Student Learning Assessment Report, Academic

Report Year 2022-2023

Program Physics Major

Department Head Michele McColgan

Submitted By

Mark Rosenberry

Previously Submitted Reports

2021-2022 Physics Major

Mission

The Physics Department aims to develop in students a thorough understanding of the laws of physics and their applications. It\r\nfosters an understanding and appreciation of the meaning and significance of the laws of physics and their relevance to students'\r\nlives; the ability to apply the laws of physics to real world situations to solve problems analytically and numerically; to think and\r\nwrite critically; to design experiments and analyze and present data and results; hands-on experience with current research\r\ntechniques employed in physics; critical thinking and investigational curiosity and drive

Assessment

1. Major/Program Student Learning Outcomes

Student will be able to...

1. Conceptual Understanding: Students will understand the fundamental concepts and theories of physics, including the historical development of those theories.

2. Phase

Check all that apply

- [ ] **Planning/ determining procedure**
- [x] **Planning/ Redesigning based on past assessment**
- [x] **Collecting/ analyzing assessment data**
- [x] **Discussing/ using result**
- [x] **Determining if Changes had an Impact on Student Learning**
- [ ] **Objective not assessed this year**

3. Assessment Procedures (Planning/ determining)

Method: (ex. tests, presentations, research paper, describe the assessment course and student sample when it is applicable, etc.)

Students are introduced to this learning outcome throughout the curriculum, as one's knowledge and conceptual understanding of physics, including its historical development, is a life-long process.

Distinct elements of this learning outcome are introduced in required 100-, 200-, 300-, and 400-level courses; reinforced in required 200-, 300-, and 400-level courses; and summatively assessed in three different ways:

First, in our two-semester general physics sequence (PHYS130/PHYS140 and PHYS110/PHYS120) students are given two standardized assessments, the Force Concept Inventory (FCI) and the Electricity & Magnetism Concept Assessment (EMCA), as a pre- and post-test exam at the beginning and end of the fall and spring semesters, respectively. Note that our calculus-based PHYS130/PHYS140 sequence is generally taken by physics, applied physics, chemistry, biochemistry, and mathematics majors, while the algebra-based PHYS110/PHYS120 sequence is taken by biology and other majors interested in the life sciences. We use these data to identify deficiencies or problem areas in the conceptual understanding of introductory-level concepts in physics.

Second, we use the distribution of final course grades in three required upper-level courses, PHYS310 (Mechanics I), PHYS410 (Electromagnetic Theory I), and PHYS440 (Quantum Physics) to assess students' understanding of advanced physics concepts. These courses are taken by all majors in their junior or senior year.

Third and finally, we encourage all graduating seniors to take the Major Field Test (MFT). Department faculty have been developing a preliminary version of this multiple choice exam to be comparable in scope and difficulty to the Graduate Record Examination (GRE) subject test in physics. The goal of the exam is to assess each student's cumulative knowledge and understanding of undergraduate-level physics concepts.

When does assessment occur?

Please see attached pdf

How often does assessment occur?

Please see the accompanying report

Criteria (How do you know students are achieving learning outcome?)

For each of our three assessment instruments, we use the following quantitative criteria:

First, our goal for the FCI and EMCA exams is for more than 75% of students to achieve a score of 60% (18/30) or higher as an assessment of their conceptual understanding of introductory-level physics concepts. Note that this threshold is used in the physics education research (PER) field to indicate Newtonian thinking by a student.

Second, we strive for more than 90% of students to receive a passing grade (C minus or higher) among our required upper-level courses (PHYS310, PHYS410, and PHYS440) as a quantitative metric of whether students are achieving a higher level of conceptual understanding of physics.

4. Assessment Results (Collecting/ analyzing, please identify the samplle size and course number when appropriate)

Please see attached pdf

Learning Outcome Met? (Based on Criteria)

No

5. Use of Results (Discussing/ using results)

Our FCI and EMCA post-test scores show that our students are not achieving our target level of understanding of introductory physics concepts: only 60% of the students in our PHYS130 (all students) courses scored 18/30 or higher (see Table 1: FCI Assessment Results). Similarly, only 23% of students in our PHYS140 courses (respectively) exceeded our target score of 18/30 on the EMCA (Table 2: EMCA Assessment Results).
The department is discussing whether the present EMCA is at an appropriate level for General Physics.

