STEM Can Lead the Way:
RETHINKING TEACHER PREPARATION AND POLICY

A Synthesis of Interviews with 30 Experts in STEM Education and Teacher Preparation

BY TORY READ

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Dear Reader,

In fall 2013, two things will happen that will significantly change education: California and many other states will begin to implement Common Core State Standards (CCSS) in Math and English Language Arts, and decide if they will adopt the Next Generation Science Standards (NGSS). These new standards provide guidance on what students should know and be able to do in Science, Technology, Engineering and Mathematics (STEM) disciplines.

CCSS and NGSS will have a profound impact on everyone — students, teachers and the higher education faculty who train them. They require a major shift in what our teachers need to know and be able to do, and higher education faculty who are charged with preparing our teachers will need to play a major leadership role in this significant transformation.

As a result of these changes, state policymakers and institutions are re-examining key policies related to the recruitment, training, credentialing and professional development of teachers and school leaders in order to ensure that they are prepared to implement the new standards and the accompanying changes in curriculum and assessment.

The California STEM Learning Network (CSLNet), a non-profit organization dedicated to catalyzing innovation in STEM education, is taking a proactive role in supporting the transformation of teacher preparation policies and programs in California. As a first step, CSLNet commissioned this report to explore the state of teacher preparation in California. More than 30 experts across the field were interviewed. The report lays out their thoughts on the current state of teacher preparation in STEM subjects and beyond, and it recommends next steps to support the development of teachers and institutions that are capable of producing the STEM-literate graduates our society needs. We hope this report will be useful to stakeholders not only in California but also in other states that are undergoing similar efforts to rethink teacher preparation.

To do this work, we intend to convene a wide variety of partners and stakeholders — from K–12, higher education, business, industry, community organizations and philanthropy — and we will use this report to catalyze an ongoing dialogue to define and implement systemic reforms in teacher preparation through the lens of STEM.

Based on the contents of this report and a review of the documents referenced by the experts interviewed, we at CSLNet believe that in order to ensure teachers of STEM subjects are adequately prepared from their very first day on the job, new preparation and credentialing programs should:

- Be coherent, progressive and ongoing for every teacher from college through career,
- Rely on close and active partnerships between school districts and higher education institutions,
- Integrate substantial clinical practice experiences into coursework, and
- Revamp induction programs to include STEM subjects.

We know that preparing competent teachers is not the lone responsibility of institutions of higher education. In order to bring about a systemic transformation, it is essential to include our partners in STEM across all sectors. No single one of us has all the answers but together we can bring about the change that will ensure all California students are STEM capable when they walk out the doors of our high schools, colleges and universities and are prepared and equipped to be successful in our increasingly STEM-focused world.

Please contact us at administrator@cslnet.org and sign up for our newsletter at www.cslnet.org to stay informed of upcoming convenings and new developments in this work. We look forward to your participation in the dialogue and planning process.

Yours in STEM,

Chris Roe
EXECUTIVE SUMMARY

The research is clear. Great teachers make all the difference. Over the past 15 years, an expanding body of studies shows that teacher quality has more impact on student learning than any other factor controlled by schools. The question is, how do we produce and support great teachers? To begin to explore this query, California STEM Learning Network (CSLNet) commissioned interviews with 30 experts in STEM education and teacher preparation to hear their views on barriers, opportunities and promising practices. (STEM stands for science, technology, engineering and mathematics.) Although the interviews focused on teacher preparation and induction in STEM subjects for K-8 teachers, what the experts had to say often applied to teacher preparation and induction systems overall.

A synthesis of the interviews suggests that there is significant alignment between what the Common Core State Standards and Next Generation Science Standards require teachers to know and be able to do and what innovative STEM teacher preparation programs are already training teacher-candidates to accomplish. The new standards and the most promising STEM education programs all require teachers to use inquiry-based instructional approaches to teach students how to reason, design experiments, analyze evidence and justify solutions.

The synthesis also suggests that we look to these innovative STEM programs for evidence and lessons as we consider how to improve teacher preparation and on-the-job training for all K-12 teachers, not just teachers in STEM subjects. In addition, the paper lists promising practices from STEM teacher education programs and calls out 20 programs to watch. Finally, it outlines specific actions that various stakeholders can take to move toward a coherent system that builds and supports great teachers from college to career.

