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# Cultivating the STEM Pipeline

## UC San Diego Chancellor
## Pradeep K. Khosla

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# Overview

- The importance of STEM education and careers
- Why early outreach is needed
- How UC San Diego is working to ensure the pipeline
  - K-12
  - Community colleges
  - University level
- Opportunities for collaboration

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# Why STEM Education Is Important

Betterment of community and economy:

- Important for improving human life and tackling societal challenges
- STEM fields propelled the U.S. to the forefront of an innovation-based economy
  - More than half of the per capita income growth in the 20th century is due to advances in science and technology
- Vital for San Diego's knowledge-economy

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# Why STEM Education Is Important

STEM literacy important for all:

- 16 of the 20 occupations with the largest projected growth in the next decade are STEM related
- The U.S. may be short as many as 3 million high-skills workers by 2018
- Need to educate holistic students

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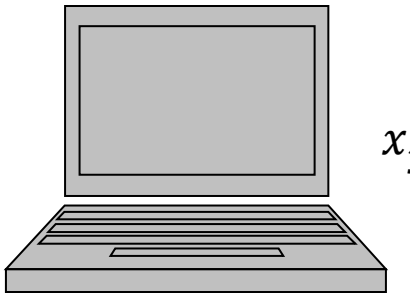
# Why We Need STEM Outreach

$a^2 + b^2 = c^2$

$\sqrt{a^2 + b^2}$

$\frac{dy}{dx}$



$x_{y^2}$

$A = \pi r^2$

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$(x + a)^n = \sum_{k=0}^{n} \binom{n}{k} x^k a^{n-k}$

Students are falling through the cracks:

- ≈ 75% of U.S. 8th graders are not proficient in math
- 27.6% of AP test takers in the class of 2011 earned a qualifying score on a STEM exam
- U.S. students recently finished 25th in math and 17th in science in the world, compared to 31 other countries

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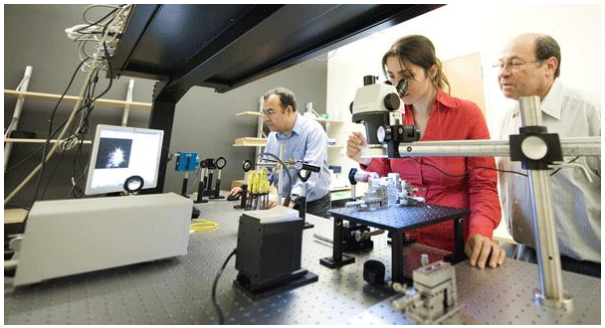
# Why We Need STEM Outreach



U.S. needs to remain competitive:

- In 2008, 31% of U.S. bachelor's degrees were awarded in science and engineering fields. Compared to 61% in Japan and 51% in China.
- New knowledge in both STEM and the teaching/learning of STEM is rapidly evolving.

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# Why We Need STEM Outreach

Need to increase the underrepresented population in STEM fields:

- Only 10% of all STEM doctorates are awarded to non-white, non-Asian students
- 9% of Hispanic and 10% of Black U.S. students took advanced algebra or calculus in 2008, compared to 22% of White students and 43% of Asian students

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# STEM Education Guidelines

## Common Core State Standards for Mathematics

8 principles:

- Make sense of problems and persevere in solving them
- Reason abstractly and quantitatively
- Construct viable arguments and critique the reasoning of others
- Model with mathematics
- Use appropriate tools strategically
- Attend to precision
- Look for and make use of structure
- Look for and express regularity in repeated reasoning

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# STEM Education Guidelines

## Conceptual Framework for Next Generation Science Standards

Goals of standards under development:

- Being designed to continually build knowledge and apply dimensions across curricula
- Provide tool for understanding/investigating complex ideas and solving problems
- Relate subjects to interests/life experiences of students

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# How UC San Diego Encourages STEM Success




Multiple avenues

- Tutoring/mentoring
- Summer camps
- Community programs
- Partnerships
- Teacher development
- Curricula and academic opportunities
- Student organizations

Multiple disciplines

- Engineering
- Physical Sciences
- Education Studies/Social Sciences
- Scripps Oceanography
- SD Supercomputer Ctr
- Extension
- Calit2
- Health Sciences

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# How UC San Diego Encourages STEM Success

## K-12 Tutoring/Mentoring Programs

Students Helping Students

- Partners at Learning (PAL) program
  - 150 undergrads provide 6 hrs/wk in high-need communities
  - Run through Education Studies

