

## UNIT REPORT

**Physics - Final Annual Report**

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**Physics Department Mission Statement****Start:** 07/01/2017**End:** 06/30/2018**Providing Department:** Physics**Department/Unit Contact:** Steve Robinson**Mission/Vision/Goal Statement:**

The mission statement for the TTU Department of Physics is to promote the learning of physics through effective teaching, research, and public service. Such learning opportunities are provided to students of all disciplines, in support of the mission of the University.

The department addresses this mission through two programs;

- i) a coherent program of study leading to a B.S. in Physics, and
- ii) a service program that provides courses in physics and astronomy that are requirements for other degree programs or are used by students to fulfill general education science requirements.

**Learning Outcome 1 - Diagnostic Test****Progress:** Ongoing**Define Goal:**

Students completing introductory physics courses will demonstrate increased understanding of certain basic concepts by achieving an average normalized gain score of at least 40% on a standardized conceptual diagnostic test.

**Learning Outcome 2 - Major Field Test****Progress:** Ongoing**Define Goal:**

Students graduating in physics will demonstrate an understanding of the principles and foundations of physics by having graduates score, on average, at or above the 75<sup>th</sup> percentile on the ETS Major Field Test in Physics.

**Learning Outcome 3 - Experimental Skills****Progress:** Ongoing**Define Goal:**

Students graduating in physics will demonstrate the skills and techniques necessary to engage in experimental investigation, by having at least 75% of students achieve a grade of C or better in the capstone senior lab course (PHYS 4710).

**Learning Outcome 4 - Oral Presentation****Progress:** Ongoing**Define Goal:**

Students graduating in physics will demonstrate the ability to communicate their understanding orally, as judged by a faculty committee who will report on oral presentations in the capstone senior lab course (PHYS 4710).

**Learning Outcome 5 - Technological Tools****Progress:** Ongoing**Define Goal:**

Students graduating in physics will have received an introduction to the technological tools appropriate to physics and related disciplines, as reported by graduating physics majors in exit interviews and by alumni in surveys conducted periodically.

### **Learning Outcome 6 - Career Preparation**

**Progress:** Ongoing

**Define Goal:**

Students graduating in physics will agree that the program gave them sufficient preparation to continue to graduate school or obtain suitable employment, as reported by graduating physics majors in exit interviews and by alumni in surveys conducted approximately every five years.

### **Learning Outcome 7 - Development of Research Skills**

**Progress:** Ongoing

**Define Goal:**

Students graduating in physics will demonstrate the skills and techniques needed to engage in planning and carrying out basic or applied research by having at least 75% of students achieve a grade of C or better in the PHYS 4730 (Research Planning) and PHYS 4740 (Research) courses taken as seniors. When applicable, during exit interviews, they will also be asked about the value of their research experiences as undergraduates in the department.

### **Program Goal 1 - Number of Majors**

**Progress:** Ongoing

**Define Goal:**

Increase the number of physics majors (as determined at the beginning of each Fall Semester) to a 5-year average of 50. This will be done through continued efforts at recruitment and retention.

**Intended Outcomes / Objectives:**

Approved - Nat

### **Program Goal 2 - STEM Center**

**Progress:** Ongoing

**Define Goal:**

Contribute to the mission of the Millard Oakley Center for Teaching and Learning in Science, Technology, Engineering, and Mathematics (STEM), by encouraging faculty members and physics students to become actively involved in the center.

### **Program Goal 3 - Teaching Reflection**

**Progress:** Ongoing

**Define Goal:**

Encourage faculty to reflect on their own teaching by making them aware of effective pedagogical developments coming from the physics education research community that may be relevant to their own classes.

### **Program Goal 4 - Undergraduate Research Opportunities**

**Progress:** Ongoing

**Define Goal:**

The department will maximize opportunities for physics majors to gain experience in basic or applied research by encouraging their participation in the research programs of departmental faculty, or in summer research programs at other institutions.

### **Tool 1 - Count Physics Majors**

**Goal/ Outcome/ Objective:** Program Goal 1

**Type of Tool:** Other

**Frequency of Assessment:** Beginning of every fall semester

**Rationale:**

At the beginning of each fall semester a count is made of the number of the total number of enrolled students who have Physics declared as a major. Because of the small numbers involved, trends are tracked using an average of the current year plus the previous four years.

