APS physics | Education & Diversity
PROMOTING PEOPLE IN PHYSICS

APS March Meeting 2018

εP^3: Guide to Effective Practices in Undergraduate Physics Programs – What It Is and Why You Should Care

APS physics

AAPT PHYSICS EDUCATION

David Craig
Le Moyne College &
Oregon State University

What is it?

APS, in cooperation with AAPT, is creating a guide to help physics departments improve, review and assess their programs …

and to help them meet challenges they may face

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Design Goals

Who is it for?

- Physics department chairs
- Program leaders
- Program reviewers
- Programs being reviewed
- Faculty facing program challenges or interested in improving their programs
- Anyone involved with student learning assessment
- Administrative leaders

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Today

I want you to:

- Become aware of this potentially transformative initiative
- Get a sense of the forces driving the effort
- Understand the Task Force vision, goals & trajectory
- Agree that outcomes are being designed to help you and not hinder you
- Know who to contact with questions and input

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What is it?

Physics is generally pretty healthy…

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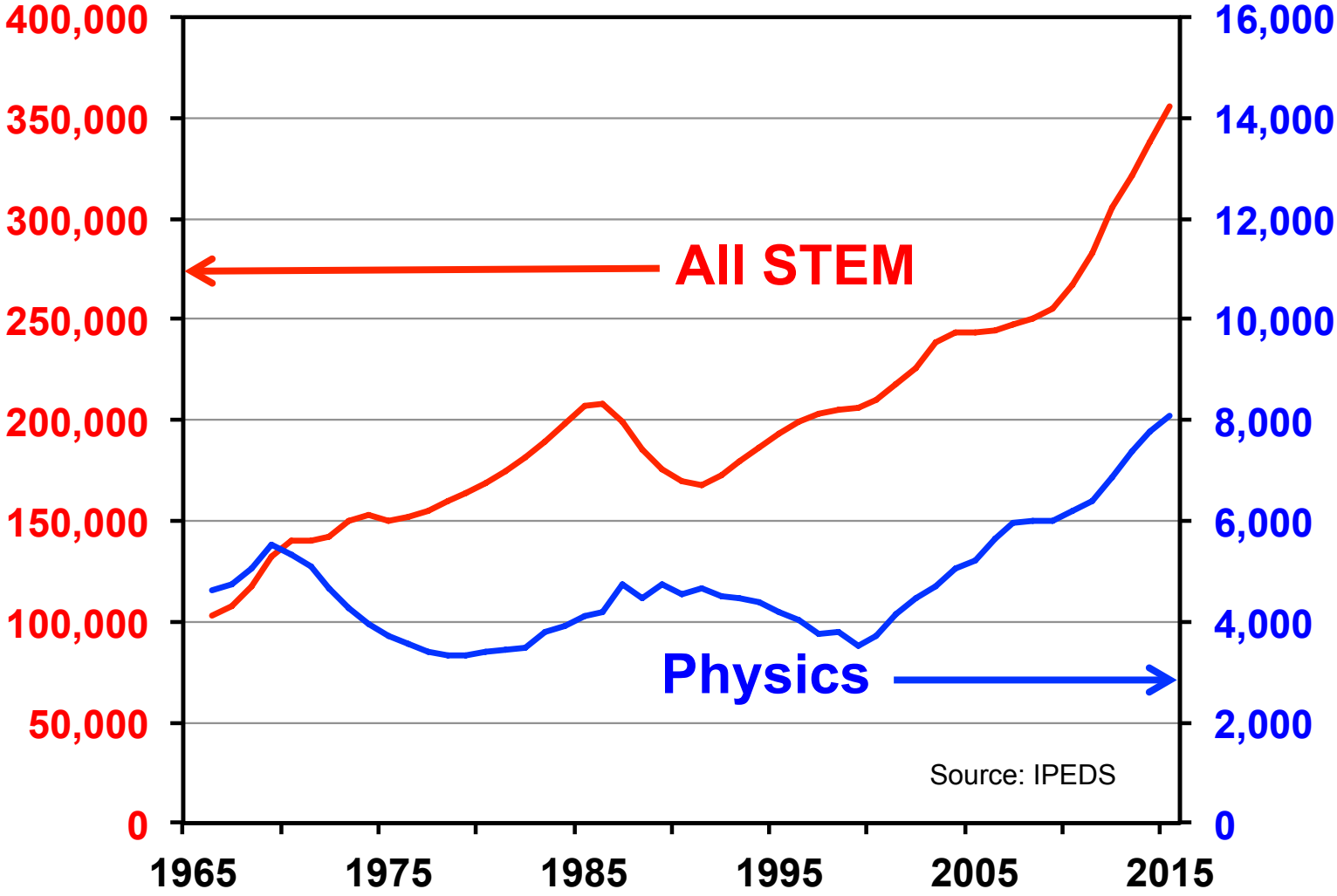
Physics / STEM Bachelor Degrees



