Weber State University
Biennial Report on Assessment of Student Learning

Cover Page

Department/Program: Physics
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We have updated the Institutional Effectiveness website, which includes an update for each program page. All Biennial Assessment and Program Review reports will now be available on a single page. Please review your page for completeness and accuracy, and indicate on the list below the changes that need to be made. Access your program page from the top-level results **page. Select the appropriate college and then your program from the subsequent page.**

A. **Mission Statement**

_x__ Information is current; no changes required.

Update if not current:

B. **Student Learning Outcomes**

_x__ Information is current; no changes required.

Update if not current:

C. **Curriculum** (please note, we are using Google Sheets for this section so that updates are easier to make)

__x_ Information is current; no changes required.

Update if not current (you may have access to the Google Sheet if that is easiest, or we can make the updates):

D. **Program and Contact Information**

__x_ Information is current; no changes required.

Update if not current:

E. Assessment Plan (please see our website for details on how to develop a program assessment plan)

__x_ Information is current; no changes required.

Update if not current: (this update can be via a Google Sheet if that iss easiest; we can then embed the Google Sheet on your program web page, as we do with the curriculum grid)

New: High Impact Educational Experiences in the Curriculum

In response to the recent USHE requirement that all students have at least 1 HIEE in the first 30 credit hours and 1 HIEE in the major or minor we are asking programs to map HIEEs to curriculum using a traditional curriculum grid. This helps demonstrate how and where these goals are accomplished.

The following are meant to serve as examples. Not every course includes the same HIEE under every instructor. All of our courses employ evidence-based teaching practices (depending on how one defines that term); virtually every lab involves team-based learning.	
Courses	**Department/Program use of High Impact Educational Experiences**
PHYS 2300 Scientific Computing	Project-based learning — Students complete a final programming project (usually a simulation of a physical system) of their own design.
PHYS 1360 PS Principles of Physical Science	Students develop independent research projects, including research methods and data analysis, presented in a mini research conference at the end of term.
ASTR 2040 PS Observational Astronomy	ASTR 2040 has project-based learning involving a guided undergraduate research experience with authentic astronomical data, taken by the students themselves.
PHYS 2090 PS Environmental Physics	PHYS 2090 has project-based learning including a final project in which they use a detailed climate simulation to seek economically viable policy solutions to climate change.
PHYS/ASTR 4800/2800 Research	Nearly all of our majors complete an undergraduate research project, most for credit under one of these course designations.
PHYS 4990 Seminar	This seminar is a capstone course for our degrees. Students give a ~45 lecture on an individual project they have completed, normally under the direction of a faculty member, but could also be through and internship or REU program
PHYS 4570 Science Teaching Methods	Community Engaged Learning designated course. Projects are developed by students to meet local needs in museums, schools, outreach programs, etc.
PHYS 4410 Materials Lab	This senior lab course employs team-based learning throughout and a capstone of a design project.

HIEEs include capstone courses or experiences, community-engaged learning, evidence-based teaching practices, internships, project-based learning, study abroad/away, supplemental instruction, team-based learning, undergraduate research, pre-professional/career development experiences.

F. Report of assessment results since the last report:

There are varieties of ways in which departments can choose to show evidence of learning. This is one example. The critical pieces to include are 1) learning outcome being assessed, 2) method(s) of measurement used, 3) threshold for 'acceptable – that is, the target performance, 4) actual results of the assessment, 5) interpretation/reflection on findings 6) the course of action to be taken based upon the interpretation, and 7) how that action will be evaluated.

Evidence of Learning: Courses within the Major

[Note: The following format is based on previous work in developing and evaluating our department learning outcomes across all of our courses. As reported in our last program review, we're reconsidering this format so that we can better meet the formatting of reports like these as well as to better target our assessment and evaluation of courses and programs. Due to a sabbatical and a pandemic, these efforts have been shelved temporarily, but we should return to them in the coming year.]

Learning Outcomes

The Department of Physics has a standing set of learning outcomes determined for students in all classes and programs. These currently include the following, including modes of assessment and brief summaries. (Each description is given a brief name, italicized, for reference in tables.)