### **Tool 10 - Exit Interviews**

**Goal/ Outcome/ Objective:** Learning Outcomes 5, 6, 7

**Type of Tool:** Other

**Frequency of Assessment:** As necessary for graduating seniors

**Rationale:**

Because of the delay in feedback via alumni surveys, we also address these student learning outcomes with students who are getting ready to graduate from the program. While these students do not have the benefit of post-program experience, they do have a fresher recollection of their TTU experiences and so can provide valuable feedback on some elements of the program. The department chair already conducts a confidential exit interview with each graduating physics major. These interviews explicitly address how well prepared each student feels for their next career step, including their preparation in the use of technological tools and development of research skills.

### **Tool 11 - PHYS 4730 (Research Planning) and PHYS 4740 (Research)**

**Goal/ Outcome/ Objective:** Learning Objective 7

**Type of Tool:** Capstone Project

**Frequency of Assessment:** Annually

**Rationale:**

All physics majors must take these two senior level research courses. To be successful in these courses students must create a detailed research plan and present it both in written and oral formats (PHYS 4730). They must then conduct the planned research and again present the results in written and oral formats (PHYS 4740). Each year the department will use the grades attained in these courses to judge students' competence in planning and conducting research.

### **Tool 2 - Examine STEM Center Involvement**

**Goal/ Outcome/ Objective:** Program Goal 2

**Type of Tool:** Survey

**Frequency of Assessment:** End of each academic year

**Rationale:**

At the end of each academic year, a count is made of the number of actual or proposed projects, programs, and outreach events in which members of the Physics faculty and physics undergraduates were jointly involved with the Millard Oakley Center for Teaching and Learning in Science, Technology, Engineering, and Mathematics (STEM).

### **Tool 3 - Research Involvement and Skills Development**

**Goal/ Outcome/ Objective:** Program Goal 4 and Learning Objective 7

**Type of Tool:** Other

**Frequency of Assessment:** End of each academic year

**Rationale:**

The department will keep a record of student participation in the research of department faculty members and in specialized summer research programs for undergraduates at other institutions. (Note: since almost all such experiences must necessarily take place during the summer it is impossible to ensure that all students will take advantage of such opportunities. However, the department will encourage such participation as actively as possible.)

#### **Tool 4 - Teaching Developments**

**Goal/ Outcome/ Objective:** Program Goal 4

**Frequency of Assessment:** End of each academic year

**Rationale:**

In their annual reports faculty members will be asked to comment on their awareness of new pedagogical developments and whether they have tried to implement them in their own teaching.

#### **Tool 5 - Video of Classes**

**Goal/ Outcome/ Objective:** Program Goal 4

**Frequency of Assessment:** Once per academic year

**Rationale:**

Once each academic year, every faculty member is video-taped teaching a class. The chair uses these video-tapes to assess a faculty member's teaching in terms of the implementation of effective pedagogy. The tapes are also made available to the faculty members concerned to facilitate reflection on their own teaching.

#### **Tool 6 - Force Concept Inventory**

**Goal/ Outcome/ Objective:** Learning Outcome 1

**Type of Tool:** Other

**Frequency of Assessment:** Beginning and end of each semester

**Rationale:**

This nationally recognized diagnostic test of basic conceptual understanding is administered to all students at the beginning of both PHYS 2010 and PHYS 2110 courses, and then again after the relevant material has been covered. The gain score, used to judge improvement in understanding, is a measure of the actual improvement in performance after instruction, versus the maximum possible improvement.

#### **Tool 7 - Major Field Test**

**Goal/ Outcome/ Objective:** Learning Outcome 2

**Type of Tool:** Exit Exam

**Frequency of Assessment:** When necessary for graduating seniors

**Rationale:**

All physics graduates will take the ETS Major Field Test in Physics during their final semester at TTU.

