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PROMOTING PEOPLE IN PHYSICS

APS March Meeting

14 March 2017

New Orleans, LA

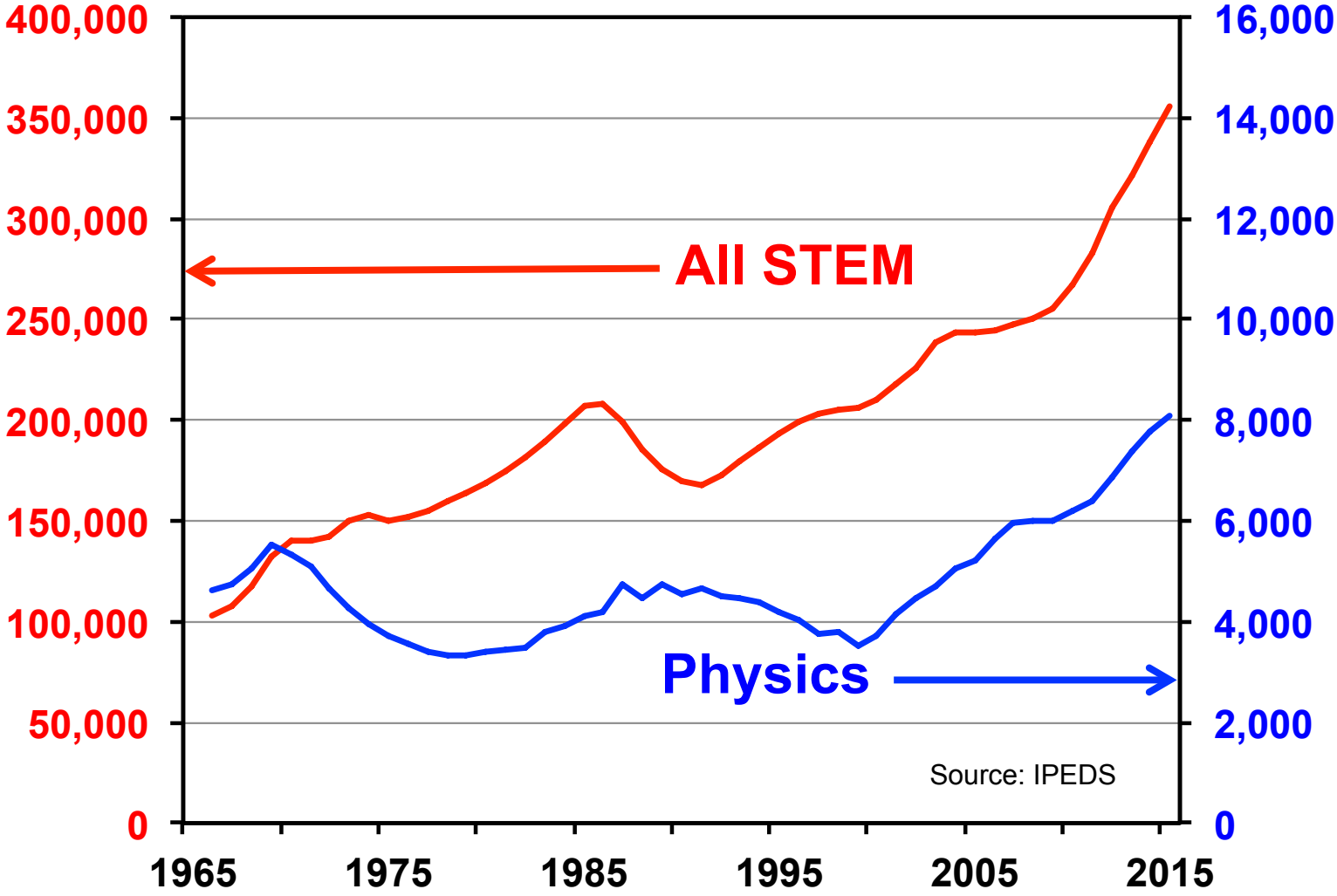
Best Practices in Physics Program Assessment:

Should APS Provide Accreditation Standards for Physics?

