



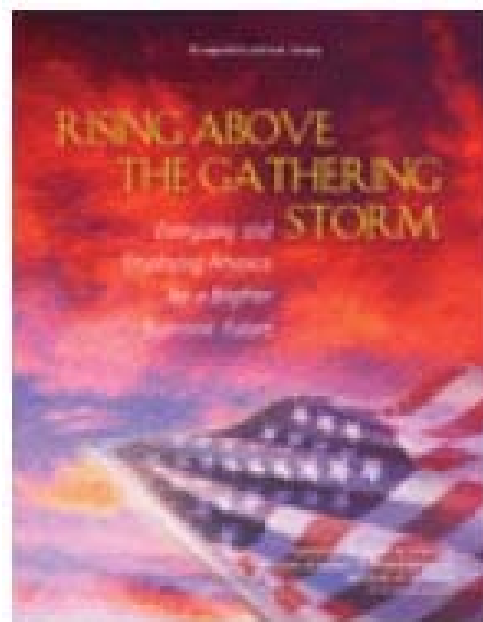
Doubling the number of physics majors who teach

Michael Marder

Chair, APS Committee on Education, 2006-2008

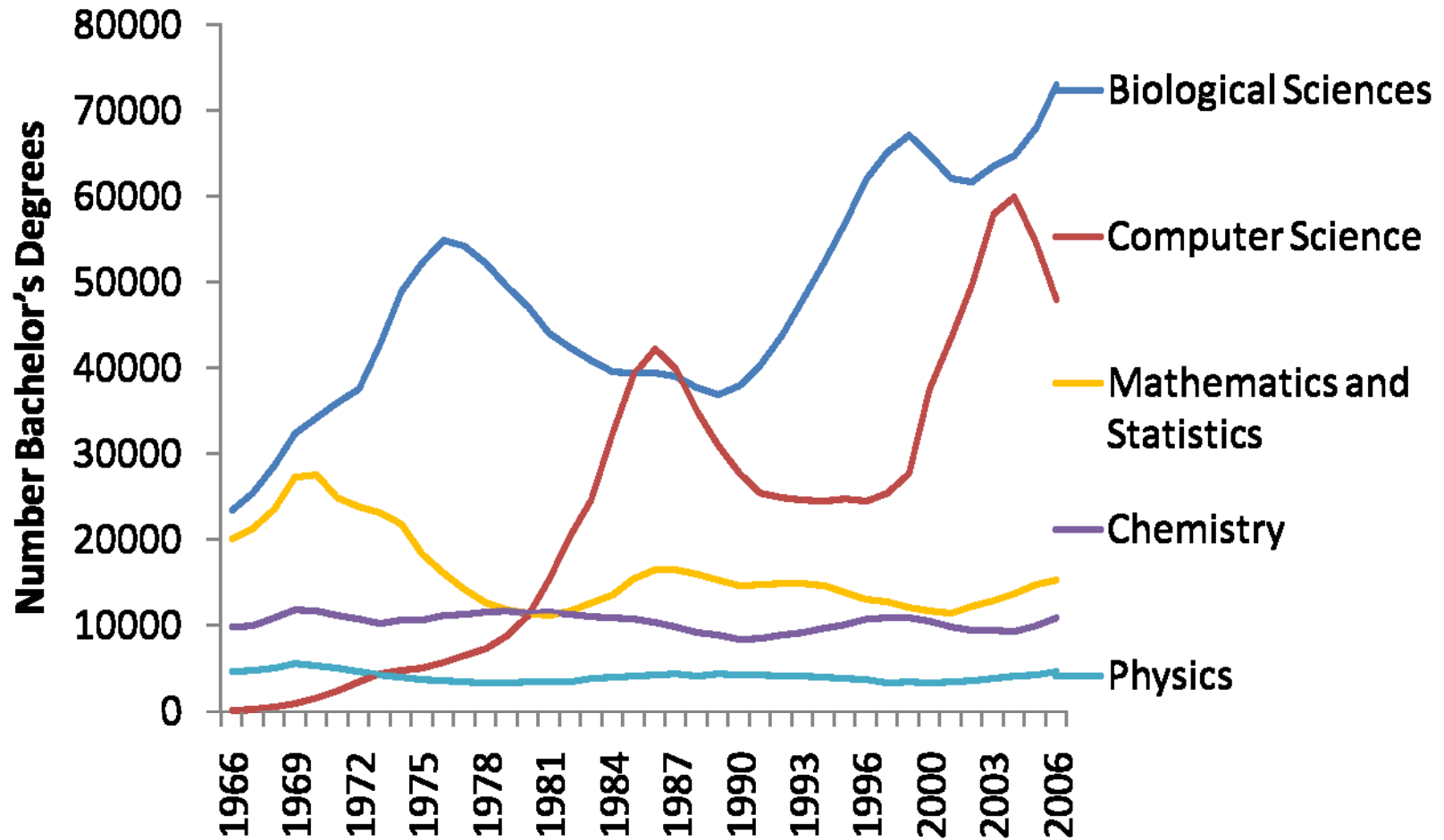
Co-Director of UTeach

Professor of Physics, UT Austin



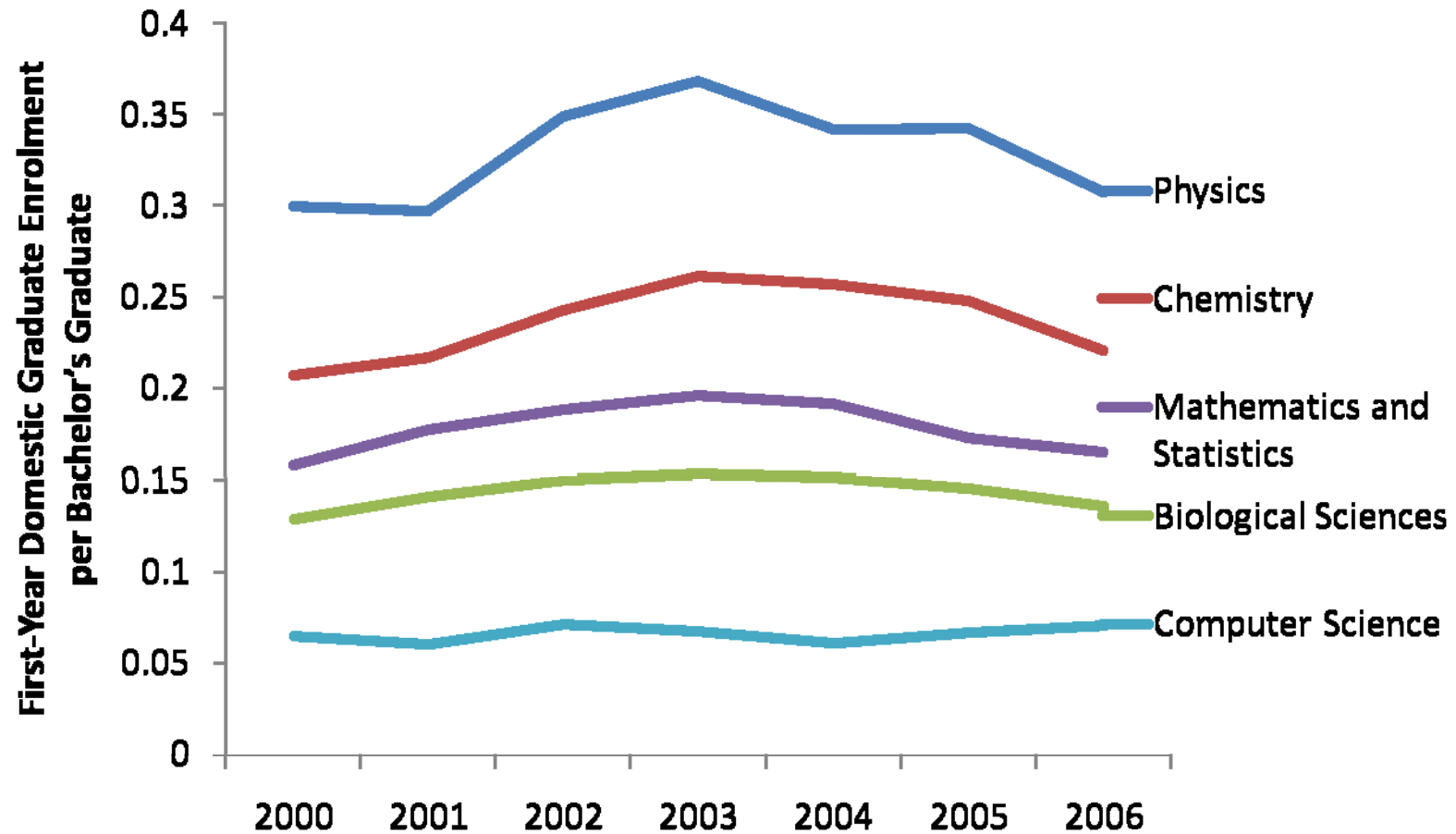


Physics over Time





Grad school ratios





Idaho



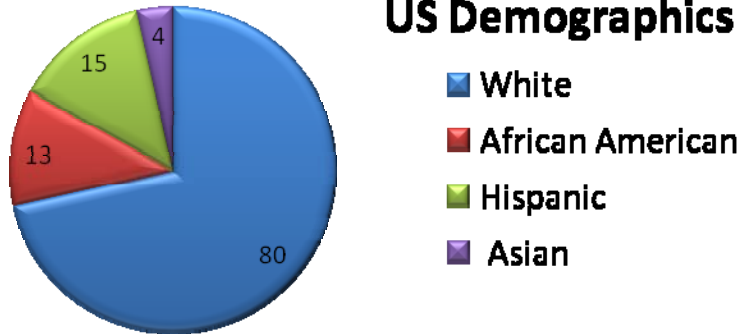
College of Science

- Proposed Elimination of B.S. and B.A. Degrees in Physics
