Physics BS

Elevate the Reputation and Visibility of SHSU

Goal Description:

The Department seeks to elevate the reputation and visibility of SHSU by developing marketable skills that equip students for success in industry and the academy.

Providing Department: Physics BS

RELATED ITEMS/ELEMENTS ------

RELATED ITEM LEVEL 1

Develop Core Mathematical Competencies in Applied Contexts Learning Objective Description:

Lower division students will develop an interlinked network of quantitative skills in the context of physics and engineering applications. Skills to be addressed include algebra, trigonometry, vectors, logarithms and exponentials, polar coordinates, sinusoidal functions, complex numbers, matrices, differentiation, and integration.

RELATED ITEM LEVEL 2

First Year Physics Pre-Post Test Indicator Description:

Students will complete a pre/post test in Physics 1411 assessing the common foundational concepts in Physics. Statistics will be collected on major, level of math coursework completed, and whether the Physics Bootcamp was completed.

Attached Files

<u>1411_Pretest.pdf</u>

Criterion Description:

Students will show significant improvement between pre and post test, relative to the standard deviation of scores. A quarter point will be deducted per incorrect response (out of five multiple choice selections) so that the expected score for guessing is a zero.

Findings Description:

The 1411 pre/post test was administered. Post-test comparison scores are not currently available due to international travel of the instructor.

Instead, we can report on another pre/post test in the summer bridge program (STEM Catapult) related to the Physics Bootcamp program. The pre/post test consisted of 20 questions which were aligned with course coverage but independent of the actual material used for instruction and examination. Deducting a 1/4 point for incorrect responses, the corrected averages for the pre/post

test were 3.2 and 5.7, with an increase of 2.5 points (a factor of 1.8 improvement).

RELATED ITEM LEVEL 3

Continue Improving Assessment Materials Action Description:

Implement instrument developed with the STEM center for the Catapult program more broadly.

RELATED ITEM LEVEL 2

Incoming Student Mathematics Pre-Post Test Indicator Description:

Students in the Physics Bootcamp will be given a pre/post test to assess mathematics readiness and progress made during the course. Two example exams are given, one focused on SAT level mathematics and the other on Caculus.

Attached Files

Math_Pretest.pdf

Calculus Pretest.pdf

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RELATED ITEM LEVEL 3

Continue Improving Assessment Materials

Action Description:

Implement instrument developed with the STEM center for the Catapult program more broadly.

RELATED ITEM LEVEL 1

Develop Experience in the Practice of Investigative Research

Learning Objective Description:

Upper division students will develop experience with research under the direct supervision of a faculty member.

RELATED ITEM LEVEL 2

Student Exposure to Research Indicator Description:

The first indicator is inclusion of all Physics Majors and optionally also Astronomy Minors in a supervised research program. The second indicator is full participation in mentoring by the faculty.

Criterion Description:

Full participation by faculty and majors is expected.

Findings Description:

All students in the major (and most in the astronomy minor) have a research experience. A group of 8 research associates was taken to the conference on particle physics phenomenology at the

University of Pittsburgh. All faculty have supervised research activities.

RELATED ITEM LEVEL 3

Action - Student Exposure to Research Action Description:

Let students know about available research opportunities and establish projects they can contribute to at the undergraduate level.

RELATED ITEM LEVEL 1

Develop Higher-Order Critical Thinking Skills Learning Objective Description: Students at all levels will develop and demonstrate higher-order critical thinking skills, including a capacity to skillfully and creatively generalize techniques and principles to new contexts.

RELATED ITEM LEVEL 2

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Students will complete a pre/post test in Physics 1411 assessing the common foundational concepts in Physics. Statistics will be collected on major, level of math coursework completed, and whether the Physics Bootcamp was completed.

