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Chairman Bart Gordon

"Science and Technology Leadership in a 21st Century Global Economy"
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Testimony of Robert C. Dynes, President, University of California

UC's Missions as a Land-Grant University

Chairman Gordon, Ranking Member Hall, and other members of the committee, I am Robert C. Dynes, President of the University of California. I want to thank you for inviting me to testify, and I want to give special thanks to Chairman Gordon and Norm Augustine for their leadership and support in seeking to enhance U.S. competitiveness through targeted investments in university research and in science and mathematics education. I am pleased to have this opportunity to share the University of California's vision in this crucially important task.

Mr. Chairman, your invitation asked me to comment on your legislation that implements recommendations from the National Academy of Sciences' report "*Rising Above the Gathering Storm*" and also to describe the University of California's Science and Mathematics Initiative, which is one of the models for the recommendation to create a national program called "10,000 teachers, 10 million minds."

The report rightly and forcefully draws our attention to the challenges we face in research and most especially in the education of our youth in mathematics and science. In the past, America's colleges and universities have played a vital role in stimulating the innovation and creativity that drives economic development. This role of higher education in the future is likely to be even greater as the world becomes even more competitive.

As one of the nation's most distinguished land-grant universities, the University of California has always had a tradition of employing its research and teaching capacity to address our state's and nation's economic and social challenges. In the 19th century, those challenges were in agriculture and mining (food and resources). Today, universities must build our nation's capacity for innovation, with greater urgency than ever before. Innovation in science and technology is the engine that will drive the 21st-century economy, and the University of California is poised to play a major role in this effort.

Looking Ahead: Vision for Future of UC and California

My vision for how the University of California will do its part to keep the U.S. and California competitive in the new global knowledge-based economy builds on the land-grant research university's tripartite mission of research, education, and public service. A simple way to describe those three missions is:

- *Research:* Create new ideas

- *Education:* Create new leaders and creators
- *Public service:* Put these creations and people to work to benefit all citizens

We believe that in carrying out these three missions—through research, education, and public service—the University must continue to contribute, as it has done to such great effect in the past, to California's ongoing achievement as one of the world's most creative laboratories for new ideas and better lives for the entire nation.

At UC, we have been undertaking new efforts at long-range thinking and planning, trying to envision what the University should be in 2025 and what we need to do now to get there. That process has led to a number of initiatives within the University to build on the advantages we have as the nation's largest research university with multiple campuses and a multitude of institutional and disciplinary strengths.

My own vision for the future of the University of California – and the state of California – focuses on three main efforts where we can harness the promise and power of our 10 campuses as one university most effectively. Those efforts are:

- R, D, & D Innovation: First, we will fuel innovation and ramp up the state's economy by leading the nation in R, D, & D – research, development, and delivery of new products to end users for society's benefit.

- Strategic Global Alliances**:** Second, we are forging strategic alliances with the best and brightest minds around the globe to solve problems that confront all societies. In the process, we will lure some of those best and brightest to the University so they can work for the benefit of California and the nation.

- Improving K-12 Education, especially in Science and Math**:** Third, we will enhance the quality of California's and the nation's future workforce by tackling the crisis in K-12 education – not just bemoaning it, but actually doing something about it.

The Science and Mathematics Initiative (SMI) or "Cal Teach" is an important piece of this last effort. We need many more science and mathematics majors to choose teaching in K-12 schools as their ultimate career. However, it is not the only piece. Public research universities must do more to transform math and science teaching in ways that will ensure future generations of Americans are offered educational opportunities that exceed those of past generations.

In this testimony, I will further describe these three initiatives, and I will point out which of the recommendations from The National Academy of Sciences' "*Rising Above the Gathering Storm*" report and the Chairman's legislation can help us in each of these efforts.

R, D, & D Innovation

We entered the era of research, development, and delivery on September 11, 2001, when we watched first responders trying – and failing – to communicate with each other at the World Trade Center. As a techie, I knew we had the communications technology. But the fire crews and the police and the rescue workers were never given that technology.

As UC President, I have vowed that this University will lead the nation in R, D, & D advancements. That leadership is centered in our four California Institutes for Science and Innovation. They are changing the way universities operate, and they represent a new algorithm for university tech transfer.

Each Institute embodies "the promise and power of our 10 campuses" by linking two or more UC campuses with industry partners to focus on an area with vast R, D, & D potential, like nanotechnology, biotechnology, information technology, and telecommunications.

Each Institute is briefly described below.

- ***The California Institute for Quantitative Biomedical Research (QB3)*:** UC San Francisco leads this partnership with UC Berkeley and UC Santa Cruz. QB3 is developing new technologies and new areas of research for drug discovery and for the diagnosis and treatment of cancer, arthritis, and other diseases through the convergence of mathematics, engineering, and physical sciences with biomedical and genome research.

- ***The California NanoSystems Institute (CNSI)*:** UCLA leads this partnership with UC Santa Barbara. CNSI is creating laboratories for research, education and technology development in the emerging field of nanoscience – the study and design of materials and functional machines at the level of individual molecules and atoms.

- ***The California Institute for Telecommunications and Information Technology (Calit2)*:** UC San Diego leads this partnership with UC Irvine that has built effective intercampus collaborations and new paradigms for performing multi-disciplinary research and education. Calit2 is defining worldwide and community-based networking scenarios to serve a broad spectrum of R, D, & D areas and global societal needs.

