Overview

Through the implementation of its system-wide Mathematics and Science Teacher Initiative (MSTI), the California State University (CSU) has achieved and sustained its goal of doubling its production of math and science teachers. CSU campuses increased the annual number of math and science teachers produced from 750 per year in 2002-03 to 1,507 in 2010-11. Of the 1,507 teachers prepared by CSU this past year, 811 were math teachers and 696 were science teachers. In the severe shortage areas of physics and chemistry, CSU has increased the number of teachers it prepares by 106%. Ten CSU campuses more than doubled their production of math and science teachers between 2003 and 2011.

Utilizing MSTI resources in strategically planned efforts, CSU campuses have not only been highly effective in increasing production of mathematics and science teachers, the campuses have also been exceptionally successful in acquiring federal grants to supplement the initiative. This includes prestigious Robert Noyce scholarship awards to all campuses from the National Science Foundation. The CSU has also developed strong partnerships with the U.S. Department of Energy, the National Aeronautics and Space Administration (NASA), and the National Oceanographic and Atmospheric Administration (NOAA). These agencies provide research internships in leading federal laboratories for more than 70 CSU future science teachers each summer.

The CSU's success in mathematics and science teacher preparation led to its selection as a partner in the prestigious 100Kin10 national initiative. As part of that initiative to increase by 100,000 the supply of excellent STEM teachers in the next decade, the CSU has committed to sustain its preparation of 1,500 excellent new math and science teachers annually. The CSU priorities include: producing increased numbers of teachers in severe shortage fields; placing excellent new math and science teachers in high need schools; and providing training for well-qualified laid-off teachers, enabling them to earn second credentials in mathematics or science and have new job opportunities in these high demand fields.

Background

The projected need for new mathematics and science teachers in California in the next ten years exceeds 33,000. The demand for mathematics and science teachers is far greater than the pool of teachers credentialed in these fields, and many students in the state continue to be taught by teachers who are under-prepared in these subjects. Students who do not have qualified mathematics and science teachers demonstrate lower achievement gains than those whose teachers are qualified in these fields.¹

The problem of an insufficient number of fully prepared teachers has continued in these two fields while dropping overall in California. The state’s institutions of higher education and school districts have worked hard to address the No Child Left Behind Act requirement that classroom teachers meet the state’s standards for highly qualified teachers. Still, in 2010-11, more than 10% of California’s high school mathematics, physical science, and life science teachers were

under-prepared in these subjects. While the number of under-prepared teachers has declined across the state, these often struggling teachers continue to be disproportionately placed in the highest need schools. More than 200 schools in the state had 20% or more under-prepared teachers in 2010-11, mostly in urban areas, serving, on average, 87% students of color, and a large number of these teachers were in math and science classes.

The CSU Mathematics and Science Teacher Initiative

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 CSU systemwide commitment to double production of teachers in these fields from a baseline of approximately 750 in 2003 to 1,500 by 2011.

CSU began its Mathematics and Science Teacher Initiative (MSTI) in 2004-05 with a planning process involving all of its 23 campuses. Each campus designed expansion approaches based on its strengths along with the needs and opportunities in the region. A seven-part systemwide action plan was developed that was focused on meeting the goal of doubling annual preparation through diverse approaches building on campus and regional capacity. Each campus now develops an annual action plan with numerical goals for increased credential production and strategies for reaching these goals.

The campus approaches are integrated within the CSU systemwide initiative that includes the seven comprehensive strategies. The evidence from efforts in math and science teacher preparation indicates that there is not one simple solution to increasing production. There are multiple obstacles to increasing recruitment and production, and these must be addressed through a multi-faceted approach for sustained effectiveness.

The CSU approach includes (1) recruitment of new students into the teaching field, (2) increasing production through new credential pathways, (3) financial support to attract outstanding candidates and facilitate credential completion, (4) community college program alignment, (5) online resources and preparation, (6) partnerships with federal labs and industry, and (7) identification of the most successful approaches to replicate on other campuses.

CSU Mathematics and Science Teacher Initiative Annual Reporting Requirements

This report provides information on the CSU Mathematics and Science Teacher Initiative and its outcomes during 2011-12. It is in response to provisions of the Budget Act that provided for an annual report addressing four areas:

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3 Ibid.