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Continue Improving Assessment Materials Action Description:

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RELATED ITEM LEVEL 2

Incoming Student Mathematics Pre-Post Test Indicator Description:

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RELATED ITEM LEVEL 3

Continue Improving Assessment Materials

Action Description:

Implement instrument developed with the STEM center for the Catapult program more broadly.

RELATED ITEM LEVEL 2

Introductory Astronomy Pre-Post Test Indicator Description:

A pre-post test will be administered in the introductory Astronomy courses to assess progress on relevant objectives.

Criterion Description:

Pre and post-test scores will be computed and tested for significant improvement against a p-value of 0.05.

Findings Description:

A pre/post content survey was administered in Fall 2023 Stars & Galaxies course as well as the Spring 2024 Solar System course. A content survey of concepts covered throughout each course was administered the first week of class, and again the last day of class, both times unannounced. The purpose was to see what preconceptions students having coming into the course and find out how well they retain the information, without the aid of studying. Averages pre and post are listed for each section. A normalized gain is also calculated.

Fall 2023 (PHYS1403) Section 2

pre-test: 30% post-test: 53% normalized gain: .34 (medium gain)

Section 3

pre-test: 30% post-test: 51% normalized gain: .30 (medium gain)

Spring 2024 (PHYS1404) Section 2

pre-test: 33% post-test: 50% normalized gain: .27 (medium gain)

RELATED ITEM LEVEL 3

Continue Improving Assessment Materials Action Description:

Implement instrument developed with the STEM center for the Catapult program more broadly.

RELATED ITEM LEVEL 2

Upper Division Physics Pre-Post Test Indicator Description:

Students in selected upper division courses will complete a pre/post test based on the Graduate Record Subject Exam in Physics. Examples are attached for PHYS 4370 (Classical Mechanics) and PHYS 4366 (Quantum Mechanics).

Attached Files

Quantum Mechanics A.pdf Classical Mechanics A.pdf

Criterion Description:

Students will show significant improvement between pre and post test, relative to the standard deviation of scores. A quarter point will be deducted per incorrect response (out of five multiple choice selections) so that the expected score for guessing is a zero.

Findings Description:

The upper division pre/post test was put on hold for one cycle, to resume subsequently.

RELATED ITEM LEVEL 3

Continue Improving Assessment Materials Action Description:

Implement instrument developed with the STEM center for the Catapult program more broadly.

RELATED ITEM LEVEL 1

Develop Marketable High-Demand Technical Skills

Learning Objective Description:

Students at all levels will develop and demonstrate skills valued in the workplace, such as mathematical sophistication, mental flexibility, trained intuition, capacity for abstraction, ability to independently and creatively solve problems, and experience working effectively on a team.

RELATED ITEM LEVEL 2

Development of Marketable Skills

Indicator Description:

Students will develop and demonstrate skills valued in the workplace, such as mathematical sophistication, mental flexibility, trained intuition, capacity for abstraction, ability to independently and creatively solve problems, and experience working effectively on a team.

Criterion Description:

A degree in physics opens a tremendous number of profitable career options because it develops marketable attributes and skills that employers are greatly interested in, such as mental flexibility, capacity for critical thinking, abstraction and generalization, training in creative problem solving, intuition for mechanical and electrical systems, and proficiency in advanced mathematics, data analysis, and computer applications (including programming).

These skills are developed throughout the degree program, starting with the Physics Bootcamp, which specifically addresses a majority of these marketable qualifications. Mathematical sophistication is developed through pedagogical exposure to the topics describe elsewhere, with extensive opportunities (recitation and homework) for self and team-based practice. Mental flexibility is encouraged by revisiting topics from multiple perspectives, by opportunities for peermentoring (where students may share distinct approaches), and by expressly furthering a recognition that any given problem can potentially be solved in a large variety of correct ways. Physical and mathematical intuition represents a bank of experience, refined by persistently comparing outcomes to expectations; thus, it may be usably projected onto new circumstances which resonate with those previously encountered. It is developed here by examples selected to build sensitivity to recurring patterns of thought, approaches to problem solving, and properties of natural law in the student's mind. Many such examples are selected expressly for their naively counter-intiuitive character. Abstraction is developed via extensive symbolic manipulation, and elevation of maximally general laws and principles. Independent creative problem solving is developed through a carefully structured sequence of examples and challenges that incrementally build on recently acquired skills,

requiring students to visualize and implement compound (multi-step) procedures in order to predict an outcome or design an optimized treatment. Teamwork is developed in collaborative small-group practice sessions.

