Program Assessment Report

Academic Year(s) Assessed: 2023-2024

College: Letters and Science

Department: Physics

Department Head: John Neumeier

Submitted by: John Neumeier

Program(s) Assessed

List all majors (including each option), minors, and certificates that are included in this assessment – add or subtract rows as needed – please use official titles:

Majors	**Minors, Options, etc.**
Physics, B.S.	Professional
Physics, B.S.	Interdisciplinary
Physics, B.S.	Astronomy/Astrophysics
Physics, B.S.	Teaching
Physics, Minor	

1. Past Assessment Summary.

Response: The AOC commented that the Physics Department takes program improvement seriously, and perhaps did too much in the last assessment. They suggested more focus on specific areas for improvement. They also requested more information on methodology.

Upon completion of last year's assessment, it was decided to revamp our PLO's and assessment method and to close the loop by reporting the results to the faculty.

2. Action Research Question.

Response: Evaluate student knowledge and problem-solving skills through their responses to Essential Knowledge Questions in 6-8 courses each academic year. Evaluate student research experiences and their communication skills using the Capstone class PHSX 499R.

Background: We revised program assessment to improve and simplify it while also closing the loop by providing feedback to faculty. Our new approach began with the creation of new Program Learning Outcomes (PLOs). The new PLOs are reduced in number, more broadly defined, and provide more latitude to assess our programs. For Spring 2024, we developed Essential Knowledge Questions for 3 courses. These questions were integrated into tests and quizzes. We requested that each EKQ require less than a 3-minute response time from students. The results were communicated back to the Undergraduate Curriculum Committee, which then reported the results at a faculty meeting. Our catalog

of Essential Knowledge Questions is developing. The current list is posted on our webpage (https://physics.montana.edu/ugrad/assessments.html) so that the community can view them.

Additional Program Improvement Activities: We have critically assessed our programs with the goal of streamlining and improving pedagogy, retention, and recruitment where possible. This led to moving PHSX 200 Research Programs in Physics to Spring semester to allow students more time to learn Physics prior to being informed as to which research programs are available for their future research involvement. We implemented a major change to the Interdisciplinary Option, requiring students to complete a MSU Minor instead of choosing a focus area. We removed a natural science elective from all programs. Syllabi, learning outcomes, and expectation for time commitment per credit hour were added to all four research and independent study courses (PHSX 290R 292, 490R, and 492). Honors Physics I and II (PHSX 240 and 242) now have their own laboratory sections, which allows differentiation between honors and non-honors students in content and expectations. We rewrote four laboratories for PHSX 222 and 242 over the summer, adding new equipment (using EFAC funds). We also rewrote the entire laboratory manual for ASTR 371 and added new equipment (also using EFAC funds). Advanced Physics Laboratory PHSX 444 received new equipment (using EFAC funds) and is undergoing improvements in Fall 2024.

Many of these changes were recommended by students in Undergraduate Town Halls that we have at the end of each semester. The department head and members of the Undergraduate Curriculum Committee attend the Town Halls, discuss, and implement changes where possible. Changes that were made were communicated to the undergraduates by the department head.

3. Assessment Plan, Schedule, and Data Sources.

a) Please provide a multi-year assessment schedule that will show when all program learning outcomes will be assessed, and by what criteria (data).

ASSESSMENT PLANNING SCHEDULE CHART					
PROGRAM LEARNING OUTCOME	2023-2024	2024-2025	2025-2026	2026-2027	***Data Source****
1. Discipline-Specific Knowledge: Students demonstrate option-appropriate knowledge of critical areas of physics.	x	x	x	x	Essential Knowledge Questions
2. Problem-Solving Skills: Students formulate and solve physics problems analytically, numerically, and experimentally.	x	x	x	x	Essential Knowledge Questions
3. Research and Communication Skills: Students apply knowledge to a contemporary problem in physics research. They discuss and describe the results of their work in oral and written form.	x	x	x	x	PHSX 499R – Capstone Class

b) What are the threshold values for which your program demonstrates student achievement?