#### **Tool 8 - PHYS 4710 Capstone Course**

**Goal/ Outcome/ Objective:** Learning Outcomes 3 & 4

**Type of Tool:** Capstone Project

**Frequency of Assessment:** When necessary for graduating seniors

**Rationale:**

All physics majors take this senior lab course. To be successful in this course students must synthesize many skills learned in their academic careers to date. They must engage in scientific investigation by planning and carrying out experiments, and they must use their physics knowledge to guide them and to interpret their results. They must also submit written reports of all their investigations and make a public oral presentation of one project at the end of the semester. Faculty present at these presentations will submit a report on them. A written summary of these reports, together with an assessment as to whether a particular student has met this outcome, will be compiled by the faculty member teaching the course, and placed in the student's file.

#### **Tool 9 - Alumni Survey**

**Goal/ Outcome/ Objective:** Learning Outcomes 5 & 6

**Type of Tool:** Survey

**Frequency of Assessment:** Approximately every five years

**Rationale:**

Because of the low number of physics graduates, these surveys are administered to department alumni on an approximate 5-year cycle. Among the questions asked are how well graduates felt the TTU physics program prepared them for their chosen career path, and how effectively they were introduced to appropriate technological tools. (The most recent results available are from the survey conducted in Fall 2014 in conjunction with the department's scheduled academic audit.)

Attached Files

[TTU Physics Alumni Survey](#)

## Result 1 - Number of Physics Majors

**Goal/Objective/Outcome Number:** Program Goal 1

**Results:**

The number of declared physics majors at the start of the Fall 2017 semester was 27, which is a slight decrease from the previous year. However, it is notable that our recently developed Option II programs with specified interdisciplinary focus areas have attracted interest from three students in the past year, and that Fall 2018 has seen our largest incoming freshman class for several years (13 students).

## Result 10 - Exit Interviews

**Goal/Objective/Outcome Number:** Learning Objectives 5, 6, 7

**Results:**

In an interview conducted just before graduation one senior expressed general satisfaction with his preparation at TTU. Addressing the department goal of giving students a good grounding in computational techniques, he said he had received a good grounding in the use of commercial software and in the skills needed to write his own, or adapt existing, code. Addressing the department goal of developing students' research skills, this student agreed that experiences within the department had been invaluable in this area.

## Result 2 - STEM Center Involvement

**Goal/Objective/Outcome Number:** Program Goal 2

**Results:**

Physics faculty involvement in projects and programs associated with the Millard Oakley STEM Center (MOSC) has continued at a high level. During the past year one faculty member taught a complete course using the MOSC facilities. In addition four faculty members were engaged with MOSC in various ways. Two were PIs on separate grants administered by MOSC and two were instructors in MOSC-facilitated externally funded professional development programs. In addition, three physics faculty and ten students were involved in three different public outreach events offered by MOSC.

## Result 3 - Student Research Involvement

**Goal/Objective/Outcome Number:** Program Goal 4.

**Results:**

During this year a total of sixteen individual undergraduate students participated in research activities of various types with department faculty members.

## Result 4 - Teaching Developments

**Goal/Objective/Outcome Number:** Program Goal 4

**Results:**

During this year several developments in instruction occurred in the department:

- The Next Gen PET materials used in PHYS 1310 were finalized and published.

- Development continued on materials for the LEAP format of the PHYS 2020 course.
- Two faculty members continued developing a 'flipped' class format for the PHYS 2120 class.
- A new format was developed for the PHYS 2420 (Modern Physics) class.
- Two new research classes (PHYS 4730 and 4740) were taught for the first time.

### Result 5 - Video of Classes

**Goal/Objective/Outcome Number:** Program Goal 4

**Results:**

No classroom video was recorded again this year because of time pressure imposed by various administrative functions.