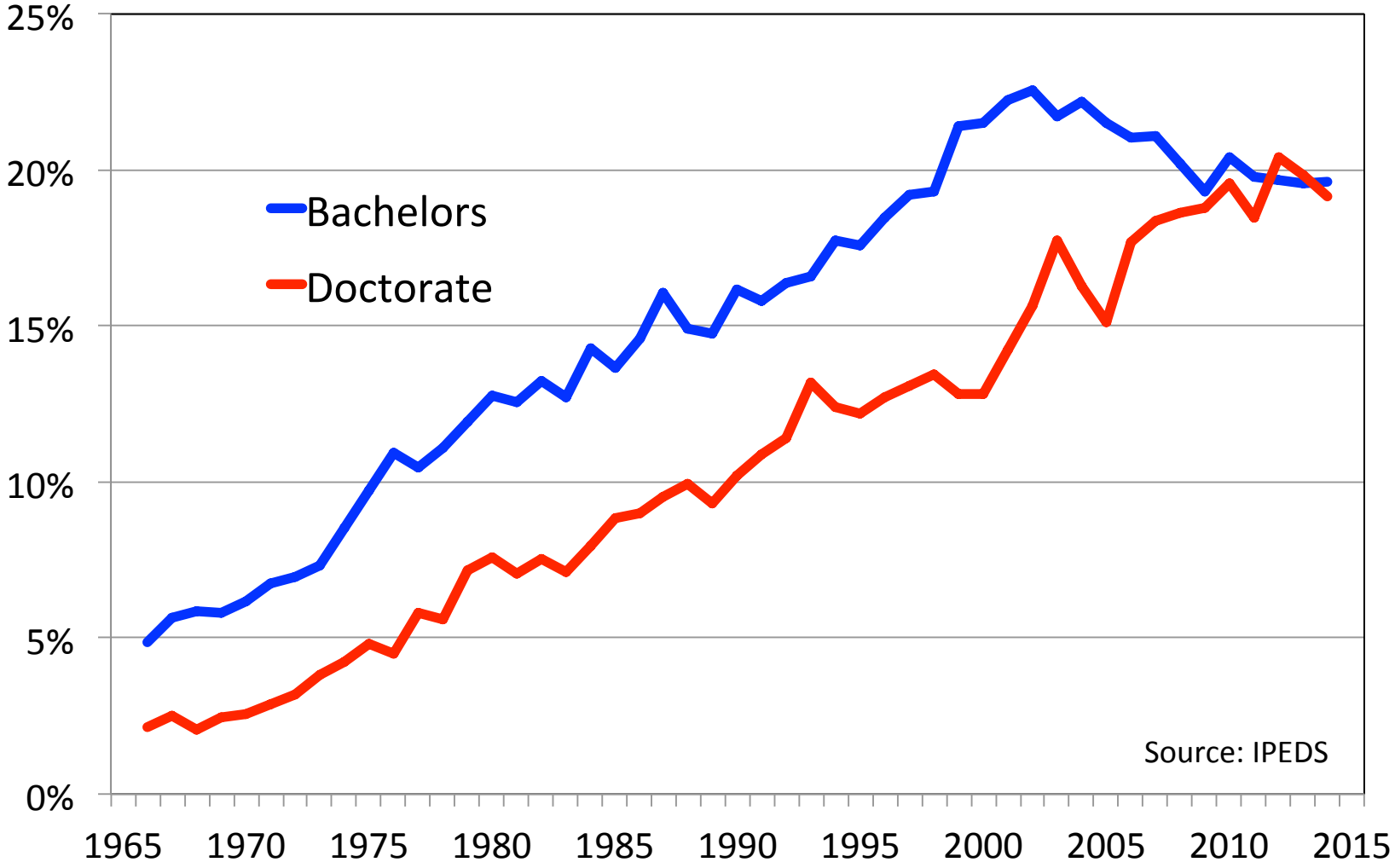
Theodore Hodapp, Director of Project Development