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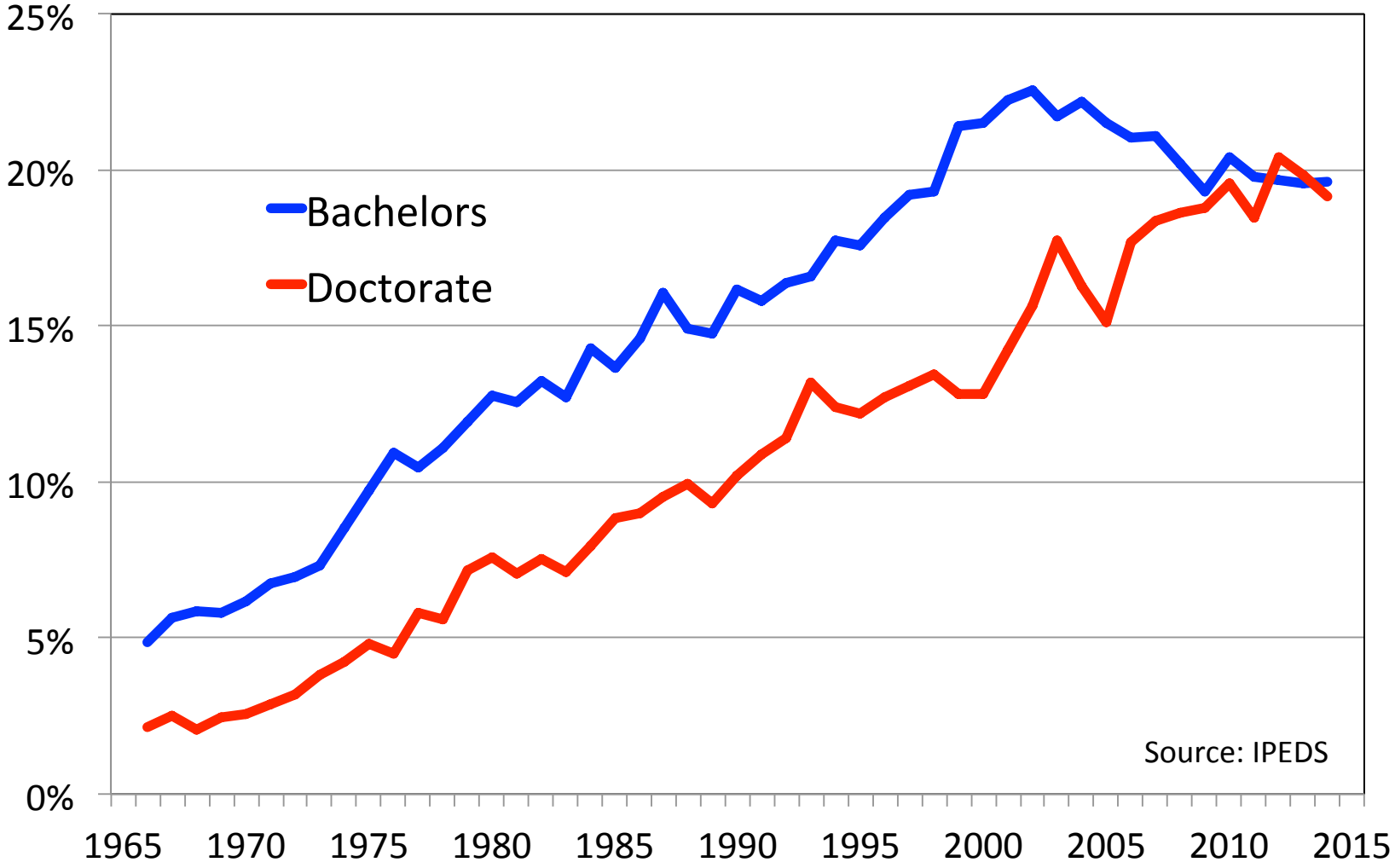
Percentage of Women in Physics



