April 20, 2018

Honorable Holly Mitchell, Chair  
Joint Legislative Budget Committee  
State Capitol, Room 5080  
Sacramento, CA 95814

Michael Cohen, Director  
Department of Finance  
State Capitol, Room 1145  
Sacramento, CA 95814

Diane Boyer-Vine  
Legislative Counsel  
State Capitol, Room 3021  
Sacramento, CA 95814

Mac Taylor  
Legislative Analyst Office  
925 L Street, #1000  
Sacramento, CA 95814

Daniel Alvarez  
Secretary of the Senate  
State Capitol, Room 3044  
Sacramento, CA 95814

E. Dotson Wilson  
Chief Clerk of the Assembly  
State Capitol, Room 3196  
Sacramento, CA 95814

RE: California State University Mathematics and Science Teacher Initiative Report

This report is about the California State University (CSU) Mathematics and Science Teacher Initiative (MSTI). The report provides (1), annual information on the number of math and science teachers credentialed, (2), an expenditure plan, (3), a report of the initiative’s different components and activities, including best practices, and (4) the job placement of students who earn a math or science teaching credential.

The report is important because the state of California continues to experience a severe teacher shortage in mathematics and science. The CSU strategies for addressing the shortage are the primary feature of MSTI and its activities are critical to ensuring that California’s students are taught by qualified mathematics and science teachers.

The annual report is provided each year in accordance with Provision 5 of the Budget Act of 2009. It indicates the four areas to be covered in an annual report due on May 1.
Should you have any questions about this report, please contact Joan Bissell, Director of Educator Preparation and Public School Programs, at ibissell@calstate.edu or (562) 941-4716.

Sincerely,

Steve Reyes
Executive Vice Chancellor and
Chief Financial Officer

Full report posted to www.calstate.edu/budget/fybudget/legislative-reports/
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California State University
Mathematics and Science Teacher Initiative

Overview

Through the implementation of its systemwide Mathematics 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 more than 100%. In 2016-17, CSU campuses prepared 1,521 teachers in these chronic shortage fields for grades K-12—677 in math and 844 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 (NSF). 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 470 CSU future mathematics and science teachers.

CSU's success in mathematics and science teacher preparation includes its being a leading partner in the prestigious 100Kin10 national initiative. Founded 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 numbers of 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 over 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. A high percentage of the under-prepared teachers are in math and science classrooms.
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. 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 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 share with 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 these areas has been recognized in its receiving major federal and philanthropic grants for developing teacher preparation designs addressing the standards.

Effectiveness of Mathematics and Science Teacher Initiative Components

The components of MSTI are integrated into a comprehensive systemwide strategy that is recognized as being one of the most significant efforts 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 STEM 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 campuses has mutually supportive leadership among the top academic leaders in STEM and teacher preparation. The commitment of leaders in the various fields is reinforced by and reinforces the work of leaders in the other fields.

A second factor that has been instrumental in supporting program effectiveness is the integration of comprehensive recruitment strategies and financial support. Strategies for recruiting candidates from diverse populations are directly aligned with scholarships and paid field experiences working with K-12 students to enable candidates from diverse backgrounds to complete a credential program without incurring significant student debt.

A third factor supporting effectiveness in preparation connects future teachers with science and math communities of practice. In programs like STAR, CSU STEM teacher candidates are
directly involved in scientific practice and discourse, and the programs engage them as members of professional communities with leading scientists. In summer, 2017, 15 CSU campuses had STEM teacher candidates participating in STAR.

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 and higher education. Included are partnerships with the California STEM Learning Network (CSLNet) statewide initiative led by Children Now. CSLNet is one of the state networks across the nation that is committed to advancing K-12 STEM teaching and learning.

The California Department of Education has placed a priority on expanding STEM learning through the state's 4,000 publicly funded after-school programs. CSU campuses have been a leader in this work, and future math and science teachers are providing inquiry-based STEM learning experiences for students in after-school programs around the state.

An important higher education partnership has been with the Association of Public Land Grand Universities (APLU) and its Mathematics Teacher Education Partnership (MTEP). Its goal is to enhance the preparation of math candidates at the secondary level for the Common Core State Standards in Math (CCSS-M). All CSU campuses participate in the CSU systemwide MTEP. Through it, campuses are collaborating in research-based efforts aimed at recruiting more math teacher candidates and enhancing their content and clinical preparation. CSU is the largest participant in the national MTEP and plays a prominent role in the APLU national initiative.