Mathematical sophistication and capacity to independently solve problems is very directly assessed by performance in exams, assignments, and weekly group problem-solving recitations. Mental flexibility, intuition, and capacity for abstraction likewise indirectly manifest themselves on assignments and tests, especially components of those exercises specifically designed to challenge students in the application of skills and techniques to novel contexts. They are also be assessed by dialog with students during instructional periods, including student polling, with opportunities to reflect and redirect based on feedback from the instructor and/or peers. Team performance is self and group assessed during the recitations. It is also monitored by faculty and/or teaching assistants walking the tables to answer questions from each student group. In addition to the career insight fostered by direct exposure to the tools and techniques of physics and engineering, the Bootcamp seeks to expose students to more advanced aspects of life as a physicist or engineer. One form for this interaction is research or professional presentations by invited departmental guests (or similar online events), where students may be required to submit a summary of the talk and their impressions. In the case of on-campus events, students also have the opportunity to ask the guest directly about their work and seek advice on pathways into similar career opportunities.

Findings Description:

We have had multiple opportunities for career specialists in the space sector, national labs, and academic research to visit with students and communicate how skills developed in the classroom translate to a career. Students have submitted written essays about how they expect to use these skills in their careers. Team work has been developed in labs. Computer and analysis sophistication has been developed in research. Mathematical sophistication has been developed in the classroom and validated on exams.

RELATED ITEM LEVEL 3

Expand Redesign of the Conceptual Physics Course Action Description:

Roll out the program to the online courses and deal with challenges associated with the lab.

Refine the course in response to student feedback.

RELATED ITEM LEVEL 1

Develop Mastery Of Fundamental Principles In Physics Learning Objective Description:

Students at all levels will be exposed to the fundamental laws of nature and understand how a small set of principles govern and relate an incredible variety of phenomena in real-world contexts.

RELATED ITEM LEVEL 2

First Year Physics Pre-Post Test

Indicator Description:

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RELATED ITEM LEVEL 3

Continue Improving Assessment Materials Action Description:

Implement instrument developed with the STEM center for the Catapult program more broadly. RELATED ITEM LEVEL 2

Upper Division Physics Pre-Post Test Indicator Description:

Students in selected upper division courses will complete a pre/post test based on the Graduate Record Subject Exam in Physics. Examples are attached for PHYS 4370 (Classical Mechanics) and PHYS 4366 (Quantum Mechanics).

Attached Files

<u>Quantum_Mechanics_A.pdf</u>
 <u>Classical_Mechanics_A.pdf</u>

Criterion Description:

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Findings Description:

The upper division pre/post test was put on hold for one cycle, to resume subsequently.

RELATED ITEM LEVEL 3

Continue Improving Assessment Materials Action Description:

Implement instrument developed with the STEM center for the Catapult program more broadly.

RELATED ITEM LEVEL 1

Develop Skills in Applied and Creative Problem-Solving Learning Objective Description:

Students at all levels will learn to combine physical reasoning with mathematical computation in order to creatively solve real world problems and make predictions for measurable outcomes.

RELATED ITEM LEVEL 2

First Year Physics Pre-Post Test Indicator Description:

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Findings Description:

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RELATED ITEM LEVEL 3

Continue Improving Assessment Materials Action Description:

Implement instrument developed with the STEM center for the Catapult program more broadly.