### Result 6 - Force Concept Inventory (FCI)

**Goal/Objective/Outcome Number:** Learning Outcome 1

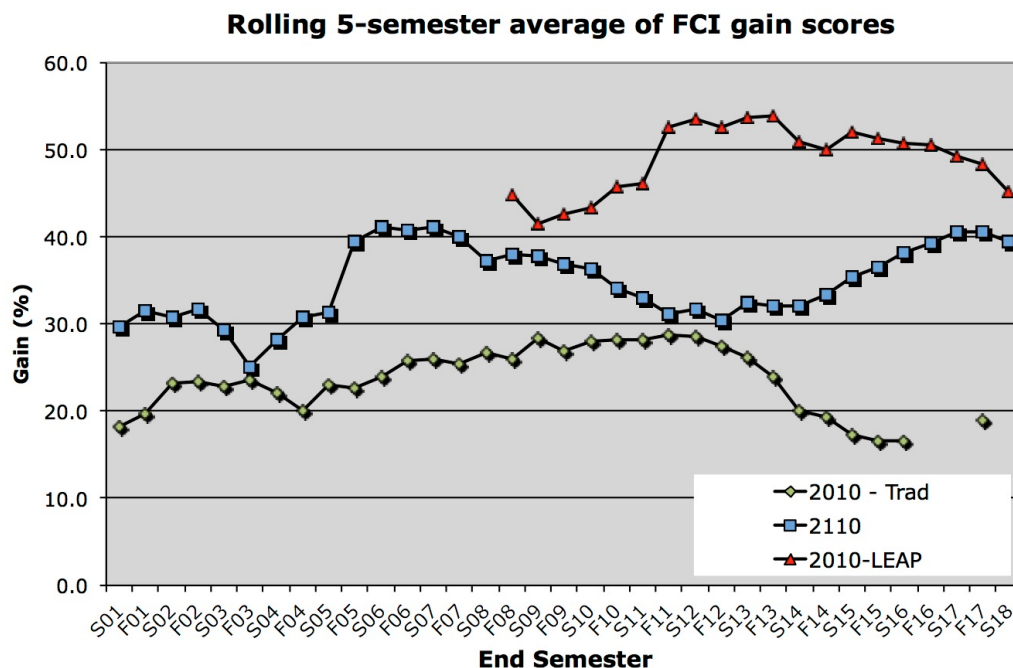
**Results:**

In the 2017/18 academic year 5 of 9 sections of PHYS 2110 achieved the goal of a normalized gain of 40% or more. The average gain of all 9 sections was approximately 39%.

In PHYS 2010 the 6 sections taught using the guided-inquiry LEAP curriculum had an average gain of 48%. While surpassing the goal of 40%, this average is lower than in previous years. Discussion with faculty has revealed that some content that is covered on the diagnostic test was not addressed fully in some sections due to time constraints. This issue is being addressed by those currently teaching the course, by reducing the time spent on in-class quizzing.

In each semester, the one section of PHYS 2010 taught in the more traditional manner again showed low gains of less than 20%, confirming that the LEAP format produces significantly enhanced student learning.

The graph below shows the rolling 5 semester average of FCI gains in relevant courses and a fuller report on a longitudinal study is attached.



**Attachments:** Attached Files

[FCI report 2018.pdf](#)

## Result 7 - Major Field Test

**Goal/Objective/Outcome Number:** Learning Outcome 2

**Results:**

Only one students took the Major Field Test in Physics this year, scoring at the 67th percentile. Our three year average percentile currently stands at 79%, which exceeds the department goal of an average of the 75 percentile. This puts the TTU physics program in the top 3% of institutions that use this test to measure student achievement.

## Result 8 - Capstone Course

**Goal/Objective/Outcome Number:** Student Learning Outcomes 3 & 4

**Results:**

No physics majors took the PHYS 4710 course this year.

## Result 9 - Alumni Survey

**Goal/Objective/Outcome Number:** Learning Outcomes 5 & 6

**Results:**

Due to the low numbers of graduates we only conduct this survey every 5 years. The last survey was completed in Fall 2014 and a report on that survey is attached. The survey will be conducted again during this coming year.

**Attachments:** Attached Files

[Physics alumni survey report 2014.pdf](#)

## Results 11 - Research Courses

**Goal/Objective/Outcome Number:** Learning Objective 7

**Results:**

In their first implementation, two students completed these course. Both achieved a grade of C or higher, thus demonstrating their attainment of the required skills and in planning and carrying out research.