1. annual number of mathematics and science teachers awarded credentials by each CSU campus beginning with the 2004-05 academic year (before the state first provided funding for the Initiative);

2. an expenditure report on the use of the funds appropriated in this provision;

3. the effectiveness of the Initiative’s different components and activities, including an identification of best practices; and

4. the job placement of candidates who earn a mathematics or science teacher credential, including the location of the K-12 school of employment and whether it is in an urban, rural, or suburban setting.

Number of Mathematics and Science Teachers Produced by CSU Campuses

The increase in CSU production of mathematics and science teachers from the baseline year of 2003 to 2011-12 has been highly significant, a doubling from 750 to 1,507. The increase has been steady and sustained over the six-year period since the initial planning and first funding for the CSU Mathematics and Science Teacher Initiative began in 2005. Systemwide data for 2010-11 and previous years for mathematics and science teacher credentials issued by CSU campuses are presented in Tables 1 and 2 at the end of this report.

The increases in production have been large in all areas of mathematics and science. In mathematics, the increase was from 349 in the 2003 baseline year to 811 in 2011-12, an increase of 132%. This is attributable in part to the introduction of the Foundational Level Mathematics credential in 2004. This credential is designed to address the need for credentialed middle school mathematics teachers. CSU prepared 351 teachers with the Foundational Level Mathematics credential in 2010-11. This new credential, authorized by the California Commission on Teacher Credentialing six years ago, prepares candidates for teaching middle school mathematics, including algebra, addressing the large need for teachers skilled in teaching this subject to meet state requirements regarding the teaching of algebra in the state’s middle schools.

The increase in production of science teachers from 2003 to 2010-11 was from 419 to 634, an increase of 51%. Within the sciences, the largest gains have been in the highest shortage fields. These include increases in chemistry of 100%, geosciences of 62%, and physics of 117%. CSU has made a deliberate attempt to increase science teachers in the highest shortage areas through its Science Teacher and Researcher (STAR) program, described later in this report. A new Foundational Level General Science credential was established by the California Commission on Teacher Credentialing in 2009 for middle school science teachers; a substantial increase in science teacher credential production is expected as a result.

The credential production increases provide clear evidence of the impact of the state support for the CSU Mathematics and Science Teacher Initiative. Campus data in Table 2 from 2002-03 through 2010-11 show that virtually all of the CSU campuses demonstrated substantial increases in math and science teacher production during the period as a result of the support provided for the Initiative.

Twelve campuses increased their yearly production in these fields by 25 or more teachers. These increases are directly related to the strategies implemented with additional MSTI
resources. In the case of CSU Bakersfield and East Bay, for example, funding has gone in large part to scholarships and has leveraged matching private sector support from the Chevron Corporation. In the case of CSU Dominguez Hills and CSU San Bernardino, funding has been used primarily to create new credential pathways and provide financial support, including use of the funds as a required match to obtain federal scholarships.

In the case of CSU Long Beach and CSU San Marcos, MSTI funding has been used for comprehensive strategies that focus on recruitment from traditional and new pools of candidates. This includes partnerships implemented with community colleges that focus on recruitment and preparation of transfer students. Across the CSU system, new strategies have been implemented that could not be initiated or continued without state support, and these approaches have resulted in major increases in mathematics and science teacher production.

The significance of these increases is underscored by the overall declines found statewide in preparation of new teachers. In California, the total number of credentials awarded declined more than 40% between 2003-04 and 2010-11, and the production of single subject candidates declined by more than 20%. CSU experienced overall declines, as did the other institutions of higher education. The continued growth in math and science teacher production is directly attributable to the continued demand for teachers in these fields, the financial support provided for the program, and the sustained commitment and effort of faculty and academic leads on campuses across the CSU system.

**Expenditure of Funds Appropriated to Mathematics and Science Teacher Initiative**

The 2010-11 State Budget appropriated $2.713 million for the CSU Mathematics and Science Teacher Initiative. The expenditure plan adopted for these funds consisted of two primary components, as described below.

- **Support provided for each of the 22 campuses preparing math and science teachers** to implement: (a) comprehensive recruitment efforts, (b) a range of credential pathways to increase math and science credential production—including innovative programs preparing candidates for the newly established Foundational Level General Science Credential, (c) financial support to candidates, and (d) programs aligned with community colleges: $2,525,000.

- **Statewide management and administration**, including activities aimed at: (a) acquiring external resources through matching federal funds to augment state funding, (b) developing partnerships with federal science agencies, (c) monitoring program implementation and effectiveness, and (d) disseminating and scaling up effective practices: $188,000.

