2021-2022

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

Progress: Ongoing

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

1411_Pretest.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:

In the most recent pre/post assessment pre-test scores were well within one standard deviation from zero. Post-test scores were above zero by 3.5 standard deviations, showing significant improvement.

RELATED ITEM LEVEL 3

Continue Improving Assessment Materials

Action Description:

Continue refinement of pre-post exam materials and expand testing.

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

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:

Results were not collected during this cycle but will be collected next cycle.

RELATED ITEM LEVEL 3

Continue Improving Assessment Materials

Action Description:

Continue refinement of pre-post exam materials and expand testing.

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 faculty are supervising student research. All graduating Physics Majors are participating in a research project, and many are funded by the National Science Foundation.

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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RELATED ITEM LEVEL 3

Continue Improving Assessment Materials

Action Description:

Continue refinement of pre-post exam materials and expand testing.

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:

Statistically significant improvement was indicated in the most recent examinations, as detailed in the attached spreadsheet.

Attached Files

Scott_S-G.xlsx

RELATED ITEM LEVEL 3

Continue Improving Assessment Materials

Action Description:

Continue refinement of pre-post exam materials and expand testing.

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:

In the most recent pre/post assessment pre-test scores were within one standard deviation from zero. Post-test scores were above zero by 1.8 standard deviations, showing significant improvement.

RELATED ITEM LEVEL 3

Continue Improving Assessment Materials

Action Description:

Continue refinement of pre-post exam materials and expand testing.

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 peer-mentoring (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:

Continuing.

RELATED ITEM LEVEL 3

Complete Redesign of the Conceptual Physics Course

Action Description:

The conceptual physics course (PHYS 1305) has historically been too similar to the course for science majors. Professor Shepherd has been redesigning the course with a focus on active learning and hands-on experiences that are transferrable to classrooms of the future educators who make up a large fraction of the course enrollment. Future related performance indicators are completion of the redesign, success with enrollment, and student self-assessment of applicability of the course content to their future use.

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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Action Description:

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RELATED ITEM LEVEL 2

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Indicator Description:

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Findings Description:

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RELATED ITEM LEVEL 3

Continue Improving Assessment Materials

Action Description:

Continue refinement of pre-post exam materials and expand testing.

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:

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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RELATED ITEM LEVEL 3

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Action Description:

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RELATED ITEM LEVEL 3

Continue Improving Assessment Materials

Action Description:

Continue refinement of pre-post exam materials and expand testing.

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

Progress: Ongoing

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:

Statistically significant improvement was indicated in the most recent examinations, as detailed in the attached spreadsheet.

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Scott_S-G.xlsx

RELATED ITEM LEVEL 3

Continue Improving Assessment Materials

Action Description:

Continue refinement of pre-post exam materials and expand testing.

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:

Statistically significant improvement was indicated in the most recent examinations, as detailed in the attached spreadsheet.

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Scott_S-G.xlsx

RELATED ITEM LEVEL 3

Continue Improving Assessment Materials

Action Description:

Continue refinement of pre-post exam materials and expand testing.

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

Introduce Astronomy Minor

KPI Description:

The first relevant indicator is completion of the approval process to offer an Astronomy Minor. Subsequently, the program may be assessed for rate of enrollment, rate of completion, and student outcomes including progress toward graduate study or employment in an associated career.

Results Description:

Pending.

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.

Results Description:

Pending

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.

Results Description:

Pending.

RELATED ITEM LEVEL 3

Complete Redesign of the Conceptual Physics Course

Action Description:

The conceptual physics course (PHYS 1305) has historically been too similar to the course for science majors. Professor Shepherd has been redesigning the course with a focus on active learning and hands-on experiences that are transferrable to classrooms of the future educators who make up a large fraction of the course enrollment. Future related performance indicators are completion of the redesign, success with enrollment, and student self-assessment of applicability of the course content to their future use.

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.

Results Description:

Pending

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

Progress: Ongoing

RELATED ITEMS/ELEMENTS

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 a new summer bridge program. 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.

Results Description:

Pending.

RELATED ITEM LEVEL 3

Complete First Offering of the Summer Bridge and Common First Year Experience

Action Description:

Planning is continuing for the first summer bridge for students who are near calculus-ready in 2023. This may subsequently form the foundation for the proposed common first year experience.

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:

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.

Results Description:

Pending.

RELATED ITEM LEVEL 3

Complete First Offering of the Summer Bridge and Common First Year Experience

Action Description:

Planning is continuing for the first summer bridge for students who are near calculus-ready in 2023. This may subsequently form the foundation for the proposed common first year experience.

RELATED ITEM LEVEL 1

Provide Greater Accessibility and Reach for the Physics Bootcamp

Performance Objective Description:

The Department seeks to expand the reach and accessibility of the Physics Bootcamp through inclusion in the University Core Science curriculum.

RELATED ITEM LEVEL 2

Inclusion of Physics Bootcamp in the Core Curriculum

KPI Description:

The indicator of success will be inclusion of Physics Bootcamp in the Core Science Curriculum for 2023.

Results Description:

Pending.

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 enhance the opportunity for incoming freshmen interested in physics and astronomy to explore the major at an early juncture without prerequisites and without penalties to financial aid eligibility, by adding Physics Bootcamp (PHYS 1401) to the core curriculum.

The department seeks to improve engagement with applied physics and pre-engineering students by assuming responsibility for the pre-engineering degree tracks in the Fall of 2022. Preparatory work will continue up to that point.

The department seeks to attract students interested in professional work in astronomy and astrophysics by opening a new minor in Astronomy.

Professor Shepherd (funded under the Engaging Classrooms / QEP) will lead redevelopment of the 1305/1105 curriculum. Updates will emphasize hands-on elements and aspects of physical science which are directly transferrable to students of elementary educators who graduate from Sam.

The department seeks to expand the number of students taking advantage of calculus-based introductory physics among majors from other departments which require calculus. This includes computer science and a subset of the engineering technology degrees.

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:

The submission of Bootcamp to the Core Curriculum was completed and approved at the College level. The proposal is pending at the University level, with the goal of approval for 2023.

Supervision of pre-engineering tracks will begin in Fall 2022, on schedule.

The new Astronomy minor has been approved.

The course redesign for Conceptual Physics was tested with a first set of students and is proceeding on schedule.

Additional student video testimonials were recorded, with publication pending.

New Plan for Continuous Improvement

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.