- ***The Center for Information Technology Research in the Interest of Society (CITRIS)*:** UC Berkeley leads this partnership with UC Davis, UC Santa Cruz, and UC Merced. CITRIS is changing the way researchers collect, share, and utilize data, and it will transform decision-making in government and commerce by delivering new kinds of vital data for rapid analyses to save lives and dollars. The original focus of this research center was on six societal-scale applications of information technology – energy efficiency, transportation, earthquake preparedness, environmental monitoring, health care and education – but it was recently expanded to include special initiatives in Homeland Defense and Cultural Research.

In partnership with the State and with industry, including more than 400 companies, the four Institutes engage UC's world-class faculty directly with California companies in tackling large-scale issues critical to California's economy and to its citizens' quality of life. Information technology, telecommunications, nanotechnology, biology, health care, traffic congestion, environmental management, homeland security, and novel energy systems are among the areas of focus for new research within these Institutes. The Institutes are taking ideas beyond theory into practice, shortening the time to product development and job creation.

On December 27, our R, D, & D mission received a huge boost with the news of California Governor Arnold Schwarzenegger's Research and Innovation Initiative. Governor Schwarzenegger proposed nearly $95 million in the state budget – $25 million from the general fund and $70 million from lease revenue bonds – for the four Institutes and for other major UC projects that will boost our economy and preserve our environment through R, D, & D of new innovations.

Specifically, the Governor's Budget proposed $30 million in lease revenue bonds to the Helios Project, run by the University's Lawrence Berkeley National Laboratory to create sustainable, carbon-neutral sources of energy, including the next generation of super-efficient solar energy technology that will help reduce greenhouse gases and oil dependency.

It also included $40 million in lease revenue bonds for UC in the event that one of its campuses won the global competition for British Petroleum's $500-million grant to build and operate an Energy Biosciences Institute. The Institute will focus on converting biomass materials into fuels, converting fossil fuels to energy with less environmental damage, and maximizing oil extraction from existing wells in environmentally sensitive ways. February 1 brought more good news with the announcement that UC Berkeley and the Lawrence Berkeley National Lab, in partnership with the University of Illinois at Urbana-Champaign, did win this global competition. Their new venture has the potential to revolutionize energy usage in this country.

I should emphasize here that, in all these undertakings, R, D, & D is being carried out by faculty AND students. UC students learn to be innovators by taking part in the creative process as students, both graduate students and undergraduates. That is the best kind of education you can give to a bright young person.

The National Academy of Sciences' "*Rising Above the Gathering Storm*" Report/ HR 363 recommendations that will help research universities carry out RD&D:

I will not go into detail about each of the recommendations that is now in H.R. 363, but let me note here that implementation of that legislation would be of tremendous assistance in helping public research universities like ours. Annual 10-percent increases in federal support for peer-reviewed competitive research would help provide needed stability to plan future research endeavors.

In particular, the University strongly supports the provision that would designate a percentage of funding dedicated to high-risk, high-payoff research projects. While undefined in the bill, the term "high-risk, high-payoff" is widely understood and supported in the scientific community. This approach generally refers to research that has the goal of exploring concepts that have the potential for huge impacts but that might also have a chance of failure.

Any successful enterprise that grows in size will tend to stick to proven methods. However, as global competition increases, we need to make sure the U.S. does not become overly complacent in how it funds research. Encouraging the federal research funding agencies to support cutting-edge research that pushes the boundaries of disciplines is a wise long-term strategy. Inevitably, there will be many examples where taking such chances does not pay off, but in the long run, just

as high-tech industry depends on venture capital to progress, we need to create the resources for scientists to take risks that lead to major advances in science and technology.

Similarly, we need to take risks on promising individuals in the sciences. I strongly support the proposals to provide large awards to the most promising researchers. This will ensure that some of the best and brightest minds stay in academia long enough to make a difference in the overall enterprise.

And of course, we strongly support more federal support for research infrastructure – for facilities and specialized instrumentation.

Strategic Global Alliances

I believe we must view the progress of other nations as an opportunity for our own nation's development and not as a threat. We must harness the best minds from different societies to tackle common problems.

On the international front, the UC's push to forge strategic global alliances is driven in large part by leaders from industry and government who want California to maintain its competitive edge. You don't do that by building walls and staying in your own yard. You do that by being open to new ideas from people of diverse cultures and different perspectives.

The University of California is expanding its global presence as close as Canada and Mexico and as far away as China, India and Africa. Other societies grapple with the same problems we do in public health, energy and transportation, and the environment. Top universities in those societies are putting their best minds to work on these problems. Shouldn't we harness our best minds with theirs to tackle these problems and create innovative solutions?

This concept has taken me to China twice to launch a "10 + 10" alliance of our 10 UC campuses and China's top 10 universities. On both trips, I brought along at least two Chancellors and many campus representatives.

I just returned from India where I was developing a "UC-India Initiative" to expand research and educational collaboration with academic, government, and industrial partners. The tour included a special meeting with Indian President Abdul Kalam, who delivered the keynote speech via high bandwidth streaming video at last fall's UC-India Summit at Calit2 at UC San Diego.

As with all our international alliances, the emphasis is on R, D, & D innovation that crosses the disciplines in areas of vital importance to both nations, areas like information technology, energy resources, and public health.