**Campus support funding** was, as in previous years, performance-based and reflected the increased production of math and science teachers by each campus. This approach has been used during the past three years in order to target resources on approaches and to campuses that show significant success in achieving the goal of doubling credential production.

Allocations to campuses ranged from $65,000 to $165,000, and individual campus amounts were based on (a) production increases the previous year, (b) increases achieved during the entire period of the systemwide initiative, and (c) total production during the previous year. In order to receive an allocation, each campus was required to submit a plan that included:

- credential production targets for the next two years
• action steps for increasing production of both mathematics and science teachers
• a detailed budget and budget justification for the allocation
• a progress report, including the identification of effective strategies and best practices.

Purposes for which the campus allocations are being used follow systemwide guidelines. There are strict limitations on uses for administration, faculty salaries, consultants, and travel in order to ensure that resources are targeted primarily to helping students enter and complete credential preparation. Only activities that are directly related to math and science teacher recruitment and preparation can be supported, and the funds cannot be used to offset costs of instruction or student support that are part of ordinary campus academic programs. All budgets are reviewed thoroughly to ensure conformity with these requirements.

Primary budget items for which campuses use funds continued to include:

• scholarships to students to assist them in completing math or science credential pathways
• stipends to students who served as mathematics or science tutors in K-12 schools
• a dedicated project coordinator responsible for planning, coordination, and reporting
• recruitment efforts such as workshops, events, advising, and outreach materials
• faculty release time to plan and develop programs for new credential pathways
• support staff to advise and assist students about credential pathways and resources
• outreach, publicity, and assistance to students in applying for scholarships and other support
• coordination with community colleges and advising for community college students
• creation of online program resources and tools
• development and maintenance of project web sites
• assisting students with preparing for the California Subject Examination for Teachers (CSET).

Systemwide guidance regarding the use of Mathematics and Science Teacher Initiative funds is provided to ensure activities are undertaken that have significant promise for recruiting and preparing new math and science teachers. In addition, a primary feature of systemwide coordination is the strategic use of program funds to leverage federal and philanthropic funding.

**Effectiveness of CSU Mathematics and Science Teacher Initiative Components and Identification of Best Practices**

The components of the CSU Mathematics and Science Teacher Initiative are integrated into a comprehensive systemwide strategy that is recognized as being one of the most significant approaches for increasing math and science teacher preparation that has been undertaken nationally. The distinctive features of the Initiative are: (a) institutional commitment that is articulated and reinforced at multiple levels, (b) comprehensive recruitment and financial support, (c) approaches that connect future teachers with communities of practice that include scientists and mathematicians as well as other dedicated teachers in their disciplines, (d) broad-ranging collaboration and partnerships with other educational agencies and with federal science agencies, and (e) rigorous data systems and evaluation procedures for monitoring outcomes.

A first factor that has supported program effectiveness is **institutional commitment at all levels.** Support of campus academic leaders and staff, engagement of faculty in Colleges of

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science, mathematics and education, and cooperative efforts to attract, recruit, and prepare outstanding candidates are characteristic of the CSU systemwide Math and Science Teacher Initiative. The program on most campuses has mutually supportive leadership among the top academic leaders. The commitment of leaders at each level is reinforced by and reinforces the work of leaders at the other levels and is encouraged by the Chancellor.

A second factor that has been instrumental in supporting program effectiveness is the integration of comprehensive recruitment strategies and financial support. Approaches for recruiting candidates from diverse populations are directly aligned with scholarships and loan assumption programs to enable candidates from diverse backgrounds to complete a credential program without incurring significant student debt.

A third factor supporting effectiveness is preparation that connects future teachers with science and mathematics communities of practice. In programs like STAR, CSU science teacher candidates are directly involved in scientific practice and discourse, and the programs engage them as members of professional communities with leading scientists.

A fourth factor enhancing effectiveness pertains to robust data systems for continuously monitoring progress and outcomes. Thorough and refined accountability systems are critical to (a) determine the strategies and institutions that are most effective in increasing production of well qualified math and science teachers and (b) examine them to identify their distinguishing features and impacts. The approach used by CSU to monitor performance builds on the robust data systems developed for the Annual Evaluation of CSU Teacher Preparation Programs conducted by the CSU Center for Teacher Quality. This is the annual evaluation that is conducted on all of the CSU campuses that prepare teachers. It surveys teacher graduates and their Principals/Supervisors to assess their degree of preparation and is able to examine the added value of particular pre-service experiences.