1. *Major Concepts*: At graduation, physics majors should have a thorough knowledge and comprehension of the core concepts of classical and modern physics, as assessed by: student success in passing the required and elective courses for their physics major; student scores on the GRE Physics Exam (in comparison with nationwide results from the American Institute of Physics and the American Association of Physics Teachers); student acceptance rates for graduate school and/or job placement; a comparison of WSU's physics curriculum with the curricula of 1) physics programs in schools with a comparable student profile, and 2) the best physics programs.
2. *Physics Skills*: At graduation, physics majors should have a set of fundamental skills that can be applied to a variety of situations. These skills should include the following:
    a. *Presentation skills*. Physics majors should be able to express (orally and in writing) their understanding of core physical principles, the results of experiments, and their analysis of physical problems, as assessed by their success in the Physics capstone presentation required of all majors and in other courses which require a written or oral report.

    b. *Laboratory skills*. Physics majors should be competent experimentalists. They should be able to design and set up an experiment, collect and analyze data, identify sources of error, and interpret their result and connect it to related areas of physics, as assessed by student performance in physics laboratory courses and faculty- supervised research projects. Students should have a basic understanding of laboratory safety issues, and follow safe practices in their own laboratories.

    c. *Computer skills*. Physics majors should be competent users of basic software, such as word processing, spreadsheet, and graphing programs, and Mathematica software. Physics majors should have an understanding of computer programming and fundamental numerical algorithms as used for problem solving and visualization in the natural sciences, as assessed by student performance in the computing components of courses in the physics curriculum.

d. *Problem-solving skills*. Physics majors should be competent problem-solvers. They should be able to identify the essential aspects of a problem and formulate a strategy for solving the problem. They should be able to estimate the solution to a problem, apply appropriate techniques to arrive at a solution, test the correctness of their solution, interpret their result and connect it to related areas of physics, as assessed by student performance in the problem-solving components of courses in the physics curriculum.

3. *Analysis*: Physics majors should be adequately trained to apply their physics experience and knowledge to analyze new situations, as assessed by: student acceptance rates and success in academic and industrial intern positions; post-graduation student success in graduate school, industry, or teaching – in physics or otherwise – as established by questionnaires and interviews of graduates, employers, and graduate faculty. This should include a "long-term" evaluation to obtain feedback from majors of 5 – 10 years ago.

4. *Nature of Science*: All physics students (majors, minors, support, and Gen Ed students) should understand the nature of science, as assessed by exams, questionnaires, interviews, and student focus groups.

5. *General Concepts*: General Education students should understand several core concepts of physics, as assessed by nationally reviewed pre- and post-tests (for example, the Force Concept Inventory and the Mechanics Baseline Test for Newton's laws) and interviews.

NOTE: In addition to these concepts, the Department recognizes and prioritizes the learning objectives designated by the University for Physical Science General Education Breadth requirements. We refer to these learning objectives by their shorthand descriptions: Nature of Science, Integration of Science, Science and Society, Problem Solving, Systems, Matter, Energy, and Forces. (These objectives are described fully at http://www.weber.edu/academicaffairs/natural_sciences.html.) Many of these naturally overlap with other extant Department learning objectives.

6. *Teacher Prep*: Physics Teaching majors and Elementary Teaching majors should have an appropriate knowledge of physics and a variety of teaching strategies to accommodate the multiple learning styles of their students, as assessed by a comparison of the WSU Physics Teaching major with the Utah State Core Curriculum, classroom observation of student teachers, interviews with physics teachers and pre-teachers, and job placement in major teaching field.

Curriculum Map

Coursework:

The department currently offers the following coursework. Courses offering the general education "Physical Science" breadth requirement are annotated with "PS" next to the course number. Courses marked with superscript "*" are crosslisted with the ASTR ("Astronomy") prefix (in addition to the PHYS prefix).

PHYS 1010 PS - Elementary Physics

PHYS 1040 PS - Elementary Astronomy*
PHYS 1360 PS - Principles of Physical Science
HNRS 1500 PS - Perspectives in the Physical Sciences (variable titles)
PHYS 2010 PS - College Physics I
PHYS 2015 - College Physics I Lab
PHYS 2020 - College Physics II
PHYS 2025 - College Physics II Lab
PHYS 2040 PS - Principles of Observational Astronomy*
PHYS 2090 - Environmental Physics - Energy and Power
PHYS 2210 PS - Physics for Scientists and Engineers I
PHYS 2215 - Physics for Scientists and Engineers I Lab
PHYS 2220 - Physics for Scientists and Engineers II
PHYS 2225 - Physics for Scientists and Engineers II Lab
PHYS 2300 - Scientific Computing for Physical Systems
PHYS 2600 - Laboratory Safety
PHYS 2710 - Introductory Modern Physics
PHYS 2800 - Introductory Individual Research Problems*
PHYS 2830 - Introductory Readings in Physics/Astronomy*
PHYS 2890 - Cooperative Work Experience
PHYS 2920 - Short Courses, Workshops, Institutes and Special Programs
PHYS 3040 – Principles of Observational Astronomy, Advanced
PHYS 3160 - Stellar and Planetary Astrophysics*
PHYS 3170 - Galaxies and Cosmology*
PHYS 3180 - Thermal Physics
PHYS 3190 - Applied Optics
PHYS 3300 - Advanced Computational Physics
PHYS 3410 - Electronics for Scientists
PHYS 3420 - Data Analysis, Statistics, and Instrumentation
PHYS 3500 - Analytical Mechanics
PHYS 3510 - Electromagnetic Theory
PHYS 3540 - Mechanical and Electromagnetic Waves
PHYS 3570 - Foundations of Science Education
PHYS 3710 - Nuclear and Particle Physics
PHYS 4200 - The Physics of Materials
PHYS 4400 - Advanced Physics Laboratory
PHYS 4410 - Materials Characterization Laboratory
PHYS 4570 - Secondary School Science Teaching Methods