The California Department of Education has been highly supportive of expanding STEM learning through the state's 4,000 publicly funded after-school programs. CSU campuses have been a leader in this work, and future math and science teachers are providing inquiry-based STEM learning experiences for students in after-school programs around the state.

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 $20 million in the past five years.

A partnership launched with the S. D. Bechtel, Jr. Foundation in 2013-14 includes a focus on significantly strengthening the preparation of future K-8 teachers in math and science and has been supported with over $15 million. The Foundation provided support for grants to campuses that included attention to enhancing the content and pedagogical expertise of teacher candidates in the Common Core State Standards in Math (CCSS-M) and the Next Generation Science Standards (NGSS). This, combined with earlier work supported by the Bechtel Foundation at the time of release of the NGSS has enabled CSU to be a leader nationally in addressing these new standards at the elementary and middle grade levels.

The Chevron Corporation has provided support of $2.25 million to CSU for its work in math and science, particularly focusing on the NGSS. Through the grants over five years, campus courses, labs, and practicum and field experiences are being revised to address the NGSS attention to (a) scientific and engineering practices, (b) crosscutting concepts in science, and
(c) the integration of engineering and science. Work supported by the Chevron at the present time includes:

- The STEM Teacher and Researcher (STAR) program: Chevron provides funding of $250,000 annually, and this has been combined with robust funding from the National Science Foundation to provide STAR summer placements in federal and other distinguished research laboratories for over 70 students each summer. STAR participants continue to be members of a community of teacher-researchers and have ongoing professional development support led by the STAR program. Data indicate that nearly 80% continue in a teaching career through their initial three years of teaching and begin roles as emergent teacher leaders during this period.

- Makerspace initiatives: Nationally, makerspaces and Fabrication labs have been established in a range of formal and informal learning environments (e.g., including after school programs and summer programs). They are spaces where students can explore, create, and invent, using a variety of materials such as 3-D printers, laser cutters, soldering equipment, LED lights, and materials for making robotic objects. CSU has established a Maker Certificate program at Sonoma State that is leading the preparation of current and future and current educators and community members in Making, with CSU a national leader in this approach that reflects the NGSS emphasis on student engagement in STEM.

During the past six years, contributions to MSTI through federal and foundation partnerships have exceeded $88 million. This include federal Teacher Quality Partnership grants of $53 million, over $15 million in National Science Foundation Noyce scholarship and fellowship grants, and $20 million in philanthropic funding. 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 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 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 recruitment, campuses use a variety of approaches, and these are shared among them. These include nominations by professors of candidates likely to be successful in a teaching

careers, social media, advertising, and pre-teaching clubs. They provide advising and mentoring, also host numerous events and develop networks of students interested in pursuing a math or science credential. They provide support for early field experiences of varying durations, some paid and some un-paid, depending in large part on the candidates’ ability to make sustained time commitment. They also use annually awarded MSTI funds for small scholarships (e.g., usually in the range of $1,000 to $2,000) for students in math and science teacher pathways.

In 2016, the CSU Chancellor’s Office launched a teacher recruitment initiative called EduCorps to increase the number and diversity of students entering CSU’s teacher preparation programs, especially in high-need areas such as math, science, special education, and bilingual education. On a number of campuses, the MSTI recruitment initiatives are being coordinated closely with EduCorps. Two initiatives that have been undertaken are (a) engaging faculty in identifying undergraduates who they consider promising as teacher candidates and (b) hosting Celebrations of Teaching that bring together undergraduates who have been identified by faculty in an event that recognizes the students, provides advising and introduces them to EduCorps opportunities, and encourages them to join EduCorps and pursue a teaching career.

In the case of 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 had more than 55 different NSF-funded scholarship and fellowship programs, and more than 20% of CSU math and science candidates have had Noyce annual awards of $10,000 over the past six years. These awards cover from one to three years of expenses during candidates’ teacher preparation.

The concurrent branding of mathematics and science teaching as a prestigious career choice is a best practice that several campuses use. Some achieve this through engaging messages on bookmarks, posters, and ads. Others created exciting videos that demonstrate that mathematics and science teaching careers are attractive and highly rewarding.

The STEM Teacher and Researcher (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. Future science and math teachers being prepared by CSU participate in some of the nation’s leading research laboratories through STAR. The 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 best practice between CSU and NASA has had similar outcomes in motivating outstanding STEM majors to consider teaching as a career. From 2006-07 to 2017-18, Spaceward Bound 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 and math teachers from several CSU campuses participate in a field research expedition with NASA scientists in the Mojave National Preserve, with subsequent follow-up involving CSU teacher candidates, teams of researchers, and high
School teachers.

