Institutional Effectiveness
2019-2020

Program: Physics BS

College and Department: College of Arts & Science – Department of Physics

Contact: Stephen Robinson

Mission: 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:

1. a coherent program of study leading to a B.S. in Physics, and
2. 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.

Program Goals:

Program Goal 1 - The Department will recruit and retain sufficient majors for a thriving educational program.

- Increase majors at least one per year. Having sustained an average of at least 30 majors for several years, the current minimum acceptable threshold is that the average number of majors should not drop below 30.

Program Goal 2 - The Physics Department will contribute to the mission of the Millard Oakley Center for Teaching and Learning in Science, Technology, Engineering, and Mathematics (STEM).

- The majority of faculty in the department will support the center by teaching at least one class using its facilities and/or facilitating activities in center outreach events.
- Physics students will engage in at least three center outreach activities per year.

Program Goal 3 - Ensure the use of effective and innovative pedogeological methods within the classroom.

- All faculty will report on changes/innovation in instruction in their annual reports, reflecting on their utility with regard to student learning and attitudes. Changes that result in improved student performance are expected to be adopted and will be shared with the department as a whole. As a minimum, faculty are expected to report on one such strategy per year.

Program Goal 4 - Provide opportunities for all physics majors to gain experience in authentic basic or applied research.

- All faculty engaged in research in suitable fields will seek support to engage interested physics majors in their work. Opportunities at other institutions and in other fields will also be made known to physics majors. The targeted outcome is that all physics majors will have the opportunity to engage in such opportunities as many times as they wish during their TTU career. At a minimum, any interested student should engage in at least one such opportunity.

Student Learning Outcomes:

Student Learning Outcome 1 - Students completing calculus-based and algebra-based introductory physics courses will demonstrate increased understanding of foundational basic concepts in mechanics.

- Students will achieve an average normalized gain score of at least 45% on a standard diagnostic test. For many years the targeted goal was a gain of 40%, but with recent improved performance, this year the target was raised to 45%. Currently, the minimum acceptable performance for any particular class section is a 30% gain, and any gain greater than 50% is regarded as exemplary.

Student Learning Outcome 2 - Students graduating in physics will demonstrate an understanding of the basic principles and foundations of physics.

- Graduating seniors will score, on average, at or above the 75^{th} percentile on the ETS Major Feld Test in Physics. The threshold of acceptability is to have all seniors score at or above the 50th percentile, thus maintaining a claim that TTU physics graduates are 'above average'.

Student Learning Outcome 3 - Students graduating in physics will demonstrate the skills and techniques necessary to engage in authentic experimental investigation.

- Students will demonstrate their ability to engage in experimental investigations by meeting or exceeding the minimum standards of the capstone Advanced Experimental Physics course (PHYS 4710 or PHYS 4711). The targeted outcome is that at least 75% of students should meet or exceed the minimum standards.

Student Learning Outcome 4 - Students graduating in physics will demonstrate the ability to communicate their understanding orally in a presentation format.

- Students will demonstrate their ability to effectively communicate their capstone Advanced Experimental Physics project (PHYS 4710 or PHYS 4711). The targeted outcome is that at least 75% of students should meet or exceed the minimum communication standards on the project rubric.

Student Learning Outcome 5 - Students graduating in physics will have received an introduction to a range of common technological tools appropriate to physics and related disciplines.

- All graduating physics majors and alumni report being adequately prepared to use technological tools appropriate to physics and related disciplines in their employment or graduate studies.

Student Learning Outcome 6 - The TTU physics program will give students sufficient preparation in content and skills/techniques to continue to graduate school or obtain suitable employment.

- All graduating seniors and alumni will report being well prepared to continue on to graduate school in physics (or a closely related discipline) or to enter immediate employment, whichever is relevant to their particular situation.

Student Learning Outcome 7 - Students graduating in physics will demonstrate the skills and techniques needed to engage in planning and carrying out basic or applied research.

- Students will demonstrate competency by completing a research project in PHYS 4730 (Research Planning) and PHYS 4740 (Research) courses taken as seniors. Students will meet or exceed the minimum standards of the research course (PHYS 4730 or PHYS 47140). The targeted outcome is that at least 75% of students should meet or exceed the minimum standards.