- As part of the Academic Program Prioritization Process, the university has issued a preliminary recommendation to discontinue the Bachelor of Science and Bachelor of Arts degree programs in physics.

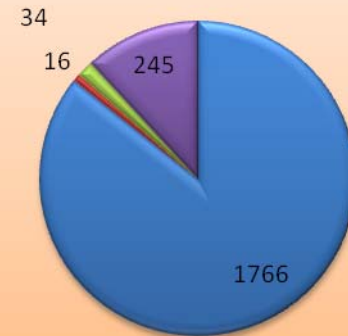


Diversity

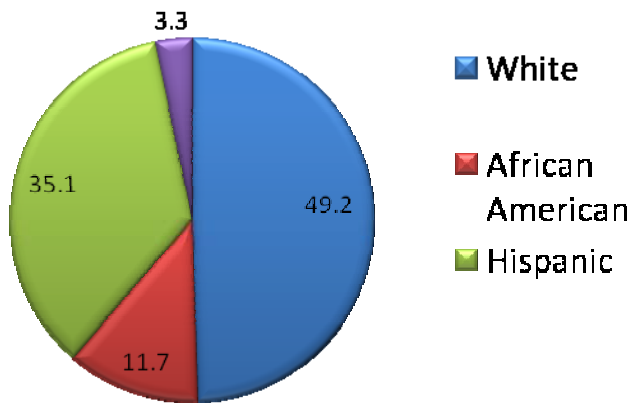
US Demographics



US Physics Faculty, Top Universities



Texas Demographics



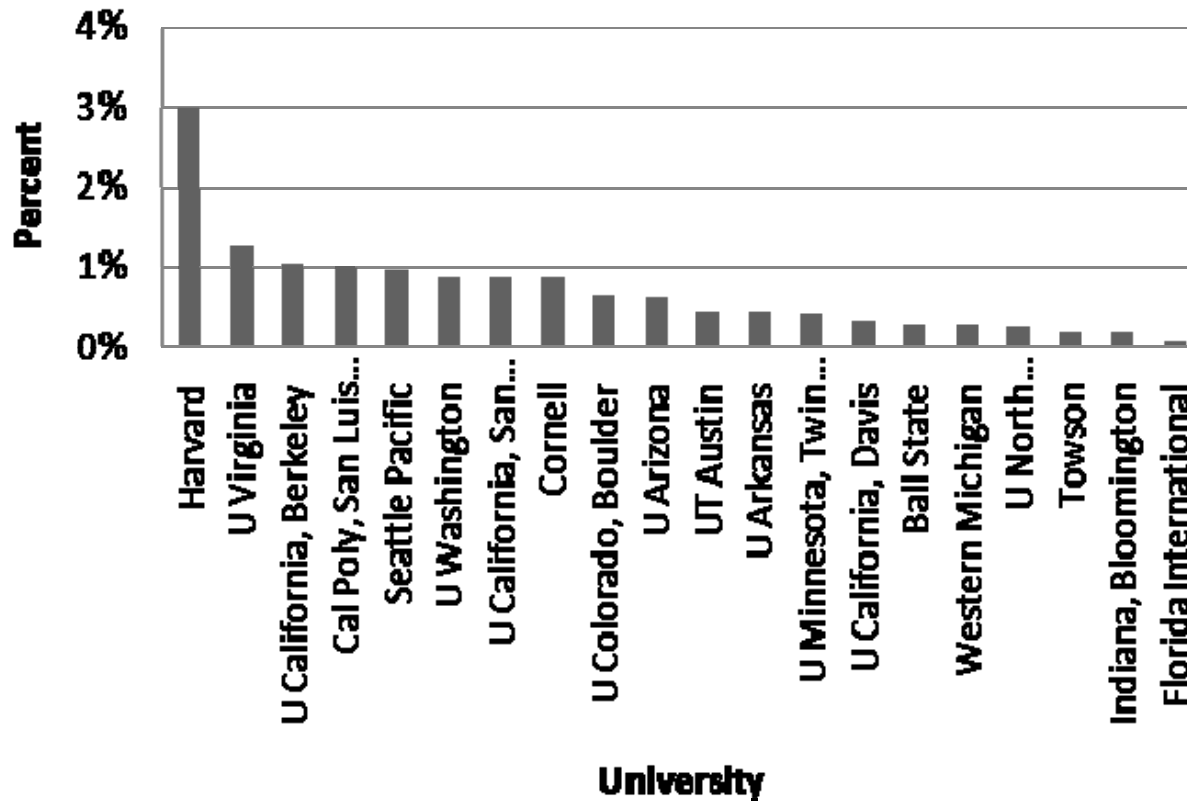
Demographics of Physics Faculty, Top Texas Universities





Curriculum and Enrollment

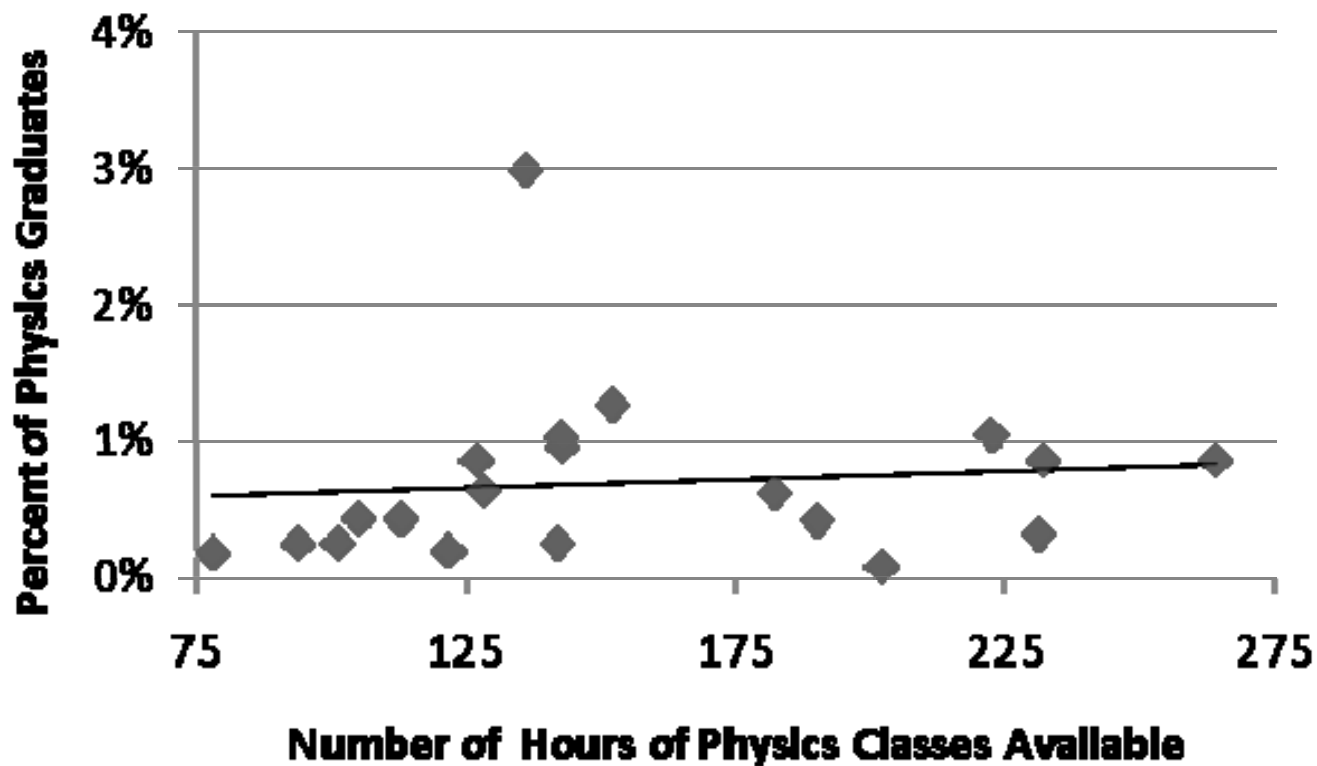
Physics Bachelors Degrees as a Fraction of Total Bachelors Degrees Granted