## Change Related to Program Goal 1 - Introduction of freshman seminar class (PHYS 1137)

**Goal/Objective/Outcome Number:** Program Goal 1

**Program Changes and Actions due to Results:**

Due to math prerequisites, most incoming students who initially declare physics as a major cannot take their first physics class (PHYS 2110) in their first semester at TTU. Not engaging with their chosen major immediately can be problematic, with some choosing to switch majors, often to the much higher-profile engineering programs. To engage incoming freshmen with physics immediately, the department has developed PHYS 1137 (Frontiers of Physics) especially for incoming freshmen. Taught in the fall, this course will introduce students to several different topics that are at the forefront of current physics research, emphasizing how they are related to the topics covered in the courses taken as undergraduates. It will also highlight the research done within the department and encourage students to become engaged in this research as soon as possible.

**Link to Assessment:**

The development of this course is intended to engage incoming freshmen with cutting-edge topics in physics, exciting them about their physics major and thus helping to retain students who we might otherwise be lost to other programs.

**Link to Flight Plan:** Enrollment, Tuition, and Scholarships  
Improve Undergraduate Student Experience

## Change Related to Program Goal 4 and Learning Outcomes 6 & 7 - Undergraduate Research

**Goal/Objective/Outcome Number:** Change addressing Program Goal 4 and Learning Outcomes 6 & 7.

**Program Changes and Actions due to Results:**

Last year we implemented our senior level research courses (PHYS 4730 and 4740) for the first time. Originally we thought this would result in undergraduate research experience changing from being a program goal to a learning objective. However, we now realize that the informal research experiences of our students during the academic year and summer are still valuable and are to be encouraged, but cannot be mandated. Therefore we have kept a program goal addressing the encouragement of research opportunities (Program Goal 4), but also implemented a learning objective focused on the research courses (Learning Objective 7).

**Link to Assessment:**

Student development of research skills will be assessed in both formal and informal settings (Tools 3 & 7), and student and alumni feedback as to their value will also be elicited (Tools 9 and 10).

**Link to Flight Plan:** Improve Undergraduate Student Experience  
Create Distinctive Programs and Invigorate Faculty

## **Change related to Learning Outcome 1 and Program Goal 4 - Adoption of LEAP Curriculum**

**Goal/Objective/Outcome Number:** Program Goal 3 and Learning Outcome 1

**Program Changes and Actions due to Results:**

We would like to offer all sections of PHYS 2010 and PHYS 2020 using the integrated LEAP curriculum format. However, for now we will continue to offer one section taught in the traditional lecture+lab format.

**Link to Assessment:**

Students using the LEAP curriculum in the PHYS 2010 course show vastly superior performance on the Force Concept Inventory diagnostic test (Tool 4, Results 4) consistently surpassing the department goal of a gain of 40% (Learning Objective 1), whereas those in traditionally taught sections do not. However, in offering all courses in this format we found that some students could not fit the three 2-hours blocks required into their class schedules. In addition we do not yet have enough instructors who feel comfortable with the LEAP format to implement it in all sections. Therefore we will reluctantly continue to offer one section of both PHYS 2010 and PHYS 2020 in the traditional format.

**Link to Flight Plan:** Improve Undergraduate Student Experience

## **Change related to Learning Outcome 1 and Program Goal 4 - Development of Online Introductory Classes**

**Goal/Objective/Outcome Number:** Program Goal 4 and Learning Outcome 1

**Program Changes and Actions due to Results:**

For the past several years significant numbers of TTU students have chosen to take the online TN eCampus versions of PHYS 2110 and PHYS 2120. While for some this is because of the perceived ease of these classes compared to the on-ground counterparts, for others it is because of the convenience in scheduling that such a class offers. Unfortunately these online classes do not prepare students well, particularly in the area of needed laboratory skills. The TTU physics department has therefore resolved to develop its own online versions of these courses, focusing on maintaining high quality while employing current best practices in online delivery in general and physics content in particular. A working group has been formed that will examine the issues involved and the resources available, with the aim of rolling out the first version of online PHYS 2110 in the fall of 2019.

**Link to Assessment:**

The department will use the established FCI diagnostic test (Tool 4, Result 4) to assess student learning in this new online course compared to current on-ground versions.

**Link to Flight Plan:** Improve Undergraduate Student Experience