



The California State University
OFFICE OF THE CHANCELLOR

**THE MATHEMATICS AND SCIENCE
TEACHER INITIATIVE**

**REPORT TO THE LEGISLATURE AND GOVERNOR
REQUIRED BY THE 2007-08 BUDGET ACT**

CALIFORNIA STATE UNIVERSITY

CHANCELLOR'S OFFICE

MARCH 1, 2008

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**The California State University Mathematics and Science Teacher Initiative
Progress Report—March 1, 2008**

Background

The need for new mathematics and science teachers in California in the next ten years is projected to exceed 33,000. Because the current demand for mathematics and science teachers is far greater than the pool of teachers credentialed in these fields, many students in the state are taught by teachers who are not fully credentialed in these subjects. This is a significant problem, particularly because students who do not have qualified mathematics and science teachers demonstrate lower achievement gains than those whose teachers are qualified in these fields.¹

In California, approximately 20% of mathematics teachers and one-third of physical science teachers are either assigned out-of-field or under-prepared.² Students in high poverty, high minority schools in the State are four times more likely to have a teacher who does not have a credential in mathematics or science than students in other schools.³ Of middle school algebra teachers in 2006-07, 24% were fully credentialed in some subject area but lacked a mathematics authorization. These out-of-field teachers taught nearly 54,000 students in Algebra 1 classes statewide—a class required for high school graduation that serves as a gatekeeper to advanced math courses required for admission to colleges and universities.⁴

¹ Darling-Hammond, L. and Baratz-Snowden, J. (Eds.) (2005). *A Good Teacher in Every Classroom: Preparing the Highly Qualified Teachers Our Children Deserve*. San Francisco, CA: Jossey-Bass.

² The Center for the Future of Teaching and Learning includes teachers who are teaching on waivers and emergency permits and interns as under-prepared.

³ Esch, C.E. et al. (2005). *The Status of the Teaching Profession 2005*. Santa Cruz, CA: The Center for the Future of Teaching and Learning.

⁴ Wechsler, M. et al. (2007). *The Status of the Teaching Profession 2007*. Santa Cruz, CA: The Center for the Future of Teaching and Learning.

The CSU Mathematics and Science Teacher Initiative

The California State University (CSU) is the largest producer of mathematics and science teachers in California, preparing close to one-half of the new teachers in these fields. In 2004, the Governor called on the state's two public university systems to develop programs to prepare significantly more teachers in these critical areas.

To address the significant need for additional mathematics and science teachers, Chancellor Charles B. Reed made a major systemwide CSU commitment. It was that the system's campuses would double their production of teachers in these fields from a baseline of approximately 750 in 2003 to a figure of 1,500 by the year 2010.

Annual Number of Teachers Awarded Mathematics and Science Credentials⁵

Since the beginning of the Mathematics and Science Teacher Initiative, CSU has increased its production by approximately 70%, to 1,288. The CSU has increased its production of mathematics teachers from its baseline of 349 to current annual production of 783, growth of more than 120%. CSU campuses this year prepared more than 250 middle school teachers through the new Foundational Level Mathematics Credential, addressing the large need in the state for qualified middle school mathematics teachers, particularly in beginning Algebra.

The CSU has increased its production of chemistry teachers by 71%, physics teachers by 30%, and geosciences teachers by 46%. Total CSU production in these severe shortage subjects increased 55% over the past four years, from a baseline of 122 to 189 currently. (See page 10 for increases by subject area.)

Since January 2005, CSU campuses have been making refinements in enrollment management processes designed to provide increased instruction for continuing students and increased access and instruction for new first-time freshmen and upper-division undergraduate transfers. These efforts resulted in CSU campuses surpassing total college year enrollment levels for 2005/06 by 2,120 FTES, and reporting that they are on trajectory to surpass funded college-year resident student enrollment levels by over 6,300 FTES in 2007/07.

The Governor and the Legislature have consistently supported the CSU Mathematics and Science Teacher Initiative. Beginning in 2005, a special budget allocation was provided to the CSU for the Initiative. Even in California's current budget crisis, the Governor has proposed sustaining the budget allocation of \$2.7 million for the Initiative.

This notable track record of success reflects increases that were typically steady and sizable by virtually all CSU campuses. (See page 11 for campus-by-campus data.) Only one campus did not show a pattern of growth, and it was affected by the hiring patterns of the school district that surrounds it. Individual campus increases in production ranged from 11% to 239%, with eight of the twenty-two CSU campuses doubling their production of mathematics and science teachers.