Curriculum and Enrollment

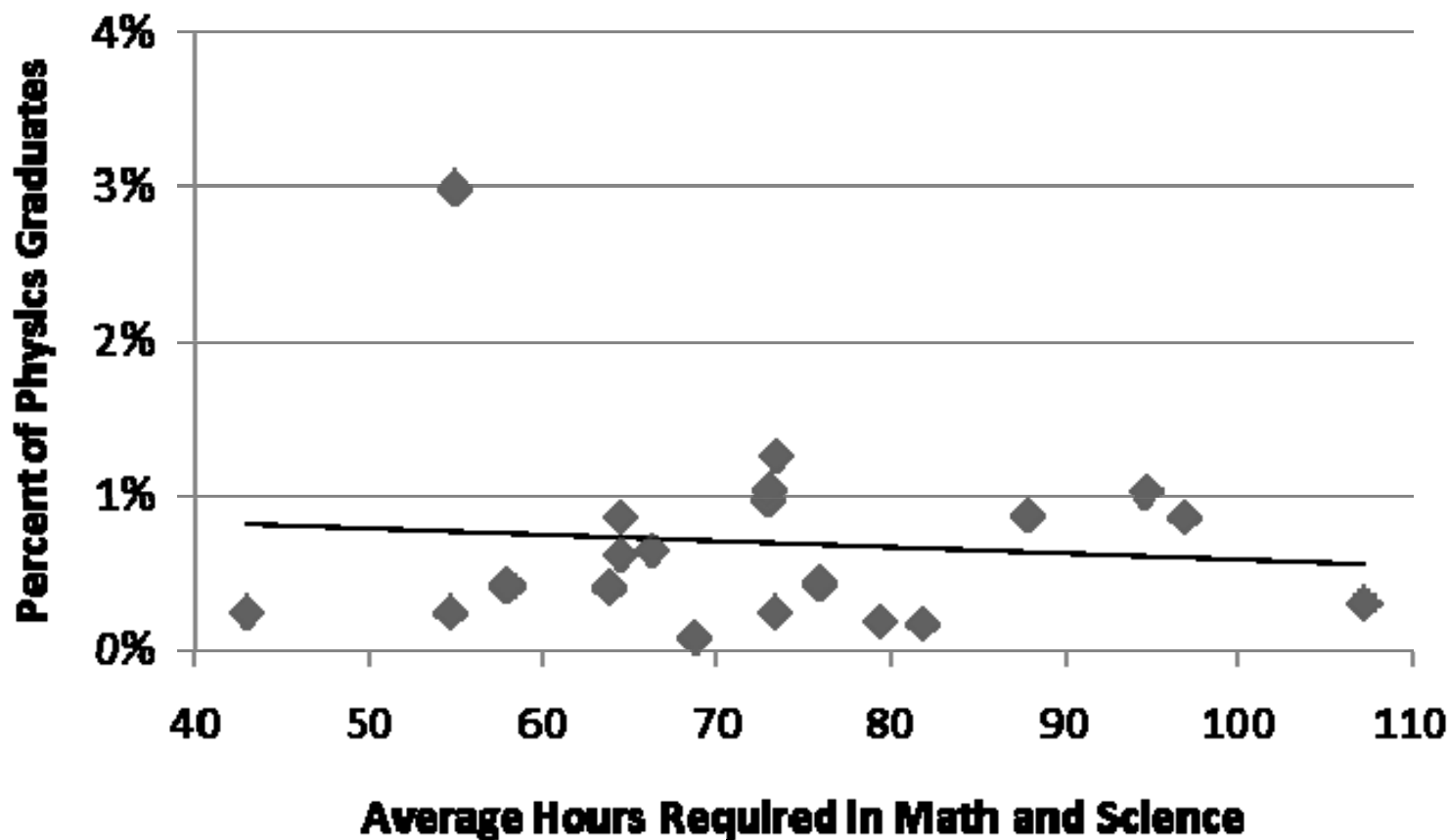
Physics Graduates vs Hours of Physics Classes Available