Spaceward Bound has for a number of years been part of a broad effort funded by NASA to enhance the integration of NASA Mission research into the classroom at the secondary level. The focus has been to introduce NASA-related field research to pre-service and in-service teachers. During the past seven years, CSU campuses have participated in NASA’s Pre-service Teacher Institute. Led by NASA Ames, this program provides future K-8 teachers a week-long experience at the NASA facility in the San Francisco Bay area, where they learn frontiers in space science and how they might incorporate these into their teaching.

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 data systems developed for the Annual Evaluation of CSU Teacher Preparation Programs conducted by the CSU Educator Quality Center. 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.

The data systems used by CSU to continuously monitor progress and assess outcomes are another example of best practices. The reporting systems developed by the CSU Educator Quality Center 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 their principals or other supervisors at their school sites.

Additionally, campus data are subjected to refined analyses by the CSU Office of Analytic Studies to determine the exact numbers of candidates enrolled and 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 have identified the California Community Colleges from which CSU STEM transfers have averaged more than 100 annually. These data facilitate planning of community college partnerships, including Associate Degrees for Transfer pathways that lead to expedited graduation and earning of credentials.

**Individual Campus MSTI Initiatives**

Based on the number of math and science candidates it prepares, each campus receives an award annually for its Math and Science Teacher Initiative program. The annual campus plans and activities are a major part of CSU’s systemwide MSTI implementation. Examples of campus strategies include the recruitment strategies described earlier. Additional strategies are described below.

A primary strategy undertaken by most campuses is test preparation for the California Subject Examination for Teachers (CSET). This might include free test preparation workshops, online courses, or resources identified by the campus for candidates. In some cases, MSTI funds are used to defray costs of candidate registration for a required CSET exam. Most campuses have a set of activities aimed at removing the obstacles that CSET examinations create to earning a math or science credential.

Another frequent strategy is aligning MSTI with an NSF Robert Noyce Teacher Scholarship or
Teacher Fellowship Program. This program provides scholarship support for from one to three years of approximately $10,000 leading to a teaching credential and may continue support thereafter if it is funded through the NSF Noyce Fellowship program. It requires a grant from the National Science Foundation, and CSU campuses are active in applying for these grants. Each CSU campus has had at least one NSF Noyce Scholarship program.

Additional campus initiatives include Learning Assistant programs. In these, candidates in math and science teacher pathways and undergraduates in math and science majors serve in teaching assistant roles, working with individual undergraduates or helping a faculty member as a course assistant. The Learning Assistant programs are used on several campuses and encourage undergraduate majors in math and science to pursue teaching as a career.

Another strategy used by campuses is development of minors in mathematics and science. On a number of campuses, these enable undergraduates who are planning an elementary credential to take coursework that will prepare them to pursue an additional Foundational Level Math (FLM) or Foundational Level General Science (FLGS) credential. Taking the coursework in the minor generally equips the candidates to pass the California Subject Examinations for Teachers (CSET) needed to earn an FLM or FLGS credential. On some campuses, a comprehensive effort is made to recruit and prepare candidates for FLM and FLGS credentials as part of MSTI.

A third approach used by some campuses is to support candidate participation at professional conferences. The campuses provide support, for example, for candidates to go as a group to the annual California Science Teachers (CSTA) conference, the annual California Mathematics Council (CMC) meeting, or the annual STEAM Symposium hosted by the California Department of Education and the CDE Foundation.

Some campuses have programs run by the campus that involve candidates in working with children as a way of enhancing their interest in teaching. One campus has a Hands-on Lab and another a Learning by Doing Lab. Local K-12 students visit the labs and candidates work with them and their teachers in structured learning activities. Another campus has a Digital Fabrication Lab (Fab Lab) and invites schools and community groups to visit it. As part of MSTI, candidates in a math or science pathway work with the visiting school and community groups as part of an active hands-on program.

Another approach is one in which undergraduates participate in a local school, after-school, Saturday, or summer program, working with K-12 students in math and science enrichment activities. The students may receive a scholarship or stipend in association with this work, normally in the range of $1,000 to $3,000, depending on the duration and intensity of the undergraduates' serving in this role. The participants on some campuses are referred to as MSTI Fellows, creating distinction for the program. Often more than one undergraduate works at a field experience site with a resultant sense of community among the CSU students. One such program is the CSU Fresno Teaching Fellows program, a partnership with the California Teaching Fellows Foundation focused on teaching in after-school and summer programs.