Senior Advisor to Education and Diversity

Physics / STEM Bachelor Degrees



Percentage of Women in Physics



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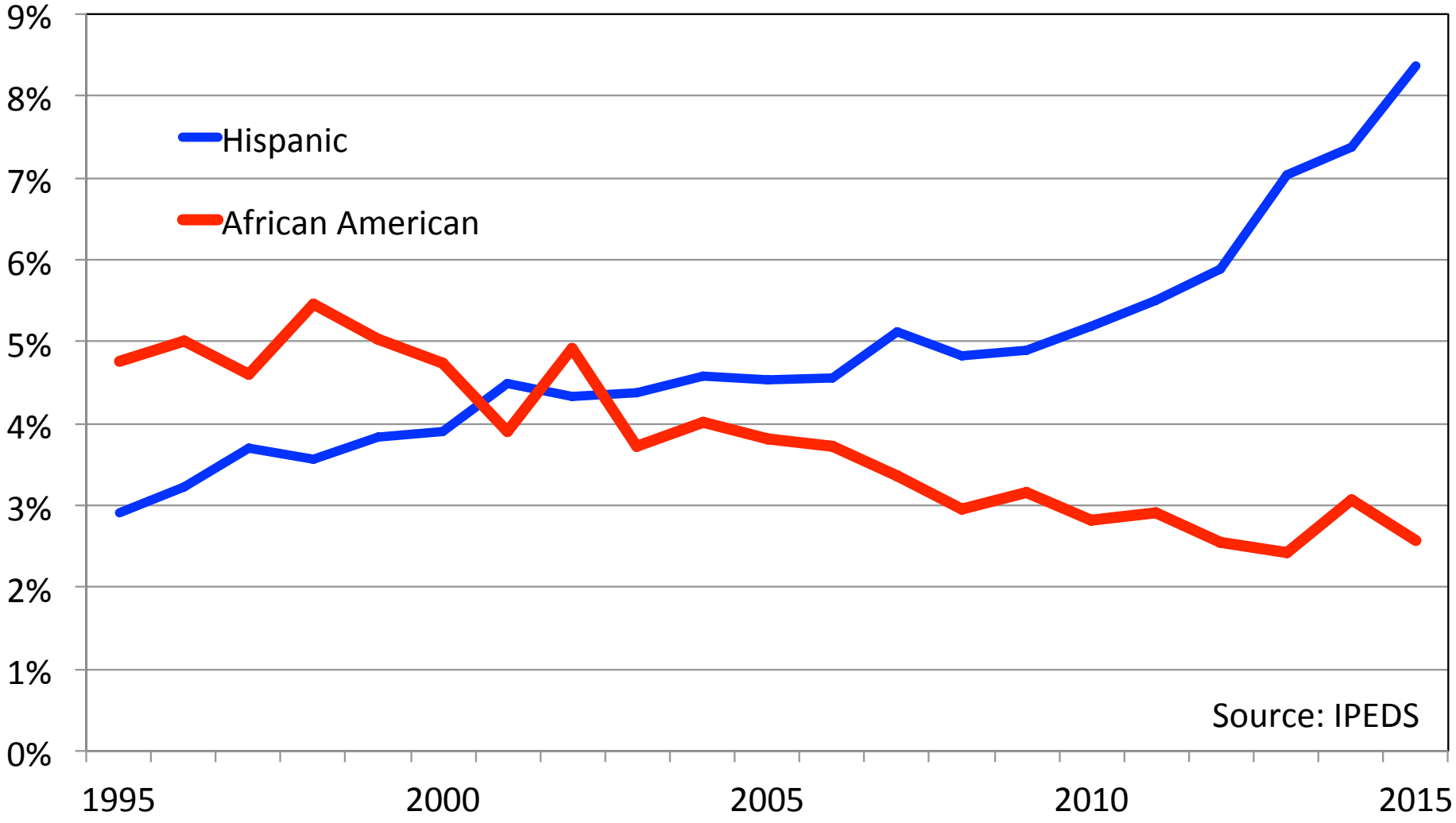
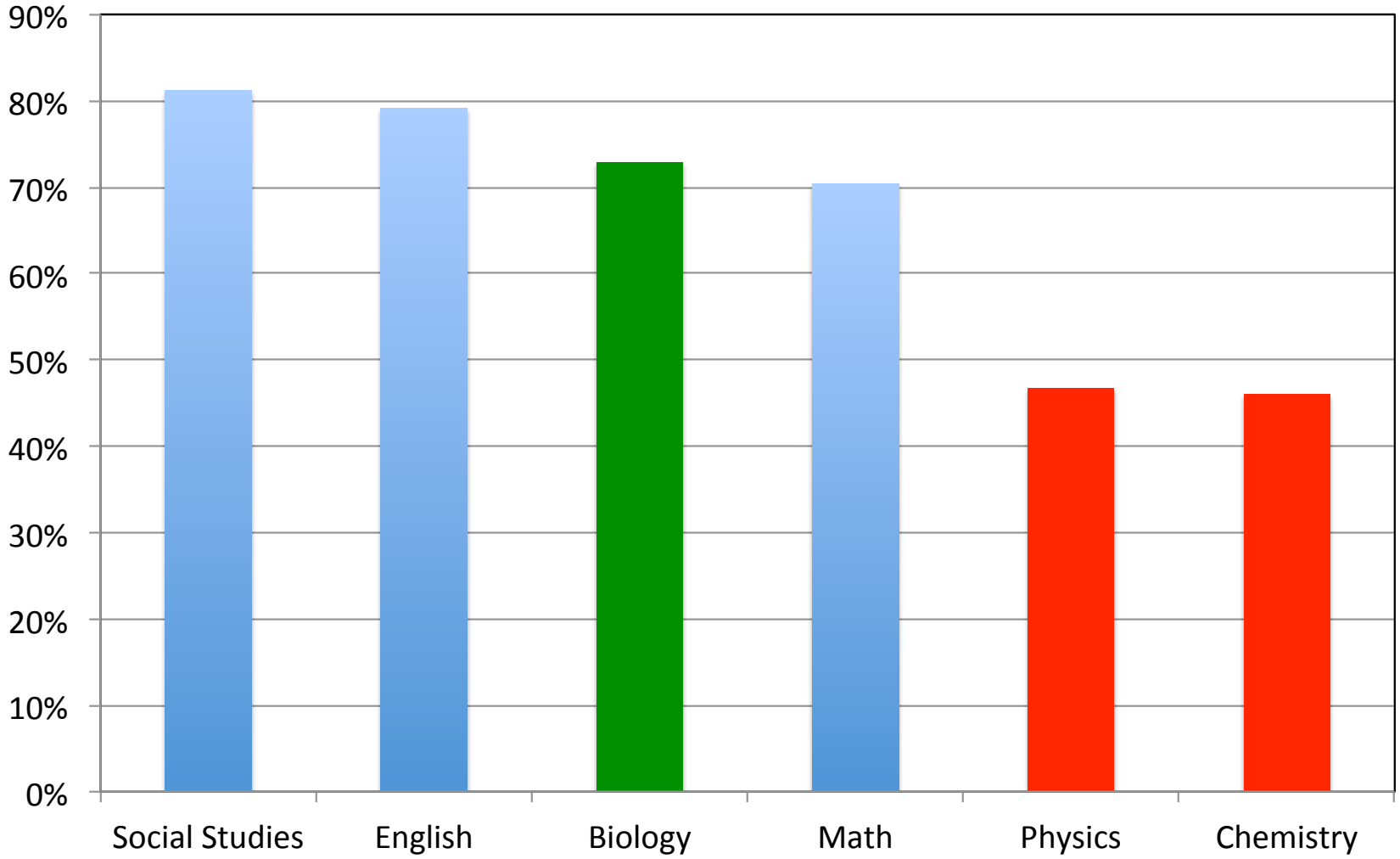
Physics Bachelor Degrees Awarded to Underrepresented Minorities

