering the same quality experience that students get in their on-campus labs.

4. Gender Inequality

We ask for suggestions and support from the administration to assist us in finding ways to address the difficult problem of increasing the number of female students in our physics classes, particularly in the calculus based series.

APPENDIX A

This Appendix contains the Learning Assessment Council reports submitted by the Physics Program during the past 5 years. The first page of each report is displayed. Please double click on the inserted page to open the embedded PDF file. This will open the full report in Adobe Acrobat.

1. Critical Thinking and Problem Solving Report (2010)

2. Communication and Professional Competence Report (2011)

3. Community and Environmental Responsibility Report (2013)

4. Self-Reflection Report (2014)

1. Critical Thinking and Problem Solving

Physics Learning Assessment Project Results

Contact: Laura Fellman lfellman@pcc.edu

1.1. Meeting core outcomes

1.1.1. Knowledge and critical thinking assessment

In order to demonstrate the improvement in student performance we designed and administered a simple test consisting of 6 questions that covered the key topics taught during the first course in all of our Physics series.

The design criteria were that the test:
1. could be taken by all three series (PHY101, PHY201 and PHY211).
2. should have minimal impact on instruction time.
3. would show whether student knowledge and problem solving abilities improved as a result of attending their Physics classes at PCC.

The nationally administered Force Concept Test and the Mechanics Baseline Test offered the opportunity to compare with national data bases but did not meet the first two criteria for our tests. As a result we decided to design our own test which covered key topics in mechanics. The test is included in Appendix A.

The tests were administered at the beginning of the quarter (pre-test) to 315 students across the district in PHY101, PHY201 and PHY211 classes during Fall 2009 and Winter 2010 quarters. The same test was then administered at the end of the quarter (post test) to a total of 203 students.

The results were significant. The average score on the pre-tests was 2.4 out of 6. This score improved by 60% to 3.8 out of 6 in our post tests. The graph below shows the number of respondents who received a particular score. The pretest shows something close to a normal distribution with most students getting 2 or 3 correct answers and only 1.6% of students getting 6 correct answers (all correct). The post test data shows a large improvement. The curve is now clearly skewed towards a higher number of correct responses. No students got all the answers wrong in the post test and 7% of students now had all the answers correct.

2. Communication and Professional Competence

Annual Report for Assessment of Outcomes

SACC: PHY (Physics)

Submitted June 2011

Outcomes Assessed this year: **Communication** and **Professional Competence**

1. **Describe changes that have been implemented towards improving students' attainment of outcomes that resulted from outcome assessments carried out in the previous academic year.**

During the last academic year (2009/2010) The Physics SACC reported on the Critical Thinking Core Outcome. We designed and administered a simple test consisting of six questions that covered the key topics taught during the first course in all of the 3-term Physics sequences. Three of the questions were conceptual in nature, and three required very basic calculations. The tests were administered at the beginning of the quarter (pre-test) to 315 students across the district in PHY 101, PHY 201, and PHY 211. The same test was administered at the end of the quarter (post-test). The results were significant, the average score improving by over 60%. However, several points required further consideration:

- **The PHY 101 students displayed the most improvement of any group on the conceptual questions. This was encouraging since PHY 101 is basically a conceptual Physics course. However, it brought to our attention the need to place greater emphasis on concepts in the other two, more mathematical Physics series (algebra-based and calculus-based).**

- **The conceptual question on rotation was the most frequently missed in the post-test. This led us to make improvements in the manner we approach the subject of rotation with our classes.**

- **The PHY 201 post-test scores were the weakest of any group - 20% of students still answered less than half of the questions correctly. This could be partially accounted for by the fact that the PHY 201 pre-test scores were also the lowest (63% of students answered less than half of the questions correctly). However, this finding resulted in several changes to instructional strategies, and when the post-tests were applied this year, only 9% of students tested in those courses answered less than half of the questions correctly. This is an issue that is still being addressed, and we look forward to even more improvement in the future.**

3. Community and Environmental Responsibility

Annual Report for Assessment of Outcomes

SAC: PHY (Physics)

Submitted June 2013

Outcomes Assessed this year: Environmental Awareness

1. Describe changes that have been implemented towards improving students' attainment of outcomes that resulted from outcome assessments carried out in the previous academic year.

During the academic year (2010/2011), the Physics SAC summarized its Self-Assessment of Learning Outcomes analysis focused on the Critical Thinking Core Outcomes: Communication and Professional Competency. Our analysis of the Communication Core Outcome was performed by the evaluation of students' writing samples from 5 separate physics courses at the beginning and end of an academic term.