A departmentally developed curriculum map can be found in Appendix 1 that shows the connections between courses and student learning outcomes.

Assessment Methods:

PG 1: The Department will recruit and retain sufficient majors for a thriving educational program.

Department Records: 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. The department keeps 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.) 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).

PG 2: The Physics Department will contribute to the mission of the Millard Oakley Center for Teaching and Learning in Science, Technology, Engineering, and Mathematics (STEM).

Department Records: 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. The department keeps 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.) 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).

PG 3: Ensure the use of effective and innovative pedogeological methods within the classroom.

Annual Faculty Reports: 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.

PG 4: Provide opportunities for all physics majors to gain experience in authentic basic or applied research.

Department Records: 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. The department keeps 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.) 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).

SLO 1: Students completing calculus-based and algebra-based introductory physics courses will demonstrate increased understanding of foundational basic concepts in mechanics.

Force Concept Inventory: The Force Concept Inventory is a nationally recognized diagnostic test of basic conceptual understanding and 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 normalized gain score, used to judge improvement in understanding, is a measure of the actual improvement in performance after instruction, versus the maximum possible improvement.

SLO 2: Students graduating in physics will demonstrate an understanding of the basic principles and foundations of physics.

Major Field Test: The ETS Major Field Test in Physics is a 70-item multiple-choice test that covers: Classical Mechanics and Relativity; Electromagnetism; Optics and Wave, Thermodynamics and Statistical Mechanics; Quantum Mechanics and Atomic Physics; and other Special Topics. All physics graduates will take the ETS Major Field Test in Physics during their final semester at TTU. Due to a low number of students, only two sub-scores are provided with the Exit exam results.

SLO 3: Students graduating in physics will demonstrate the skills and techniques necessary to engage in authentic experimental investigation.

PHYS 4710/4711 Capstone Course: All physics majors take a senior lab course, either PHYS 4710 (4 cr) or PHYS 4711 (2 cr). 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.

SLO 4: Students graduating in physics will demonstrate the ability to communicate their understanding orally in a presentation format.

PHYS 4710/4711 Capstone Oral Comm.: All physics majors take a senior lab course, either PHYS 4710 (4 cr) or PHYS 4711 (2 cr). 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.

SLO 5: Students graduating in physics will have received an introduction to a range of common technological tools appropriate to physics and related disciplines.

Exit Interviews: Exit Interview 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.

Alumni Surveys: Because of the low number of physics graduates, the alumni 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 2019 in conjunction with the department's scheduled academic audit.)

SLO 6: The TTU physics program will give students sufficient preparation in content and skills/techniques to continue to graduate school or obtain suitable employment.

Exit Interviews: Exit Interview 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.

Alumni Surveys: Because of the low number of physics graduates, the alumni 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 2019 in conjunction with the department's scheduled academic audit.)

SLO 7: Students graduating in physics will demonstrate the skills and techniques needed to engage in planning and carrying out basic or applied research.