⁵ California defines NCLB compliant, highly qualified teachers to include teachers with intern credentials who (1) hold a bachelor's degree and (2) have demonstrated subject matter competency in each required subject. State policy changes affecting intern teachers and related added requirements means that the most accurate comparisons are between candidates regularly credentialed in 2002-03 and NCLB compliant candidates, including interns, credentialed in 2006-07. All credential data are preliminary based on figures provided by the Commission on Teacher Credentialing as of 02/27/08.

Expenditure of Funds Appropriated to Mathematics and Science Teacher Initiative

The 2007-08 State Budget appropriated \$2.713 million for the CSU Mathematics and Science Teacher Initiative. The expenditure plan adopted for these funds consisted of four primary components, as described below.

- ***Support was provided to campuses*** to continue (a) expansion of innovative and flexible credential pathways proven to be effective and (b) recruitment and preparation of new populations of candidates, including expanded populations of undergraduates, second field teachers, and mid-career professionals: **\$2,250,000**

- ***Funding was provided for the development of online courses and resources*** to (a) facilitate access to credential programs for non-traditional populations, (b) help support alignment between CSU programs and community college courses: **\$203,000**

- ***Resources were allocated for initiating regional and statewide recruitment efforts***, including support for (a) development of multi-campus approaches, (b) planning of new regional strategies, and (c) preparation of recruitment resources to serve each area of the state: **\$50,000**

- ***Statewide management and administration were supported***, including activities aimed at (a) acquiring external resources, (b) developing partnerships, (c) conducting rigorous program evaluation, (d) scaling-up successful approaches, and (e) disseminating effective practices: **\$210,000**. **Effectiveness of the CSU Mathematics and Science Teacher Initiative Components**

The CSU Initiative included six action components and a seventh component focused on identifying successful approaches for scale-up and replication. The components were initially selected based on practices identified as successful by CSU campuses. As part of the Initiative, the components were all implemented on one or more campuses. The effectiveness of the components was judged based on increases in credential production and is described below.

- ***Creation of new credential pathways***: this has been one of the most effective components in the Initiative systemwide. Most campuses developed new Foundational Level Mathematics Credential programs; several established blended programs of undergraduate and credential preparation; and two created new credential-Master's programs. Each of these approaches increased pools of qualified candidates who successfully completed credential programs. Campuses are expanding initial models to new subject areas with, for example, blended programs in additional fields, and sharing their models with other campuses.

- ***Financial support and incentives***: this has consistently been one of the most effective approaches for promoting growth across the CSU system. Financial support has included the state's Assumption Program of Loans for Education (APLE), National Science Foundation (NSF) Robert Noyce Scholarships, campus and private scholarships, stipends to assist candidates with textbooks and costs of required tests and test preparation, and paid tutoring. Sixteen CSU campuses have now received NSF Robert Noyce grants, and approximately 200 students are receiving \$10,000 scholarships each year. The CSU has allocated approximately 1,000 APLE awards to mathematics and science candidates during the past three years, valued at over \$15

million in student loan debt reduction. There appears to be a direct association between the number of APLE awards made by campuses and the increase in mathematics and science credentials. This pattern conforms with national research showing that loan debt often deters students from pursuing teaching careers.⁶

- *Recruitment to expand and diversity the pool of candidates:* campuses have used a wide range of recruitment strategies to increase candidate pools. Effective approaches have included broadly based outreach, web-based approaches, and campus recruitment campaigns. Targeted efforts have addressed high school students, community college transfers, undergraduates, current teachers interested in a second credential, and mid-career professionals. The Teacher Recruitment Projects on CSU campuses have been linked with the Initiative. These projects have long-standing connections with local middle and high schools and community colleges. Several campuses partnered with the Tulare County Office of Education in the statewide California Teacher Recruitment Project (CTRP). The project included media outreach, collaboration with county offices of education, and a large number of mathematics and science teacher recruitment fairs.

- *Internet-supported delivery of instruction and resources:* effective strategies have included three basic approaches: (1) hybrid credential program delivery, in which the majority of preparation has been face-to-face but part of the instructional program was online to facilitate student access, (2) online support to enhance candidate subject matter knowledge, in which web-based tools were made available to assist candidates in their development of content expertise, and (3) online tools and resources that helped candidates to prepare for the California Subject Examination for Teachers (CSET).