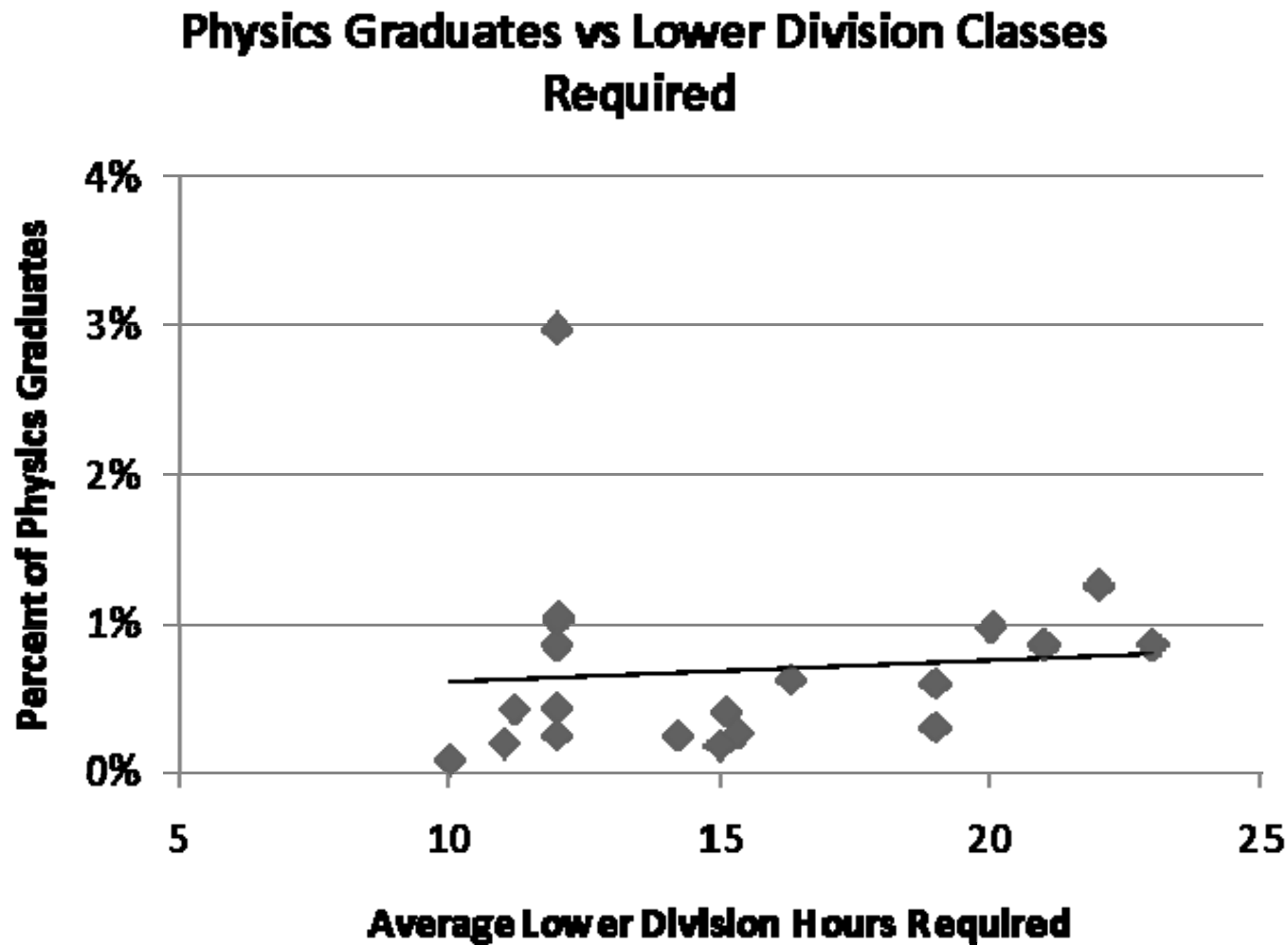
Curriculum and Enrollment

Physics Graduates vs. Hours Required in Math and Science





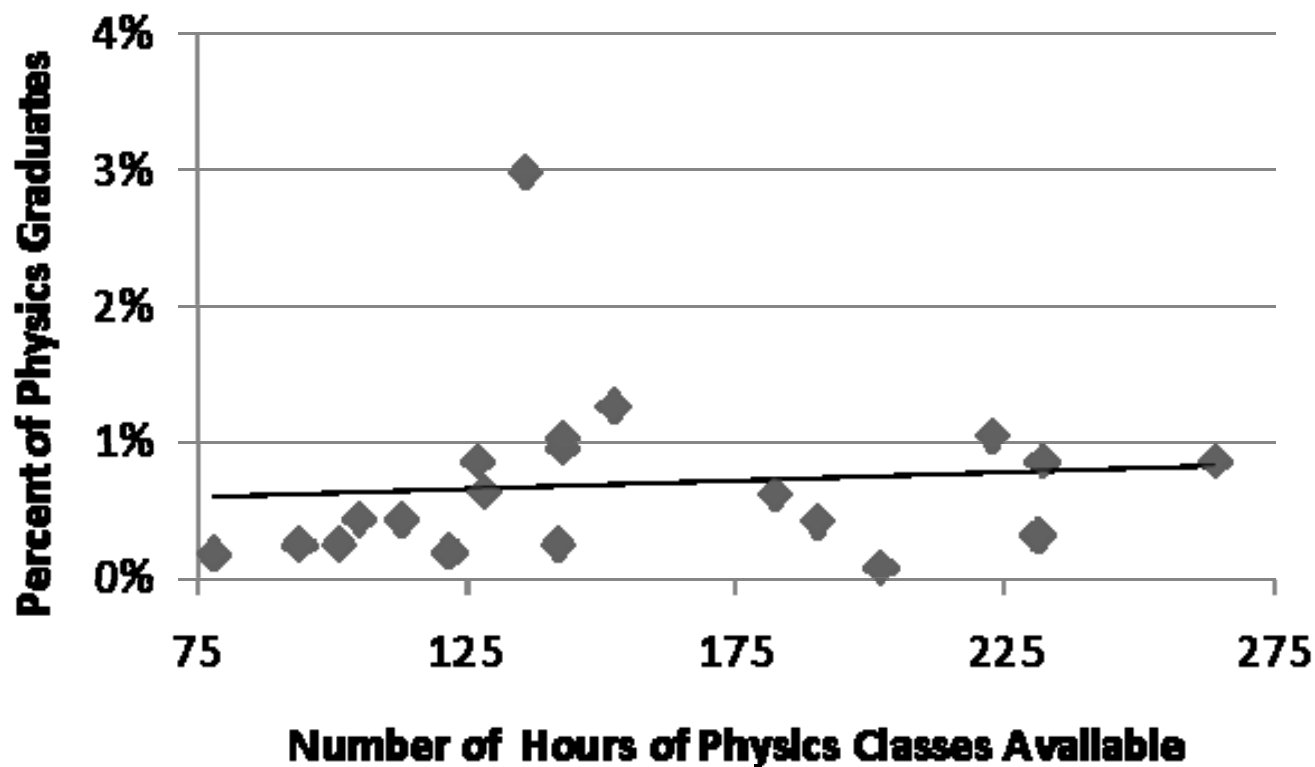
Curriculum and Enrollment





Curriculum and Enrollment

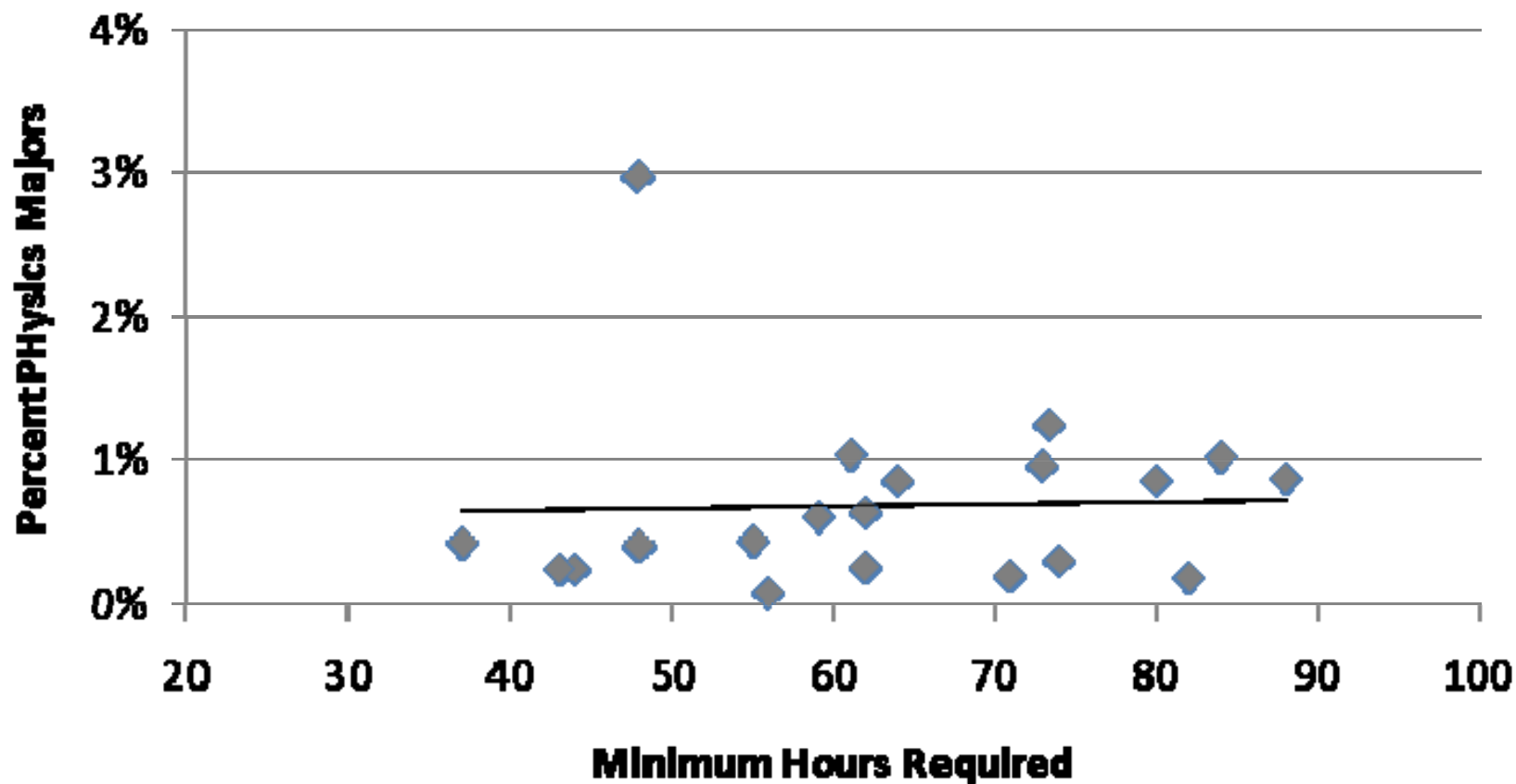
Physics Graduates vs Hours of Physics Classes Available





