



The California State University
WORKING FOR CALIFORNIA

**THE CALIFORNIA STATE UNIVERSITY
MATHEMATICS AND SCIENCE
TEACHER INITIATIVE**

ANNUAL REPORT

**CALIFORNIA STATE UNIVERSITY
OFFICE OF THE CHANCELLOR**

APRIL 2016

Overview

Through the implementation of its system-wide Math and Science Teacher Initiative (MSTI), the California State University (CSU) has achieved and sustained its goal of doubling the 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 more than 1,500 by 2011-12 and have sustained their track record of large production, even as overall teacher production declined. In the especially severe shortage areas of physics and chemistry, CSU has increased the annual number of teachers it prepares by over 100%. In 2014-15, CSU campuses prepared 1,504 teachers in these chronic shortage fields, 866 in math and 638 in science.

Utilizing MSTI resources in strategically planned efforts, CSU campuses have not only been effective in increasing production of math and science teachers, the campuses have also been 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 have provided research internships in leading federal labs for over 400 CSU future science teachers.

CSU's success in math and science teacher preparation includes its being a leading partner in the prestigious 100Kin10 national initiative. Led by the Carnegie Corporation of New York, this is a group of national foundations, education institutions, and businesses that have joined together to prepare 100,000 excellent STEM teachers over the next decade. As part of the initiative, CSU has committed to sustain its preparation of 1,500 new math and science teachers annually. CSU priorities include: producing increased teachers in severe shortage fields; placing new math and science teachers in high need schools; and preparing candidates credentialed in more than one STEM discipline to assist hard-to-staff schools.

Background

The projected need for new mathematics and science teachers in California in the next ten years continues to exceed 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. Numerous studies show that students who do not have qualified mathematics and science teachers demonstrate lower achievement gains than those whose teachers are qualified in these fields.

The problem of an insufficient number of fully prepared teachers has been persistent in these two fields. More than 10% of California's middle and high school mathematics and physical science teachers continue to be under-prepared in these subjects or are teaching out-of-field.

Under-prepared teachers are disproportionately placed in the highest need schools. More than 200 schools in the state have 20% or more under-prepared teachers; these are mostly in urban areas, serving, on average, 87% students of color. The majority of the under-prepared teachers are in math and science classrooms.

CSU Math 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. Each campus implements a strategy based on its strengths along with the needs and opportunities in the region. All have an annual action plan with numerical goals for increased credential production and strategies for reaching those 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.

Significant attention is given to preparing new math and science teachers for the Common Core State Standards in Math (CCSS-M) and the Next Generation Science Standards (NGSS). CSU's leadership in this area has been recognized in its receiving major federal and philanthropic grants for developing models that address the new standards.

The system received over \$53 million in federal Teacher Quality Partnership grants in 2014 focused on STEM teacher preparation—almost one-third of federal funding. It also received \$6 million for federal Investing in Innovation (i3) grants developing innovative strategies for preparing teachers in the CCSS-M. It was awarded \$3 million from the S.D. Bechtel, Jr. Foundation for Preparing a New Generation of Educators, a system-wide initiative advancing the CCSS and NGSS and \$1 million from Chevron Corporation for projects that prepare teachers in grades K-12 for the engineering design components of the NGSS.

Effectiveness of MSTI Components and Identification of Best Practices

The components of MSTI 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 science, mathematics and education, and cooperative efforts to attract, recruit, and prepare outstanding candidates are characteristic of MSTI. 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 math 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 advancing effectiveness is collaborative strategies and partnerships that often extend beyond traditional boundaries. These include innovative partnerships between colleges of education, science, and engineering that have resulted in recruitment of outstanding undergraduates. A variety of partnerships also exist with K-12 educational institutions. Included are partnerships with the California STEM Learning Network (CSLNet) statewide regional networks. CSLNet is one of more than a dozen state networks that are committed to advancing K-12 STEM teaching and learning. CSLNet includes an emphasis on expanding STEM learning through the state's 4,000 publicly funded after-school programs. In collaboration with CSLNet, CSU campuses are providing inquiry-based STEM clinical experiences for future teachers in after-school programs around the state.

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 \$75 million that has been possible through use of MSTI funds as matching resources.

Another important set of partnerships has been with philanthropic foundations having a commitment to advancing STEM education and teacher preparation. These partnerships include the S.D. Bechtel, Jr. Foundation, the Carnegie Corporation of New York, the James Irvine Foundation, and the David and Lucile Packard Foundation. Philanthropic matching support for activities that complement MSTI exceeded \$5 million in the past three years.

CSU also has productive partnerships 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 math and science to earn second teaching credentials in these subjects and become employed in these high demand fields. WIBs have invested more than \$2.5 million in these programs, addressing both teacher layoffs and the need for additional math and science teachers.

An ongoing partnership with Google has been focused on preparing math and science teachers in highly accessible, low cost technology applications that support 21st century learning. Forty CSU faculty members were supported as Google Faculty Fellows and explored advanced applications of digital technologies to secondary school STEM teaching and learning. Google has also provided support for the CSU Digital Ambassador program, enabling Google Fellows to provide training to other faculty in digital technologies.