PHYS 4610 - Quantum Mechanics
PHYS 4620 - Advanced Quantum Mechanics
PHYS 4800 - Individual Research Problems*
PHYS 4830 - Readings in Physics/Astronomy*
PHYS 4890 - Cooperative Work Experience
PHYS 4920 - Short Courses, Workshops, Institutes and Special Programs
PHYS 4970 - Senior Thesis
PHYS 4990 - Seminar in Physics

Program Outcomes:

1) At graduation, Physics majors should have a thorough knowledge and comprehension of the core concepts of classical and modern physics, as assessed by:

a) student success in passing the required and elective courses for their physics major.

Courses: PHYS/ASTR 2040, 2210, 2219, 2220, 2229, 2300, 2600, 2710, 3040, 3160, 3170, 3180, 3190, 3300, 3410, 3420, 3500, 3510, 3540, 4200, 4400, 4410, 4610, 4620, 4800, 4830, 4970, 4990.

b) student scores on the GRE Physics Exam (in comparison with nationwide results from AIP, AAPT).

Extra-curricular experience: GRE Physics Exam.

c) student acceptance rates for graduate school and/or job placement (in comparison with nationwide results from AIP, AAPT).

Extra-curricular experiences: application for graduate school and/or employment.

d) a comparison of WSU's physics curriculum with the curricula of 1) physics programs in schools with a comparable student profile, and 2) the best physics programs.

Courses: PHYS/ASTR 2040, 2210, 2219, 2220, 2229, 2300, 2600, 2710, 3040, 3160, 3170, 3180, 3190, 3300, 3410, 3420, 3500, 3510, 3540, 4200, 4400, 4410, 4610, 4620, 4800, 4830, 4970, 4990.

2) At graduation, physics majors should have a set of fundamental skills that can be applied to a variety of situations. These skills should include the following:

a) Presentation skills. Physics majors should be able to express (orally and in writing) their understanding of core physical principles, the results of experiments, and their analysis of physical problems, as assessed by their success in the Physics capstone presentation required of all majors and in other courses which require a written or oral report.

Courses: PHYS 4400, 4410, 4970, 4990.

b) Laboratory skills. Physics majors should be competent experimentalists. They should be able to design and set up an experiment, collect and analyze data, identify sources of error, and interpret their result and connect it to related areas of physics, as assessed by student performance in physics laboratory courses and faculty-supervised research projects. Students should have a basic understanding of laboratory safety issues, and follow safe practices in their own laboratories.

Courses: PHYS 2040, 2219, 2229, 2600, 3040, 3190, 3410, 3420, 4400, 4410, 4800, 4970.

c) Computer skills. Physics majors should be competent users of basic software, such as word processing, spreadsheet, and graphing programs. They should also have an understanding of the fundamental aspects of a programming and/or computer algebra language (PYTHON, C++, Mathematica, LabView etc), as assessed by student performance in the computing components of courses in the physics curriculum.

Courses: PHYS 2219, 2229, 2300, 3300, 2710, 3510, 4400.

d) Problem-solving skills. Physics majors should be competent problem-solvers. They should be able to identify the essential aspects of a problem and formulate a strategy for solving the problem. They should be able to estimate the solution to a problem, apply appropriate techniques to arrive at a solution, test the correctness of their solution, interpret their result and connect it to related areas of physics, as assessed by student performance in the problem-solving components of courses in the physics curriculum.

Courses: PHYS/ASTR 2040, 2210, 2220, 2710, 3040, 3160, 3170, 3180, 3190, 4200, 3300, 3410, 3420, 3500, 3510, 3540, 3640, 4570, 4610, 4620, 4800, 4830, 4970.

3) Physics majors should be adequately trained to apply their physics experience and knowledge to analyze new situations, as assessed by:

a) student acceptance rates and success in academic and industrial intern positions.

Extra-curricular experiences: application for graduate school and/or employment.

b) post-graduation student success in graduate school, industry, or teaching --- in physics or otherwise -- as established by questionnaires and interviews of graduates, employers, and graduate faculty. This should include a "long-term" evaluation to obtain feedback from majors of 5 - 10 years ago.

Extra-curricular experiences: opportunities for career advancement and promotion.

4) All physics students (majors, minors, support, and Gen Ed students) should understand the nature of science, as assessed by questionnaires, interviews, and student focus groups.