Next, among our upper-level physics courses (see Table 3: Upper-Level Physics: Conceptual Understanding), we just failed to achieve our target of more than 90% of students passing all three of these courses, achieving 87% instead.

6. Determining if changes impacted student learning

Not yet complete

Assessment

1. Major/Program Student Learning Outcomes

Student will be able to...

Students will develop strong analytical skills and facility with mathematical modeling. Furthermore, students will learn to use computers to analyze and visualize data.

2. Phase

Check all that apply

- [x] **Planning/ determining procedure**
- [x] **Planning/ Redesigning based on past assessment**
- [x] **Collecting/ analyzing assessment data**
- [x] **Discussing/ using result**
- [x] **Determining if Changes had an Impact on Student Learning**
- [ ] **Objective not assessed this year**

3. Assessment Procedures (Planning/ determining)

Method: (ex. tests, presentations, research paper, describe the assessment course and student sample when it is applicable, etc.)

Method (ex. tests, presentations, research paper)?

Students are introduced to this learning outcome throughout the curriculum.

Distinct elements of this learning outcome are introduced in required 100-, 200-, 300-, and 400-level courses; reinforced in required 200-, 300-, and 400-level courses; and summatively assessed in two different ways:

First, we use the distribution of final course grades in four required upper-level courses (PHYS250, PHYS310, PHYS410, and PHYS440) to assess students' ability to solve physics problems analytically, and to use computers to analyze and visualize data. These courses are taken by all majors in their sophomore and junior or senior year.

When does assessment occur?

Please see attached pdf

How often does assessment occur?

Please see attached pdf

Criteria (How do you know students are achieving learning outcome?)

Among our upper-level courses (PHYS250, PHYS310, PHYS410, and PHYS440), we strive for more than 90% of students to receive a passing grade (C minus or higher).

4. Assessment Results (Collecting/ analyzing, please identify the samplle size and course number when appropriate)

Please see attached pdf

Learning Outcome Met? (Based on Criteria)

Yes

5. Use of Results (Discussing/ using results)

Among the upper-level courses we use to assess this learning outcome (see Table 4: Upper-Level Physics Courses: Problem Solving), we find that exactly 90% of the students passed.

6. Determining if changes impacted student learning

In the context of discussing assessment with other departments, it is worth noting that last year was the first year that the Math department required the ALEKS exam to place our students in an appropriate math class (Calculus I or PreCalc). This exam was given to freshmen seeking to take Calc I, which is nearly the entire school of Science, and scores are based on national values; please see Dr. Bannon for details.

Only a few years ago, many freshmen physics majors took Calc I their first semester, though a fair fraction went directly into Calculus II, and small number wound up in PreCalc. This year we had virtually no Calc II students and the majority of students taking PreCalc. Although calculus is often glossed over in General Physics, students who start in PreCalc are often unready for later classes that rely on Calc III and Differential Equations (typically taken in the 4th semester). Given that Siena is admitting weaker and weaker students, the School of Science needs to clarify to the administration that a certain level of mathematical preparation is really the foundation of most major sequences.

Assessment

1. Major/Program Student Learning Outcomes

Student will be able to...

Students will demonstrate facility with laboratory equipment and techniques, including computers as acquisition and experimental tools

2. Phase

Check all that apply

- [x] **Planning/ determining procedure**
- [ ] **Planning/ Redesigning based on past assessment**
- [x] **Collecting/ analyzing assessment data**
- [x] **Discussing/ using result**
- [ ] **Determining if Changes had an Impact on Student Learning**

☐ **Objective not assessed this year**

3. Assessment Procedures (Planning/ determining)

Method: (ex. tests, presentations, research paper, describe the assessment course and student sample when it is applicable, etc.)

Lab courses pervade our curriculum, so students are introduced to this learning outcome early and their skills are reinforced in several distinct upper-level courses.

We assess student learning using the distribution of final course grades in four required upper-level courses, SCDV230 (Electronics), PHYS370 (Laboratory Techniques), PHYS380 (Observational Astronomy), and PHYS470 & PHYS472 (Capstone Research I & II). Note that students may take either PHYS370 or PHYS380 in order to fulfill the program requirements, so the students in these courses are independent. Also, PHYS380 is only offered every two years, so we won't have data on this course every year.