A partnership launched with the S.D. Bechtel, Jr. Foundation in 2012-13 focused on significantly strengthening the preparation of future elementary teachers in science. The Foundation provided support for grants to campuses aimed at enhancing the content and pedagogical expertise of these teacher candidates and increasing their confidence and excitement about science. The project was aligned with the release of the Next Generation Science Standards (NGSS), enabling CSU to be a leader nationally in addressing the new standards. Through the project, campus courses, labs, and practicum and field experiences are being revised to address the NGSS focus on (a) scientific and engineering practices, (b) crosscutting concepts in science, and (c) the integration of engineering and science.

During the past six years, contributions to MSTI through federal and foundation partnerships have exceeded \$80 million. This represents leveraging of MSTI funds in acquiring external funding at a level greater than 5 to 1. In virtually all cases, the availability of matching MSTI funds was a key factor in enabling CSU and its campuses to receive substantial external support.

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 math 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.¹ 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

¹ Resnick, L., & Glennan, T. (2003). Leadership for Learning: A Theory of action for urban school districts. In S.T. Hightower, M. Knapp, J. March, and M. McLaughlin (Eds). School districts and instructional renewal. New York: Teachers College Press.

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 are essential. In science and math, fellowships often exist for students who are pursuing research careers. The use of MSTI 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 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 more than 20% of CSU math and science candidates have Noyce annual awards of \$10,000, the majority lasting for from three to five years during their teacher preparation pathway.

The concurrent branding of math and science teaching as a prestigious career choice has been highly effective. One campus achieved this through engaging messages on bookmarks, posters, and ads. Another created exciting videos that demonstrate that math and science teaching careers are attractive and highly rewarding. 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 290 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 2014-13, Spaceward Bound² included more than 240 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 involving 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.³ The focus is to introduce NASA-related field research to pre-service and in-service teachers. During the past six years, CSU campuses received \$2.5 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.

² Heldmann, J., McKay, C., & Coe, L. Spaceward Bound: Training and inspiring the next generation of space explorers. Paper presented at the Annual Meeting of the Lunar and Planetary Institute, Houston, TX. October 1-5, 2007.

³ Ibid.

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.

In addition, data provided by the CTC are subject to refined analyses by the CSU Office of Analytic Studies to determine the exact numbers of credentials recommended by each CSU campus. The Office of Analytic Studies has also performed analyses of community college transfers to CSU with declared STEM majors. These data identify the California Community Colleges from which CSU STEM transfers have averaged more than 100 annually. They facilitate planning of transfer patterns that are common across campuses, part of CSU's commitment to facilitating efficient transfer under SB 1440.

Job Placement of Math and Science Teacher Graduates

A comprehensive analysis was conducted on the job placement of CSU math and science teachers whose first year of teaching was 2015-16. The findings were striking, demonstrating that large numbers teach in high need schools. Of CSU math and science teacher graduates:

- Approximately 56% taught in city schools and 10% taught in rural schools
- Approximately one-third taught in schools that did not meet their annual Academic Performance Index (API) in 2014-15
- 80% taught in schools with more than half of the students in poverty and close to 90% in schools where one-fourth or more of the students were from families in poverty
- 70% 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 teacher graduates—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 math and science teachers.

Conclusions

CSU campuses have demonstrated a pattern of sustained production of math and science teachers, with the doubling from 750 to over 1,500 teachers since 2002-03 continued. The CSU system prepared 1,504 math and science teachers in 2014-15. Of these, 806 were in math and 698 were in the science fields of biology, chemistry, earth science, and physics.

The new teachers produced by CSU campuses are taking positions in high need schools across the state. They are contributing markedly to reducing the disparities in access to qualified math and science teachers that have been found in the state and that have been a contributing factor to continued achievement gaps in these fields throughout the past three decades. CSU and its new teachers are now among the state's leaders in reforms addressing both the Common Core State Standards in Mathematics and the Next Generation Science Standards and in fostering high quality implementation of them in historically underserved schools.

Mathematics and Science Teacher Production

CSU Mathematics and Science Teacher Candidate Production by Subject: 2002-03 to 2014-15^a

| | 2002-03 | 2004-05 | 2006-07 | 2008-09 | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 |
|--|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Subject | | | | | | | | | |
| Mathematics Sub-total | 349 | 524 | 572 | 783 | 786 | 773 | 718 | 746 | 740 |
| Science Sub-total | 419 | 487 | 485 | 505 | 570 | 594 | 660 | 634 | 639 |
| Math and Science Sub-total Secondary and Elementary | 768 | 1011 | 1057 | 1288 | 1356 | 1367 | 1378 | 1380 | 1379 |
| Supplemental Authorizations of Elementary Candidates in Science or Mathematics | | | | | | | 74 | 70 | 61 |
| Science or Mathematics Authorizations Among Current Teachers through CSU Campuses | | | | | | | 50 | 57 | 64 |
| Mathematics and Science Grand Total Across CSU Campuses | | | | | | | 1502 | 1507 | 1504 |
| ^a Data include total CSU mathematics and science teacher credentials, authorizations, and specializations from 2002-03 through 2011-12. Since 2012-13, the data have included and differentiated elementary candidates who received supplemental preparation in mathematics or science. | | | | | | | | | |

This table presents data from 2002-03 through 2014-15 for new teachers prepared in mathematics and science. The numbers are based on the count of (1) regular mathematics and science credentials that were received by (a) preliminary credential candidates and (b) intern credential candidates, as well as (2) elementary and secondary candidates who have earned supplemental authorizations, and (3) those who have received Foundational Level Mathematics (FLM) and Foundational Level General Science (FLGS) preparation.