- Fifth Dimension
  - After-school program connects undergrads with community children in a mixed-activity system that combines education, play and peer interaction

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# How UC San Diego Encourages STEM Success

- SIO Classroom Connections
  - Grad students create lessons and improve communication skills
  - SD Unified schools learn about Earth Science
- BioCircuits Institute Elementary School Science Partnership
  - Grad students share hands-on experiments and incorporate scientific method into lessons each week
  - Partner with Ocean Knoll Elementary in Encinitas

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# How UC San Diego Encourages STEM Success

Video of Experiment

- Seismic Outreach Program
  - UC San Diego students from all disciplines teach 6th grade classes about earthquake science and engineering
  - Begins with classroom presentations, then build miniature skyscrapers, and finally test structures during field trip to campus
- San Diego Math Circle
  - One of the nation's largest
  - 400 students from 40 zip codes participate

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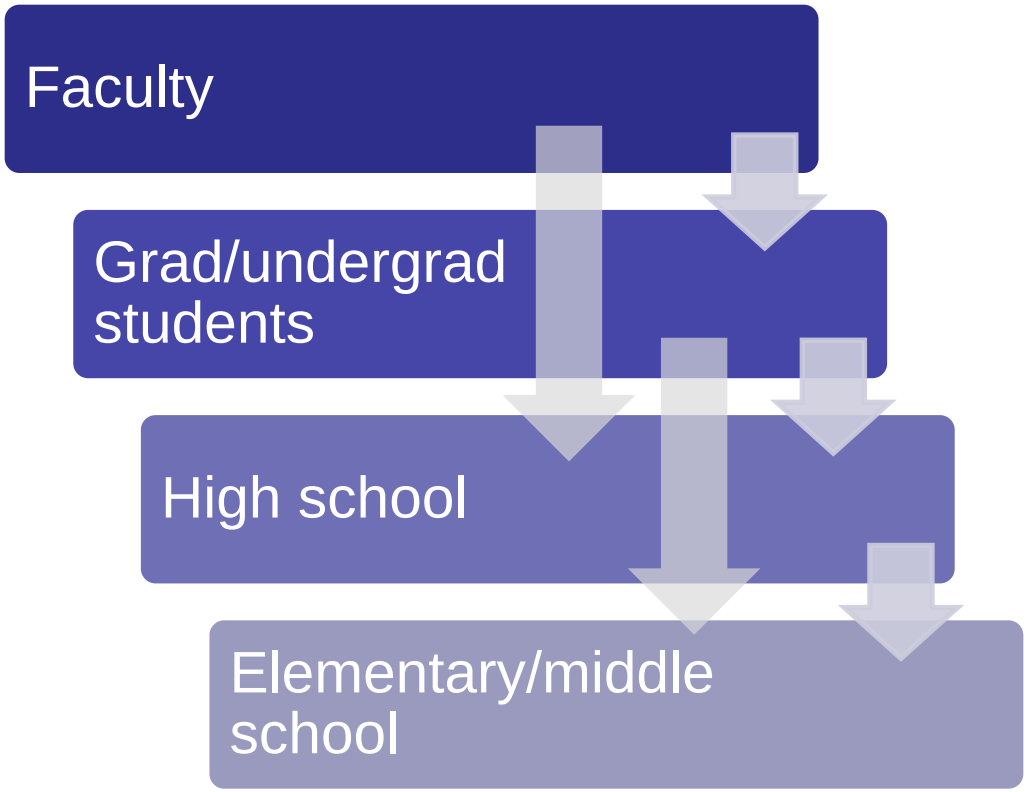
# How UC San Diego Encourages STEM Success

## Dr. Robert “Skip” Pomeroy’s “Pay-It-Forward” Model



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# How UC San Diego Encourages STEM Success


- Teach undergrads to synthesize biodiesel fuel from waste cooking oil or algae, then use analytical chemistry to assess quality of product
- Teach high school students to power combustion engine from coffee grounds & build own tools
- UC San Diego and high school students work with 60 elementary students, and host booth at annual SD Science/Engineering Festival Expo