On other campuses, MSTI collaborates closely with one or more community colleges. In some cases, the community college and CSU students together serve as STEM assistants in local schools or community organizations. In most cases, there is a comprehensive recruitment and advising program, with thorough coordination between the community college lower division math and science experience—both academic and student services—and the CSU upper division math and science preparation pathway.
On some campuses, MSTI outreach involves high school student outreach and working with students interested in teaching careers. Typically, a partnership includes middle and high school teachers and the collaboration includes students who are in a secondary Teaching Academy serving students interested in teaching careers. Some campus programs are undertaken with Educators Rising, which provides leadership to local high school teacher clubs that provide a range of activities for students who wish to pursue or learn more about teaching.

On additional campuses, prospective math and science teachers serve as Teacher Outreach Ambassadors. These University students work with high schools, community colleges and at university events to promote careers in teaching, with an emphasis on math and science teaching. They, along with undergraduates, attend career fairs aimed at helping them make connections with potential employing school districts and schools.

Collaboration with EduCorps

On a number of campuses, the MSTI recruitment initiatives are being coordinated with EduCorps. Examples of initiatives that have been undertaken are (a) engaging STEM faculty in identifying undergraduates who they consider promising as teacher candidates and (b) hosting Celebrations of Teaching that bring together undergraduates who have been identified by faculty in an event that recognizes the students, provides role models, introduces them to EduCorps opportunities, and encourages them to join EduCorps and pursue a teaching pathway.

Job Placement of Mathematics and Science Teacher Graduates

Comprehensive analyses have conducted on the job placement of CSU math and science teachers after their first year of teaching. The findings are striking, demonstrating that large numbers teach in high need schools. Of the schools where 2016 CSU math and science teacher graduates taught:

- Approximately 56% taught in city schools and 10% taught in rural schools
- 84.5% were schools having 25% or more students from families in poverty and 63% of the schools had 50% or more students from families in poverty
- 43% of schools had teaching staff who were fully credentialed in the subject taught
- 19.5% of students in the schools met California’s math standards and 13.9% exceeded the standards: a total of one-third (33.4%) achieved them, below statewide averages.

Data regarding the California teacher workforce underscore the importance of these job placements among CSU mathematics and science teacher graduates—which show a striking pattern in which the majority teach in high need schools. Challenges of finding qualified mathematics and science teachers are acute among the state’s highest need schools. The new mathematics 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 in California.

MSTI and Graduation Initiative 2025

The MSTI program contributes to the Academic Preparation pillar of CSU’s Graduation Initiative 2025 in two ways. First is enhancing the content and pedagogical preparation of CSU teacher candidates to teach math and science. Through programs like STAR, the
content expertise of math and science teacher candidates is substantially deepened. STAR participants create lesson plans that are to be shared with other STEM teacher candidates, and this broadens the impact. Pedagogical preparation is enhanced through early field experiences in schools and out-of-school time. In roles of future math and science candidates, their own preparation for teaching is enhanced while they also contribute to the STEM preparation of K-12 students, many of whom will be applicants to CSU.

Second is increasing the number of math and science teacher candidates. Data show that California's "most vulnerable learners" bear the brunt of the state's unfilled STEM teacher demand. "The shortage leads to overcrowded classrooms and fewer opportunities to take STEM coursework. This scarcity means lost opportunities for California's students." Increasing the numbers of math and science teachers in California contributes directly to addressing teacher shortages in math and science and to improving the secondary preparation of future CSU students.

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 1,521 mathematics and science teachers and elementary teachers with expertise in math and science in 2015-16. Of these, 677 or 45% were in math and 844 or 55% were in the fields of biology, chemistry, earth science, and physics.

The new mathematics and science 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 mathematics 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.

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Mathematics and Science Teacher Production

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Supplemental Authorizations of Elementary Candidates in Science or Mathematics 74 70 61 68 *See below
Science or Mathematics Authorizations Among Current Teachers through CSU Campuses 50 57 65 57
Mathematics and Science Teacher Production: Total Across CSU Campuses 1502 1507 1504 1516 1521

Data includes total CSU mathematics and science teacher credentials, authorizations, and specializations for grades K-12.

Tables 1 and 2 present data from 2002-03 through 2016-17 for new teachers prepared in mathematics and science. The figures 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.

*Authorizations are now included in campus figures.
Table 2: CSU Mathematics and Science Teacher Candidate Production by Campus: 2004-05 to 2016-17

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Math and Science Teachers Production: Total Across CSU Campuses

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Included in campus figures.