- *Partnerships with federal laboratories, business, and industry:* a distinctive partnership strategy has been developed for the severe shortage fields of physics, chemistry, and geosciences. It is based on collaboration between CSU and the U.S. Department of Energy and the National Aeronautics and Space Administration (NASA) in a highly promising program in which future CSU science teachers work in paid laboratory research during the summer. Lawrence Livermore National Laboratory, Lawrence Berkeley National Laboratory, the Stanford Linear Accelerator Center, and NASA Ames Research Center are participating. It is similar to a business and industry program for current teachers, *Industry Initiatives for Science and Mathematics Education (IISME)*, which has reduced teacher attrition by 50%.⁷ It is also similar to the NSF supported Pre-service Teacher Program of the U.S. Department of Energy Office of Science, which has shown positive impacts on new teachers' professional identify⁸ and their effectiveness in inquiry-oriented instructional practices.⁹

- *Collaboration between campuses and community colleges:* CSU campuses have collaborated with local community college campuses to identify common patterns of coursework enabling students to transfer and immediately begin upper division study towards a mathematics or science credential. Initial results of the program alignment are

⁶ The State PIRGS' Higher Education Project. (2006). *Paying Back, Not Giving Back: Student Debt's Negative Impact on Public Service Career Opportunities*. Washington, DC: Author.

⁷ Industry Initiatives for Science and Mathematics Education. (2007). *IISME Evaluation Outcomes: The Impact of Teacher Fellowships*. Palo Alto, CA: Author.

⁸ Varelas, M., House, R., and Wenzel, S. (2005). Beginning Teachers Immersed into Science and Science Teacher Identities. *Wiley InterScience*, 7 April 2005, 493-516.

⁹ Westerhind, J. et al. (2002). Summer Scientific Research for Teachers: The Experience and Its Effect. *Journal of Science Teacher Education*, 13 (1), 63-83.

promising, and with models of curricular pathways now developed, they can be implemented on a large-scale basis.

- *Identification of promising approaches having scale-up potential:* Identifying successful approaches for scale-up has been a priority since the inception of the CSU Mathematics and Science Teacher Initiative. A consistent effort has been made to identify best practices that contribute to the recruitment and high quality preparation of new teachers and to their persistence in the profession. This focus reflects recognition that the shortages in these fields are due both to the challenges of recruiting additional teachers and the relatively high attrition of mathematics and science teachers, a pattern that begins early. To address the teacher shortages in these fields, the pattern of high attrition, in which over one-third of new teachers in these fields in California leave the profession within their first five years of teaching, must be overcome.

The evidence from the CSU initiative is that these seven components are working together effectively to increase the production of mathematics and science teachers systemwide. The one component for which direct evidence of impacts on credential production is not yet available is the strategy of course alignment with community colleges. Campuses report that the approach has increased enrollments in credential pathways, and the initial evidence for this component is promising.

Best Practices in Mathematics and Science Teacher Production

The CSU has identified four fundamental best practices that reflect its campuses' experiences in the Mathematics and Science Teacher Initiative and the research on teacher recruitment, preparation, and retention in these fields.¹⁰ These best practices are being integrated into a CSU long-term strategic plan for sustaining increased preparation of mathematics and science teachers. This effort is being led by Warren Baker, President of California Polytechnic State University, San Luis Obispo, and primary author of the Business Higher Education Forum's blueprint for K-12 science, technology, engineering, and mathematics (STEM) education and teacher preparation reforms.¹¹

In the identification of best practices, the CSU has focused on those underlying approaches that have been shown to be associated with effectiveness in recruiting, preparing and retaining well-qualified mathematics and science teachers. Together, the four best practices represent a systemic approach for preparing and retaining a high quality mathematics and science teacher workforce for California.

- **Best Practice #1: Supporting approaches that increase the prestige, distinction, and compensation of teaching careers in mathematics and sciences.** These approaches serve to make mathematics and science teaching rewarding as a career choice by adding significant new dimensions to the profession. The approaches begin by making preparation for teaching in these fields prestigious on campuses. An essential element for doing this is creating strong campus partnerships between faculty in science, mathematics, and education in which students are encouraged, supported, and

¹⁰ Stigler, J. W. and Hiebert, J. (2004, February). Improving Mathematics Teaching. *Improving Achievement in Math and Science*, 4, 12-17.

¹¹ Business Higher Education Forum (2005). *A Commitment to America's Future: Responding to the Crisis in Mathematics and Science Education*. Washington, DC: Author.