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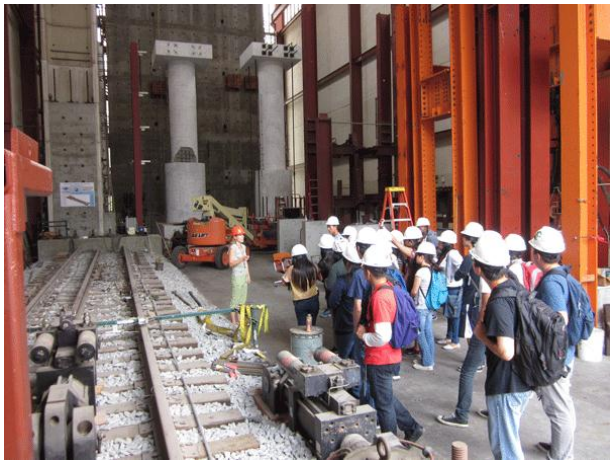
# How UC San Diego Encourages STEM Success



## Summer Programs:

- Academic Connections through UC San Diego Extension
  - Connects high-achieving high school students with college subject matter courses led by graduate students
  - Participants can earn college prep units

- CA State Summer School in Mathematics and Science (COSMOS)
  - Introduces students to subjects not traditionally offered in high school

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# How UC San Diego Encourages STEM Success

- StudentTech
  - Weekend and summer program for middle and high school students
  - Past workshops include Sound Design, Do It Yourself Robotics, The Mathematics of Music
- Research Experience for High School Students (REHS)
  - 7-week summer internship at SDSC for high school students interested in computational science and research
  - Work on real-world, team projects

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# How UC San Diego Encourages STEM Success

## Bilingual Programs:

- La Clase Mágica
  - Bilingual program for elementary students (primarily)
  - Serves 5 community centers / schools
  - Culturally relevant curriculum uses language, technology and communication
- Noche de la Ciencia y la Ingeniería (Night of Science and Engineering)
  - Events include science demonstrations, hands-on activities, panel discussions and motivational talks from STEM professionals and students

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# How UC San Diego Encourages STEM Success

## Community and Family Programs:

- Birch Aquarium
  - Local and mobile science programs
  - School programs reach about 100,000 K-12 students and teachers each year
  - 420,000 people visit aquarium each year
- Early Academic Outreach Program
  - Works with K-12 students, their parents, school representatives and community members
  - Offers academic advising and enrichment, and college-prep info
- Girls Day Out
  - Hands-on STEM activities for middle school girls and their parents

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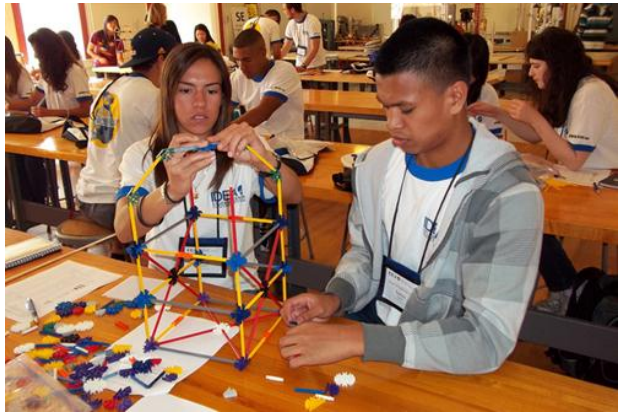
# How UC San Diego Encourages STEM Success



## Transitioning to UC San Diego:

- Upward Bound Math & Science (TRiO)
  - Students complete science projects for evaluation at the end of the program
- Summer Pre-Engineering Program
  - Fosters community, prepares students for the rigor of engineering studies
- Opportunities for Research in Behavioral Science (ORBS)
  - For high school students and undergrads at 2-year colleges
  - Encourages students to transition to 4-year institution to pursue careers in behavioral science

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# How UC San Diego Encourages STEM Success

- The Health Careers Opportunity Program, San Diego Regional Consortium
  - Academic enrichment that address barriers to resources and academic prep that can lead to healthcare careers
  - Students gain hands-on experience in the Research Methodology Training Lab

- The UniversityLink Medical Science Program
  - Health workforce development program that assists and prepares community college students from disadvantaged backgrounds to successfully transfer to university, graduate and enter career positions

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# How UC San Diego Encourages STEM Success

## Professional Development for Teachers:

- Math for America/San Diego
  - Fellows participate in summer institutes, community service programs, seminars, and local and national professional communities
- San Diego Science Project
  - Develops partnerships/school-based teams to improve instruction and learning
  - Explores the intersection of informal and formal science learning
- TeacherTech
  - Highlights online/handheld resources and the latest software to engage students
- Math Diagnostics Testing Program