In addition, we use the distribution of final course grades in PHYS470 & PHYS472 (Capstone Research I & II), the capstone independent research course, to assess whether students are achieving this learning outcome. Under the guidance of a faculty supervisor, students propose, design, execute, and present (at a local or national meeting or conference) an independent project; they may take one or both of these courses over the span of one or two semesters (but for a minimum of two credits), and this course is taken annually by all physics majors in their senior year.

When does assessment occur?

Please see attached pdf

How often does assessment occur?

Please see attached pdf

Criteria (How do you know students are achieving learning outcome?)

We strive for more than 90% of students to receive a passing grade (C minus or higher) in their upper-level courses and for 100% of students to pass Capstone Research I & II (PHYS470 & PHYS472).

4. Assessment Results (Collecting/ analyzing, please identify the samplle size and course number when appropriate)

Please see attached pdf

Learning Outcome Met? (Based on Criteria)

Yes

5. Use of Results (Discussing/ using results)

We are indeed achieving the target level of experimental competency both based on our upper-level laboratory courses (94.9% students passing versus our target of 90%; see Table 5: Upper-Level Physics Labs: Experimental Competency) and our capstone research sequence (100% of students passing; see Table 7: Capstone Research).

We list in Table 5 both the fraction of students passing the PHYS370 course, and separately the fraction of the same students passing the PHYS370 practical. We note that the fraction of students passing the practical itself is lower than in the broader course. We will discuss department standards for such practicals, and we will be expanding practical reporting to other courses next year.

Last year's common experimental competency rubric for PHYS470 & PHYS472 is also attached separately.

Assessment

1. Major/Program Student Learning Outcomes

Student will be able to...

Students will be able to research and clearly express scientific ideas using oral, visual and written communication.

2. Phase

Check all that apply

☑ **Planning/ determining procedure**

☐ **Planning/ Redesigning based on past assessment**

☑ **Collecting/ analyzing assessment data**

☑ **Discussing/ using result**

☐ **Determining if Changes had an Impact on Student Learning**

☐ **Objective not assessed this year**

3. Assessment Procedures (Planning/ determining)

Method: (ex. tests, presentations, research paper, describe the assessment course and student sample when it is applicable, etc.)

Students are required to write detailed reports in all required laboratory courses, so they are exposed to the key elements of this learning outcome throughout the curriculum.

We assess student learning of this outcome using the distribution of grades in the capstone research sequence, PHYS470 & PHYS472 (Capstone Research I & II).

We shall be requiring a presentation in PHYS310 this coming year, and also we will separately assess presentation and research skills in Capstone research.

When does assessment occur?

Please see attached pdf

How often does assessment occur?

Please see attached pdf

Criteria (How do you know students are achieving learning outcome?)

We strive for 100% of students to pass Capstone Research I & II (PHYS470 & PHYS472).

4. Assessment Results (Collecting/ analyzing, please identify the samplle size and course number when appropriate)

Please see attached pdf

Learning Outcome Met? (Based on Criteria)

Yes

5. Use of Results (Discussing/ using results)

This year we had 100% of students pass our capstone research sequence (see Table 7: Capstone Research).

In the 2021-2022 academic year we deployed a more refined rubric in PHYS470 & PHYS472 in order to assess the Communication Skills portion of our learning outcomes; please see attached documents.

Assessment

1. Major/Program Student Learning Outcomes

Student will be able to...

Students will be able to analyze and interpret experimental data, and assess the statistical significance of results. Students will be able to evaluate the quality of scientific information.

2. Phase

Check all that apply

- [x] **Planning/ determining procedure**
- [ ] **Planning/ Redesigning based on past assessment**
- [x] **Collecting/ analyzing assessment data**
- [x] **Discussing/ using result**
- [ ] **Determining if Changes had an Impact on Student Learning**
- [ ] **Objective not assessed this year**

3. Assessment Procedures (Planning/ determining)

Method: (ex. tests, presentations, research paper, describe the assessment course and student sample when it is applicable, etc.)

This learning outcome is introduced in 100-level courses, reinforced in our upper-level courses, and summatively assessed three different ways:

First, in our two-semester general physics sequence (PHYS130/PHYS140 or PHYS110/PHYS120) students are given the Physics Lab Inventory of Critical thinking (PLIC) standardized assessment, which was developed by the Cornell Physics Education Research Lab. This pre- and post-test exam assesses students' ability to critically evaluate experimental methods, data, and models. The Cornell group performs an analysis of the data and either sends a report to Siena or provides access to a dashboard for further exploration.