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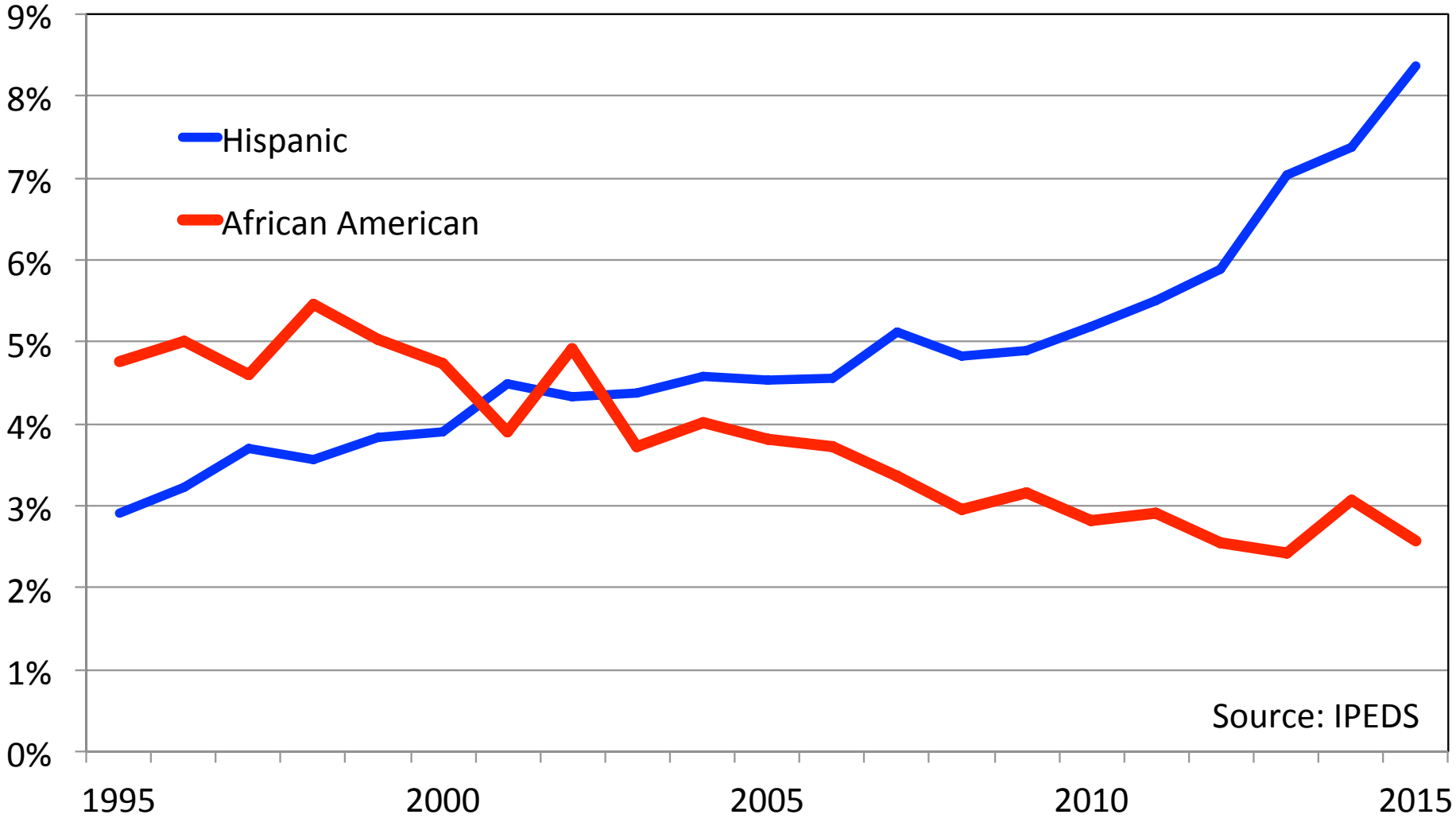
Physics Bachelor Degrees Awarded to Underrepresented Minorities



