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

Source: IPEDS
Percentage of Women in Physics

Source: IPEDS
Physics Bachelor Degrees Awarded to Underrepresented Minorities

Source: IPEDS
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

Section 1: Addressing Current Financial Challenges

Public Higher Education

Higher education has long been described as the “balance wheel” of state budgets. Public colleges and universities are different from other state agencies: they have their own revenue streams, they can adjust their program offerings, and they have some control over employee salaries. As this report will make clear, their budgets are not definitely flexible, but they are more flexible than the budgets of most state institutions. Accordingly, the states tend to increase their contributions to public higher education when the economy is strong, and cut their contributions when the economy is weak.

Figure 1: Percent Change in State Support for Public Higher Education (All Colleges and Universities) per Full-Time Equivalent Student, in Constant 2014 $, since 2000

Despite modest increases in 2013 and 2014, state support for public higher education per full-time equivalent student remains nearly 30 percent below spending in 2000, after adjusting for inflation using the State Higher Education Finance cost adjustment.

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

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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 suggest that the overall effect is not the result of publication bias. The results also appear robust to variation in the continued use of traditional lecturing as a control in research. The overall mean effect size for performance on identical or equivalent examinations, concept inventories, and 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 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?
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
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:
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