

Creating Futures

University of Colorado *Boulder*



Sparking Engagement in Math and Science

*Teaching and learning initiatives that
generate lifelong passion*

College of Arts & Sciences

New Pioneering Ways to Experience Math and Science

We have heard the alarming statistic that students in the United States lag their counterparts in more than 20 countries in math and science proficiency. To preserve the nation's competitive edge, we must better prepare more students to succeed in science and math.

CU-Boulder is leading the way. The College of Arts and Sciences has implemented the Science Education Initiative (SEI) and, in conjunction with the School of Education, the Learning Assistant program and CU Teach. CU has also ramped up undergraduate research opportunities.

Helping Students Experience the Excitement of Discovery

"Here's something cool," thought undergraduate biology major Zach Travis when he enrolled in the innovative phage lab instead of a traditional lab. He was right. Funded by the Howard Hughes Medical Institute (HHMI) for three years, the phage lab teaches students to isolate and sequence the DNA of dirt-dwelling viruses called phages.

This model of learning by doing makes the lab experience very meaningful. The data produced by the 24 freshmen in CU-Boulder's phage lab yielded findings that may someday improve our ability to fight antibiotic-resistant bacteria. "You have ownership of what you're discovering, and accountability," Travis says.

In Distinguished Professor Leslie Leinwand's python project lab, funded by HHMI, upperclassmen engage in research by studying the "extreme biology" of Burmese pythons.

"Not only was I learning from my research project and contributing to the science community, but the [undergraduate research] programs provided me a job, mentors and skills in grant writing. I even got to present a poster at a conference and found that my research sparked a lot of interest."

Tara O'Brien, MCDB '10

These snakes can go a full year without food; after a meal, their liver and heart nearly double in size. Dr. Leinwand's groundbreaking research into the genetics and molecular biology of pythons could generate therapeutics to improve cardiovascular health in humans. Dr. Leinwand thinks the python lab is an ideal learning environment—students get excited about research and learn to think scientifically. As CU-Boulder alumna Ashley Crary '10 says, "It's exciting that we are actually practicing what we say we want to grow up and do."



Leslie Leinwand in the Python Lab

Undergraduate research initiatives such as this cut across a dozen College of Arts & Sciences science and math departments. In another such project, Applied Math students receive stipends funded by the National Science Foundation to work on challenging math problems that have real-world significance—using partial differential equations to study heating and cooling in a bakery, and signal processing to help detect counterfeit ID cards. They also get experience that provides a competitive edge when applying to graduate school or seeking employment after graduation.



Augmenting Traditional Lectures

After winning the Nobel Prize in Physics in 2001, Dr. Carl Wieman turned his attention to dramatically improving science education. Working with the School of Education, Wieman launched the Science Education Initiative to apply the latest advances in pedagogical excellence toward making large introductory courses more engaging and effective.

Carl Wieman

Many introductory lectures now include interactive strategies to increase complex-problem-solving skills and move students beyond simply memorizing facts and plug-and-chug recipes. Students use “clicker” technology to respond to classroom queries, and often group into teams to talk through a solution.



“The shift in attitude toward teaching that I see here is phenomenal. I see signs all over the place of faculty making changes to how they are teaching, such as using ‘clicker’ questions and asking students to draw conclusions instead of telling them what they should know... This has triggered what, for me, has been an earth-shattering paradigm shift in how I think about teaching science.”

Valerie Sloan, *Instructor, Department of Geology*

Learning Assistants Build Interactive Learning

First implemented at CU-Boulder in 2003, CU-Boulder’s Learning Assistant (LA) program has been replicated at 13 universities and received national recognition at a White House ceremony.



An undergraduate Learning Assistant, leading a discussion

The LA program recruits talented undergraduate students to serve as expert learners in introductory courses. Each semester, about 175 learning assistants lead participatory discussions during lectures and recitation sections; they often anticipate students’ potential difficulties more easily than faculty or even graduate teaching assistants.

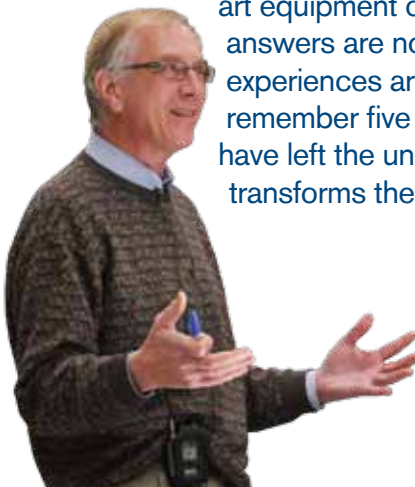
Data indicate that not only do undergraduates participating in LA-assisted classes boast higher test scores and a deeper understanding of science, but the learning assistants themselves increase their knowledge. After just two semesters as LAs, these undergraduates boast subject comprehension on a par with incoming graduate student teaching assistants.

“When you walk into a traditional classroom, students are sitting quietly, and there is one teacher. But when you walk into a Learning Assistants classroom, you see people articulating and defending ideas. They’re actually doing science. They’re not just doing school.”

Valerie Otero
Assistant Professor, School of Education

“The most vibrant science education experiences research universities can foster comes not from classroom teaching, but when undergraduates enter research laboratories. This is where they get personalized education. They work with state-of-the-art equipment on questions whose answers are not yet known. Those experiences are the ones students remember five or ten years after they have left the university. This is what transforms their lives.”

Tom Cech,
*Distinguished Professor,
Department of Chemistry
1989 Nobel Laureate*



"I view CU-Boulder as the national leader in driving improvements in STEM education at the college level. I am unaware of any other institution that has even one Nobel Laureate leading their education reform processes; CU-Boulder has leadership from two in Tom Cech and Carl Wieman, and from other members of the National Academy of Sciences nationally recognized for innovations in science education, Dick McCray and William Wood. CU really is unique."

Bruce Alberts

*Editor-in-Chief, Science
Past President, National Academy of Sciences
Professor Emeritus, Biochemistry and
Biophysics, UCSF*



To learn about projects you can support in participating College of Arts & Sciences departments, contact:

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How You Can Help

We need your help to continue and expand these initiatives! For example, the number of students who are qualified and would like to become learning assistants and/or secure undergraduate lab positions exceeds the resources available to hire them. The phage lab and the python project lab are funded by soon-to-expire federal grants.

Your donation will go to work immediately to directly benefit the quality of science and math education at CU. For example:

- \$1,500 supports one learning assistant for one semester. You can donate to the LA program in general, or to the LA program within the department of your choice.

- Applied Mathematics
- Astrophysics and Planetary Sciences
- Chemistry and Biochemistry
- Ecology & Environmental Biology
- Environmental Sciences
- Geography
- Geology
- Integrative Physiology
- Math
- Molecular, Cellular & Developmental Biology
- Physics
- Psychology and Neuroscience

- \$3,000 funds one student's undergraduate research year. You can donate to the undergraduate research program in general, to a department, or a specific lab.



All gifts should be payable to the University of Colorado Foundation, specifying the appropriate fund.

Thank you for you support!