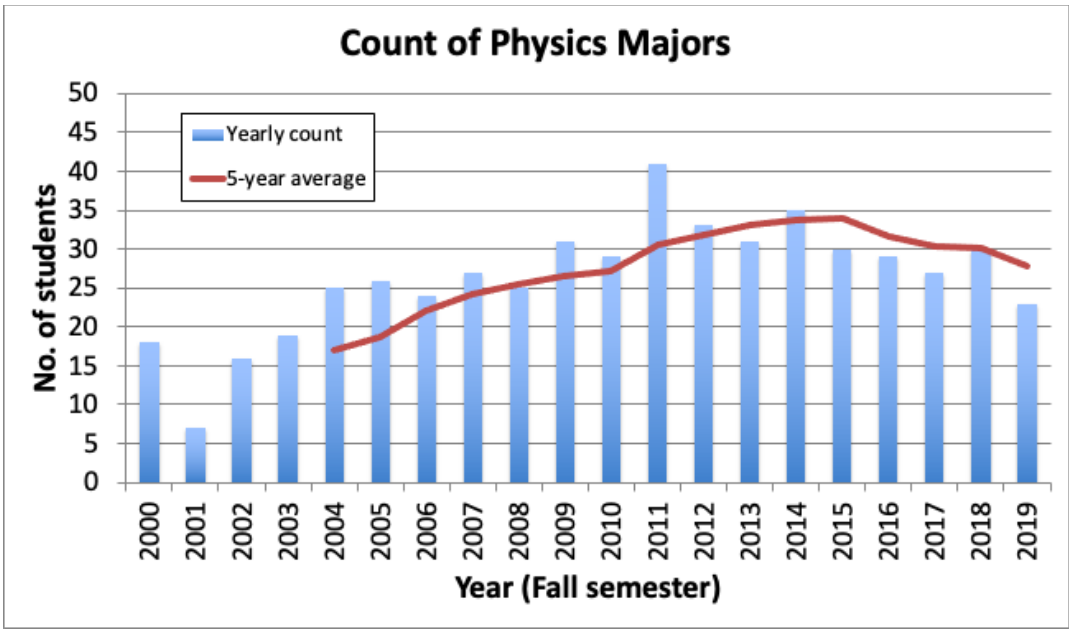
PHYS 4730 (Research Planning) and PHYS 4740 (Research) Capstone: All physics majors must take these two senior level research courses. To be successful in these courses, students must create a detailed research plan and present it both in written and oral formats (PHYS 4730). They must then conduct the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

Results:

Program Goal 1 - The Department will recruit and retain sufficient majors for a thriving educational program.

- *Increase majors at least one per year. Having sustained an average of at least 30 majors for several years, the current minimum acceptable threshold is that the average number of majors should not drop below 30.*

The number of declared physics majors at the start of the Fall 2019 semester was 23. This was an anomalously low number which nevertheless reduces the 5-year average to 28, below the minimum acceptable threshold. Thus, in the coming year, we are placing an increased emphasis on recruitment and retention, as discussed in another section of this report.



Program Goal 2 - The Physics Department will contribute to the mission of the Millard Oakley Center for Teaching and Learning in Science, Technology, Engineering, and Mathematics (STEM).

- *The majority of faculty in the department will support the center by teaching at least one class using its facilities and/or facilitating activities in center outreach events.*
- *Physics students will engage in at least three center outreach activities per year.*

Physics faculty involvement in projects and programs associated with the Millard Oakley STEM Center (MOSC) increased significantly due to the department being displaced while Bruner Hall is renovated. Four faculty members taught at least one course using the MOSC facilities. Two of these faculty members were also PIs on separate grants administered by MOSC and three were involved in four separate public outreach events offered by MOSC. In addition, several physics majors were involved in planning and facilitating 'stations' at two of these outreach events. This does not quite meet the target for involvement of students or faculty, but far exceeds the minimum acceptable.

Program Goal 3 - Ensure the use of effective and innovative pedogeological methods within the classroom.

- *All faculty will report on changes/innovation in instruction in their annual reports, reflecting on their utility with regard to student learning and attitudes. Changes that result in improved student performance are expected to be adopted and will be shared with the department as a whole. As a minimum, faculty are expected to report on one such strategy per year.*

Encouragingly, all faculty reported that they tried at least one different strategy in a class this year (though some of this was related to the COVID-induced transition to online delivery). However, not all reflected on the effect of their chosen strategy on student learning or attitudes.