Business Higher Education Forum (2007). *An American Imperative: Transforming the Recruitment, Retention, and Renewal of Our Nation's Mathematics and Science Teaching Workforce*. Washington, DC: Author.

mentored by faculty in their subject discipline and in education. Another key approach is developing communities on campuses that clearly value this professional pathway and provide a supportive network for students. Central to this is the role of top-level campus top leaders. Presidents, Vice Presidents, Deans and other leaders make clear that preparation of mathematics and science teachers is a campus priority. An additional approach entails making special opportunities available to mathematics and science teacher candidates. The Mathematics and Science Teacher Initiative has done this through its partnerships with federal laboratories, providing paid summer research opportunities for candidates in which they are part of a distinguished scientific community.

• **Best Practice #2: Utilizing strategies that fully prepare new mathematics and science teachers and provide them with opportunities for continuous professional growth and development.** Evidence collected by CSU on the preparation of its mathematics and science credential graduates over the past eight years demonstrates that a full credential program is required to fully prepare candidates. Findings from the *CSU Annual Evaluation of Teacher Preparation* demonstrate that with full credential programs, candidates are rated by Principals at their school sites and give themselves self-ratings of preparation that are high on almost all variables that are central to being successful as a new teacher. The important best practice that has been implemented on CSU campuses as part of the Mathematics and Science Teacher Initiative has been establishment of credential programs followed by Master's degree study, enabling new teachers to become expert in their craft. The CSU is working with the Woodrow Wilson National Fellowship Program to expand this best practice through a program of fellowship support akin to a Rhodes Scholarship, enabling a sizable number of mathematics and science candidates to pursue linked credential-Master's programs.

• **Best Practice #3. Preparing candidates for inquiry-based teaching and learning.** Research demonstrates that the most effective approaches for teaching and learning of science and mathematics are inquiry-based, and that these approaches improve student engagement, performance and retention in science and mathematics across grade levels¹² The distinguishing feature of the CSU Mathematics and Science Teacher Initiative has been its focus on quality preparation that equips teachers to be effective in the classroom. This entails preparing candidates to be capable of bringing exciting, inquiry-oriented learning to schools. On all campuses, candidates work in local schools, and some campuses have community-oriented science labs, such as CSU Chico's Hands-on-Lab, or other facilities in which candidates are able to work with K-12 students in active learning and discovery. In association with the Mathematics and Science Teacher Initiative, CSU obtained support from the National Science Foundation to use its internationally recognized Multimedia Educational Resources for Learning and Online Teaching (MERLOT) to provide its Noyce Scholars with electronic resources that support inquiry-based teaching and learning in science and mathematics. The CSU plans to enhance preparation of candidates in inquiry-oriented approaches through additional campus learning programs for K-12 students, drawing on current best practices in a foundation-supported expansion project.

• **Best Practice #4. Collaborating with school districts in mathematics and science teacher preparation and education reform.** CSU teacher candidates are prepared

¹² National Science Resources Center. (2005). *NSRC Inquiry-Based Science Education Programs*. Washington, DC: Author.
NSRC web site: http://www.nsrconline.org/about_the_nsrc/impact.html#CA.

through partnerships with public schools. Ensuring quality preparation entails working with school site and district leaders to strengthen K-12 science and mathematics instruction, with special attention to improving instruction in high need, low-income, and high-minority schools. CSU campus activities carried out as part of the Mathematics and Science Teacher Initiative have included such best practices as tutoring, service learning as teacher aides, and other early field experience in classrooms. All campuses have active programs in which their mathematics and science candidates work in nearby schools, and most focus on high need schools. The campuses uniformly report that this experience helps significantly in recruiting students to teaching, enabling them to experience directly the rewards of making a difference in children's lives. CSU plans to broaden its partnerships with K-12 schools and to work with instructional leaders at site and district levels to achieve alignment between its efforts in mathematics and science teacher preparation and school district curricular and instructional reforms.

Job Placement of CSU Students Who Earn a Mathematics or Science Credential

A comprehensive study was conducted on the job placement of CSU mathematics and science teachers credentialed in 2006. The findings were striking, demonstrating the large number who teach in high need schools:

- 44.6% taught in city schools, 8.7% in rural schools, 42.8% in suburban schools, and 3.9% in schools located in smaller areas defined as towns
- 41.3% taught in schools that did not meet their annual Academic Performance Index (API) in 2006-07; the remaining 58.7% taught in schools that did meet their API
- 72.5% taught in schools where 25% or more of the students qualified for free/reduced lunch; 42.7% taught at schools where 50% or more of the students qualified for free/reduced lunch
- 92.1% taught in schools with less than 100% fully credentialed teachers.