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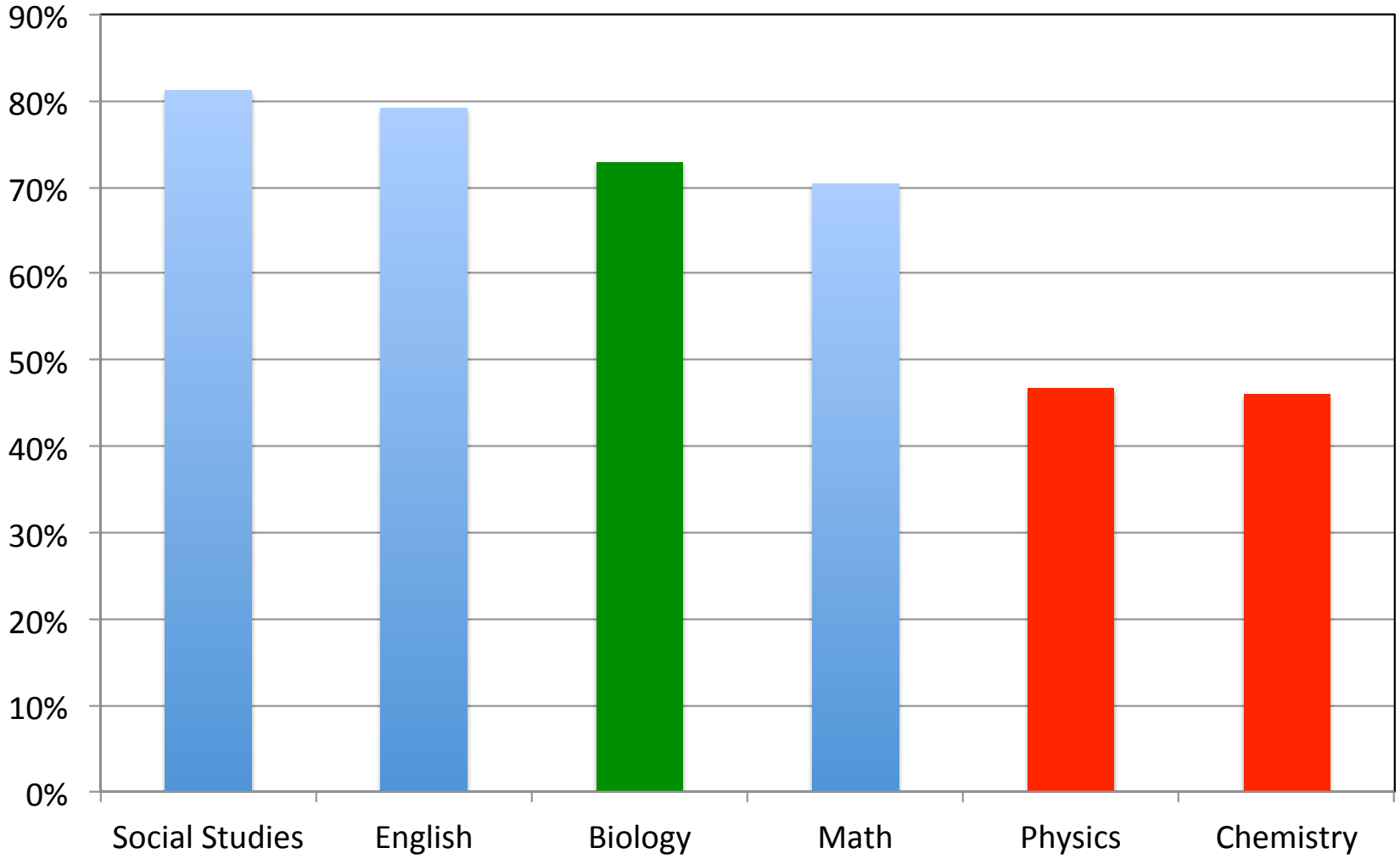
High school classes taught by teacher with degree in the field



Source: Schools and Staffing Survey

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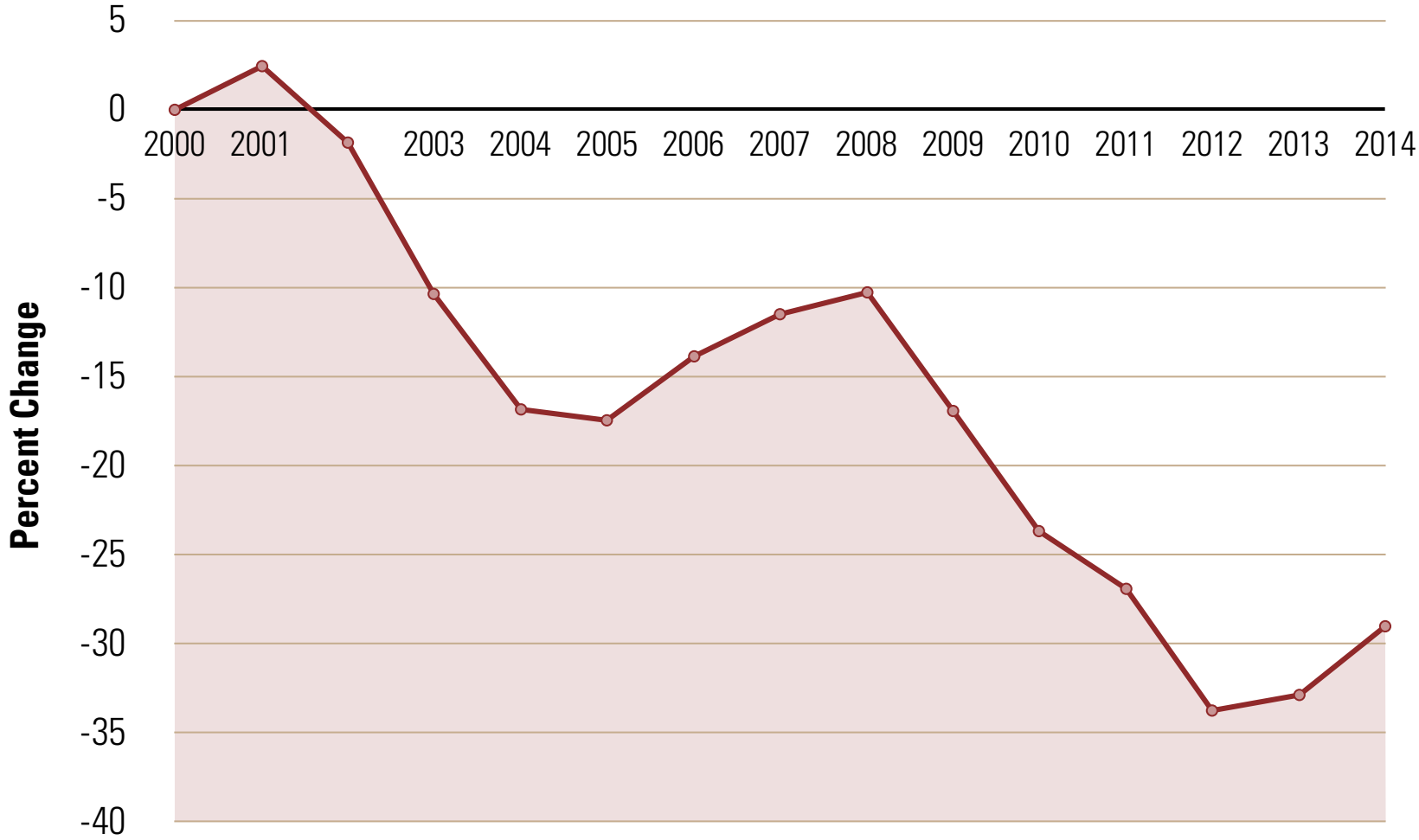
Change in Public Funding of Higher Education in the US