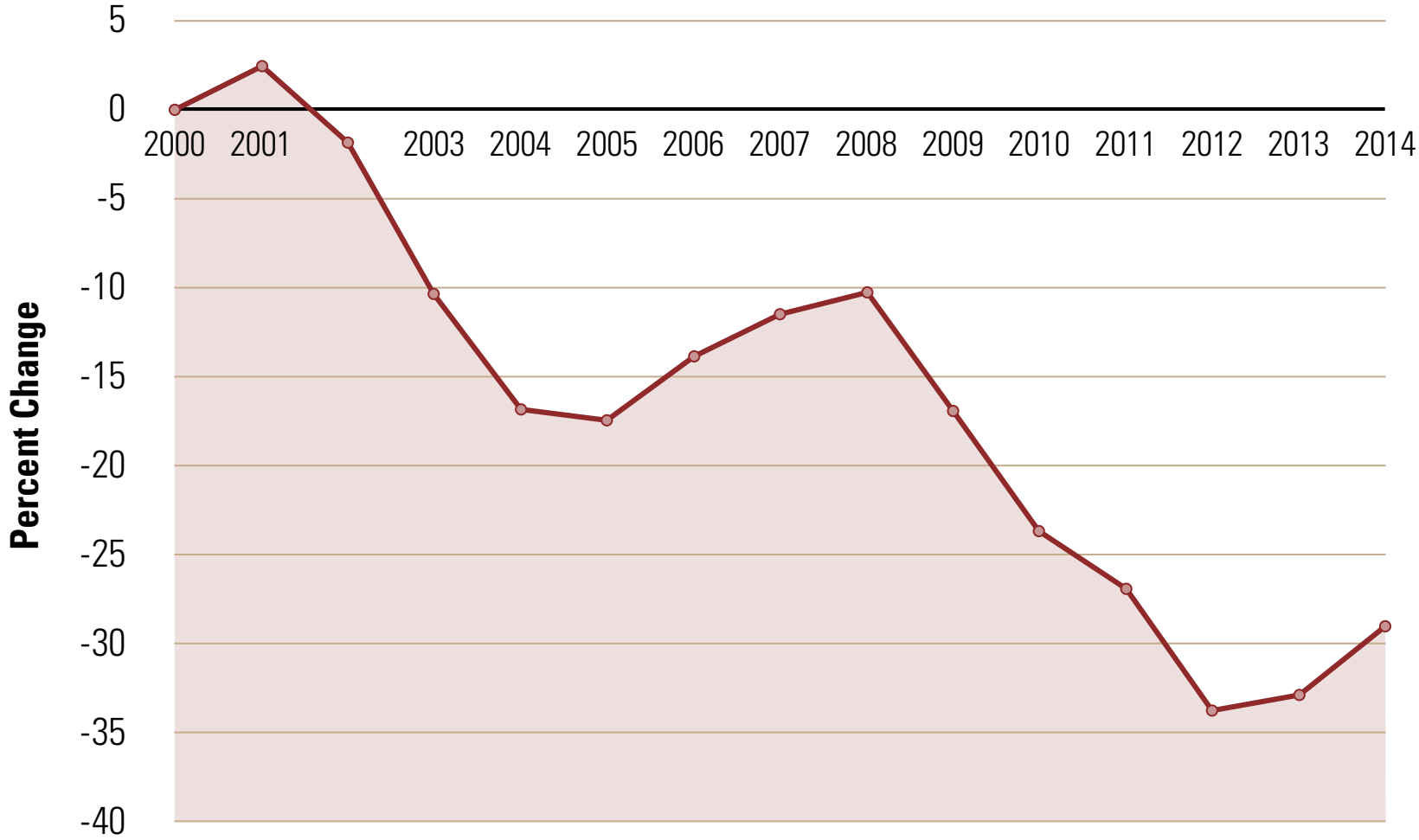


High school classes taught by teacher with degree in the field



Source: Schools and Staffing Survey

Change in Public Funding of Higher Education in the US

