Student Learning Assessment Report, Academic

Report Year

2022-2023

Program

Applied Physics Major

Department Head

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Submitted By

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Previously Submitted Reports

2021-2022 Applied Physics Major

Mission

The Department of Physics & Astronomy aims to develop in students a thorough understanding of the laws of physics and their applications to engineering problems. It fosters an understanding and appreciation of the meaning and significance of the laws of physics and their relevance to broader society; the ability to apply the laws of physics to real world situations to solve problems analytically and numerically; to think and write critically; to design experiments and analyze and present data and results; and hands-on experience with current research techniques employed in physics and applied physics.

Assessment

1. Major/Program Student Learning Outcomes

Student will be able to...

Students will understand the fundamental concepts and theories of physics, and how they are applied to engineering.

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.)

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, in our two-semester general physics sequence for majors (PHYS130/PHYS140) 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. 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, taken by all majors in their junior year), PHYS410 (Electricity and Magnetism, taken by Applied Electrical as juniors), and APHY320 (Fluids and Heat Transport, taken by Applied Mechanical as juniors).

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?)

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 APHY320) as a quantitative metric of whether students are achieving a higher level of conceptual understanding of physics.

Third and finally, although our development of the Major Field Exam is still in its early stages, we would like to strive for 75% of our majors to score 75% or higher on the exam.
However, we want to emphasize that we are still refining the range of questions (in terms of subject areas covered), as well as the exact wording and difficulty level of the problems. Once we have converged on a version of the exam that is satisfactory, we will revisit and refine the quantitative threshold for assessing our students' cumulative conceptual understanding of physics.

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

Please see attached document

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, respectively, scored 18/30 or higher (see Table 1: FCI Item Analysis) on the FCI. Similarly, only 23% of students in PHYS140 courses exceeded our target score of 18/30 on the EMCA (Table 2: EMCA Assessment Results). The department is discussing the appropriate level of the EMCA course.

Next, among our upper-level physics courses, we achieved our target of 91.4% (more than 90%) of students passing these courses, indicating (from these data) that most students are achieving a good understanding of upper-level physics concepts.

6. Determining if changes impacted student learning

Not yet determined.

Assessment

1. Major/Program Student Learning Outcomes

Student will be able to...

Students will develop strong analytical skills and facility with mathematical modeling.

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.)

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 and assessed in required 200-, 300-, and 400-level courses. We use the distribution of final course grades in required upper-level courses (PHYS250, PHYS310, PHYS410, APHY320; see Table 4) to assess students' ability to solve physics problems analytically, and to use computers to analyze and visualize data. The first two of these courses are taken by all majors in their sophomore and junior or senior year; the second two are only taken by one track of the major.

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?)

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

Among our upper-level courses (PHYS250, PHYS310, PHYS410, APHY320), we strive for more than 90% of students to receive a passing grade (C minus or higher).

Normally we also use the Major Field Test as well, aiming for 75% of our seniors to achieve a score of 75% or better.

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 92.6% of our students passed, exceeding our goal of 90% passing.

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 a small number wound up in PreCalc. This year we had virtually no Calc II students in Applied Physics and the majority of them 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 design, build, and troubleshoot experiments, and they will gain competency with both the instrumentation and data-visualization software that are frequently encountered in the engineering workplace.

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 three required upper-level courses, SCDV230 (Electronics), PHYS370 (Laboratory Techniques), and APHY470 (Experimental Design). Experimental Competency is now also assessed in SCDV150, a one credit course teaching programming. For PHYS370, Table 5 also includes a separate line for the number of students passing the 370 lab practical.

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 Experimental Design (APHY470).

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 all of our upper-level laboratory courses (96.8% students passing versus our target of 90%; see Table 5: Upper-Level Physics Labs: Experimental Competency). However, we note that the separate row for the 370 practical indicates some students struggle there. We will extend to include other lab practical assessments next year.

Assessment

1. Major/Program Student Learning Outcomes

Student will be able to...

Students will be able to effectively communicate their solutions to physics and engineering-oriented problems and experiments in written and oral form.

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 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 Experimental Techniques PHYS370, and the senior Applied course, APHY470

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 Experimental Design (APHY470).

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 exactly 90% of students pass our Experimental Techniques class (please see Table 5) and 100% pass APHY470 (please see Table 7: Capstone Research), so we achieving this goal. However, we still have concerns for the ability of some students to present work. Dr. Finn intends to require a presentation in PHYS310 this coming year to strengthen this learning outcome.

Assessment

1. Major/Program Student Learning Outcomes

Student will be able to...

Students will learn to assess the validity of experimental data and assess the uncertainties in these data

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 two different ways:

First, in our two-semester general physics sequence (PHYS130/PHYS140 and 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, based on labs that had been workshopped by other faculty and tested out by either summer students or off-sequence terms (e.g. Spring PHYS110). 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.

Second, we use the distribution of final course grades in our PHYS370 (Laboratory Techniques) course.

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 two different criteria for our assessment procedures.
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.
The use of PLIC assessment by the Siena group is still being developed, but there are some takeaways. 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. While we have not dug into the details of the outcomes there are some bulk results that we can comment on. First, all students in all labs improve in the criteria assessed by the PLIC. Secondly, 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.

In addition, we strive for more than 90% of students to receive a passing grade (C minus or higher) in PHYS370.

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 for 130 students, but the lower line representing the quartile does not change a lot, indicating that we do not reach some students. Based on the fact that 90% of our students passed PHYS370 (see Table 6: Upper-Level Physics Labs: Data Analysis, we find that we did meet this learning outcome.

Package History

Date	User	Action	
6/30/2023 10:26:35 AM	Mark Rosenberry		Submitted 'Student Learning Assessment Report'
6/30/2023 10:27:07 AM	School of Science - Asst. Dean		Received
6/30/2023 10:27:07 AM	Institutional Effectiveness		Received
6/30/2023 10:27:08 AM	Michele McColgan		Received
6/30/2023 10:27:08 AM	Thomas Giarla		Received
6/30/2023 10:27:08 AM	Provost and Senior Vice President		Received
6/30/2023 10:27:08 AM	School of Science - Dean		Received
6/30/2023 11:38:56 AM	Margaret Madden		Decision Approved
6/30/2023 1:04:34 PM	Michele McColgan		Decision Approved