Expand Our Service to the State and Beyond Goal Description:

The Department seeks to expand its service to the state and beyond by promoting science appreciation in the general population and offering innovative credentialing tracks supporting high-value careers.

Providing Department: Physics BS

RELATED ITEMS/ELEMENTS

RELATED ITEM LEVEL 1

Expand and Promote Appreciation for the Methods and Progress of Science Learning Objective Description:

Students in core science and introductory courses will be instructed in the methods and successes of scientific approaches to understanding the world.

RELATED ITEM LEVEL 2

Introductory Astronomy Pre-Post Test Indicator Description:

A pre-post test will be administered in the introductory Astronomy courses to assess progress on relevant objectives.

Criterion Description:

Pre and post-test scores will be computed and tested for significant improvement against a p-value of 0.05.

Findings Description:

A pre/post content survey was administered in Fall 2023 Stars & Galaxies course as well as the Spring 2024 Solar System course. A content survey of concepts covered throughout each course was administered the first week of class, and again the last day of class, both times unannounced. The purpose was to see what preconceptions students having coming into the course and find out how well they retain the information, without the aid of studying. Averages pre and post are listed for each section. A normalized gain is also calculated.

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Spring 2024 (PHYS1404) Section 2

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RELATED ITEM LEVEL 3

Continue Improving Assessment Materials Action Description:

Implement instrument developed with the STEM center for the Catapult program more broadly.

RELATED ITEM LEVEL 1

Expand and Promote Appreciation for the Wonder of the Natural World Learning Objective Description: Students in introductory and core science courses will be exposed to the magnificence and order of the natural world.

RELATED ITEM LEVEL 2

Introductory Astronomy Pre-Post Test Indicator Description:

A pre-post test will be administered in the introductory Astronomy courses to assess progress on relevant objectives.

Criterion Description:

Pre and post-test scores will be computed and tested for significant improvement against a p-value of 0.05.

Findings Description:

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pre-test: 33% post-test: 50% normalized gain: .27 (medium gain)

RELATED ITEM LEVEL 3

Continue Improving Assessment Materials

Action Description:

Implement instrument developed with the STEM center for the Catapult program more broadly.

RELATED ITEM LEVEL 1

Expand and Promote Credentialed Tracks in Astronomy

Performance Objective Description:

The Department seeks to expand student pathways in Astronomy with a new Astronomy Minor, supporting graduate study and careers in sectors such as space science and education.

RELATED ITEM LEVEL 2

Expand and Promote Astronomy Minor KPI Description: The Astronomy Minor has been approved, with students registered and courses offered. Subsequently, the program will be assessed for rate of enrollment, rate of completion, and student outcomes including progress toward graduate study or employment in an associated career.

Target Description:

See at least 10 students enrolled in upper division astronomy courses associate with the minor, and offer each upper-division course once per year.

Results Description:

This goal has been met and we look forward to expanding further.

RELATED ITEM LEVEL 3

Action - Expand and Grow Astronomy Minor

Action Description:

Resume operation of the advanced astronomy courses in Fall 2025 and initiate a new 1-hour seminar to close the "gap" in the 18-hour curriculum.

RELATED ITEM LEVEL 3

Create new 1-hour Astronomy Seminar Course

Action Description:

Add course to the catalog to "close the gap" in the 18 hour curriculum.

RELATED ITEM LEVEL 1

Expand and Promote Credentialed Tracks in Engineering and Applied Physics Performance Objective Description:

The Department seeks growth in the Pre-Engineering 2+2 tracks, as well as the dual degree Physics / Pre-Engineering track, and provide opportunities for students in applied physics. The performance objectives are increased enrollment and successful graduations / transfers.

RELATED ITEM LEVEL 2

Promote Tracks in Pre-Engineering KPI Description:

The performance indicator will be growth in the number of students declaring a Pre-Engineering Major (or participating in the dual degree program) and transitioning successfully to an accredited Engineering school. Graduates may be tracked after graduation to self-assess the quality of their preparation and to gather statistics on secondary outcomes.