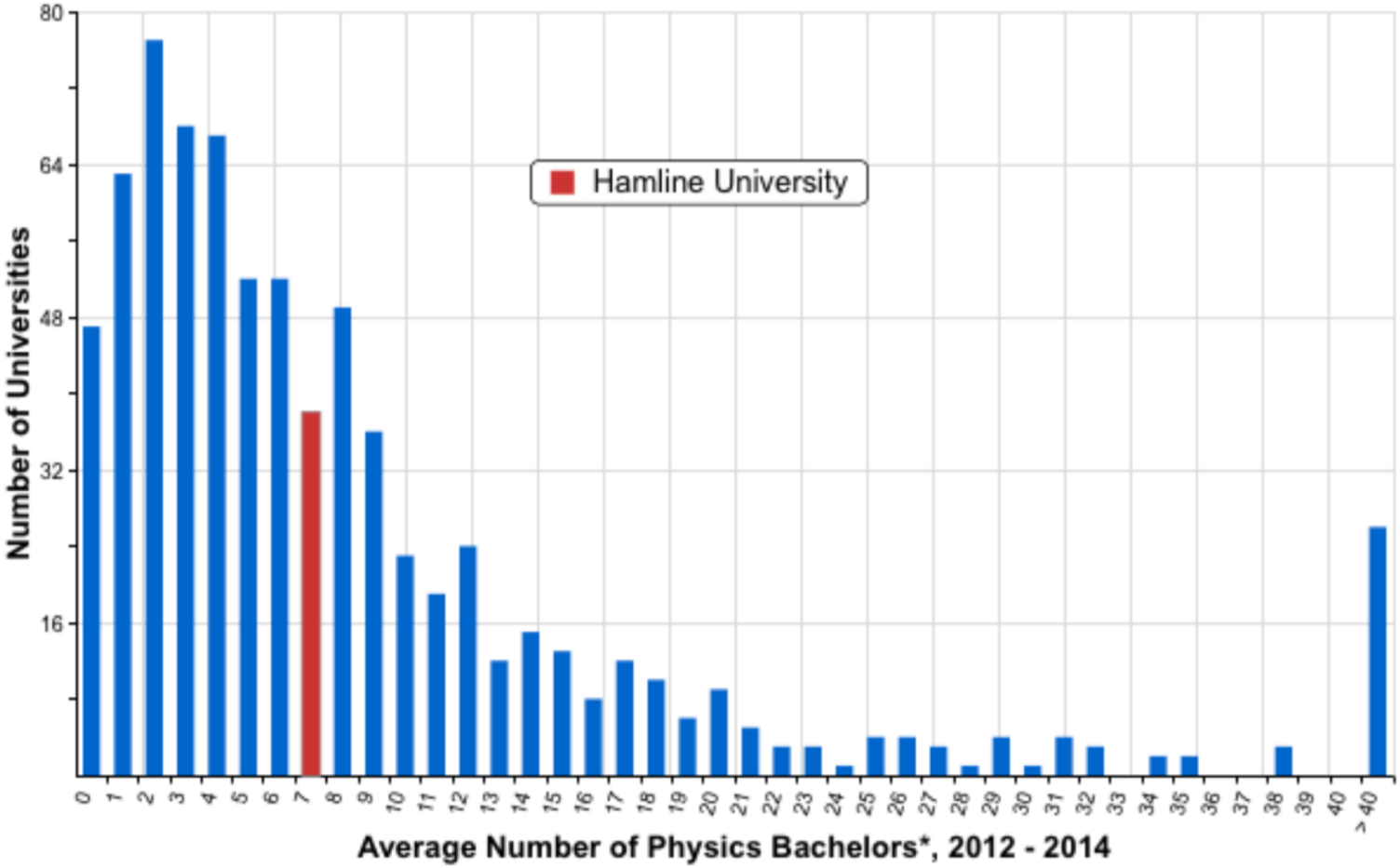


Source: The Lincoln Project: Public Research Universities - Recommitting to Lincoln's Vision: An Educational Compact for the 21st Century (Amer. Acad. of Arts & Sciences)