A fifth factor that has advanced effectiveness addresses collaborative strategies and partnerships that often extend beyond traditional boundaries. These include innovative partnerships between colleges of education and colleges of science and engineering that have resulted in recruitment of outstanding undergraduates. They also include systemic partnerships with the entire spectrum of K-20 educational institutions throughout regions. Another important partnership has been with the California Student Aid Commission. It has enabled CSU campuses to award more than $10 million in loan assumption funds to future science and mathematics teachers.

Significant partnerships have been established with federal agencies, including NSF, the Department of Education, the Department of Labor, the Department of Energy, NASA, and NOAA. These have led to federal funding of more than $66 million that has been possible through use of MSTI funds as matching resources.

Another important set of partnerships have been with philanthropic Foundations having a commitment to advancing STEM education and teacher preparation. These partnerships include 100Kin10, a national movement led by major philanthropic Foundations, including the Carnegie Corporation of New York, the S.D. Bechtel, Jr. and Gates Foundations, and individual collaborations with California Foundations. The latter include, for example, several initiatives with the David and Lucile Packard Foundations placing future math and
science teachers in after-school program field experiences to enhance the STEM learning opportunities of the high need children served by these programs in California.

Another major partnership has been with Workforce Investment Boards (WIBs) across the state. These have led to the development of programs supported with Department of Labor funding that are enabling laid-off teachers who have strong backgrounds in mathematics and science to earn second teaching credentials in these subjects in order to become employed in these high demand fields. WIBs have invested more than $2.5 million in these programs due to the large number of teacher layoffs in California and the sizable need for additional math and science teachers.

An additional partnership has been with Google and has been focused on preparing math and science teachers in a range of highly accessible, low cost technology applications designed to transform classroom learning. Forty CSU faculty selected as Google Fellows are exploring advanced applications of leading software to secondary school STEM teaching and learning in approaches that enable students to actively explore math and science phenomena first hand.

During the past five years, contributions to MSTI through these partnerships have exceeded $73 million. They represent leveraging of MSTI funds in acquiring external funding at a level greater than 5 to 1.

Identification of Best Practices

Best practices have been identified for each factor associated with effectiveness by examining relationships between the factors and changes in credential production. There has been a consistent association between certain approaches and large increases in preparation of well-qualified teachers and this is the basis for judging them best practices.

In the case of institutional commitment, a common feature is seen both at campuses that began with little institutional engagement but that now have science and mathematics teacher preparation as a campuswide priority, and those that have a long tradition of commitment to this area and where the institution has more than doubled its programs. The feature characteristic of the institutional commitment is sometimes referred to as nested leadership. There is a concerted, campuswide effort that involves the President, Provost, Deans, Department Chairs, and faculty all working toward the same goal. The actions at each level support one another and yield a culture of campuswide support for a long-term commitment to attracting and preparing outstanding new math and science teachers.

In the case of recruitment and financial support, campus efforts to secure external scholarship funding for candidates is essential. In science and mathematics, fellowships often exist for students who are pursuing research careers. The use of Mathematics and Science Teacher Initiative funds as matching resources to secure federal funds and the commitment of these funds for the entire periods of federal grants allows for the type of

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scholarship that attracts outstanding math and science majors into teaching. CSU campuses have the largest number of National Science Foundation Robert Noyce scholarships in the nation. The 23 campuses have more than 50 different NSF-funded scholarship and fellowship programs, and fully 20% of CSU math and science candidates have Noyce annual awards of $10,000, the majority lasting for from three to five years of their teacher preparation. The simultaneous branding of math and science teaching as prestigious has been highly effective. One campus achieved this through engaging and inviting messages on bookmarks, posters, and ads. Another created exciting videos that demonstrate that science and mathematics teaching are exceptionally attractive and rewarding careers. These are being shared with other campuses through the online MSTI Recruitment Toolkit.

The STAR program is an example of best practices enabling future science and math teachers to participate actively in scientific communities of practice. Through it, outstanding science teacher candidates work with some of the nation’s most outstanding researchers. More than 220 future science teachers have now participated in some of the nation’s finest research laboratories through STAR. The STAR program was cited by the President’s Council of Advisors on Science and Technology (PCAST) as a model for the nation for recruiting outstanding science, technology, engineering, and mathematics (STEM) majors into teaching and enabling them to continue participating in scientific communities of practice.