***"Rising Above the Gathering Storm"* recommendations related to strategic global alliances**

Although not specifically addressed in Chairman Gordon's legislation, we also wish to express our support for recommendations in the National Academy of Science's report, "*Rising Above The Gathering Storm",* that would facilitate entry of international students and scholars to the United States. There is a significant and ongoing need to facilitate institutions' efforts to attract and retain high-caliber U.S. and foreign students and researchers. With growing competition

from other nations for international talent, the U.S. needs to make changes to the current visa system in order to compete. The current U.S. visa system increasingly prevents U.S. businesses, universities, medical institutions, and research centers from competing for needed talent.
Like many institutions around the country, UC has seen a decrease in international enrollments, which are crucial at the graduate level. In fall 2002, for example, UC enrolled 7,532 international graduate students. In fall 2005, that figure declined to 6,988 – a drop of 7.2 percent.

Improving K-12 Education

The University is moving forward in addressing shortcomings in K-12 education. This task may hold the greatest potential for economic and societal impact, but in many ways, it may present our most difficult challenges. In my travels throughout California to meet with constituents, I have found this to be our most urgent problem by far. Mathematics and science achievement in California is lagging, and the ramifications for our state are alarming. Let me cite a few specifics:

- On the 2000 National Assessment of Educational Progress (NAEP), nearly half of California's eighth grade students scored "below basic" in science and math.
- National testing data (Trends in International Mathematics and Science Study) reveal that California's children are among the worst in the U.S. in their knowledge and abilities in both mathematics and science. U.S. children are falling further behind children of other countries in their knowledge of and abilities in mathematics and science.
- Statewide, 25% to 35% of California's science and mathematics teachers either have no credentials or are not qualified, i.e., they have neither a major nor minor in the subject area they are teaching. The situation is much worse in lower performing schools where as many as 80% of science and mathematics teachers are not qualified.
- The National Center for Education Statistics found in its 2002 report that at least 60% of high school science ***classes*** are taught by "out-of-field" teachers. In middle school, the problem is even more acute.
- At present, nearly 25,000 teachers in California are teaching with emergency credentials, meaning they do not meet the current requirements in the federal No Child Left Behind legislation.
- Projections indicate that more than 30% of California's teacher workforce will be eligible to retire in the next decade.
- For the first time in many years, California experienced a decrease in the number of credentialed teachers entering its workforce in 2005-06.
- This year, California has a shortage of more than 2,000 mathematics teachers, 1,000 life science teachers, and 1,000 physical science teachers.
- Little or no science is being taught in many of California's K-5 classrooms.

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The one experience that really brought this home to me in my travels up and down the state was visiting entire schools and even school districts that did not have a single qualified mathematics or science teacher.

Having been in the sciences my whole career, I know first-hand that great K-12 teachers are indispensable to the future scientific interest and success of students.

Without any doubt, some of these problems are due to the shortage of teachers with deep content knowledge in mathematics and science. California's supply of mathematics and science teachers falls far below the number needed. The state barely produces half of the necessary credentialed teachers to cover the demand.

In May 2004, UC and California State University (CSU) entered into a compact with Governor Schwarzenegger that offered us stability in state funding in exchange for meeting certain state accountability goals and addressing state needs. The compact called for a new UC initiative to address the shortage of trained K-12 teachers in science and math.

In May 2005, in consultation with Governor Schwarzenegger and Chancellor Charles Reed of the CSU system, we launched a bold program. UC made a commitment to quadruple the number of students trained to be science and math teachers from 250 per year to 1,000 a year. We called the program "Cal Teach" or the UC Science and Mathematics Initiative (SMI). CSU committed to 1,500 science and math teachers a year for a combined total of 2,500.

The basic elements of SMI as we envisioned it were:

- Recruiting UC students to be math and science teachers from students who are majoring or considering majoring in those fields.
- Providing these students the training they need by drawing on the expertise of our faculty in those fields, both in the disciplines and in advances in pedagogy specific to science and math education.
- Offering financial incentives to retain these students as teachers.

As this process has developed, two interesting things have happened on the campuses. First, the SMI campus directors are deans in the sciences, so they carry a lot of clout. They are committed to the success of this program, and they are energized about it.

Second, we are seeing faculty in science and mathematics departments team up with faculty in education departments. Now they are collaborating on entirely new curricula for preparing science and math undergraduates to be master teachers. Included with this testimony is an example from UC Berkeley of this new curricula, blending cutting-edge content knowledge in the sciences, including field and lab experiences, with distinctive new pedagogy specifically suited to conveying this knowledge.

As the campuses develop these new curricula, and as they come back together to pool their ideas, I predict we are going to see real magic happen. Because your committee is considering a similar program for the nation, I want to include a significant amount of detail in the rest of this testimony on what we have done to date.

As we provide this detail about our program, I think it is important to remember that we need flexibility in implementation. SMI at each of our campuses will look different to account for local campus and regional circumstances.

UC's Unique Resources for Addressing the Teacher Deficit

As the nation's largest public research university, the University of California has an extraordinary array of intellectual and other resources for addressing issues such as the achievement gap in K-12 education. I believe that no issue so commands the application of those resources as does improvement in the achievement of our youth. Let me add that I believe we must do everything we can to identify and encourage K-12 student talent to study and work in the fields of science, technology, engineering, and mathematics (STEM).