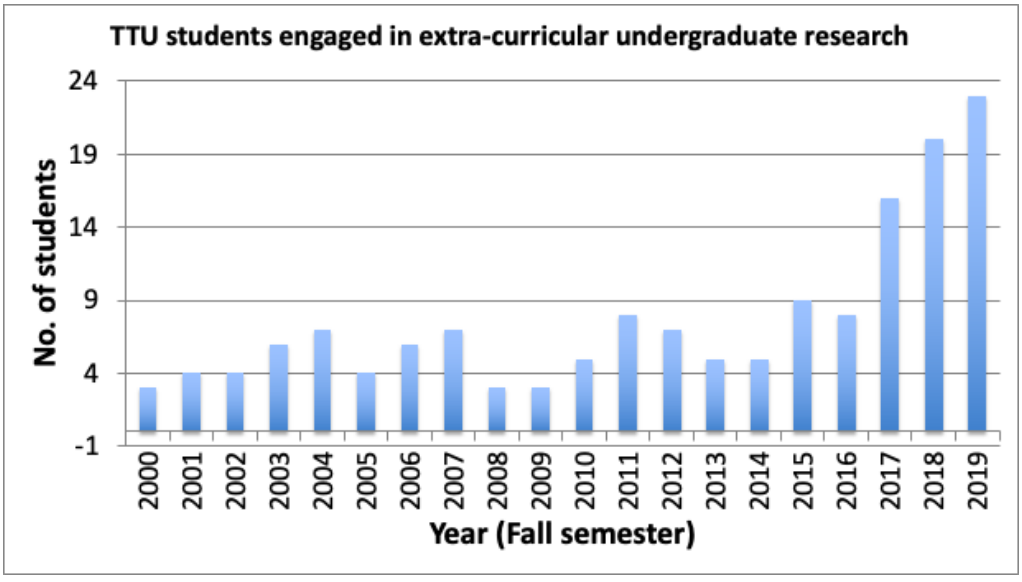
Major developments in instruction that were reported included:

- Further adoption of the 'flipped' class format developed for the PHYS 2110 class.
- Offering of an online section of PHYS 2110 in the Fall, Spring, and Summer semesters.
    - Initial indications are that students in this section did not perform any worse than those in face-to-face sections.
- Development of an online version of PHYS 2120 that will be field tested by two faculty in the coming Fall semester.
- Refinement of the Frontiers of Physics freshman seminar class (PHYS 1173), taught for the second time.
- Initial offering of the Observational Astronomy (ASTR 3100) course in Fall 2019.

Program Goal 4 - Provide opportunities for all physics majors to gain experience in authentic basic or applied research.

- *All faculty engaged in research in suitable fields will seek support to engage interested physics majors in their work. Opportunities at other institutions and in other fields will also be made known to physics majors. The targeted outcome is that all physics majors will have the opportunity to engage in such opportunities as many times as they wish during their TTU career. At a minimum, any interested student should engage in at least one such opportunity.*

During this year a total of twenty-three individual undergraduate students participated in research activities of various types with department faculty members. In addition, one graduate student in the College of Education was mentored by two physics faculty members. All physics majors who desired such an experience were accommodated, thus achieving the target for this goal.



Student Learning Outcome 1 - Students completing calculus-based and algebra-based introductory physics courses will demonstrate increased understanding of foundational basic concepts in mechanics.

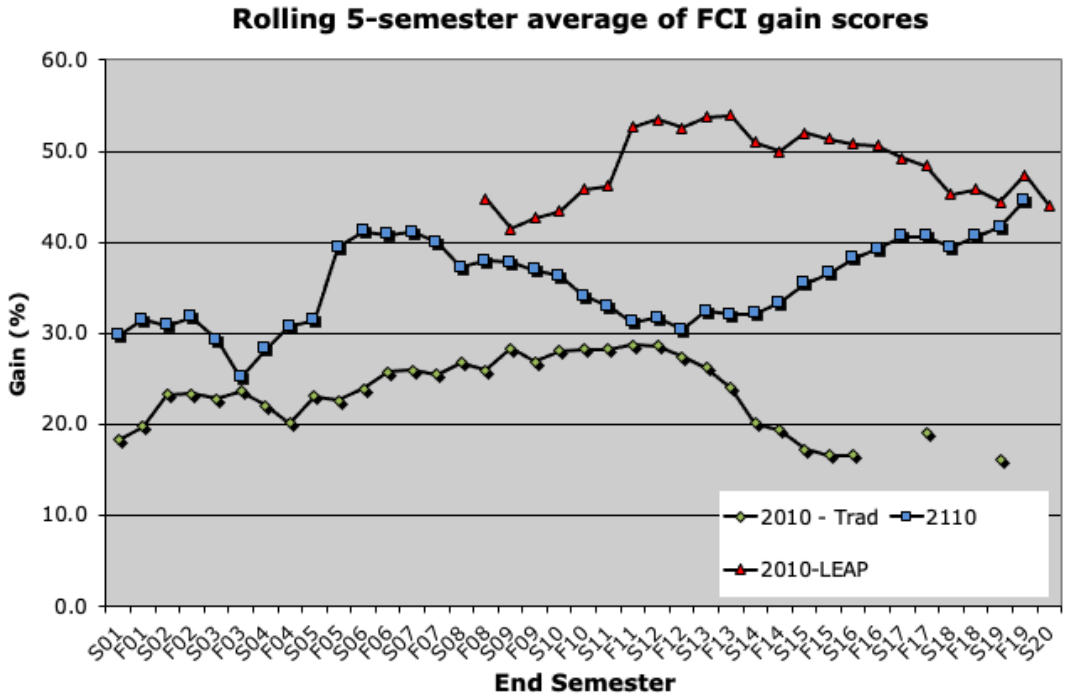
- *Students will achieve an average normalized gain score of at least 45% on a standard diagnostic test. For many years the targeted goal was a gain of 40%, but with recent improved* performance, this year the target was raised to 45%. Currently, the minimum acceptable