Target Description:

See growth of at least 25% in registration for pre-engineering tracks in the first three years of assuming program supervision.

Results Description:

This goal has been substantially exceeded, and enrollment in the first semester Physics Bootcamp course has more than doubled, with significant registrations from pre-engineering and dual degree students.

RELATED ITEM LEVEL 3

Action - Promote Tracks in Pre-Engineering Action Description:

Partner with UT Tyler to reformalize the articulation agreement and update the catalog.

RELATED ITEM LEVEL 1

Expand and Promote Credentialed Tracks in Physics and Astronomy Education Performance Objective Description: The Department seeks to partner with the College of Education to promote careers in science education and to equip students pursuing those careers with a suitable combination of core science competencies and pedagogical methods. The performance objectives are increased graduation rates, job placement, and career longevity.

RELATED ITEM LEVEL 2

Promote Tracks in STEM Education KPI Description:

The performance indicator will be growth in the number of students enrolled in STEM education tracks with a (second) Major in Physics or a Minor in Astronomy. Graduates may be tracked after graduation to self-assess the quality of their preparation and to gather statistics on career longevity.

Target Description:

Reach agreement with Education Department on partnering to increase interest in this degree combination by Fall 2024.

Results Description:

Efforts have progressed on an agreement, but the agreement is not yet finalized. This goal remains pending.

RELATED ITEM LEVEL 3

Action - Promote Tracks in STEM Education

Action Description:

Partner with the education department to establish a degree plan for future teachers.

RELATED ITEM LEVEL 3

Expand Redesign of the Conceptual Physics Course

Action Description:

Roll out the program to the online courses and deal with challenges associated with the lab.

Refine the course in response to student feedback.

RELATED ITEM LEVEL 1

Expand and Promote Tracks Leading to Graduate Study in Physics Performance Objective Description:

The Department seeks to expand pathways for students interested in continuation to graduate programs in Physics and Astronomy. The performance objectives are increased applications, acceptances, and degree completions.

RELATED ITEM LEVEL 2

Promote Continuation to Graduate Study KPI Description:

The performance indicator will be growth in the number of students with a Major in Physics or a Minor in Astronomy proceeding to PhD and Masters programs. Graduates may be tracked after graduation to self-assess the quality of their preparation and to gather statistics on secondary outcomes.

Target Description:

See at least 1/3 of graduates applying for post-secondary education.

Results Description:

We are meeting the goal for applications to graduate study.

RELATED ITEM LEVEL 3

Action - Promote Continuation to Graduate Study Action Description: Take students to conferences, advertise application dates, and partner with faculty at programs that are accepting students.

RELATED ITEM LEVEL 3

Create new 1-hour Astronomy Seminar Course Action Description: Add course to the catalog to "close the gap" in the 18 hour curriculum.

Prioritize Student Success and Student Access

Goal Description:

The Department seeks to prioritize student success and student access by providing accessible educational pathways matched to high-value careers and mitigating achievement gaps.

Providing Department: Physics BS

RELATED ITEMS/ELEMENTS

RELATED ITEM LEVEL 1

Capitalize on Improved Accessibility and Reach for the Physics Bootcamp

Performance Objective Description:

The Department has successfully expanded the reach and accessibility of the Physics Bootcamp through inclusion in the University Core Science curriculum. Next, we must capitalize on this with effective marketing to students and departments who can benefit from this initiative.

RELATED ITEM LEVEL 2

Expand and manage enrollment in the Physics Bootcamp KPI Description:

After successful inclusion of Physics Bootcamp in the Core Science Curriculum, the next indicator is enrollment growth and management of that growth.

Target Description:

Expand enrollment to at least 25 students per spring and fall semester, and manage possible expansions of course sections if this enrollment consistently reaches a level of 40 or more students.