So what can a research university like UC bring to this issue?

- The University produces almost half of all the students earning baccalaureate degrees in science and math in California. Research universities tend to have higher concentrations of students in the science and math disciplines.
- UC students constitute our state's highest achievers, and they have the potential to make enormous contributions as science and math teachers, as well as in all other fields.
- UC has a faculty unmatched in the depth and breadth of their expertise in science and math. We can apply this expertise in advancing the subject matter mastery of these students as well as the skills and content knowledge of teachers already in the field.
- Yet, in the past, the University and most other top research universities have not tapped their potential for attracting science and math students into the teaching force. Addressing that issue energetically and effectively may be the very best way that UC and peer institutions can contribute to the improvement of public schools and their students.

So how are we proposing to organize these resources to address this urgent problem?

SMI Model--The University

UC's response, working in partnership with K-12 schools, CSU Chancellor Reed, Governor Schwarzenegger, the California Legislature, and California industry leaders, has been to launch the SMI in Spring 2006 at the nine UC general campuses. The goal of the program is the goal the Governor and I agreed to the year before – to quadruple the number of math and science teachers the University produces from 250 in 2005-6 to 1,000 by 2010-11, as CSU doubles its output to 1,500 by 2010-11. This is a bold challenge to our faculty, staff, and students. But the crisis is real, and we must take dramatic action to address it.

Quantity and Quality in the Teaching Force

Of course, quantity is only one of the goals of SMI. We also are committed to improving the preparation of teachers in ways that will result in superior teaching and learning, and that will attract some of our most talented and high-achieving science and math majors into a teaching career. Specifically, SMI is developing better methods for preparing these students as science and math teachers so that they have an extraordinary command of their discipline and more refined pedagogical skills in their fields. UC will attract to the teaching force more of its undergraduate majors in science, math or engineering, and we are creating curricula that focus on newly developed teaching techniques specifically geared to science or math learning.

UC is developing the SMI program in consultation with a broad spectrum of stakeholders: faculty members, inter-segmental education partners, industry leaders, foundations, and state and national organizations specializing in science, math, engineering, technology and teaching. We are building upon the Community Teaching Fellowships in Mathematics and Science program,

which began at UC Berkeley over 20 years ago, as well as a model pioneered in 1997 at the University of Texas, Austin, which has prepared hundreds of new math and science teachers since its inception, in response to the same pressures we feel in California today.

Program Growth and Development—First Steps

SMI is now in its second year of operation. UC campuses began by establishing Resource Centers in their schools of sciences and mathematics for advising, as well as for placement, student recruitment, and coordination with schools. Making math and science departments the locus of the program emphasizes the centrality of subject matter mastery, and in the preparation of new teachers, it more directly involves those faculty most attuned to the scientific ideas and knowledge that our citizens should master. Concurrently, UC education faculty are collaborating with scientists and mathematicians in new ways to identify pedagogies appropriate to various disciplines and students.

A second benefit of locating SMI in math and science units is that this promotes student recruitment and clearly demonstrates the interdisciplinary aspects of the program – learning science/math and teaching techniques as a blended effort. Having the program in the science and math departments demonstrates this is clearly right in the place where the students "live."

We supplement the program recruitment with a "field experience" course, beginning at the freshman level, called CaT1 courses, where students work in local schools under the supervision of mentor teachers and meet regularly in small seminar groups to discuss experiences and learn from one another. These courses bring potential teachers into direct contact with schools and students immediately so they can experience the exhilaration of guiding students in their field while they experience the challenges of teaching and test their own capacities. These CaT courses extend throughout the student's undergraduate experience.

Our early research on the outcomes of this field experience course has demonstrated that it has a pronounced effect on student aspirations. Many intensify their commitment to teaching, and many find that their interest deepens in various aspects of their own science and math learning as they work with their students' learning patterns. And some discover that teaching is not for them, which we know is important.

Community College Component

During this past year, UC has also expanded SMI to the California Community Colleges. Students who transfer from community college campuses comprise about 30 percent of UC graduates and about two-thirds of CSU graduates. Community college students who intend to transfer to UC or CSU represent a rich source of future teachers for California's schools since many return to their home communities after completing undergraduate degrees.

The University began its SMI community college work with the Foothill-De Anza Community College district, extending its first- and second-year SMI courses to students who plan to transfer. This project has since expanded to include 16 community colleges (5 in southern California, 3 in the Santa Barbara region, 5 in the Silicon Valley area, and 3 in the Santa Cruz/Monterey Bay region). This academic year, as many as 100 community college freshmen

are participating in a field experience at a local school accompanied by a follow-up seminar at their home community college.