An additional partnership between CSU and NASA has had similar outcomes in motivating outstanding STEM majors to consider teaching as a career. From 2006-07 to 2010-11, Spaceward Bound included more than 150 CSU students in field research with NASA scientists in extreme environments that have similarities with remote planetary conditions. Each spring, future science teachers from several CSU campuses participate in a field research expedition with NASA scientists in the Mojave National Preserve, with subsequent follow-up with teams of researchers and high school teachers.

Spaceward Bound is now part of a broader effort funded by NASA to enhance the integration of NASA Mission research into the classroom at the secondary level. The focus is to introduce NASA-related field research to pre-service and in-service teachers. During the past three years, CSU campuses received $2 million in grants from NASA headquarters in Washington, D.C. and its three California research centers to enable them to establish model programs preparing both current and future teachers in using NASA research in middle and high school classrooms.

The data systems used by CSU to continuously monitor progress and assess outcomes are another example of best practices. They build on data from the annual CSU Evaluation of Teacher Preparation Programs. The reporting systems developed by the CSU Center for Teacher Quality enable CSU to track its teacher graduates, identify the attributes of the schools in which they teach, and analyze the degree of preparation as reported by candidates and the Principals at their schools.

8 Ibid.
In addition, data provided by the California Commission on Teacher Credentialing are subject to refined analyses by the CSU Office of Analytic Studies to determine exact numbers of credentials recommended by each CSU campus. This spring, the Office of Analytic Studies also performed an in-depth analysis of community college transfers to CSU with declared STEM majors. These data identified the 23 California Community colleges from which CSU STEM transfers have averaged more than 100 during the past three years. These data have been valuable in planning transfer patterns that are common across campuses, part of CSU’s commitment to facilitating efficient transfer under SB 1440.

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

A comprehensive analysis was conducted on the job placement of CSU mathematics and science teachers whose first year of teaching was 2011. The findings were striking, demonstrating that large numbers teach in high need schools. Of CSU math and science teacher graduates:

- Approximately 55% taught in city schools and 12% taught in rural schools;
- More than one-third taught in schools that did not meet their annual Academic Performance Index (API) in 2010-11;
- 71% taught in schools with more than half of the students in poverty and 92% in schools where one-fourth or more of the students were from families in poverty;
- 90% taught in schools with less than 100% fully credentialed teachers.

Data on the California teacher workforce underscore the importance of these job placements among CSU math and science teachers—which show a striking pattern in which the majority teach in high need schools. Challenges of finding qualified math and science teachers are acute among the state’s highest need schools. The new math and science teachers prepared by CSU are teaching in the state’s neediest schools and contributing substantially to overcoming inequities in the distribution of well-qualified mathematics and science teachers.

Conclusions

CSU campuses demonstrated a trajectory of significant growth in mathematics and science teacher production in 2010-11, with the doubling to 1,500 since 2003 sustained and continuing to increase. The new teachers produced by CSU campuses are taking job positions in high need schools across the state. They are contributing markedly to reducing the disparities in access to qualified mathematics and science teachers that have been found in the state and been a significant factor in causing achievement gaps in these fields throughout the past three decades.
## Data Tables

### Table 1. CSU Mathematics and Science Teacher Credential Production by Subject: 2002-03 to 2010-11<sup>a,b</sup>

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<sup>a</sup>Data on new credentials are provided by the California Commission on Teacher Credentialing (CCTC).  
<sup>b</sup>Data include total CSU mathematics and science teacher credentials and authorizations in 2010-11.

This table presents California Commission on Teacher Credentialing data from 2002-03 through 2010-11 for mathematics and science Credentials recommended by California State University campuses. The numbers are based on the count of math and science credential authorizations that have been recommended for (a) regular credential candidates and (b) intern credential candidates, since both are compliant with federal No Child Left Behind (NCLB) requirements.
## Table 2. CSU Mathematics and Science Teacher Credential Production by Campus: 2003-04 to 2010-11<sup>a,b</sup>

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### Supplemental Authorizations Preparing Elementary Teachers in Science or Mathematics
- Additional Science or Mathematics Authorizations Among Current Secondary Teachers
- Math and Science Grand Total Across CSU Campuses

<sup>a</sup>Data on new credentials are provided annually by the California Commission on Teacher Credentialing (CCTC). The data for each campus represent new secondary math and science credentials each year.

<sup>b</sup>Data in table represent new secondary credentials (sub-total) and additional elementary and secondary credentials to provide total CSU mathematics and science credentials at each year. All data are based on the 2010-11 academic year.