Examples of city schools in which CSU credential recipients taught included Anaheim High School, East Oakland Community High School, Oakland Military Institute, Ganesh High School in Pomona, Gunderson High School in San Jose, Hoover High and McClane High in Fresno, Torrance High, and Washington Preparatory High School in Los Angeles.

Schools in rural areas and towns in which CSU credential graduates taught included Cahuilla Desert Academy Junior High and Jurupa Valley High in Riverside County, La Contenta Junior High in San Bernardino County, Nevada Union High in Grass Valley, San Ysidro High in San Diego County, and Tulare Western High. Suburban schools in which CSU credential graduates taught included Arthur E. Wright Middle School in Calabasas, San Marino High, and White Hill High in Marin County.

Summary

The CSU is on a trajectory to double its production of mathematics and science teachers. Its campuses have initiated a multi-pronged set of strategies that have demonstrated substantial effectiveness. The success of this effort demonstrates the capacity of CSU to provide leadership to California in addressing this significant problem. In continuing its statewide leadership, the CSU will draw on the best practices in recruitment and preparation of new teachers that it has identified. The CSU system and its campuses will, in addition, continue their distinctive focus not only on doubling production but also on creating careers of prestige and distinction that have significant promise for retaining new teachers.

Appendices—Data Tables¹³

Table 1							
Total Mathematics and Science Teachers Awarded Credentials by CSU Campuses							
Mathematics and Science Credentials							
2002-03				2006-07			% Change
Mathematics	Science	Total		Mathematics	Science	Total	2002-03 to 2006-07
349	419	768	MSTI Began in 2004 First Campus Funding Began In 2005	783	505	1288	+68%

¹³ All data are preliminary based on credential figures provided by the Commission on Teacher Credentialing as of 02/27/08.

Table 2A							
Total Mathematics Teachers Awarded Credentials by CSU Campuses							
Mathematics: Regular and Foundational Level Credentials							
2002-03			MSTI Began in 2004	2006-07			% Change
Regular	Foundational Level	Total		Regular	Foundational level	Total	2002-03 to 2006-07
349	0	349		525	258	783	+124%

Table 2B											
Total Science Teachers Awarded Credentials by CSU Campuses											
Science: Credentials by Discipline											
2002-03					MSTI Began In 2004	2006-07					% Change
Biological	Chemistry	Geosciences	Physics	Total		Biological	Chemistry	Geosciences	Physics	Total	2002-03 to 2006-07
296	56	37	30	419		316 +7%	96 +71%	54 +46%	39 +30%	505 +21%	+21%

**Table 3. CSU Campus Math and Science Teacher Production
2002-03 to 2006-07¹⁴**

Campus	2002-03			2006-2007		
	Math	Science	Total	Math	Science	Total
CSU Bakersfield	14	15	29	25	43	68
CSU Channel Islands	0	0	0	12	8	20
CSU Chico	18	18	36	26	14	40
CSU Dominguez Hills	40	35	75	66	42	108
CSU Hayward/East Bay	16	20	36	93	29	122
CSU Fresno	15	23	38	22	25	47
CSU Fullerton	11	43	54	50	26	76
Humboldt State University	5	8	13	11	4	15
CSU Long Beach	16	26	42	59	37	96
CSU Los Angeles	38	33	71	31	15	46
CSU Monterey Bay	0	0	0	10	6	16
CSU Northridge	42	41	83	71	32	103
Cal Poly Pomona	17	14	31	39	17	56
CSU Sacramento	6	15	21	25	18	43
CSU San Bernardino	12	16	28	51	32	83
San Diego State University	20	23	43	34	25	59
San Francisco State University	32	30	62	45	33	78
San Jose State University	16	25	41	36	42	78
Cal Poly San Luis Obispo	5	8	13	6	10	16
CSU San Marcos	6	10	16	14	17	31
Sonoma State University	12	11	23	17	19	36
CSU Stanislaus	8	5	13	40	11	51
CSU Campuses Total	349	419	768	783	505	1288

¹⁴ All data are preliminary based on credential figures provided by the Commission on Teacher Credentialing as of 02/27/08.