SMI—Second Year—Current Program Components and Organization

We are now well into our second year of operation, and the model is still evolving. At Texas, UTeach originated on just one campus. At UC, to help address the enormous needs of California, the program is being developed simultaneously on all nine of our general campuses. Each UC campus has a distinctive curriculum and a different set of local schools and educational issues, so our various campuses provide an excellent laboratory for testing different approaches to the goal of increased teacher numbers and improvements in preparation. Some campuses have developed education minors with a math or science emphasis, and faculty from across the disciplines have collaborated to develop math and science education courses. Common elements of the model include:

- Development of new curricula, which combines cutting-edge content knowledge in the sciences, including field and lab experiences, with distinctive new pedagogy specifically suited to conveying this knowledge.
- Student recruitment, focusing on freshmen and community college transfers, but providing student entry at all levels of the undergraduate program.
- Lower-division academic program elements that combine field experiences (CaT 1, 2, and 3) with seminar participation and "Master Teacher" supervision, encompassing as subject matter California's standards-based instruction, learning assessment tools, classroom management, diversity, and learning theory.
- Upper-division program elements that form a bridge to the credential program by building upon the early field experiences and math and science subject matter preparation to connect with the University or district internships.
- Alignment of subject matter preparation with educational coursework to assure prompt and timely completion of an undergraduate degree, a preliminary teaching credential, and a master's degree in five years.
- Summer STEM institutes to develop distinctive pedagogy for teaching math, biology, physics, chemistry, and geosciences.
- Financial incentives for student participation.

There are a number of "paths to teacher certification," and I am including illustrations from two of our campuses, UC Irvine and UC Santa Barbara, to display the wide variety of ways in which students will earn certificates and the many different paths that students may follow when they enter the SMI program—whether as a freshman, a transfer, or a junior or senior at a UC campus.

These two patterns also illustrate graphically:

- the capacity for students to gain deep grounding in the knowledge and methodology characteristic of a major in math or science gained at a research university level;
- early field experience in the classroom, combined with seminars for reflection and analysis of the field experience; and,
- multiple entry points to the "pathway" at different times in a student's academic career, and expeditious progress to gaining teacher certification via a number of different routes.