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

Physics Bachelor Degrees



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

BPUPP: Brief Timeline

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

2012: APS leadership asks to investigate

2013: Working group formed to investigate

2014: Survey of physics chairs, report written

2015: Committee on Education (COE) discusses, and makes recommendation to APS Council; ABET announces intention to accredit all science fields

2015: APS Council charges COE to form task force

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

2016: Task force starts meeting

2017: Applied for funding, beginning drafts and discussions on underlying issues

*Since Time Began

Guide for Undergraduate Physics Program Assessment, Review, and Improvement

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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APS BPUPP Task Force Members

Co-Chair: David Craig, Le Moyne College

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
- Kathryn Svinarich, Kettering University
- Carl Wieman, Stanford University
- Lawrence Woolf, General Atomics Aeronautical Systems, Inc.

Project Manager: Sam McKagan

Staff Liaison: Ted Hodapp; **Task Force Support:** Miranda Bard

AAPT Liaison: Bob Hilborn

www.aps.org/bpupp

What BPUPP is Doing

Designing a process to help department chairs with:

- Periodic program assessment (departmental review)
- Improve usefulness of assessment
- Bring together known literature on topics, and best practices when there is insufficient evidence-based knowledge about topics
- Encourage discussions in departments on continuous improvement of physics major using evidence-based methods
- Provide a leverage point for departments to advocate for resources to improve the major
- Engage PER community on departmental needs

Main Sections

- Recruitment and retention (enrollment strategies, degree tracks, partnerships, student interactions)
- Student learning (curriculum, education research, undergraduate research)
- Career preparation (teacher preparation, graduate school, diverse careers)
- Assessment (program and student learning)
- Diversity and equity
- Department climate and faculty professional development
- Department leadership
- Program Review (for reviewers and departments)

1-Minute Exercise

- Take a piece of paper
- Write one or two things you would like addressed in this guide
- Pass the paper to the aisles

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

Backward Design Goals

I want you to:

- Get a sense of the motivation driving this effort
- Understand BPUPP Task Force vision and goals
- Agree that outcomes are being designed to help you and not hinder you
- Know who to contact with questions and concerns

Fundamentals of Writing Across the Curriculum (WAC)

Writing to Learn

- Using writing (and other forms of communication) to enhance learning

Learning to Write

- Improving writing skills within the disciplinary context

Implementation: Learning to Write

Learning to Write

- Class size is important (to provide timely feedback)
- Multiple opportunities to write (and receive feedback) – some programs require at least 7,500 words (15 pages)
- Multiple revisions
- Assessed (graded) – some require assessment fraction
- Approached from different perspectives (e.g., concept outlines, drafts, document structure, editing, proofreading, ethics), and graded in these contexts
- Explicitly taught, not just required
- Support services

Implementation: Writing to Learn

Writing to Learn

- Informal (lab notebooks, white boards, 1-minute interactions, at chalkboard, online posts, etc.), not intended for public consumption
- Many opportunities (throughout the entire course)
- Classroom expectation
- Graded on participation rather than writing
- Instructor acknowledgment
- Includes words, drawings, numbers, equations, etc.

Why the 1-minute writing?Metacognitive Analysis

- Active engagement
- Sent message of my interest
- Got (anonymous) feedback on your interests
- Example: Writing to learn
- Physically engaged (can’t sleep)

Guide Timeline

2017: Initial drafts; external input on drafting sections; external section reviews by invited department chairs and experts in the field

2018: Limited release of first sections; feedback from community; continued development and feedback

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

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

Writing across the curriculum:

John Bean, "*Engaging Ideas: The Professor's Guide to Integrating Writing, Critical Thinking, and Active Learning in the Classroom*"

Active learning:

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

More information?

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