In 2019, the department redesigned the PHYS130 labs to be more in line with what the PER (Physics Education Research) community refers to as inquiry-based labs. These labs are less "cookie-cutter" with less explicit instruction and require the students to think about how to design their lab and how to physically construct it. The PHYS110 labs remained as they were. The newer inquiry-based labs used in PHYS130 lead to a greater improvement in the PLIC results than the PHYS110 labs. The numbers are still relatively small (~50 in each group) but encouraging.

Second, we use the distribution of final course grades in our PHYS370 (Laboratory Techniques) and PHYS380 (Observational Astronomy) courses.

And finally, we use the distribution of final course grades in our capstone research sequence, PHYS470 & PHYS472 (Capstone Research I & II).

When does assessment occur?

Please see attached pdf

How often does assessment occur?

Please see attached pdf

Criteria (How do you know students are achieving learning outcome?)

We use three different criteria for each of our assessment procedures.

First, because the PLIC was adopted recently, we are still discussing the appropriate quantitative threshold (if any) for determining whether students are fulfilling this learning outcome satisfactorily.

In addition, we strive for more than 90% of students to receive a passing grade (C minus or higher) in PHYS370 and PHYS380, and for 100% of students to pass Capstone Research I & II (PHYS470 & PHYS472).

4. Assessment Results (Collecting/ analyzing, please identify the samplle size and course number when appropriate)

Please see attached pdf

Learning Outcome Met? (Based on Criteria)

Yes

5. Use of Results (Discussing/ using results)

For the PLIC, you can see in Figure 2 that the middle line representing the median goes up for the post test compared to pre, but the outer lines representing quartiles do not change a lot, indicating that we do not reach some students.

However, based on the fact that 90% of our students passed PHYS370 (see Table 6: Upper-Level Physics Labs: Data Analysis) this past academic year, and that 100% of students passed our capstone research sequence (see Table 7: Capstone Research), we find that we did meet this learning outcome.

Assessment

1. Major/Program Student Learning Outcomes

Student will be able to...

Students will be able to design, plan and conduct an independent research project.

2. Phase

Check all that apply

- [x] **Planning/ determining procedure**
- [ ] **Planning/ Redesigning based on past assessment**
- [x] **Collecting/ analyzing assessment data**

- [x] Discussing/ using result
- [ ] Determining if Changes had an Impact on Student Learning
- [ ] Objective not assessed this year

3. Assessment Procedures (Planning/ determining)

Method: (ex. tests, presentations, research paper, describe the assessment course and student sample when it is applicable, etc.)

Students are introduced to key aspects of the scientific method early in our curriculum, and those ideas are reinforced in sophomore- and junior-level courses. For example, in the second semester of our general physics sequence (PHYS140) students have to design and build a bike generator using their theoretical knowledge of circuits gained in the lecture component of this course.

Nevertheless, we summatively assess student learning of this outcome using the distribution of grades in the PHYS470 & PHYS472 capstone research sequence, with the goal that 100% of students will pass this course.

When does assessment occur?

Please refer to attached pdf

How often does assessment occur?

Please refer to attached pdf

Criteria (How do you know students are achieving learning outcome?)

We strive for 100% of students to pass PHYS470 & PHYS472 (Capstone Research I & II).

4. Assessment Results (Collecting/ analyzing, please identify the samplle size and course number when appropriate)

Please refer to attached pdf

Learning Outcome Met? (Based on Criteria)

Yes

5. Use of Results (Discussing/ using results)

This academic year we had 100% of students pass PHYS 470 & PHYS472, so we did indeed meet this learning goal.

Package History

Date	User	Action
6/30/2023 10:07:25 AM	Mark Rosenberry	Submitted 'Student Learning Assessment Report'
6/30/2023 10:08:04 AM	Michele McColgan	Received
6/30/2023 10:08:04 AM	Institutional Effectiveness	Received
6/30/2023 10:08:05 AM	School of Science - Dean	Received
6/30/2023 10:08:05 AM	Provost and Senior Vice President	Received
6/30/2023 10:08:05 AM	Thomas Giarla	Received
6/30/2023 10:08:05 AM	School of Science - Asst. Dean	Received
6/30/2023 11:39:03 AM	Margaret Madden	Decision Approved
6/30/2023 1:04:49 PM	Michele McColgan	Decision Approved