Curriculum and Enrollment

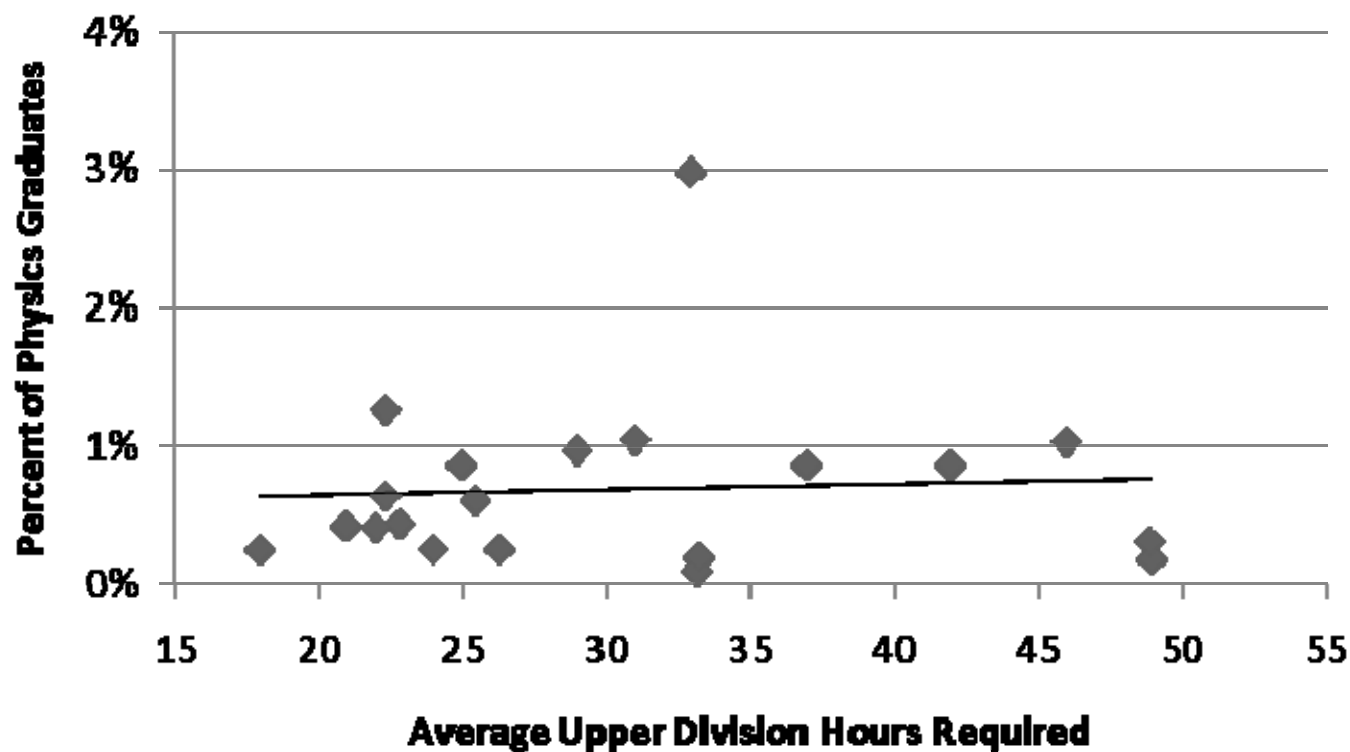
Physics Graduates vs. Minimum Required Hours





Curriculum and Enrollment

Physics Graduates vs. Required Hours of Upper Division Classes





APS Doubling Initiative

• ***Unifying Theme:*** Double the number of bachelor degrees in physics to address critical national needs including K-12 education, economic competitiveness, energy, security, and an informed electorate

• ***Special Objectives:***

- › **Increase the number of highly-qualified high school physics teachers**
- › Increase the fraction of both women and under-represented minorities who major in physics

Three critical areas of action (in ranked priority order):

- › **Preparation of high school teacher physics teachers**
- › Under-representation of minorities and women in physics
- › The undergraduate physics major



Teacher Shortage

[T]he country must ... adopt measures that increase the supply of high-quality teachers — especially in math and science — while cutting down on the distressingly large number of teachers who bail out of the profession early.

Public colleges and universities, which rely heavily on tax dollars, are a good place to start. The government should require them to turn out more high quality teachers of all kinds, especially math and science teachers. Ideally, the enrollments at these colleges of education should be based not on whim, but on projected need. The states should find ways to reward colleges that turn out excellent graduates, while shutting down diploma mills. The states and localities should also develop comprehensive plans not just for hiring, but for mentoring and retaining teachers as well.

NY Times Editorial, August 29, 2007



Higher Education Act: H.R.4137

“SEC. 205. ACCOUNTABILITY FOR PROGRAMS THAT PREPARE TEACHERS.

“(a) INSTITUTIONAL AND PROGRAM REPORT CARDS ON THE QUALITY OF TEACHER PREPARATION.—

“(1) REPORT CARD.—Each institution of higher education that conducts a traditional teacher preparation program or alternative routes to State certification or licensure program and that enrolls students receiving Federal assistance under this Act shall report annually to the State and the general public, in a uniform and comprehensible manner that conforms with the definitions and methods established by the Secretary, the following:

“(H) For the State as a whole, and for each teacher preparation program in the State, the number of teachers prepared, in the aggregate and reported separately by—

“(i) area of certification or licensure;

“(ii) academic major; and

“(iii) subject area for which the teacher has been prepared to teach.

“(I) A description of the extent to which teacher preparation programs are addressing shortages of highly qualified teachers, by area of certification or licensure, subject, and specialty, in the State’s public schools.

“SEC. 206. TEACHER DEVELOPMENT.

“(a) ANNUAL GOALS.—Each institution of higher education that conducts a traditional teacher preparation program (including programs that offer any ongoing professional development programs) or alternative routes to State certification or licensure program, and that enrolls students receiving Federal assistance under this Act, shall set annual quantifiable goals for increasing the number of prospective teachers trained in teacher shortage areas designated by the Secretary or by the State educational agency, including mathematics, science, special education, and instruction of limited English proficient students.



Teacher Shortage

	US	Texas
Total schools with grades 9-12	15,400	1846
Total individuals teaching physics	20,000	1852
Teachers out of field	~5000	524
Students per secondary grade	3,000,000	300000
Teachers required to teach 1 physics to each student	28,000	2,800
Shortage	~13,000	~1500
New physics teachers/year	~1000	?
Physics majors entering teaching	~300	25?

	Physics	Chemistry	Biology	Math
Total individuals teaching	1852	3657	4967	10262
Number individuals out of field	524	1069	1588	1539
Teachers required to teach one of each science and 4 math courses to each high school student, with 20 students per class.	2889	2889	2889	12165
Shortage	1561	301	None	3442



Targets for Doubling

Institution	Actual		Target Physics Majors	Actual/ Target	Physics Teachers
	Physics	STEM			
California Institute of Technology	45	217	5	900%	0
Hastings College	7	48	1	700%	0
Reed College	14	100	2	700%	0
Coe College	7	64	1	700%	0
Harvey Mudd College	24	159	4	600%	0
Hampden-Sydney College	10	74	2	500%	0
Augsburg College	10	109	2	500%	0
Roanoke College	5	72	1	500%	0
Grinnell College	14	137	3	467%	0
Whittier College	4	59	1	400%	0
Georgetown College	4	68	1	400%	0
Knox College	8	108	2	400%	0
Lycoming College	4	68	1	400%	0
Ouachita Baptist University	4	62	1	400%	0
University of Dallas	4	62	1	400%	0
New Mexico Institute of Mining and Technology	15	174	4	375%	0
Morehouse College	15	161	4	375%	0
Hamline University	7	102	2	350%	0
Bates College	13	182	4	325%	0
Occidental College	13	164	4	325%	0
Massachusetts Institute of Technology	80	964	26	308%	3
Austin College	6	90	2	300%	0
Kalamazoo College	6	101	2	300%	0
Lebanon Valley College	6	110	2	300%	0
Westminster College (New Wilmington, PA)	3	62	1	300%	0
Wheaton College (Norton, MA)	6	86	2	300%	0
Houghton College	3	65	1	300%	0