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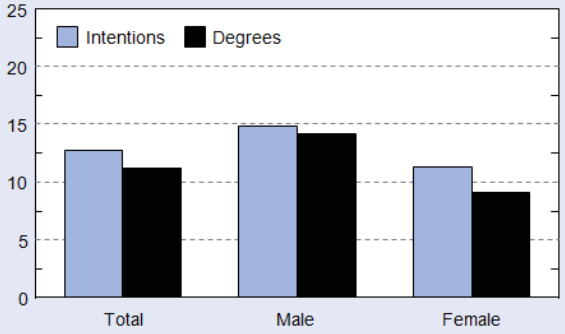
# STEM Education Intentions and Degrees

## Thinking Beyond K-12 Outreach and Support

**Natural sciences: Freshmen intentions and degrees, by sex**

Percent



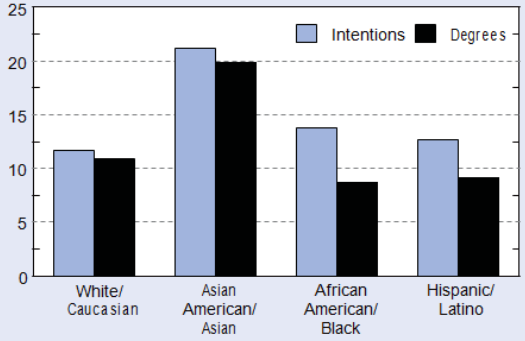

NOTES: Data for freshmen intentions are for 2003; data for degrees are for 2009. Degrees do not reflect the same student cohort.

SOURCES: Higher Education Research Institute, University of California at Los Angeles, Survey of the American Freshman: National Norms, special tabulations (2011); National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, National Center for Science and Engineering Statistics, WebCASPAR database, http://webcaspar.nsf.gov. See appendix tables 2-12 and 2-18.

*Science and Engineering Indicators 2012*

**Natural sciences: Freshmen intentions and degrees, by race/ethnicity**

Percent




NOTES: Data for freshmen intentions are for 2003; data for degrees are for 2009. Degrees do not reflect the same student cohort. Asian American/Asian includes Native Hawaiian/ Pacific Islander.

SOURCES: Higher Education Research Institute, University of California at Los Angeles, Survey of the American Freshman: National Norms, special tabulations (2011); National Center for Education Statistics, Integrated Postsecondary Education Data System, Completions Survey; and National Science Foundation, National Center for Science and Engineering Statistics, WebCASPAR database, http://webcaspar.nsf.gov. See appendix tables 2-12 and 2-19.

*Science and Engineering Indicators 2012*

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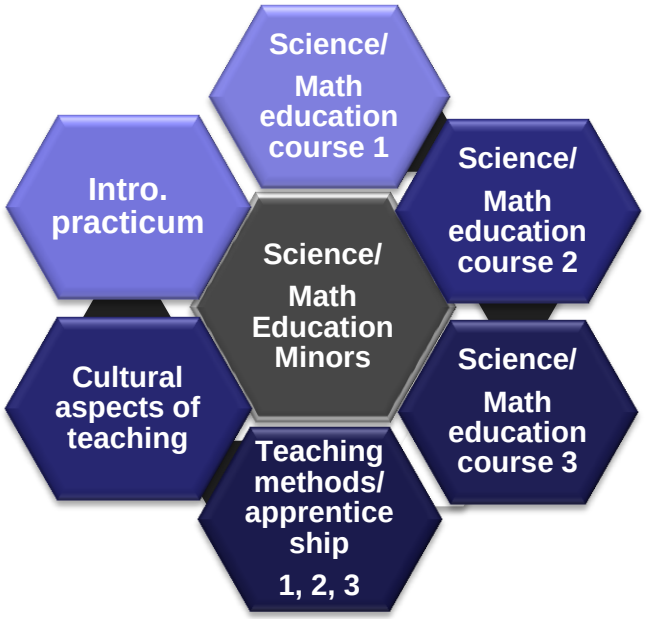
# How UC San Diego Encourages STEM Success

## Cal Teach




- Cal Teach forms a bridge between students' STEM major and the credential program
- Offers intro classes for math and science students who want to teach the subjects K-12
- Explores teaching and learning strategies in the context of STEM content
- Taking the minor as undergraduates reduces the Master of Education / Single Subject Credential Program from 2 years to 1 year, plus 1 summer (15 months)
- Co-taught by faculty in Physical Sciences and Education Studies
- Provides classroom experience at local middle and high schools