Courses: PHYS/ASTR 1010, 1040, 1360, 2010, 2010L, 2020, 2020L, 2210, 2210L, 2220, 2220L, 2740, 3160, 3170,3180, 3190, 4200, 3300, 3410, 3420, 3500, 3510, 3540, 3640, 4610, 4620, 4800, 4830, 4970, 4990; HNRS 1500

5) General Education students should understand several core concepts of physics, as assessed by nationally reviewed pre- and post-tests (for example, the Hestenes Force Concept Inventory and the Hestenes Mechanics Baseline Test for Newton's laws) and interviews.

Courses: PHYS/ASTR 1010, 1040, 1360, 2040, 2010, 2210; HNRS 1500

6) Physics Teaching majors and Elementary Teaching majors should have an appropriate knowledge of physics and a variety of teaching strategies to accommodate the multiple learning styles of their students, as assessed by:

a) a comparison of the WSU Physics Teaching major with the Utah State Core Curriculum.

Courses: PHYS/ASTR 1010, 1040, 1360, 2210, 2220, 2600, 2710, 3160, 3170, 3180, 3190, 3200, 3300, 3410, 3420, 4570.

b) classroom observation of student teachers.

Extra-curricular experience: student teaching.

c) interviews with physics teachers and pre-teachers.

Extra-curricular experiences: preparation and employment experiences of teachers and pre-teachers.

d) job placement in major teaching field.

Extra-curricular experience: application for employment with public or private schools.

The learning objectives, assessment instruments, and courses all listed above have multiple intersections, as described in the following summaries, including where in which each learning objective is assessed (e.g., PHYS 2210, or another experience of a student/graduate), as well as what assessment tools are used (e.g., WE for "written exams,") to measure these outcomes. The Department has identified a set of direct measures and a set of indirect measures of these outcomes. These sets are not meant to be exhaustive. Abbreviations for each of these measures are indicated and utilized as follows:

Direct Measures: WE = written exams (standardized or locally-developed), OE = oral exams, LAB = laboratory activities, REP = reports/writing samples, CAP = capstone projects, IEX = inside examiners, CO = comparisons with external programs or standards, OEX = outside examiners, INT = internship experiences

Indirect Measures: EI = exit interviews, GR = graduate school acceptance, JOB = job placement, PO = participant observation, FG = focus groups, PGS = survey of post-graduation success, JP = reported job performance

Major Concepts:

A. student success in passing the required and elective courses for their physics major. [WE, OE, LAB, REP] *Courses*: PHYS 2210, 2219, 2220, 2229, 2300, 2600, 2710, 2800, 2830, 3040, 3160, 3170, 3180, 3190, 3200, 3300, 3410, 3420, 3500, 3510, 3540, 3640, 3710, 4200, 4400, 4410, 4610, 4620, 4800, 4830, 4970, 4990.

B. student scores on the GRE Physics Exam (in comparison with nationwide results from the American Institute of Physics and the American Association of Physics Teachers). [OEX] *Extra-curricular experience*: GRE Physics Exam.

C. student acceptance rates for graduate school and/or job placement (in comparison with nationwide results from AIP, AAPT). [GR, JOB] *Extra-curricular experiences*: application for graduate school and/or employment.

D. a comparison of WSU's physics curriculum with the curricula of 1) physics programs in schools with a comparable student profile, and 2) the best physics programs. [CO] *Courses*: PHYS 2210, 2219, 2220, 2229, 2300, 2600, 2710, 2800, 2830, 3040, 3160, 3170, 3180, 3190, 3200, 3300, 3410, 3420, 3500, 3510, 3540, 3640, 3710, 4200, 4400, 4410, 4610, 4620, 4800, 4830, 4970, 4990.

Skills:

A. Presentation skills. [CAP, REP] *Courses:* PHYS 3190, 3410, 3570, 3640, 4830, 4970, 4990.

B. Laboratory skills. [LAB, WE, OE, REP, PO] *Courses:* Phys 2219, 2229, 2600, 3040, 3190, 3410, 3420, 3640, 4400, 4410, 4800, 4970.

C. Computer skills. [WE, REP] *Courses:* PHYS 2219, 2229, 2300, 3040, 3160, 3170, 3180, 3300, 3420, 3510, 3640, 4400, 4410, 4610, 4620, 4800, 4830, 4970, 4990.

D. Problem-solving skills. [WE, REP] *Courses:* PHYS 2210, 2219, 2220, 2229, 2300, 2600, 2710, 2800, 2830, 3040, 3160, 3170, 3180, 3190, 3200, 3300, 3410, 3420, 3500, 3510, 3540, 3640, 3710, 4200, 4400, 4410, 4610, 4620, 4800, 4830, 4970, 4990.

Analysis

A. student acceptance rates and success in academic and industrial intern positions. [JP, INT] *Extra-curricular experiences:* application for summer research appointments and intern positions.