performance for any particular class section is a 30% gain, and any gain greater than 50% is regarded as exemplary.

In the Fall 2019 semester 4 of 5 face-to-face sections of PHYS 2110 achieved the new goal of a normalized gain of 45%. The newly implemented online section of this course had the lowest gain (29%). However, these results must be tempered with the knowledge that very few students completed the post-test in any section, and thus no meaningful conclusions can yet be drawn on the efficacy of the online format for this course. Folding these uncertain results, the rolling 5-semester average gain stood at 44.8% already approaching the new goal! Unfortunately, the disruption caused by the COVID-19 pandemic meant that we could not gather any post-course data for this course in the Spring 2020 semester, so we will have to wait to see if this trend continues.

Turning to PHYS 2010 all 3 fall sections taught using the guided-inquiry LEAP curriculum surpassed the 45% goal, with an average gain of 55%, the highest it has been for two years. This may be due to deliberate attempts on the part of the faculty in this course to re-emphasize conceptual understanding. However, we will have to wait because, although data was collected in the spring, it cannot be seen as indicative due to the sudden transition to an online format for what is essential a 'hands-on' course. Reluctantly, we continued to offer one section of PHYS 2010 in the more traditional manner. This because of i) the need to accommodate students who cannot fit the LEAP format into their schedule, and ii) not enough faculty who are comfortable teaching in the LEAP format. Low registration in this section meant that no meaningful data could be collected in either semester, but past history indicates that gains of less than 20% are typical. We hope that an expected opportunity to hire a new faculty member in the near future will help to address this issue.

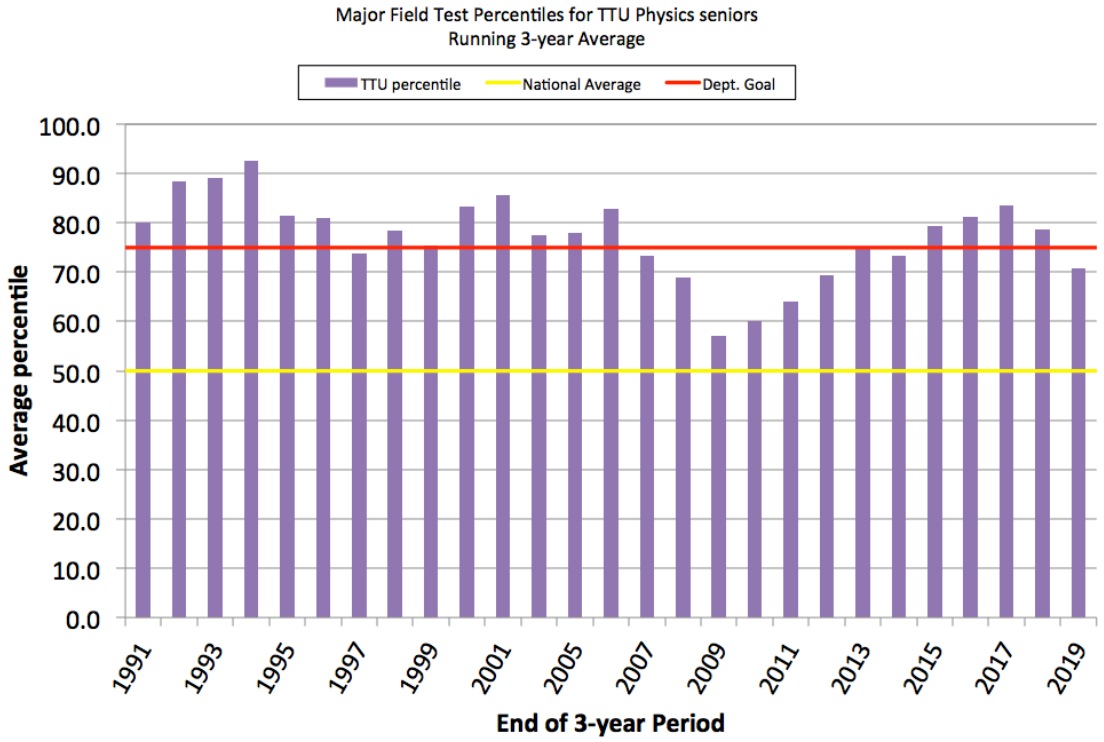
The graph below shows the rolling 5 semester average of FCI gains in relevant courses and a fuller report on a continuing longitudinal study is attached.