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# How UC San Diego Encourages STEM Success

## Cal Teach – Community College Partnership

- Grossmont College has offered an Intro to Teaching Mathematics course for the past 3 years. Last year, San Diego Mesa College launched Intro to Teaching Physical Sciences and is launching Intro to Teaching Mathematics.
- All three courses are approved for UC transfer and articulate to UC San Diego's science and math education minors.
- Grossmont College, San Diego Mesa College, Southwestern College and UC San Diego have submitted a collaborative proposal to the NSF Advanced Technological Education (ATE) Program, "Creating a Pipeline of STEM Teachers Who Can Prepare Students to Excel in a Technological World."

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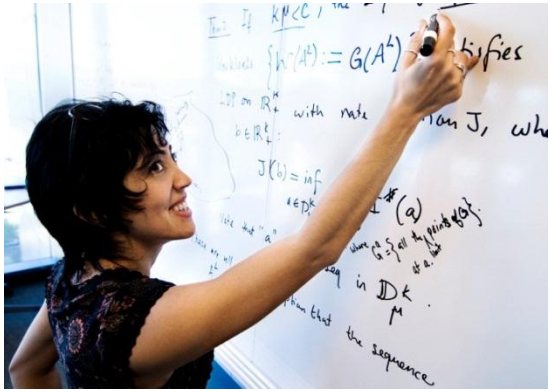
# How UC San Diego Encourages STEM Success




Support at UC San Diego:

- Center for Teaching Development
  - Services include classes, workshops, instructor observation/consultation
- Office of Academic Support & Instructional Services (OASIS)
  - Free tutoring; serves 3,000/yr.
- Jacobs School IDEA Student Center
  - Promotes diversity and inclusion
- Initiative for Maximizing Student Development
  - Helps students transition from college to Ph.D. science programs

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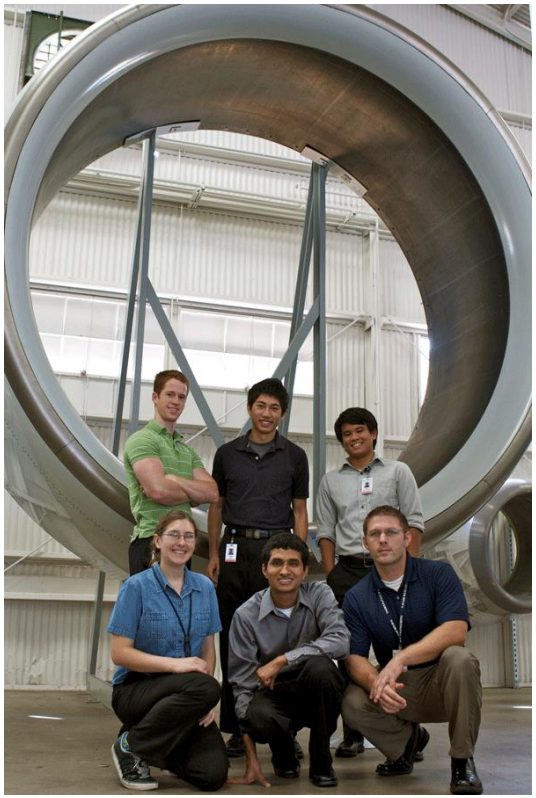

- Hands-on lab training and internships for undergraduates, including paid positions
  - Team Internship Program
  - Research experience with *Gordon*
- Summer Training Academy for Research in the Sciences (STARS)
  - For undergrads/grads and recent alumni
  - Provides faculty mentorship, research experience, prep for grad school/fellowships
- Campus student organizations

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# Next Steps

Center for Research in Educational Equity, Assessment and Teaching Excellence (CREATE)

- Identify and fill “leaks” at all levels
- Reduce duplicative efforts
- Broaden impact
- Streamline outreach training, transportation and paperwork
- Support professional development of teachers and academic support of students
- Evaluate success and outcomes

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# Opportunities for Collaboration



## Increase Partnerships and Outreach:

- Enhance relationships with local elementary and secondary schools
  - Preuss, Gompers and Lincoln are examples of collaboration
- Expand partnerships with community colleges
- San Diego Festival of Science and Engineering
  - Allows us to reach 55,000 students, parents, scientists, educators and community members each year
- Exploring additional MOOCs

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# Cultivating the STEM Pipeline