B. post-graduation student success in graduate school, industry, or teaching. [PGS, JP]

Nature of Science

A. as assessed by exams, questionnaires, interviews, and student focus groups. [WE, OE, FG, EI, IEX] *Courses:* Phys 1010, 1040, 1360, 2040, 2010, 2019, 2020, 2029, 2210, 2219, 2220, 2229, 2710, 2800, 2830, 3040, 3160, 3170, 3180, 3190, 3200, 3300, 3410, 3420, 3500, 3510, 3540, 3570, 3640, 3710, 4200, 4400, 4410, 4610, 4620, 4800, 4830, 4970, 4990; HNRS 1500

General Concepts

A. as assessed by exams, questionnaires, and interviews [WE, EI, IEX] *Courses:* PHYS 1010, 1040, 1360, 2010, 2019, 2040, 2210, 2219; HNRS 1500

Teacher Prep

A. appropriate content knowledge of physics and teaching strategies to accommodate diverse learners as assessed by a comparison of the WSU Physics Teaching major with the Utah State Core Curriculum. [CO] *Courses:* PHYS 1010, 1040, 1360, 2040, 2210, 2219, 2220, 2229, 2300, 2600, 2710, 2800, 2830, 3040, 3160, 3170, 3180, 3190, 3200, 3300, 3410, 3420, 3500, 3510, 3540, 3570, 3640, 3710, 4200, 4400, 4410, 4570, 4610, 4620, 4800, 4830, 4970, 4990.

B. *Extra-curricular experience:* student teaching and interviews with physics teacher candidates. [EI, PGS, PO]

C. *Extra-curricular experiences:* job placement and experiences in the teaching profession [JOB]

Evidence of Learning: **General Education Courses**

NOTES:
Our Gen Ed assessment protocols and results have remained constant over the past 4 years. We're reporting on the most recent developments here.

- *First, we're prototyping some pre-/post- tests that could be applicable for all PS Gen Ed courses in Physics and we report those below for the most recent attempt at using these.*
- *Second, we've recently received approval for PHYS 2090 and report the extensive ongoing assessment measures for that course. (These measures are based largely on other course assessments previously reported.)*
- *Finally, we're currently revising a major component of our lower division lab program that support the PS PHYS 2010/2210 courses and incorporates a Signature Assignment used across all sections of those courses.*

Course: Elementary Physics (PHYS 1010) Semester taught: All Sections included: Johnston, Fa2020

Evidence of Learning: General Education						
Measurable Learning Outcome Students will…	Method of Measurement pre/post- test	Target Performance (Initial development of measure)	Actual Performance	Interpretation of Findings	Action Plan/Use of Results	"Close the Loop"

Learning Outcome 1: Equilibrium and change are determined by forces acting at all organizational levels	Question 1: "Elevator weights" prediction – assesses understanding of equilibrium, net force, and changing motion in one-dimensional case	80% correct answer on conceptual multiple choice This is an arbitrary target, and likely overly ambitious given previous research in physics education. But this was also addressed explicitly in the course.	Measure 1: 62% pre- 62% post-	This is a notoriously difficult question. It's actually surprising that students did as well as they did in the pre-test.	This notoriously difficult question is used in research in physics education. Instruction was planned specifically to address this particular situation and although students "performed" well in assignments in class, this particular question plagues them and others.	This might not be a fair question. We'll look to use it more extensively in different populations to see if there are different results; or we may change this measure altogether.
	Question 2: Bowling ball motion analysis	80% correct answer on conceptual multiple choice This is an arbitrary target, and likely overly ambitious given previous research in physics education. But this was also addressed explicitly in the course.	Measure 1: 30% pre- 48% post-	This is a notoriously difficult question. It's impressive to see these gains, but still disappointing. To be fair, these are conceptions that research shows are built into our psyches throughout our lifetimes.	This notoriously difficult question is used in research in physics education. Instruction was planned specifically to address this particular situation and although students "performed" well in assignments in class, this particular question plagues them and others.	We'll look to use it more extensively in different populations to see if there are different results; or we may change this measure altogether.
Learning Outcome 2: Matter comprises an important component of the universe, and has physical properties that can be described over a range of scales.	Conceptual Question regarding matter on Earth and its source.	80% correct answer on conceptual multiple choice This is an arbitrary target, but reasonable as a goal since this topic doesn't defy common	pre: 78% post: 89%	Students perform well on this measure. Although the initial pre-test measure shows a high score, there's still significant improvement.	It's possible this question could be too easy.	We'll continue to evaluate the use of this measure in multiple courses.