Source: The Lincoln Project: Public Research Universities - Recommitting to Lincoln's Vision: An Educational Compact for the 21st Century (Amer. Acad. of Arts & Sciences)

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What do these institutions have in common?

- Cleveland State University
- Elizabeth City State University
- Long Island University
- Minnesota State University Moorhead
- Prairie View A&M University
- Southern Oregon University
- Tennessee State University
- Texas Southern University
- University of Northern Iowa
- University of Southern Maine

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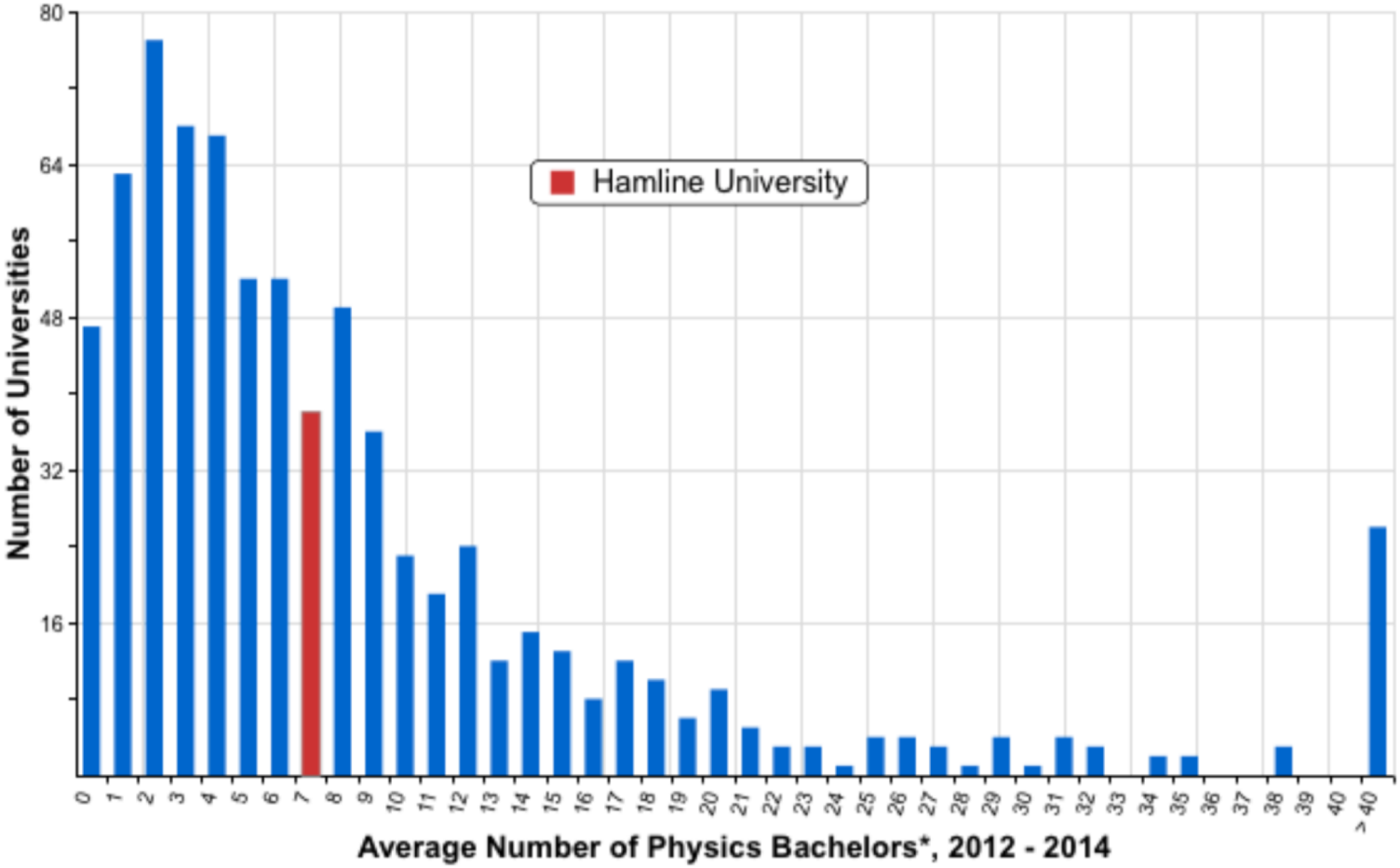
Physics Bachelor Degrees