For the three math intensive physics courses scrutinized (Phy 201, Phy 202, and Phy 203), student writing samples, in the form of student lab reports, were evaluated according to a rubric developed by the Physics SAC to measure the effectiveness of written communication based on: (1) identification of purpose/objective; (2) effectiveness and appropriate of description of the lab procedures implemented; (3) organization and presentation of collected data, analysis and results; and (4) clarity of summary and conclusions drawn.

Based on our analysis of student lab reports, the following results were obtained:

1. Student written communication exhibited significant improvement, with an average lab report score increase of 25%, based on the rubric.
   a. Average Lab report score *(beginning of term):* 2.92 out of 4
   b. Average Lab report score *(end of term):* 3.64 out of 4
2. Perhaps the most notable improvement was the decrease in writing samples with scores of 2 or below.
   a. % Scores of 2 or below *(start of the term)*: 32%
   b. % Scores of 2 or below *(end of the term)*: 7%
3. The area of most improvement was observed in the writing of effective conclusions
4. The area of least improvement was observed in the description of experimental procedures.

For the two non-math intensive physics courses (both Phy 101 classes), student writing samples, in the form of written answers to conceptual homework problems, were evaluated according to a separate rubric developed to measure effectiveness of written communication based on: (1) explanation of underlying physical concepts involved; (2) accurate description of facts presented; (3) effective description of reasoning and problem solving methodology; and (4) completeness and correctness of final solution.

Based on our analysis of conceptual homework problems, the following results were obtained:

4. Self-Reflection

End-Of-Year (EOY) Report for Assessment of Outcomes LDC 2013-2014

Subject Area Committee Name: Physics

Contact Person

Name	*e-mail*
Vicki Schroeder	vschroed@pcc.edu

Use this form to report the results of your Core Outcome Assessment Projects.

Information and Reminders:

- If you used rubrics/assignments/etc. in this project that were not attached to your Annual Plan for this project, please attach them to this report.
- If you have trouble completing this form, contact your SAC Assessment Coach for additional help. A list of coaches can be found at: http://www.pcc.edu/resources/academic/learning-assessment/sac-resources.html

- **Due: June 20, 2014**; Send to Learning Assessment Council: learningassessment@pcc.edu
- **Subject Line of Email:** End-of-Year Report (or EOY) for <your SAC name> (Example: EOY for MTH)
- **File name:** SACInitials_EOY_2014 (Example: MTH_EOY_2014)

- The End-of-Year (EOY) Report is the last assessment document due this academic year.
- For 2013-2014 a Multi-Year Plan (and Annual Plan) were due January 17, 2014, and the submissions are posted for each SAC under Learning Assessment at the PCC website (http://www.pcc.edu/resources/academic/Assessmentintropage.html). EOY Reports will be posted to the website this summer.
- Information from the EOY Report may be inserted into or summarized in Section 2C of the Program Review Outline.
- SACs are encouraged to share this report with their LAC coach for feedback before submitting.

1

APPENDIX B

This test was used as both a pre and post-test for all our mechanics physics classes.

Please circle the class you are taking and then answer the 6 questions below by circling the letter you think best answers each question.

PHY101 **PHY201** **PHY211**

1. A ball is thrown upward at 30 m/s. If we ignore air drag and assume gravity is 10 m/s^2, the ball will be in the air for:
   (a) 3 seconds
   (b) 6 seconds
   (c) 10 seconds
   (d) 12 seconds

2. Ball A is rolled off the edge of the table while a second ball, Ball B, is simultaneously dropped from the height of the table. Ignore air drag.
   (a) Ball A hits the ground first.
   (b) Ball B hits the ground first.
   (c) Both ball hit the ground at the same time.

3. An object in outer space is accelerated by a 50N force. If a second 50N force acting in the *opposite* direction is then suddenly applied to the object, the object:
   (a) rapidly stops.
   (b) gradually slows down and then stops.
   (c) continues accelerating.
   (d) continues moving at the speed it was going when the second force was applied.
   (e) none of the above.

4. Two train coaches collide. Coach A is 2000 kg and is travelling at 5 m/s and collides with Coach B which is 3000 kg and is at rest. If the two coaches stick together after the collision, what is their combined final speed?
   (a) 1 m/s
   (b) 2 m/s
   (c) 3 m/s
   (d) 5 m/s
   (e) 10 m/s

5. A 2 kg ball is lifted off the ground so that it gains 100J of gravitational potential energy. If the ball is dropped, what is the speed of the ball when it hits the ground? Ignore air drag.
   (a) 2 m/s
   (b) 4 m/s
   (c) 10 m/s
   (d) 20 m/s

6. A hammer is easier to balance upright on your hand when:
   (a) the hammer head is farthest from your hand.
   (b) the hammer head is nearest to your hand.
   (c) makes no difference, same either way.