University of California Santa Barbara: CAL TEACH PROGRAM

Science Math Initiative Leading to Teacher Certification

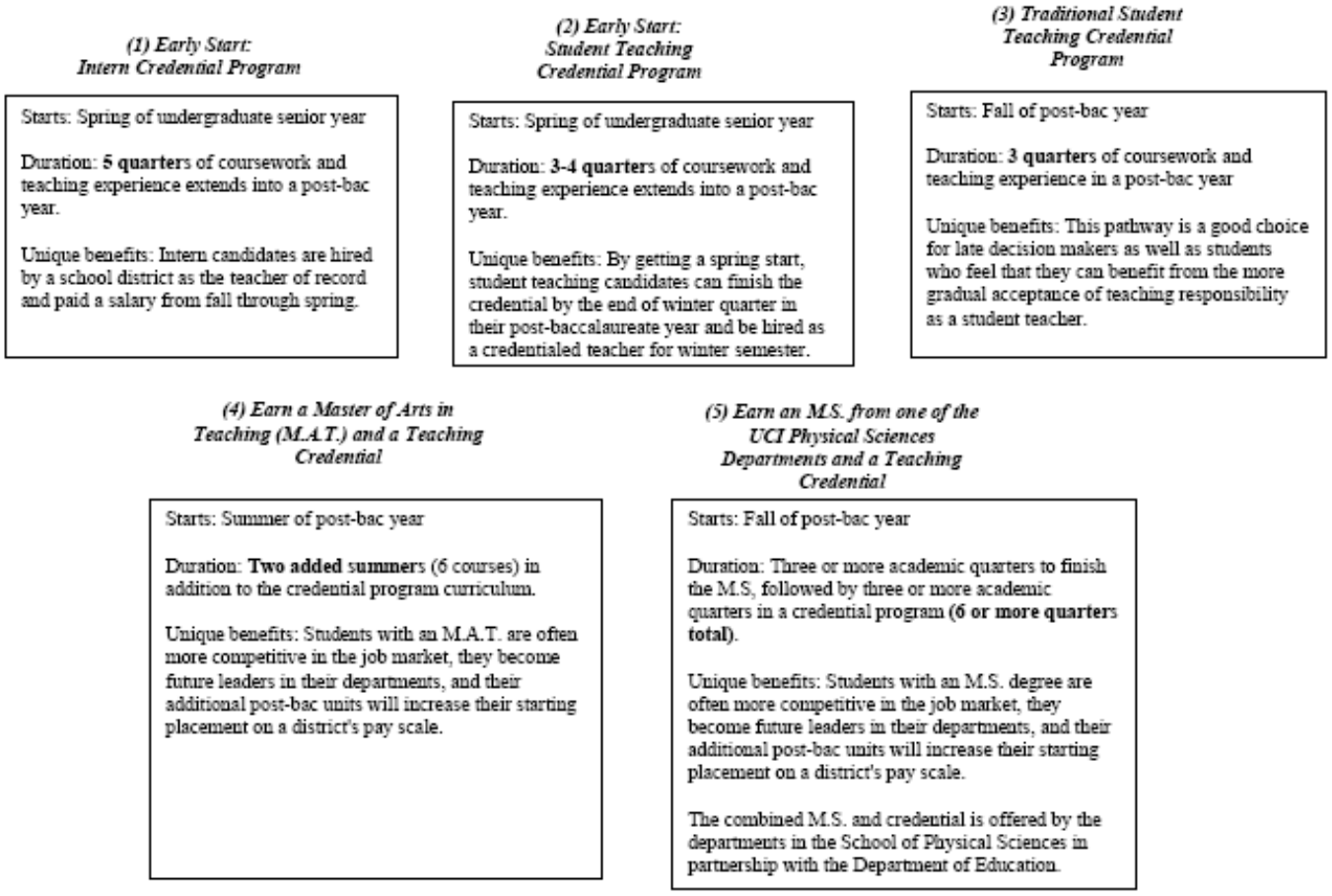
Recruiting Summers

Invitation from Math, Science and Education; orientation sessions; contact info

If student begins as a	Freshman Year	Sophomore Year	Summer Institute	Junior Year	Summer Institute	Senior Year	Post graduate Requirements
Freshman Start here	CAT 1	CAT 2 Instructional Technology and Design	Education minor	school placement Special Ed	Content pedagogy Education minor CSET test prep (If needed) Literacy	ELD/SDAIE school placement content & literacy supervision	One semester of student teaching OR One semester paid internship with university supervision (opti 2nd sem supervision) Content/professional issues seminar & PACT
Sophomore Start here		CAT 1 CAT 2	Education minor	Computers for Teachers school placement Special Ed	Content pedagogy CSET test prep (If needed) Literacy	ELD/SDAIE school placement content & literacy supervision	One semester of student teaching OR One semester paid internship with university supervision (opti 2nd sem supervision) Content-professional issues seminar & PACT
Junior Start here			Education minor	CAT 1 and 2 (If not taken in CC) Instructional Technology and Design (If not taken at CC) and/or Special ED	Content pedagogy CSET test prep (If needed) Literacy	ELD/SDAIE More extensive school placement content & literacy supervision Special Ed (If not taken earlier)	One semester of student teaching OR One semester paid semester internship with university supervision Content-professional issues seminar & PACT _____ OR planned year-long internship program
Senior Start here						CAT 1 Test prep & Ed Minor courses to ease credential or intern year load	UCSB 5th year _____ OR planned year-long internship program
Post graduate							UCSB 5th year program

Courses to be taken as General Ed courses: U.S. Constitution, Technology, Equity & Diversity
State tests: CBEST taken any time. CSET-sub tests taken after courses or any time during program. CSET test prep in summer before Senior year if needed
Program assessments: Teaching Portfolio developed throughout program. Used to develop induction year plan. Built upon for M.Ed.

UCI SMI students have the following post-baccalaureate credential program options:



Enrollment in SMI

Initial student interest in SMI has been very enthusiastic. Campuses made initial projections of enrollment in the CaT (seminar), and in some cases, interest has considerably surpassed the estimates. At the UC Berkeley campus, the number of students enrolled in the program far exceeded projections and greatly increased the number previously headed for math/science teaching careers. Based on experience to date, campus SMI directors anticipate an enrollment of 1,184 students in the second CaT (seminar), and they project that science and math teachers matriculating from UC programs will reach 800 by 2010.

We are exploring many avenues to raise that figure to our goal of 1,000. To that end, we are focusing on the issues of recruitment and retention. Possible strategies include:

- Increasing recruitment of community college freshman students who plan to major in STEM fields and who will transfer into UC STEM credentialing programs. These students represent a rich vein of potential candidates.
- Creating pathways for "career changers."
- Developing on-line materials to enable non-STEM credentialed teachers to prepare and pass subject-specific exams in STEM fields.
- Integrating, where appropriate, the California Subject Matter Projects (CSMP) in math and science, ISME, the California State Summer School for Mathematics and Science (COSMOS), Teacher Fellow program, and other STEM professional development experiences to help prepare and retain STEM teachers.

SMI STUDENT CHARACTERISTICS—2005-6

Gender	**Students**	**Percentage**
Female	397	67%
Male	198	33%
TOTAL	595	

Academic Level	**Students**	**Percentage**
Freshmen	207	35%
Sophomore	171	29%
Junior	132	22%
Senior	85	14%
TOTAL	595	

Major	**Students**	**Percentage**
Mathematics	196	33%
Science: Biology	186	31%
Science: Chemistry	58	10%
Science: Physics	27	5%
Engineering	33	6%
Other*	95	16%
TOTAL	595	

*"Other" includes undeclared or undecided

Student enrollment in SMI shows a roughly 2-to-1 ratio of women to men, a welcome story for young women excelling in math and science. The ethnicity of students participating in this program conforms very closely to the ethnic distribution of UC's undergraduate population. Our premise that students would enter the program at all academic levels is proven true. The number of SMI students majoring in mathematics and biology far exceed numbers in other majors. Demand for physics teachers is somewhat lower than in other fields. Larger numbers of future teachers of chemistry would be valuable.

Participating Schools

To date, nearly 1,000 student placements have occurred in schools for field experiences. This process has involved 467 teachers and 174 schools in 41 districts. We believe this will have positive outcomes for all who are participating. We are tracking the socioeconomic characteristics and academic performance of schools where students are placed, and to date, they represent a wide spectrum. And, because students bring observations back to their university classes for discussion, they are able to compare and contrast different experiences from different sites.

What the University Has Learned Thus Far and How It Will Respond to Evidence Collected as Program Develops—Research and Learning Via SMI

SMI leadership consists of a consortium of campus SMI officials headed by Dr. Fred Eiserling, Associate Science Dean and Professor of Microbiology at UCLA. The group meets via teleconference once a month, and members are in regular contact by email. Campus Faculty Program Directors and Academic Coordinators also confer by teleconference bi-weekly and are actively sharing information on program progress.