www.aps.org/programs/education/statistics/compare.cfm

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Interactive Education: Read this Article

PNAS

Active learning increases student performance in science, engineering, and mathematics

Scott Freeman[a,1], Sarah L. Eddy[a], Miles McDonough[a], Michelle K. Smith[b], Nnadozie Okoroafor[a], Hannah Jordt[a], and Mary Pat Wenderoth[a]

[a]Department of Biology, University of Washington, Seattle, WA 98195; and [b]School of Biology and Ecology, University of Maine, Orono, ME 04469

Edited* by Bruce Alberts, University of California, San Francisco, CA, and approved April 15, 2014 (received for review October 8, 2013)

To test the hypothesis that lecturing maximizes learning and course performance, we metaanalyzed 225 studies that reported data on examination scores or failure rates when comparing student performance in undergraduate science, technology, engineering, and mathematics (STEM) courses under traditional lecturing versus active learning. The effect sizes indicate that on average, student performance on examinations and concept inventories increased by 0.47 SDs under active learning (n = 158 studies), and that the odds ratio for failing was 1.95 under traditional lecturing (n = 67 studies). These results indicate that average examination scores improved by about 6% in active learning sections, and that students in classes with traditional lecturing were 1.5 times more likely to fail than were students in classes with active learning. Heterogeneity analyses indicated that both results hold across the STEM disciplines, that active learning increases scores on concept inventories more than on course examinations, and that active learning appears effective across all class sizes—although the greatest effects are in small ($n \leq 50$) classes. Trim and fill analyses

225 studies in the published and unpublished literature. The active learning interventions varied widely in intensity and implementation, and included approaches as diverse as occasional group problem-solving, worksheets or tutorials completed during class, use of personal response systems with or without peer instruction, and studio or workshop course designs. We followed guidelines for best practice in quantitative reviews (*SI Materials and Methods*), and evaluated student performance using two outcome variables: (*i*) scores on identical or formally equivalent examinations, concept inventories, or other assessments; or (*ii*) failure rates, usually measured as the percentage of students receiving a D or F grade or withdrawing from the course in question (DFW rate).

The analysis, then, focused on two related questions. Does active learning boost examination scores? Does it lower failure rates?

Results

The overall mean effect size for performance on identical or equivalent examinations, concept inventories, and other assess-

PSYCHOLOGICAL AND COGNITIVE SCIENCES

Regional Accreditation

Regional Accrediting Bodies:

NWCCU
NORTHWEST COMMISSION ON COLLEGES AND UNIVERSITIES

WASC

CHEA Council for Higher Education Accreditation
CHEA International Quality Group CIQG

NEASC
NEW ENGLAND ASSOCIATION OF SCHOOLS AND COLLEGES
Commission on Institutions of Higher Education (CIHE)