Targets for Doubling

Institution	Actual		Target	Actual/ Target	Physics Teachers
	Physics	STEM	Physics Majors		
New York University	12	1063	28	43%	3
University of PR Rio Piedras Campus	6	516	14	43%	1
East Stroudsburg University of Pennsylvania	3	278	7	43%	0
Pennsylvania State U at Erie-Behrend College	3	265	7	43%	0
St Cloud State University	6	547	14	43%	1
University of Redlands	3	285	7	43%	0
Lafayette College	3	292	7	43%	0
University of California-Riverside	14	1242	33	42%	4
Boston University	14	1265	34	41%	4
University of Texas at Austin	39	3499	95	41%	11
Ball State University	9	842	22	41%	2
SUNY College at Brockport	4	383	10	40%	1
University of Maryland Baltimore County	10	939	25	40%	3
Cedarville College	2	185	5	40%	0
Jackson State University	2	217	5	40%	0
Grambling State University	2	207	5	40%	0
Elon College	2	206	5	40%	0
University of South Dakota	2	209	5	40%	0
Loyola College	2	189	5	40%	0
Pittsburg State University	4	393	10	40%	1
University of Central Arkansas	4	381	10	40%	1
Armstrong Atlantic State University	4	394	10	40%	1
University of Minnesota - Twin Cities	28	2622	71	39%	8
Michigan State University	28	2637	71	39%	8
University of Oklahoma, Norman Campus	13	1235	33	39%	4



UTeach



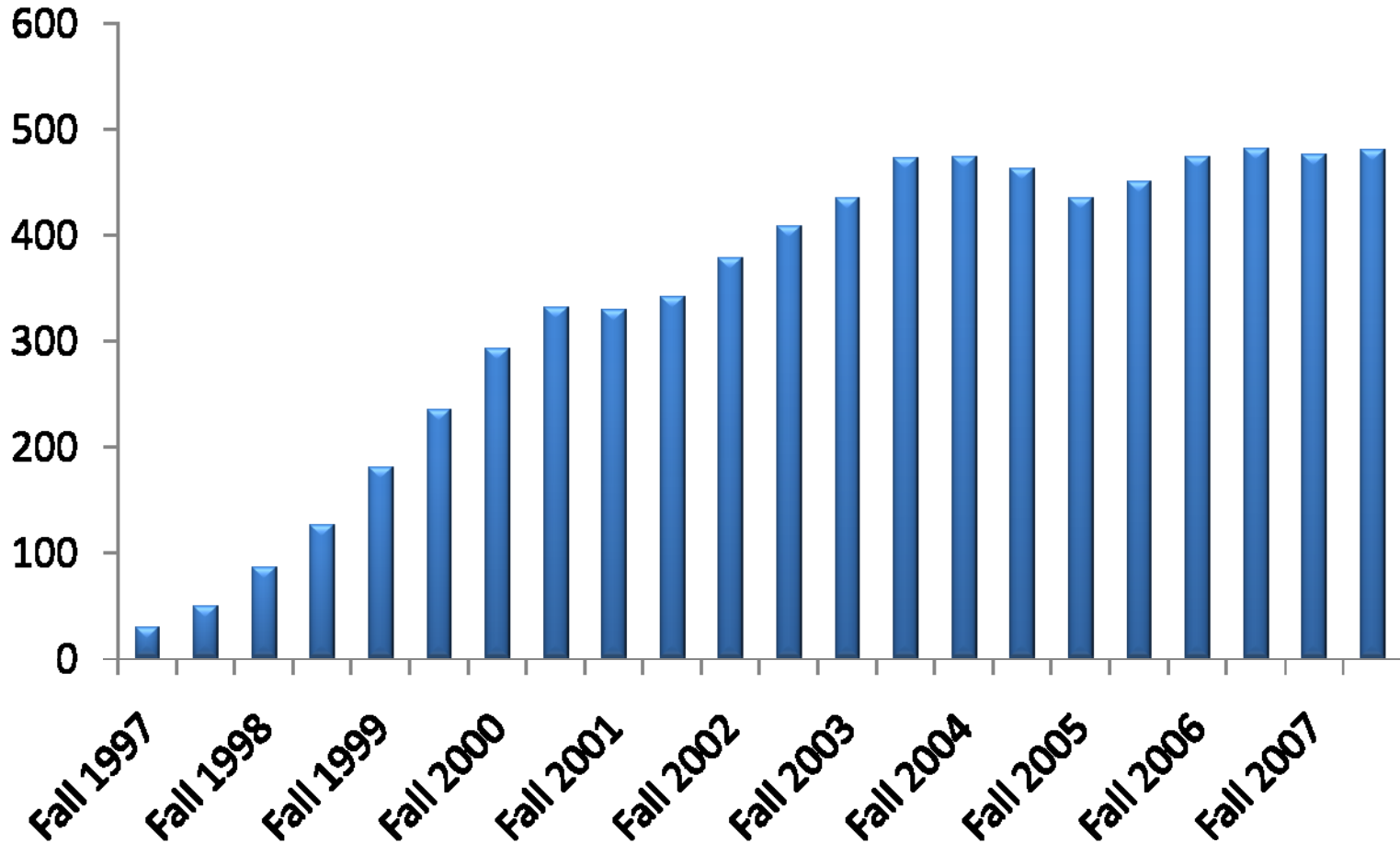


Hallmarks of UTeach

- **Collaboration** between Colleges of Sciences, Education, and Liberal Arts
- **Active recruitment** of science and mathematics majors to take the two initial one-hour UTeach courses free of charge
- Early and intensive **field experiences** throughout the program
- **Compact degree plans** that allow most students to graduate with a degree and certification in four years
- A focus on developing deep-level understanding of the **subject material** and incorporating effective approaches using technology in teaching
- Guidance and inspiration provided by faculty and highly experienced public school teachers who serve as **Master Teachers** in the program
- Courses taught by **faculty** who are actively engaged in research in mathematics and science and in the teaching and learning of mathematics and science
- Integrated **professional development courses** that all focus on teaching both mathematics and science, and are based on recent research in science and mathematics teaching and learning
- An array of **student benefits**, including paid internships that offer opportunities for community outreach in education
- All essential program elements on **permanent budget** or endowment.