SMI is being implemented at our nine general campuses as a system-wide program, one that provides flexibility for each individual campus to grow the program within its own unique environment and curriculum. This is a highly unusual opportunity to test the program's basic tenets in diverse settings. Similar teaching programs have been developed at other universities, but none has encompassed the number and type of institutions involved in this effort. Outcomes will provide a rich source of insights for future work in this area.

As this work develops, implementation is being approached deliberately as a project for study.

Data Collection and Research

UC is collecting data systematically on each step of the program, including student interviews and close monitoring of each participant. For this tracking, UC has developed an on-line "My California Teach" portal. The system:

- tracks all student participants, including hours in the classroom and other activities;
- provides students the opportunity to assess the usefulness of their own activities in class;
- provides students an on-line journal to write about their experiences and to begin developing their teacher professional portfolio;
- provides programmatic information and on-line advice to students;
- tracks all K-12 teacher participation; and,
- pays students and teachers for in-class work.

This extensive data base will allow the University to track and study a large number of teachers as they move through the pipeline over a period of five years. Data will provide information to allow better testing of hypotheses about teaching and teacher preparation, including the effect of various types of field experiences and course work that are newly developed for this effort.

In particular, UC will study the effects and effectiveness of field experiences and the patterns of coursework being offered via SMI. Questions that will be studied include how field experiences

impact teacher preparation and how particular courses in major fields of math and science and also in education affect the quality and number of teacher aspirants and graduates.

Funding

SMI has attracted financial support from the public and private sectors. Governor Schwarzenegger and the California Legislature are now funding the program at both UC and CSU. In 2005-06, the State provided UC with $750,000, which was matched by $750,000 in University funds, to support the initial infrastructure needed to implement the new initiative. In 2006-07, the State provided an additional $375,000, again matched by University funds, for a total of $2.25 million for the program. These funds are being used to develop resource centers on UC campuses to operate the program. Using a combination of State and University funds, each campus resource center has at least $250,000 for program operations.

In addition, The Regents of the University of California initially secured pledges totaling $4,024,850 from 19 foundations and corporations toward SMI.

The bulk of those funds came from two major underwriters: the Intel Corporation, which pledged $2 million over four years in $500,000 increments, and SBC (now AT&T), which pledged $1 million over five years. Since those original commitments, other funds have been pledged to other campus sites, the largest being an endowed chair for over $2 million at UC Irvine.

Private funding agents have expressed great interest in providing support that will help attract and retain student engagement in the program. They also are interested in supporting teachers who either directly mentor these students or who serve as master teachers.

The University will need to secure support for intern-credentialed teachers from states, school districts and other sources. UC also will need to secure ongoing funding, public and private, to make the program affordable for underserved populations. Working with a variety of partners will be crucial to the program's ultimate success.

The Governor's budget also proposes funding 600 assumable loans for SMI students, loans that would be forgiven in exchange for a teaching commitment.

H.R. 362 would greatly assist programs such as SMI

The University supports federal legislation such as H.R. 362, which would boost funding for federal competitive grant programs that support higher education efforts to improve the development of K-12 math and science teachers, as well as undergraduate STEM programs. H.R. 362 would seek to expand the SMI concept from California across the nation, and also to focus more broadly on other elements essential to improving U.S. math and science education.

H.R. 362 is modeled on our original idea of having students graduate in a science and math discipline and receive their credential within four years. However, we are finding that this stipulation runs counter to the goal of increasing the number of highly-qualified teachers in science and math. Even many of our best students take slightly more than four years to complete a science or math degree. SMI does integrate education courses long before completion of the bachelor's degree and streamlines the credentialing process. However, varying teacher licensure

requirements, especially in California, mean that additional post-Bachelor of Science degree training will be needed.

We would like to see the legislation amended to delete reference to a four-year completion period under the Robert Noyce Scholarship Program. Instead, we hope for flexibility in creating integrated programs that result in a bachelor's or even a master's degree and a teaching credential or license. We want to reduce the time to obtain both the degree and the license, but we need the flexibility because of the varying teacher licensure requirements within and across each of the 50 states.

Two UC campuses, Irvine and Los Angeles, are current recipients of Noyce Scholarship Program funding, and at least two other campuses, Riverside and Santa Cruz, are preparing to respond to the latest request for proposals. Our campuses are collaborating with local school districts and community colleges to provide support for future math and science teachers. Continued access to these funds would help us implement SMI and achieve our goal of 1,000 teachers by 2010.

In the Noyce Scholarship program, in years where appropriations fall below $70 million, no more than 15 percent of appropriations may be used for capacity-building activities. These include academic courses, early field teaching experiences, and stipend programs. Our campuses have indicated that this 15 percent cap hinders program effectiveness, and we therefore request that the cap be removed from the program.

Conclusion

Let me conclude by reiterating my gratitude to Chairman Gordon and the members of this Committee for addressing an issue that is so crucial to the future of the nation. The University strongly supports the recommendations of the National Academy of Science's report, "*Rising Above The Gathering Storm"*. I feel certain that we need to take bold action. As this testimony has charted, we have taken bold action with SMI. In California, we were willing to take the necessary steps to address the shortage of science and math teachers. As we build SMI, we will find better ways to do this. As we refine this program, we urge you to make sure that legislation provides the necessary flexibility for national implementation, because conditions will vary in different states and localities within states.