		sense in the same way some other physics concepts do.				
Learning Outcome 3: Interactions within the universe can be described in terms of energy exchange and conservation.	Conceptual multiple select question on energies from the Sun. (Must select ALL right answers.)	60% correct answer on conceptual multiple choice This arbitrary cutoff is lower than others simply because there were multiple ways to get it wrong (due to multiple right answers required).	pre: 28% post: 43%	There's significant improvement in this concept, though there's still a major challenge.	This question asked students to select ALL energy sources whose energy could be traced back to the Sun, so "wrong" answers included those that missed even one of these.	We need to continue to use this question and perhaps find variations in it that provide more credit for partially correct answers. We'll continue to work on this measure to better validate it.
	Conceptual choice concept question on the nature of boiling water and phase changes.	60% correct on conceptual multiple choice This arbitrary cutoff is lower than others simply because there were multiple concepts involved and the question might still need to be clarified.	pre: 75% post: 79%	There's improvement in this concept, though the initial understanding was already high.	This question could be too easy and could actually be broken into two questions, one about the matter and one about the energy. There is likely some nuance to this.	We'll break this question into two parts so that it more clearly demarcates understanding and spans two ELOs.
Learning Outcomes: The universe is scientifically understandable in terms of interconnected systems. The systems evolve over time according to basic physical laws. (with connections to the Nature of Science	Conceptual multiple choice question about the process of science over time.	80% correct answer on conceptual multiple choice	pre: 91% post: 89%	The pre- and post-measures are high and nearly unchanged.	This was a first attempt to get at this idea with a single question. It's probably not getting at the nuance of the idea like more sophisticated, qualitative assignments and measures would.	We'll reevaluate the use of this question and others addressing the Natural Science objectives. Coinciding with this data were a student project and the Signature Assignment that asked them to deeply consider data collection,

and how scientific knowledge changes)						analysis, modeling, and general construction of scientific knowledge. We have these built into this course and our laboratory courses, but we haven't correlated those with these questions or otherwise tried to report what we know from those assignments. This is an ongoing project.

Energy and the Environment, PHYS 2090 (Palen; Fall 2017-2019)

Gen Ed Learning Goal Students will demonstrate understanding of:	**Measurable Learning Outcome** Students will demonstrate their understanding by:	**Method of Measurement** Direct and Indirect Measures*	**Threshold**	**Findings Linked to Learning Outcomes**	**Interpretation of Findings**	**Action Plan/Use of Results**

Nature of Science. Scientific knowledge is based on evidence that is repeatedly examined, and can change with new information. Scientific explanations differ fundamentally from those that are not scientific.	Students will understand how scientists propose hypotheses, obtain and analyze data, and draw conclusions.	"IPCC Report: Analysis and Discussion" assignment, as well as HW 12 and 13: students read and analyze the collected work of scientists in the literature.	On assignments/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	The average score on this assignment was 81%.	Students are meeting this learning outcome.	No action plan.

GE Learning Goal	**Measurable Learning Outcome**	**Method of Measure**	**Threshold**	**Findings**	**Interpretation**	**Action Plan**
Integration of Science All natural phenomena are interrelated and share basic organizational principles. Scientific explanations obtained from different disciplines should be cohesive and integrated.	Students will apply the physics that they have learned to power plants, renewable energy systems and Earth.	Homework 3 asks students to explore how the concepts of energy conservation and transformation apply to the electromagnetic spectrum, automobiles of various masses, climbing mountains, chocolate chip cookie consumption and the domestic uranium resource.	On assignments/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	The average score on this assignment was 74%, with a few students earning an exceptional 100%.	Students are meeting this learning outcome.	No action plan.

GE Learning Goal	Measurable Learning Outcome	Method of Measure	Threshold	Findings	Interpretation	Action Plan
Science and Society The study of science provides explanations that have significant impact on society, including technological advancements, improvement of human life, and better understanding of human and other influences on the earth's environment.	Issues surrounding energy use and production are central to current societal arguments about climate change. Students address these ideas throughout the course.	In the C-ROADS climate activity, where students use a computer model to explore various societal decisions and their impact on Earth's climate.	On assignments/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	The average score on the assignment was 91%.	Students are meeting this learning outcome.	No action plan.

GE Learning Goal	Measurable Learning Outcome	Method of Measure*	Threshold	Findings	Interpretation	Action Plan
Problem Solving & Data Analysis Science relies on empirical data, and such data must be analyzed, interpreted, and generalized in a rigorous manner.	Students will find, analyze, and interpret data.	One explicit data analysis exercise is the air quality assignment. Students review and analyze the latest air quality data for the Wasatch Front.	On assignments/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	Students achieved an average score of 93.5% on this assignment.	Students are meeting this learning outcome.	No action plan.