CHE MSA
MIDDLE STATES COMMISSION ON HIGHER EDUCATION

ACCJC

HIGHER LEARNING COMMISSION

SACS COC

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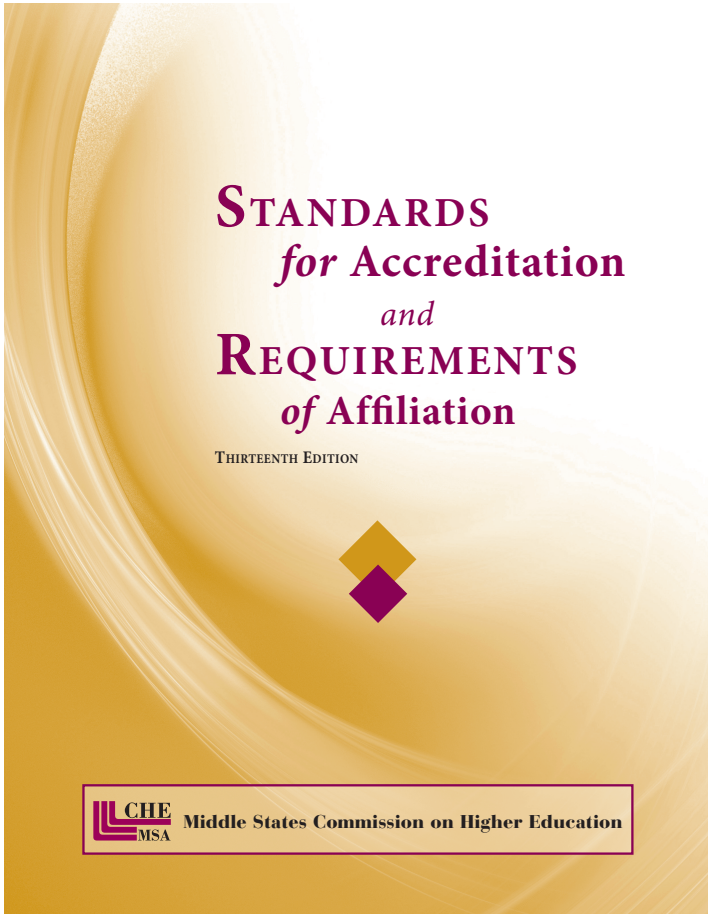
Assessment of Student Learning

Accreditation Standards:



Standard V

Educational Effectiveness Assessment

Assessment of student learning and achievement demonstrates that the institution's students have accomplished educational goals consistent with their program of study, degree level, the institution's mission, and appropriate expectations for institutions of higher education.

Criteria

An accredited institution possesses and demonstrates the following attributes or activities:

1. clearly stated educational goals at the institution and degree/program levels, which are interrelated with one another, with relevant educational experiences, and with the institution's mission;

2. organized and systematic assessments, conducted by faculty and/or appropriate professionals, evaluating the extent of student achievement of institutional and degree/program goals. Institutions should:
   a. define meaningful curricular goals with defensible standards for evaluating whether students are achieving those goals;
   b. articulate how they prepare students in a manner consistent with their mission for successful careers, meaningful lives, and, where appropriate, further education. They should collect and provide data on the extent to which they are meeting these goals;
   c. support and sustain assessment of student achievement and communicate the results of this assessment to stakeholders;

3. consideration and use of assessment results for the improvement of educational effectiveness. Consistent with the institution's mission, such uses include some combination of the following:
   a. assisting students in improving their learning;
   b. improving pedagogy and curriculum;
   c. reviewing and revising academic programs and support services;
   d. planning, conducting, and supporting a range of professional development activities;
   e. planning and budgeting for the provision of academic programs and services;
   f. informing appropriate constituents about the institution and its programs;
   g. improving key indicators of student success, such as retention, graduation, transfer, and placement rates;
   h. implementing other processes and procedures designed to improve educational programs and services;

4. if applicable, adequate and appropriate institutional review and approval of assessment services designed, delivered, or assessed by third-party providers; and

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Assessment of Student Learning

Accreditation Standards:

Standard V

Educational Effectiveness Assessment

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Assessment of Student Learning

Meaningful, effective assessment of student learning is critically important not just for the good of our students and programs, but for the survival of our institutions

… but so far, there has been very little help for programs in implementing sustainable, effective assessment plans

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External Review

All departments and programs face periodic program review, and many of us serve as external reviewers

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Motivation

- How many of you have had or will have your programs reviewed?
- How many of you have served as program reviewers?
- How many of you would appreciate help with student learning assessment?
- How many would like to have nationally-based arguments to increase resources for your department?
- How many would like to convince your colleagues about the effectiveness of evidence-based practices?
- How many would like ***your*** program to undergo accreditation?

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Motivation

1. Numerous requests to APS to provide service that ACS provides: Program approval (de facto accreditation)
2. Get effective practices into physics programs; promote the use of evidence-based teaching: "*Promote widespread use of evidence-based education practices throughout the undergraduate physics curriculum*"
3. ABET has decided to accredit ***all*** natural science disciplines (ANSAC)

ABET ACCREDITATION FOR NATURAL SCIENCE PROGRAMS

JOIN THE CONVERSATION

ABET accreditation has long been the global standard for programs in applied science, computing, engineering, and engineering technology. And recently programs that fall outside of these four main areas have shown interest in becoming ABET-accredited.