Student Learning Outcome 2 - Students graduating in physics will demonstrate an understanding of the basic principles and foundations of physics.

- *Graduating seniors will score, on average, at or above the 75th percentile on the ETS Major Feld Test in Physics. The threshold of acceptability is to have all seniors score at or above the 50th percentile, thus maintaining a claim that TTU physics graduates are 'above average'.*

Unfortunately, due to the COVID-19 situation, the two graduating seniors who had not already taken the Major Field Test were not able to do so. (The third had already taken the test in the previous year, scoring at the 93rd percentile.) Thus, we will have to wait until next year to see whether last year's dip below the targeted goal (a three-year average of the 75th percentile) was a temporary 'blip'.



Student Learning Outcome 3 - Students graduating in physics will demonstrate the skills and techniques necessary to engage in authentic experimental investigation.

- *Students will demonstrate their ability to engage in experimental investigations by meeting or exceeding the minimum standards of the capstone Advanced Experimental Physics course (PHYS 4710 or PHYS 4711). The targeted outcome is that at least 75% of students should meet or exceed the minimum standards.*

Two physics majors took the PHYS 4711 course this year. Both met the minimal expectations. Thus, the target for this goal was attained. However, the small number of students involved in these courses means we will have to wait several years to get the general picture.

Student Learning Outcome 4 - Students graduating in physics will demonstrate the ability to communicate their understanding orally in a presentation format.

- *Students will demonstrate their ability to effectively communicate their capstone Advanced Experimental Physics project (PHYS 4710 or PHYS 4711). The targeted outcome is that at least 75% of students should meet or exceed the minimum communication standards on the project rubric.*

Two physics majors took either the PHYS 4710 or 4711 course this year, both were judged by the faculty to have made acceptable oral presentations

Student Learning Outcome 5 - Students graduating in physics will have received an introduction to a range of common technological tools appropriate to physics and related disciplines.

- *All graduating physics majors and alumni report being adequately prepared to use technological tools appropriate to physics and related disciplines in their employment or graduate studies.*

Exit Interview: Unfortunately, due to the COVID-19 situation, it was not possible to conduct exit interviews with this year's three graduating seniors.

Alumni Survey: Due to the low numbers of graduates we only conduct this survey every 5 years. The most recent survey was conducted last year, in conjunction with our program review. A full report is attached, but significant results are:

- Alumni continue to be highly satisfied with the program and the overall level of preparation they receive for their future careers.
- The standard of preparation in Classical Mechanics and Thermodynamics is consistently rated as somewhat weaker than that in other topics.
- Alumni continue to rate their undergraduate research experiences as extremely valuable.
- We need to closely monitor perceptions of preparation for collaboration/working in teams.

Student Learning Outcome 6 - The TTU physics program will give students sufficient preparation in content and skills/techniques to continue to graduate school or obtain suitable employment.