GE Learning Goal	**Measurable Learning Outcome**	**Method of Measure***	**Threshold**	**Findings**	**Interpretation**	**Action Plan**
Organization of systems The universe is scientifically understandable in terms of interconnected systems. The systems evolve over time according to basic physical laws.	Students will create predictions of physical outcomes based on physical system's conditions and principles.	The course begins with an overview of the formation and evolution of Earth, with a special emphasis on the creation of fossil fuels, and the contribution of life to the past and present atmosphere of Earth. The first homework is the one that concentrates most directly on this evolutionary aspect of Earth's history, although the entire climate change unit is also relevant.	On assignments/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	Students obtained an average of 68.5%. The average on this first homework assignment is somewhat low, because students are still learning what is expected in the course, however it is above the threshold	Students are meeting this outcome.	No action plan.

GE Learning Goal	**Measurable Learning Outcome**	**Method of Measure***	**Threshold**	**Findings**	**Interpretation**	**Action Plan**

Matter Matter comprises an important component of the universe, and has physical properties that can be described over a range of scales.	Students learn that forces and energy are important at both the scale of Earth and the atomic scale, and at scales in between.	The course ranges from the formation of Earth (large, planetary scale) to the absorption of light by atoms in solar cells (tiny, atomic scale). The spectroscopy activity most obviously relates to these concepts.	On assignments/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	The average score was an 88%.	Students are meeting this outcome.	No action plan.

GE Learning Goal	**Measurable Learning Outcome**	**Method of Measure***	**Threshold**	**Findings**	**Interpretation**	**Action Plan**

Energy Interactions within the universe can be described in terms of energy exchange and conservation.	Students will predict and explain the conversion of energy from one form to another.	Energy transformations are the heart of this course. Whether we are talking about stored chemical energy (in coal or in chocolate chip cookies) or energy from the Sun contributing to photosynthesis or photovoltaics, the students are tracing how energy is transformed from one form to another. Energy "losses" are explored in our discussion of "efficiency". The Chapter 12 Homework explores Earth's energy balance and the effect of Earth's atmosphere on transmission of energy from the surface.	On assignments/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	The average score was a 75%.	Students are meeting this outcome.	No action plan.

GE Learning Goal	**Measurable Learning Outcome**	**Method of Measure***	**Threshold**	**Findings**	**Interpretation**	**Action Plan**

Forces Equilibrium and change are determined by forces acting at all organizational levels.	Students will analyze forces to describe physical properties of a system.	At bottom, nearly all means of energy production involve "spinning the spinny thing"; that is, making a generator turn in order to produce electricity. A small amount of discussion on this topic shows up in the Making Electricity activity, in which students use a small handheld generator to light a light bulb.	On assignments/exams, 60% correlates to a "mostly proficient" understanding of the learning outcome; 75% correlates to a "proficient" understanding.	The average score was an 88%.	Students are meeting this outcome.	No action plan. This activity needs further development to more explicitly address the "forces" aspect.

Additional narrative (optional – use as much space as needed):

A major shift in our General Education Assessment took place when we developed a dedicated 3-hour laboratory session to the Big Question for all sections of PHYS 2010 and PHYS 2210. The report for this lab became the Signature Assignment for students in all of these sections fulfilling PS breadth requirement. The lab has been under development and has been evaluated by individual lab instructors. However, for the fall of 2020, a uniform grading rubric for all lab sections has also been implemented. We plan to use these data to better understand the use of this lab as a signature assignment once we have more data and more consistent in-person laboratory sessions in the post-pandemic regime.

Appendix A

Most departments or programs receive a number of recommendations from their Five/Seven-Year Program Review processes. This page provides a means of updating progress towards the recommendations the department/program is enacting.

Date of Program Review: 2019	Progress Description
Program Support: "The laboratory support staff appears to be relatively underutilized while instructional staff is stretched too thin."	With help from the CoS dean, we executed a major restructure. One staff person was moved to another college (EAST); another faculty member was reduced to half-time appointment by mutual agreement. These two moves allowed us to hire a new tenure-track faculty member (starting Fall 2020), increasing our faculty by 0.5 FTE. Discussions with the Program Review team were based on an increase of 1.5 FTE, so we are still looking for ways to add another faculty member.
Teaching: Revision of curriculum and teaching methodologies.	Our Department Curriculum Committee has been charged with a curriculum revision to "streamline" the tracks within our Physics major. While progress has been slowed by the pandemic, we expect several revisions. A team of faculty has created shared resources for experiential learning in PHYS 1010 *Elementary Physics.* A departmental name change (to Department of Physics and Astronomy) aimed at recruiting and better communicating our full department purview has been approved at the department level and is in the Curriculog process.

Appendix B

Please provide the following information about the full-time *and adjunct faculty* contracted by your department during the last academic year (summer through spring). Gathering this information each year will help with the headcount reporting that must be done for the final Five Year Program Review document that is shared with the State Board of Regents.