During this half-day, three-part session you will explore the value of ABET accreditation, and specifically the value that it could bring to the natural sciences. Presenters from ABET as well as industry and programs in physics, geology, biology, and chemistry will share their perspectives and describe how

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BPUPP: Brief Timeline

STB*: Requests to APS to do what ACS does: Program Certification

2012: APS leadership asks Committee on Education (COE) to investigate

2013: Working group formed to investigate

2014: Survey of physics chairs, report written

2015: COE discusses, makes recommendation to APS Council
ABET announces intention to accredit all fields of natural science

2015: APS Council charges COE to form BPUPP ("Best Practices for Undergraduate Physics Programs") task force

2016: COE begins process, drafts preliminary documents, recruits task force

2016: Task force begins meeting

2017: Applied for funding, beginning drafts & discussions on underlying issues, determination of content & structure of guide, development

2018: Guide development and dissemination begins in earnest

*Since Time Began

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APS Council Charge for the Task Force

1. **Develop a guide for self-assessment of undergraduate physics programs founded on documented best practices linked to measurable outcomes**

   The guide should provide a physics-community-based resource to assist programs in developing a culture of continuous self-improvement, in keeping with their individual mission, context, and institutional type. The guide should include considerations of curricula, pedagogy, advising, mentoring, recruitment and retention, research and internship opportunities, diversity, scientific skill development, career/workforce preparation, staffing, resources, and faculty professional development.

2. **Recommend a plan for ongoing review and improvement of this guide under the oversight of the APS Committee on Education**

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BPUPP Task Force Membership

Co-Chair: David Craig, Le Moyne College & Oregon State University

Co-Chair: Michael Jackson, Millersville University of Pennsylvania

- Noah Finkelstein, University of Colorado Boulder
- Courtney Lannert, Smith College and UMass Amherst
- Ramon Lopez, University of Texas at Arlington
- Willie Rockward, Morehouse College
- Gay Stewart, West Virginia University
- Gubbi Sudhakaran, University of Wisconsin-La Crosse
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AAPT Liaison: Bob Hilborn

Task Force Support:

External Reviewer: Stephanie Chasteen

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Goals of the Guide

Help department chairs (& other program leaders)

- External program assessment (departmental review)
- Improve usefulness of assessment
- Bring together known literature on topics
- Collect practices recognized by the community as effective when there is insufficient evidence-based literature
- Encourage discussions in departments on continuous improvement of physics programs using evidence
- Provide a leverage point for departments to advocate for resources to improve the major
- Engage PER community on departmental needs

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Structure of the Guide

Chapters:

- Introduction: how to navigate and use the guide
- Assessment of Student Learning: developing a useful and efficient culture of assessment
- Departmental Leadership
- Effective Practices (~22 “sections”)
- Departmental Review:
  - Guide to reviewers
  - Preparing for a review
- Ancillary material: sample program learning outcomes, assessment plans, *etc.*

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Tentative Section List

- Capstone experiences
- Career preparation
- Communications skills
- Computational skills
- Departmental climate
- ***Equity, diversity, and inclusion***
- ***Ethics***
- Facilities
- Faculty development
- ***Implementing research-based instructional practices***
- Individuated degree tracks: engineering / applied physics
- Institutional partnerships: dual-degree physics / engineering programs
- Internships
- Introductory STEM major courses
- Laboratory / experimental skills
- Learning assistants
- Mentoring / advising
- Non-STEM major courses
- Online education
- Outreach
- ***Recruiting***
- ***Retention***
- Teacher preparation programs
- ***Undergraduate research***
- Upper-level physics courses

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What the Guide Is and Isn't

Is:

- Collection of community knowledge and evidence-based practices
- Authored, reviewed, approved by physics community
- *Living* document (not static), with stewardship by APS COE
- Primarily online
- Ethics and diversity included throughout
- Effort to implement evidence-based pedagogy
- Transform mandatory assessment into useful exercise
- Suggestions on how to improve all aspects of a program
- Opportunity to extend reach of education research

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What the Guide Is and Isn't

Isn't:

- Accreditation or program certification
- Mandate to conform
- **Finished (yet)**

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Guide Timeline

2017: Initial drafts; external input on drafting sections; external section reviews by invited department chairs and experts in the field; NSF proposals; establish processes for soliciting section authors and reviewers with diverse points of view in the community; completion of one section

2018: Limited release of first sections; feedback from community; primary push to develop guide sections and solicit feedback (~ 6 well in hand so far)

2018: Begin workshops on use of guide; training of departmental reviewers

2019: Release of entire (1st edition) of guide; continued workshops

2020: First review by COE to update/improve content, updating of review procedures to ensure fidelity of design principles

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Contact?

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Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

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References

SPIN-UP 2002 (enrollment):

aps.org/programs/education/undergrad/faculty/spinup/

T-TEP 2012 (teacher education):

phystec.org/webdocs/TaskForce.cfm

Phys21 2016 (careers):

compadre.org/phys21/

Vision and Change 2011 (biology):

visionandchange.org

Active learning:

Scott Freeman, et al., “Active learning increases student performance in science, engineering, and mathematics,” PNAS **111** (23), 8410-8415 (2014).

PTEPA (assessment):

Physics Teacher Education Program Analysis: phystec.org/thriving

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