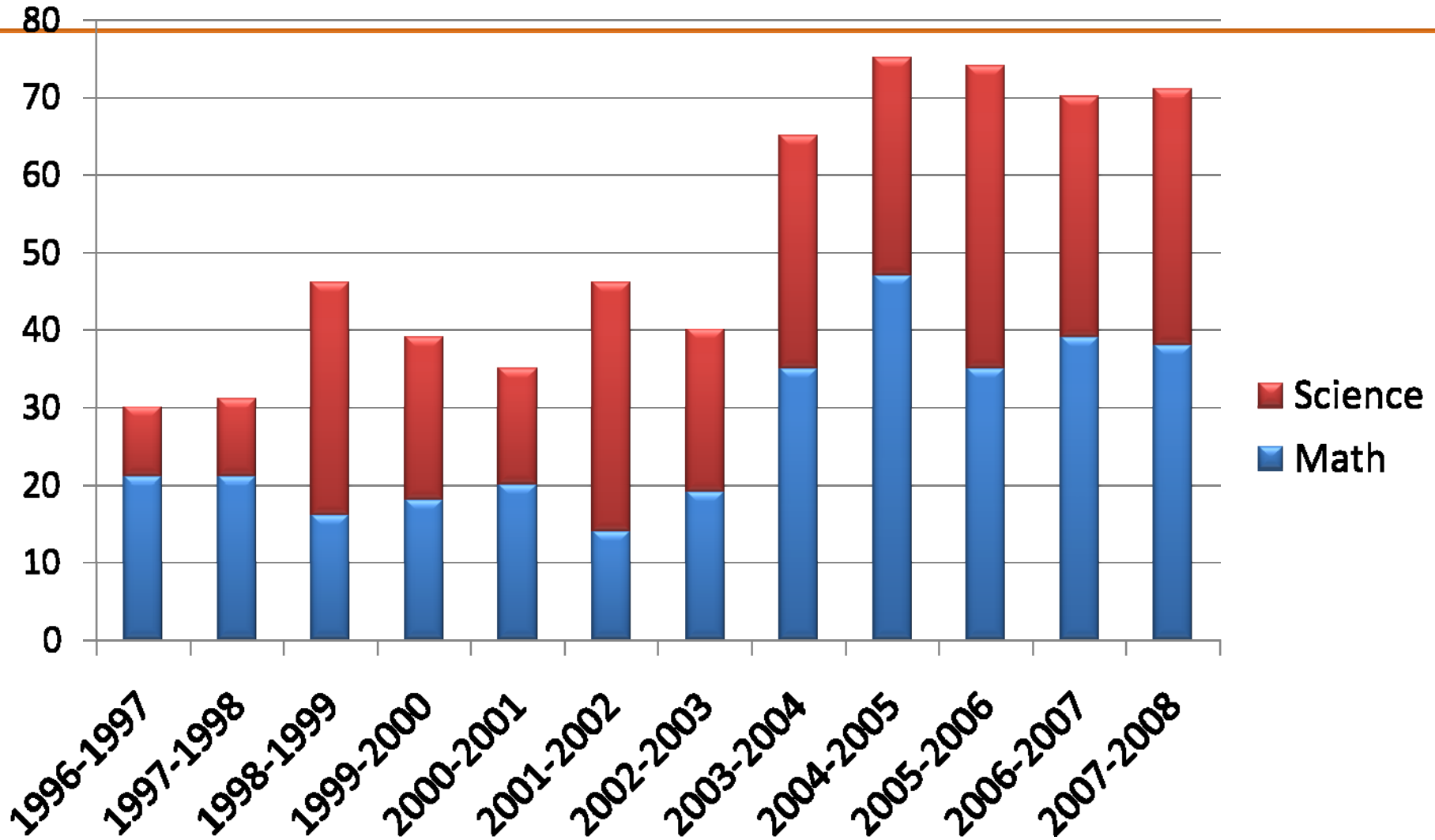
UTeach Enrollment





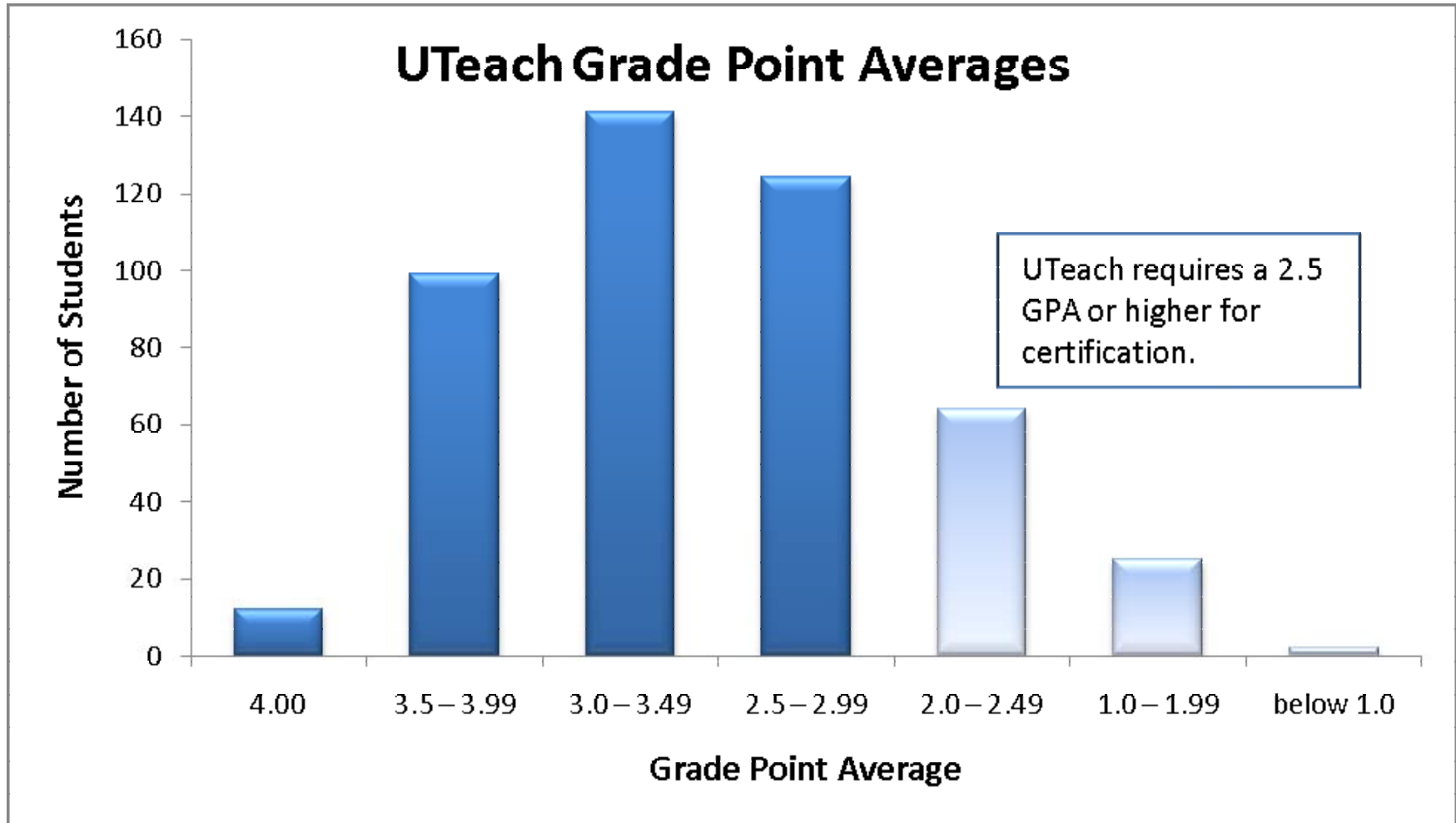
Math and Science Teachers

graduating from UT Austin





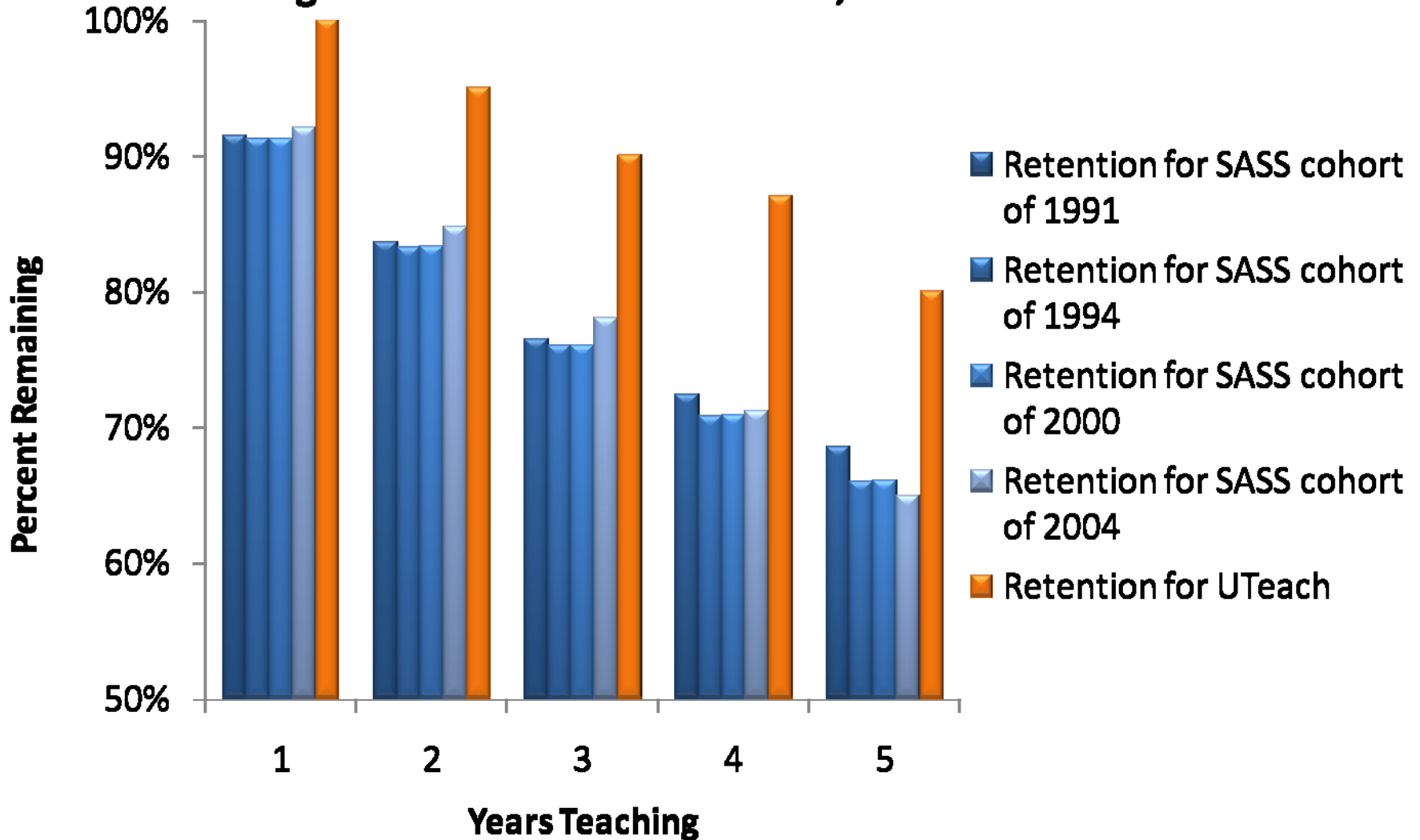
UTeach Student Grades





UTeach Retention

Percentage teachers left in classroom, SASS vs UTeach





UTeach Course Sequence

	Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6	Semester 7	Semester 8
Freshman Pathway →	STEP 1	STEP 2	Knowing & Learning	Classroom Interactions	Perspectives	Research Methods	Project-Based Instruction	Apprentice Teaching
		Sophomore Pathway →	STEP 1	STEP 2 Knowing & Learning	Classroom Interactions	Perspectives	Research Methods Project-Based Instruction	Apprentice Teaching
				Junior/Senior Pathway →	STEP 1 Knowing & Learning	STEP 2 Classroom Interactions	Research Methods Project-Based Instruction Perspectives	Apprentice Teaching
							STEP 1 & 2 Knowing & Learning	Apprentice Teaching Perspectives
							Project-Based Instruction Classroom Interactions Research Methods	

University Provider

Professional Development Courses

Natural Sciences

One-hour Courses: **STEP 1, 2** **

Research Methods

Apprentice Teaching **

College of Education

Knowing & Learning

Classroom Interactions **

Project-Based Instruction **

College of Liberal Arts

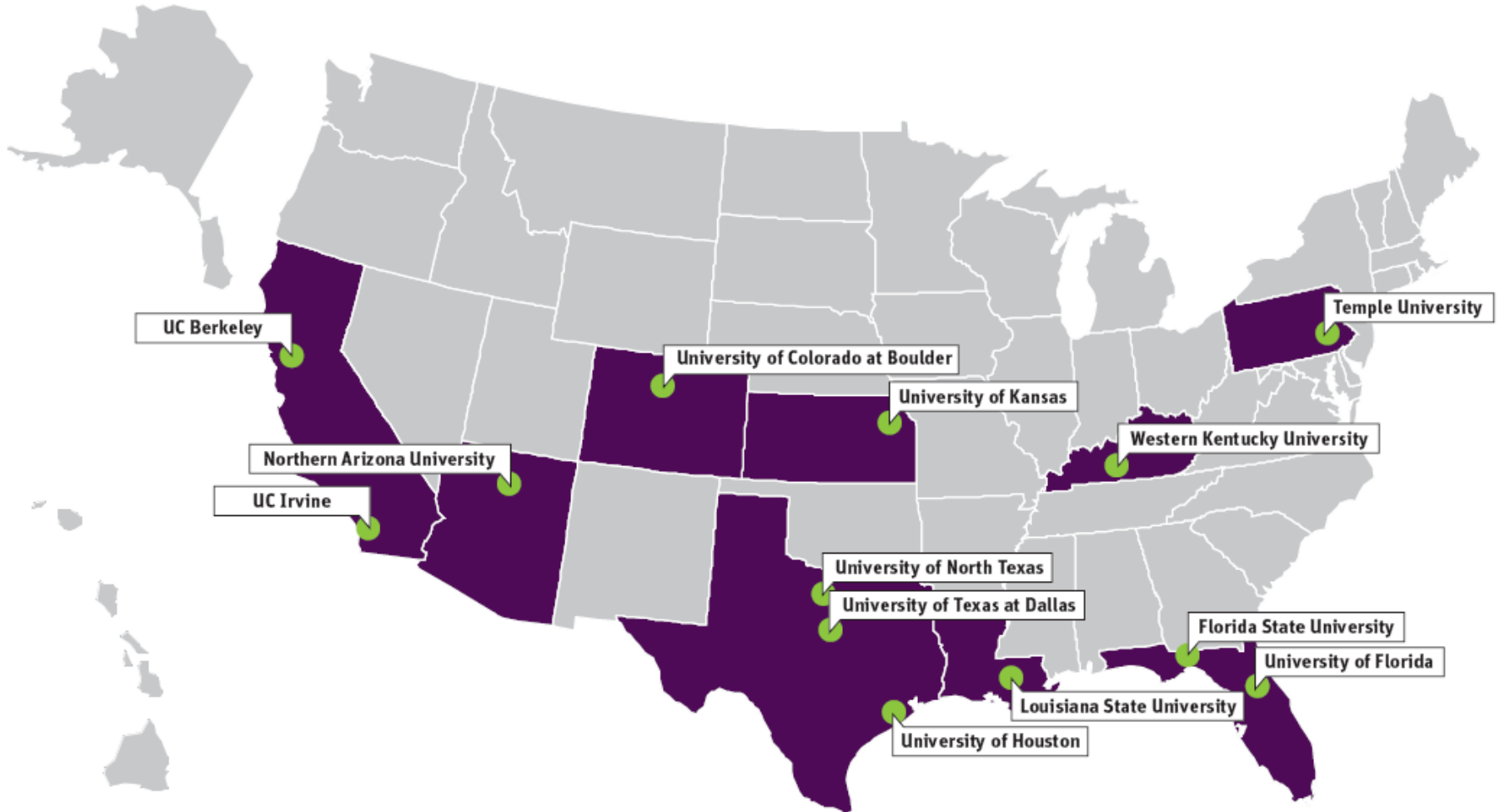
Perspectives in Math & Science

Post-Baccalaureate Pathway →

** includes field experience



UTeach Replication Sites

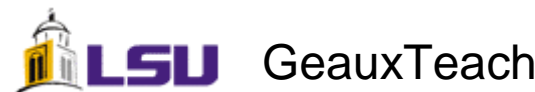




UTeach Replication Sites



California Teach Science & Mathematics Initiative at UC Berkeley





UTeach: 8-12 Composite Science

MAJOR REQUIREMENTS: All major requirements must be taken on a letter-grade basis. A GPA of at least 2.0 in these physics courses is required.

LOWER-DIVISION PHYSICS:

PHY 301 + 101L PHY 316 + 116L PHY 315 + 115L PHY 319

UPPER-DIVISION PHYSICS:

15 semester hours of upper-division Physics courses consisting of:

PHY 341 Topic: Research Methods-W PHY 353 Junior Lab:: Introduction to Quantum Phenomena

Three of the following:

PHY 333 Modern Optics PHY 352K Classical Electrodynamics PHY 373 Quantum Mechanics

PHY 338K Electronic techniques PHY/SCI 360 Topic: Physics by Inquiry PHY 329 Computational Physics

PHY 336K Classical Dynamics I

COMPOSITE SCIENCE CERTIFICATION REQUIREMENTS: Courses intended for non-science majors may not be counted toward this requirement.

6 semester hours in Biology courses including: BIO 311C + BIO 311D

6 semester hours in Geological Sciences:

6 semester hours in Chemistry:

CH 301 CH 302

Enough additional hours in Biology, Chemistry or Geological Sciences for a total of 12 semester hours required for second field composite science.

TS 101- Step 1 & UTS 110 Step 2

DC 365E Project Based Instruction

DC 365C Knowing & Learning in Math & Science

DC 650S Apprentice Teaching in Secondary Schools

DC 365D Classroom Interactions

TS 170 Apprentice Teaching Seminar



UTeachEngineering



UTeachEngineering

Preparing Secondary School Teachers to Deliver Design-Based Engineering Courses



UTeachEngineering

Need for Engineering: Texas allows Engineering as 4th year science class under 4x4 plan [and is considering making physics optional]

4 pathways to engineering certification:

- a) Summer institutes for inservice teachers
- b) Summer Master's program for inservice teachers
- c) Undergraduate certification
- d) Post-baccalaureate certification

4 new courses developed:

- a) Knowing and Learning in Engineering
- b) Principles of Engineering Design
- c) Engineering Energy Systems
- d) Design of Machines and Systems

Aim to certify an additional 20 UTeach students per year with engineering certification, perhaps 10 of them physics majors.



Doubling the number of physics majors who teach

Either we respond to the national calls to greatly increase the numbers of physics majors who become teachers

Or

Our universities may be penalized for failing to produce teachers in critical areas, undergraduate physics programs may be closed, states may back off on requirements that students learn physics, and the U.S. physics community may suffer irreparable damage.