Threshold Values		
PROGRAM LEARNING OUTCOME	**Threshold Value**	**Data Source**
Students demonstrate option-appropriate knowledge of critical areas of physics.	Grading: Accomplished=4, Competent=3, Developing=2, Beginning=1, Inadequate=0. Threshold value = 3.	Essential Knowledge Questions
Students formulate and solve physics problems analytically, numerically, and experimentally.	Grading: Accomplished=4, Competent=3, Developing=2, Beginning=1, Inadequate=0. Threshold value = 3.	Essential Knowledge Questions
Students apply knowledge to a contemporary problem in physics research. They discuss and describe the results of their work in oral and written form.	Performance on classroom discussions, presentation, and final paper.	Capstone Course PHSX499R Performance

4. What Was Done.

a) Self-reporting Metric (required answer): Was the completed assessment consistent with the program's assessment plan? If not, please explain the adjustments that were made.

☒ Yes ☐ No

b) How were data collected and analyzed and by whom? Please include method of collection and sample size.

We assessed three courses using Essential Knowledge Questions (EKQs). The EKQs were developed by the instructors of PHSX 301 (Math Methods), PHSX 423 (Electricity and Magnetism I), and PHSX 446 (Thermodynamics and Statistical Physics). There were several EKQs per class, which were integrated into quizzes and exams. The instructors determined the numerical scores that were used. The Undergraduate Curriculum Committee used those scores to determine thresholds and identify common failure modes from student written responses.

We assessed PLO #3 through instructor interaction with students in PHSX 499R. Students were required to produce a resume, discuss it with classmates, and revise. They engaged in classroom discussions and were required to present the results of their research in oral and poster presentations. They were also required to write a paper about their research project. All students performed above threshold.

c) Please provide a rubric that demonstrates how your data were evaluated. (Delete example below and replace with program's assessment-specific rubric.)

Indicators	Inadequate 0	Beginning 1	Developing 2	Competent 3	Accomplished 4
Exhibit discipline-specific and option-specific knowledge	Does not exhibit knowledge of topic	Attempts answer but is not successful	Identifies topics, displays modest understanding	Understands most aspects with minor errors	Displays complete understanding
Formulate and solve physics problems analytically, numerically, and experimentally	Does not exhibit ability to solve	Identifies problem but unable to craft solution	Begins solution but misses essential elements to complete	Manages most aspects of solution	Achieves clear, unambiguous solution
Apply knowledge to contemporary physics research. Discuss and describe results in oral and written form	No research or advanced lab activity. No oral and written reporting.	Some research or advanced lab activity. Weak understanding. Poor oral and written reporting.	Participates in research or advanced lab work. Understands at basic level. Fair oral and written reporting.	Successful research or advanced lab work. Understands at above-average level. Good oral and written reporting.	Successful research or advanced lab work. Understands at high level. Excellent oral and written reporting.

5. What Was Learned.

a) Based on the analysis of the data, and compared to the threshold values established, what was learned from the assessment?

Thresholds values were met in PHSX 301, with 23 out of 30 students meeting them. Room for improvement was identified. Knowledge of matrix algebra could be strengthened and advanced solution methods were not always utilized.

In PHSX 423 of the 6 EKQs, most of the 15 students met threshold values. For one EKQ, 5 students did not. The performance was overall very strong. However, some students exhibit fundamental deficiencies with physical units, basic geometry, understanding of how a conductor behaves in an electric field, and graphing.

Threshold values in PHSX 446 were met by about half of the students on the EKQs. Students who did not meet the threshold exhibited problems with reading and understanding the questions and application of provided information. Connections between the physics and math were often not well understood.

Threshold values were met in PHSX 499R. Students participated in contemporary physics research and clearly communicated their contributions to research and discovery in oral and written form.

b) What areas of strength in the program were identified from this assessment process?

The topical material of the courses is adequate and strong students are excelling. The program offers a background in physics that is the pathway to graduate school in STEM or careers in technology. PHSX 499R revealed excellent student engagement and learning from research activity.

c) What areas were identified that either need improvement or could be improved in a different way from this assessment process?

We need to step back and understand the strengths and weaknesses of our students, and design and deliver courses accordingly. For example, it was observed that some students do not understand how to plot data or interpret plotted data. Faculty also realized that some students exhibit difficulties in working with physical units or are not able to use those units to advise problem solving. These skills can be exercised starting at the 200-level. Some very basic concepts need emphasis. For example, What is a conductor and how does it respond to a uniform electric field? What is an ideal gas? What is meant by equilibrium? Instructors were made aware of these deficiencies in a faculty meeting, and they actively engaged in developing approaches to address them.