- *All graduating seniors and alumni will report being well prepared to continue on to graduate school in physics (or a closely related discipline) or to enter immediate employment, whichever is relevant to their particular situation.*

Exit Interview: Unfortunately, due to the COVID-19 situation, it was not possible to conduct exit interviews with this year's three graduating seniors.

Alumni Survey: Due to the low numbers of graduates we only conduct this survey every 5 years. The most recent survey was conducted last year, in conjunction with our program review. A full report is attached, but significant results are:

- Alumni continue to be highly satisfied with the program and the overall level of preparation they receive for their future careers.

- The standard of preparation in Classical Mechanics and Thermodynamics is consistently rated as somewhat weaker than that in other topics.
- Alumni continue to rate their undergraduate research experiences as extremely valuable.
- We need to closely monitor perceptions of preparation for collaboration/working in teams.

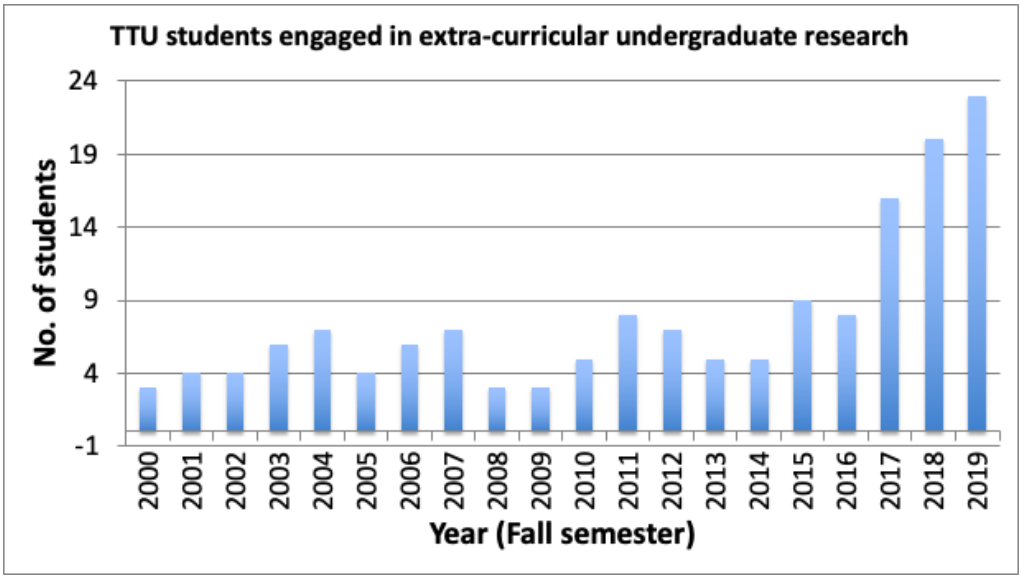
Student Learning Outcome 7 - Students graduating in physics will demonstrate the skills and techniques needed to engage in planning and carrying out basic or applied research.

- *Students will demonstrate competency by completing a research project in PHYS 4730 (Research Planning) and PHYS 4740 (Research) courses taken as seniors. Students will meet or exceed the minimum standards of the research course (PHYS 4730 or PHYS 47140). The targeted outcome is that at least 75% of students should meet or exceed the minimum standards.*

PHYS 4730 (Research Planning) and PHYS 4740 (Research) Capstone

Two students completed these courses this year and met the minimal standards for success, thus demonstrating their attainment of the required skills and in planning and carrying out research.

Student Research Involvement: During this year a total of twenty-three individual undergraduate students participated in research activities of various types with department faculty members. In addition, one graduate student in the College of Education was mentored by two physics faculty members. All physics majors who desired such an experience were accommodated, thus achieving the target for this goal.



Exit Interviews: Unfortunately, due to the COVID-19 situation, it was not possible to conduct exit interviews with this year's three graduating seniors.

Modifications for Improvement:

Program Goal 1

In an effort to raise the profile of the department, as well as make direct contact with prospective physics majors, we will compile a list of high schools offering AP and Honors physics classes. We will then contact the instructors of these classes and offer faculty and student volunteers as visiting speakers who can give presentations on various topics, as well as advertise/recruit for our program.