Faculty Headcount	2017-18	2018-19	2019-20
With Doctoral Degrees (Including MFA and other terminal degrees, as specified by the institution)			
Full-time Tenured	7	7	7
Full-time Non-Tenured (includes tenure-track)	1	1	1
Part-time and adjunct	3	4*	3
With Master's Degrees			
Full-time Tenured			
Full-time Non-Tenured	1	1	1
Part-time and adjunct	5	4	3
With Bachelor's Degrees			
Full-time Tenured			
Full-time Non-tenured			
Part-time and adjunct		1	
Other			
Full-time Tenured			
Full-time Non-tenured			
Part-time			
Total Headcount Faculty			
Full-time Tenured	7	7	7
Full-time Non-tenured	2	2	2
Part-time	8	9	6

*I included Dr. Valle from the Computer Science department in the 18/19 data, who taught PHYS 2300 in Sp19. His salary came entirely from CS. This was a mutually beneficial arrangement between the two departments.

Please respond to the following questions.

1) First year student success is critical to WSU's retention and graduation efforts. We are interested in finding out how departments support their first-year students. Do you have mechanisms and processes in place to identify, meet with, and support first-year students? Please provide a brief narrative focusing on your program's support of new students:

   Given the upheaval of COVID to our usual course dynamics, our recruitment and retention committee emailed all introductory physics students midway through the semester in our PHYS 2210/2220 courses to check in with them. Through this process, the committee was able to guide several students to Colin Inglefield for advising as well as understand avenues to help increase student success in our current online environment. All students who responded were appreciative of our efforts to reach out to them. We plan to continue this effort in the spring and may potentially expand it to the upper division majors courses.

   The recruitment and retention committee is also in the process of planning a virtual brown bag lunch series for introductory physics students in the spring. This effort is designed to help integrate our first year majors into our department remotely. The brown bag lunch series should help students learn about research, introduce faculty, and provide them the opportunity to be involved with other physics students further along in their education here at WSU.

   To help recruit new students, the committee is also highlighting introductory level research projects that can be taken on early in one's education to help provide another avenue to engage with our department.

2) A key component of sound assessment practice is the process of 'closing the loop' – that is, following up on changes implemented as a response to your assessment findings, to determine the impact of those changes/innovations. It is also an aspect of assessment on which we need to improve, as suggested in our NWCCU mid-cycle report. Please describe the processes your program has in place to 'close the loop'.

   We have a department committee structure where committees and charges are drafted by the chair and approved by the whole department. Assessment informs charges to several committees, including Curriculum, Advanced Lab, and Introductory

Lab.

Glossary

Student Learning Outcomes/Measurable Learning Outcomes

The terms ‘learning outcome’, ‘learning objective’, ‘learning competency’, and ‘learning goal’ are often used interchangeably. Broadly, these terms reference what we want students to be able to do AFTER they pass a course or graduate from a program. For this document, we will use the word ‘outcomes’. Good learning outcomes are specific (but not too specific), are observable, and are clear. Good learning outcomes focus on skills: knowledge and understanding; transferrable skills; habits of mind; career skills; attitudes and values.

- Should be developed using action words (if you can see it, you can assess it).
- Use compound statements judiciously.
- Use complex statements judiciously.

Curriculum Grid

A chart identifying the key learning outcomes addressed in each of the curriculum’s key elements or learning experiences (Suskie, 2019). A good curriculum:

- Gives students ample, diverse opportunities to achieve core learning outcomes.
- Has appropriate, progressive rigor.
- Concludes with an integrative, synthesizing capstone experience.
- Is focused and simple.
- Uses research-informed strategies to help students learn and succeed.
- Is consistent across venues and modalities.
- Is greater than the sum of its parts.

Target Performance (previously referred to as ‘Threshold’)

The level of performance at which students are doing well enough to succeed in later studies (e.g., next course in sequence or next level of course) or career.

Actual Performance

How students performed on the specific assessment. An average score is less meaningful than a distribution of scores (for example, 72% of students met or exceeded the target performance, 5% of students failed the assessment).

Closing the Loop

The process of following up on changes made to curriculum, pedagogy, materials, etc., to determine if the changes had the desired impact.

Continuous Improvement
An idea with roots in manufacturing, that promotes the ongoing effort to improve. Continuous improvement uses data and evidence to improve student learning and drive student success.

Direct evidence
Evidence based upon actual student work; performance on a test, a presentation, or a research paper, for example. Direct evidence is tangible, visible, and measurable.

Indirect evidence
Evidence that serves as a proxy for student learning. May include student opinion/perception of learning, course grades, measures of satisfaction, participation. Works well as a complement to direct evidence.

HIEE – High Impact Educational Experiences
Promote student learning through curricular and co-curricular activities that are intentionally designed to foster active and integrative student engagement by utilizing multiple impact strategies. Please see https://weber.edu/weberthrives/HIEE.html