6. How We Responded.

a) Describe how “What Was Learned” was communicated to the department, or program faculty. How did faculty discussions re-imagine new ways program assessment might contribute to program growth/improvement/innovation beyond the bare minimum of achieving program learning objectives through assessment activities conducted at the course level?

The results were communicated in a faculty meeting. The faculty established a clear connection between the assessment and how to gear their instruction to realize improvement of student learning. Strategies were discussed and some improvements to the assessment method were recommended. Faculty are now thinking about learning objectives at the program level, rather than thinking only about learning objectives in their individual courses.

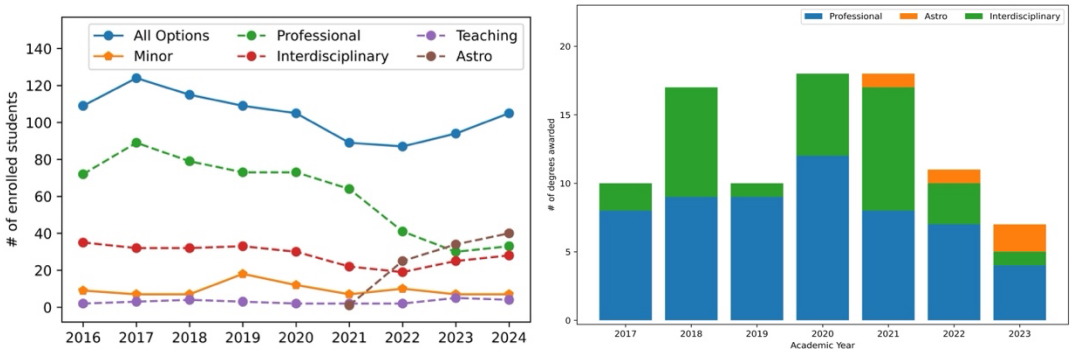
b) How are the results of this assessment informing changes to enhance student learning in the program?

Student responses to EKQs did illustrate a need to focus on some basic skills (plotting, interpreting plots, units, dimensional analysis, fundamental concepts) that will be addressed going forward.

c) If information outside of this assessment is informing programmatic change, please describe that.

We have plans to conduct exit interviews with graduating students. We will continue use of Undergraduate Town Halls to inform program improvement.

The figures below show changing demographics of degree options selected and completed by students. Because the degree options require different 400-level courses, we will be implementing reorganization of Course Learning Outcomes for several courses beginning Fall 2025 to better serve students in all Physics options.



d) What support and resources (e.g. workshops, training, etc.) might you need to make these adjustments?

Nothing yet.

7. Closing the Loop(s).

Reflect on the program learning outcomes, how they were assessed in the previous cycle (refer to #1 of the report), and what was learned in this cycle. What action will be taken to improve student learning objectives going forward?

a) Self-Reporting Metric (required answer): Based on the findings and/or faculty input, will there be any curricular or assessment changes (such as plans for measurable improvements, or realignment of learning outcomes)?

☒ Yes ☐ No

Faculty agreed to bring more examples of plotting, dimensional analysis, work with units, and problem-solving examples into lectures.

We have devised a way to include laboratory reports into the assessment. We will allow more open-ended EKQs, instead of short (max 3-minute response time).

We plan to develop a policy to keep CLOs in synch with current syllabi.

b) In reviewing the last report that assessed the PLO(s) in this assessment cycle, what changes proposed were implemented and will be measured in future assessment reports?

We completely redesigned our assessment approach. The assessment method was simplified to reduce the number of PLOs, making each broader in scope. Specific courses are now targeted each year, using them as measurement tools, instead of targeting the entire program.

The department agreed that the new assessment method was valuable. We will continue along the current path, modifying as needed.

c) Have you seen a change in student learning based on other program adjustments made in the past? Please describe the adjustments made and subsequent changes in student learning.

It is too soon to say.

Submit report to programassessment@montana.edu
Update Department program assessment report website.
Update PLO language in CIM if needed (Map PLOs to Course LOs)