The number of physics majors at TTU seems to have stabilized at a five-year average of around 30. In order to try to grow this number (Program Goal 1) we continue to try various approaches to improve recruitment and retention. This speaker program is an attempt to recruit directly to those already taking a physics course in high school.

Program Goal 3, Student Learning Outcomes 1 & 2

Over the past few years most department faculty have reformed their courses to incorporate more active-learning strategies. Examples include the use of 'clickers', think-pair-share questioning, and group problem solving. Some faculty have completely restructured their courses to be much more student-centered, such as the development of the LEAP format for PHYS 2010/2020 and the development of a 'flipped-class' format for PHYS 2110/2120. This has also been done in some upper division courses. It is likely that this shift in instructional modalities is responsible for the evident improvement in diagnostic test scores, such as the gradual improvement in the PHYS 2110 course to a current average gain of almost 45%, and the gains in the LEAP sections of PHYS 2010 that are regularly over 50%.

However, for some faculty, after introducing one or two such strategies nothing more has been tried for several years. In order to promote more reflection on their teaching, Program Goal 3 will be changed to state explicitly that faculty are expected to report on at least one NEW strategy per year."

While faculty will reflect on the effectiveness of new strategies in their annual reports, improvements in student learning and attitudes should also become apparent in the FCI diagnostic test, Major Field Test, and Exit Interviews. Longer term effects will be assessed using the Alumni Survey, hopefully addressing some deficiencies in preparation reported in certain content areas.

Program Goal 1, Student Learning Outcome 6

Until recently the physics program at TTU has been mainly geared toward those who wanted to pursue their studies into graduate school, with little emphasis on preparation for other careers. (A few years ago, we did develop Option II (Applied Physics) programs of study with emphases in different areas, but none of these were really oriented toward a specific career or societal need.) With this primary emphasis, the number of students majoring in physics seems to have stabilized well below the long-term goal of 50. However, during the past year, through a newly established contact at Cookeville Regional Medical Center (CRMC), it has been brought to our attention that a program in Health Physics may offer an opportunity to help address a predicted shortage of practitioners in this field, as well as recruiting more students for the department. Preliminary discussions along this line were interrupted by the COVID-19 situation, but during the coming year we will assess as to whether it would be feasible to collaborate with CRMC to establish such a program. This will involve a needs assessment, development of a possible program of study, and plans for the development and delivery of any necessary new

courses. As a first step, and to gauge interest among students already at TTU, we will offer a 'special topics' course in Introductory Health Physics, taught by our contact at CRMC.

The number of physics majors at TTU seems to have stabilized at a five-year average of around 30. In order to try to grow this number (Program Goal 1) we continue to try various approaches to improve recruitment and retention. Therefore, one consideration in exploring the possibility of proposing a Health Physics program is the impact it may have on the number of majors. Eventually such a program would contribute to alumni perceptions of career preparation (Learning Outcome 6).

Appendices

1. Physics BS Curriculum Map

Appendix 1: Physics BS Curriculum Map

Support for core goals and learning outcomes in the program of study for a B.S. in Physics.

		Goals/Learning Outcomes					
Course	Title	Physics knowledge	Analytical skills	Laboratory skills	Communication skills	Computer skills	Research experience
PHYS 1137	Frontiers of Physics	X					
PHYS 2110	Calculus-based Physics I w/lab.	X	X	X			
PHYS 2120	Calculus-based Physics II w/lab	X	X	X			
PHYS 2420	Modern Physics	X	X		X	X	
PHYS 2920	Mathematical Physics		X		X	X	
PHYS 3610	Classical Mechanics	X	X		X	X	
PHYS 4610	Classical Elec. & Mag. I	X	X		X	X	
PHYS 4620	Classical Elec. & Mag. II	X	X		X	X	
PHYS 3120	Statistical Thermal Physics	X	X		X	X	
PHYS 3810	Quantum Mechanics I	X	X		X	X	
PHYS 3820	Quantum Mechanics II	X	X		X	X	
PHYS 4710/ PHYS 4711	Advanced Experimental Physics	X	X	X	X	X	
PHYS 4130	Computational Physics		X		X	X	
PHYS 4130	Research Planning	X	X	X	X	X	X
PHYS 4140	Research	X	X	X	X	X	X