And we must recognize that one initiative is not enough. We need more engagement across the board between our research universities and our K-12 public schools. We need partnerships with community colleges, state universities, private universities, business, and industry, as well as state and federal government. The University of California has the capacity to take a leadership role in improving K-12 student learning and achievement. It is my belief that, as a land grant university, we have the responsibility to do that. Our campuses have the expertise to unlock the reasons why so many young people – the future workforce and the future hope of this country – are not being prepared to participate fully in the economic and civic life of our country. I believe we can change that. I know you share my belief. I thank you again for this opportunity to speak with you.

ATTACHMENT #1

BERKELEY CAL TEACH SUMMER INTENSIVE INSTITUTE IN PARTNERSHIP WITH BERKELEY LAB

Berkeley Lab has offered to provide a summer institute for Cal Teach students the summer following their Junior Year.

The Berkeley Cal Teach Program goals for the summer institute are to:

- Deepen student's content knowledge
- Develop student's pedagogical skills to transfer the summer experience into the classroom.

Berkeley Lab developed and implemented a ten week summer undergraduate Preservice Teacher Intensive Research Institute in 2002 to 2005. The first of the ten weeks included orientation to the lab, safety training, a course on journal writing and tours of research facilities. The core experience of the institute consisted of 4 two-week consecutive sessions. Each session consisted of a small group of 5 to 6 students preparing for an experiment, collecting and analyzing data, developing a science presentation and creating a lesson translating the experience to the classroom. A lead Berkeley Lab scientist typically taught the students scientific principles needed for the experiment in the morning. An experience teacher joined the students as a coach. Afternoons were spent in the lab setting with the lead scientist and his or her group. Examples of two week sessions include, micro fingerprint analysis at the ALS Infrared beam line, A neutron activation analysis with irradiation at a nuclear reactor, building and testing a cosmic ray coincidence detector, and gamma ray analysis of terrestrial radio activities as related to antiterroism. The final week students prepared for their final presentations and reports. Students received a stipend of $400/week and were expected to work 40 hours each week.

Students all participated in:

- Weekly Friday afternoon seminar on translating experience to the classroom
- Subject matter knowledge self assessment
- Job Hazards Questionnaire and Safety Training
- Journal/Research notebook
- Short scientific paper writing assignment with peer review
- Weekly one on one meeting with a Master Teacher(s)
- Weekly "Summer Lecture Series" at noon and Lab tours

Weekly seminars were held on Friday afternoon. Topics included.

- Favorite lessons from inservice teachers
- Vernier probeware workshop
- Model inquiry based lessons and instructional materials design (Lawrence Hall of Science)
- National Board Certification requirements presented by a NBC teacher.
- Issues for New Teachers
- Scientific Inquiry and Inquiry Based Teaching and Learning

- Professional Recognition and Grant Opportunities

Outline for Berkeley Cal Teach Summer Intensive Research Institute

Design Criteria

- 50 students per summer
- 8 to 10 week program
- Exposure to scientists and engineers at UCB and Berkeley Lab
- Access to and use of scientific resources of the UCB and Berkeley Lab
- Small group learning opportunities (5 students per group)

Goals

- Deepen content knowledge for each student in four areas, earth, life, physical science and engineering (prepare for breadth on the CSET Test)
- Transfer content knowledge to classroom setting
- Develop understanding of scientific inquiry and engineering design and construction
- Encourage Understanding of the interconnection and relationship between science disciplines
- Introduce frontier science and technology topics
- Instill view of science teaching as integral to the scientific and engineering enterprise

Strategies (experiences common to all students)

- Orientation to research, safety, journaling and course requirements.
- Four two-week research activities, one in earth, life, physical science and engineering (72 hours for each two week session)
- Weekly seminars (4 hours/wk) with master teacher and inservice teachers on translating the research experience to the classroom.
- Daily mentoring by scientist and resource teacher with expertise in subject area (e.g. an experienced physical science teacher would participate with the students in the two week research experience led by scientist or engineer as content coach.)
- Berkeley Cal Teach student subject matter knowledge assessments based on high school student standards and expectations.
- Science short paper to show understanding of research programs.
- Power point presentation to teacher and scientists colleagues based on summer experience.
- Standards-based science lesson based on summer experience.

Supporting Structures

- Program administrator responsible for organizing, monitoring, documenting and evaluating the summer intensive research institute
- A master teacher for each strand, earth, life, physical science and engineering.
- A teacher coach for each group of 10 students.

- Four lead research investigators each willing to dedicate two weeks in the summer to teach and lead students in research for each group of 5 students. (One in earth, life, physical science and engineering for each group of 5 students.)
- $4000 of stipend funds for each student.
- Program administrative funds.
- Advanced workshops for lead investigators to assist them in developing learning objectives and resource materials.

Feasibility and cost.

With 50 students is it possible that in any one week 10 groups of 5 students would be working with a lead investigator. We expect that the program coordinator could find 5 of these investigators at Berkeley Lab and 5 on campus.

The total annual cost of the program would be about $350K. Of this amount $200K for Berkeley Cal Teach Student Stipends and $100K for 10 inservice teacher coaches. $25K for the Teacher Coordinator salary, $12K for the Master Teacher and $13K for materials, supplies and other expenses.