Results Description:

This goal has been exceeded, with close to (or above) 30 students enrolled for the upcoming and two prior terms.

RELATED ITEM LEVEL 3

Action - Capitalize on inclusion of Physics Bootcamp in Core Curriculum Action Description:

The bootcamp enrollment has doubled. We will plan to complete the associated textbook (Walker/Dent), publicize the course, and refine the student experience.

RELATED ITEM LEVEL 1

Provide Efficient Pathways for Students Who Arrive Near-to-Calculus-Ready Performance Objective Description:

The Department seeks to efficiently transition students who arrive near calculus-ready into successful coenrollment in Physics I and Calculus I during their first semester at SHSU through expansion of the summer bridge program and partnerships with the department of mathematics and statistics, as well as the STEM center. The performance objective is improvement in the pass rate coupled with acceleration of the degree plan.

RELATED ITEM LEVEL 2

Introduce Summer Bridge Program and Common First Year in STEM KPI Description:

The first indicator will be initiation of the programs. Subsequently, the summer bridge will be assessed for enrollment, and progress of participants will be assessed using pre-post testing. Their subsequent outcomes in the first year STEM experience at SHSU may also be compared against a control group, correcting for other educational and preparatory differences.

Target Description:

Successfully operate a first trial of the bridge program in July 2023, with at least 15 students enrolled.

Results Description:

The STEM bootcamp was operated in conjunction with the STEM center and the department of Math and Statistics. It was an success, with more than 15 students enrolled and several fast-tracked for more advanced coursework in the following term.

RELATED ITEM LEVEL 3

Complete First Offering of the Summer Bridge and Common First Year Experience Action Description:

Find a funding mechanism to renew this course in future summers (external, Federal preferred). **RELATED ITEM LEVEL 1**

Provide Flexible Pathways for Students With Broad Interests in STEM Performance Objective Description:

The Department seeks provide students with general interest in various STEM disciplines an opportunity to complete a common first year experience that samples various possibilities without sacrificing credit or degree progress.

RELATED ITEM LEVEL 2

Introduce Summer Bridge Program and Common First Year in STEM KPI Description:

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Complete First Offering of the Summer Bridge and Common First Year Experience Action Description:

Find a funding mechanism to renew this course in future summers (external, Federal preferred).

Update to Previous Cycle's Plan for Continuous Improvement Item Previous Cycle's Plan For Continuous Improvement (Do Not Modify):

Closing Summary

The Department seeks to grow enrollment in several targeted academic tracks, including STEM Education, Pre-Engineering, and Astronomy, while also increasing the number of Physics majors progressing to graduate study.

The Department seeks to develop marketable technical skills, with a focus on the promotion of critical thinking, abstract reasoning, mathematical sophistication, physical intuition, creative problem solving, and teamwork.

The Department seeks to promote student success with expansion of the Physics Bootcamp, development of a summer bridge program for students who are near calculus-ready, and initiation of a common first year program for quantitative STEM tracks.

The Department seeks to promote appreciate for the progress of science and the majesty of the natural world.

The department seeks to improve outreach and advertisement, including by further improvements to the website, including video student testimonials.

Update of Progress to the Previous Cycle's PCI:

Enrollment in the major courses at the front of the degree (Bootcamp, PHYS 1, PHYS 2) was close to doubled.

A successful model of the summer bridge program was instructed.

Better communication with the advising center led to improved awareness of our programs among students.

Students were integrated into research and the department was recognized at the annual Pheno conference in Pittsburgh (for leadership in undergraduate research inclusion).

New Plan for Continuous Improvement

Closing Summary:

We will formalize the continuation of the articulation agreement with UT Tyler and update the catalog.

We will continue to partner with advising and the visitor center to get relevant information to students.

We will continue to lead in undergraduate research inclusion.

We will promote the Physics Bootcamp curriculum to a national (and international) audience ahead of the book release.

We will emphasize marketable skills that are developed by our degree program.