Promising Practices from STEM Teacher Education Programs

According to the experts interviewed — and corroborated by the literature on STEM teacher preparation — the most promising STEM teacher education programs share common characteristics. They:

- Are coherent and progressive and stay with the teacher from college through career, including induction and ongoing professional learning
- Rely on close and active partnerships between school districts and higher education institutions
- Combine content and pedagogy
- Integrate substantial clinical practice experiences into undergraduate and credential coursework
Provide teacher-candidates with research opportunities in the nation’s leading laboratories, STEM after school programs and STEM programs in informal science institutions.

Feature professors (in both content and pedagogy) collaborating with K-12 teachers to design programs and courses.

Retrain higher education faculty to use technology fluently in teaching and course management and to teach these uses to teacher-candidates.

Expand university reach via best-practice online learning programs.

Create programs to retrain laid-off teachers to teach in STEM subjects.

Revamp induction programs to include STEM subjects.

Staff induction programs with master teachers in math and science, giving them targeted training and releasing them part-time from classroom teaching so they can coach teachers across the district.

The most promising clinical practice experiences also share common attributes. They:

- Start early, during undergraduate coursework.
- Require higher education faculty to work directly with classroom teachers to co-plan clinical practice experiences.
- Provide special training to mentor teachers who oversee and co-teach with teacher-candidates.
- Occur in schools where principals and mentor teachers agree to allow teacher-candidates to practice what they are learning in their courses.
- Include reflective practice, in which teacher-candidates learn how to use available data to evaluate themselves and their peers.
- Train and deploy teacher-candidates in cohorts to enable peer-to-peer learning and create communities of practice that will continue beyond the clinical practice experience.

Recommendations from the Experts

A number of different things need to happen in order to train and support teachers in STEM subjects and bring the Common Core State Standards and the Next Generation Science Standards to life. According to the experts interviewed, all stakeholders need to own their roles in the problem, and they would do well to come together to craft a common vision, define their roles in the solution and make a plan for action.

While each stakeholder — including the California Commission on Teacher Credentialing (CCTC), higher education institutions, school districts and philanthropy — can take a range of steps to advance teacher preparation in STEM and all subjects, collaboration and coordination will maximize efficiency and impact.

What the CCTC Can Do

- Require all teacher preparation programs to have a strong partnership with at least one school district, by a certain date.
- Require that all teacher preparation programs adopt a clinical practice model, by a certain date. Clinical practice experiences should be well sequenced and well supervised.
- Lift restrictions on the separation of content coursework in the undergraduate years and pedagogical coursework in the fifth year to enable blended learning experiences for teacher-candidates. Identify and disseminate high-quality models of such blended learning programs.
- Create a continuum of training and professional learning that is linked to a ladder of credentials awarded as competency increases over time. Award and renew credentials based on demonstrated competencies.
- Beef up math and science content and pedagogy for all multi-subject credential candidates. All teachers should acquire basic math and science literacy, and they should understand and experience an inquiry-based approach to learning. The solution is not about adding more course requirements. What is taught in teacher preparation courses — and how it is taught — must change.
- Overhaul the BTSA induction program, and keep it simple. The BTSA program is working well in some districts, but overall it has become a repetitive, paperwork-heavy compliance experience for new teachers. Include math and science in
BTSA induction standards. Mine the STEM induction project in Long Beach for evidence of impact on student learning, lessons learned and best practices.

- Revisit the requirements for ELL-related coursework in light of the latest research on the benefits of integrating ELL with STEM, Common Core State Standards and Next Generation Science Standards.

- Because quality math instruction must begin in the early years, consider whether creating a P-3 credential with a strong early math component would address this issue.

- Ensure articulation and alignment in math and science courses between two- and four-year higher education institutions.

- Require school principals to demonstrate math and science literacy, as well as an understanding of child development and best practices in ELL instruction.

- Hold out-of-state teacher-candidates to similar standards to those required of California teacher-candidates. It is currently too easy for out-of-state teachers to get credentialed in California. Reciprocity with other states means that a credentialed teacher from out-of-state automatically gets a credential in California. Requirements for credentials vary dramatically from state to state, with some requiring as little as six weeks of coursework and others allowing teachers to get credentialed by passing an online multiple choice test.

- Tighten up accreditation standards and the criteria and procedures for accreditation renewal, in all routes to certification. Sanction and close teacher preparation programs that are not doing a good job.

- Keep things simple. Give teacher preparation entities flexibility to design and run their programs. In exchange, require that programs back up their decisions with data that demonstrate that what they are doing is working to improve student learning.

**What Higher Education Institutions Can Do**

- Convene math, science and education faculty to examine the Common Core State Standards and Next Generation Science Standards and discuss implications for teacher preparation. Use this process to build faculty leadership to transform teacher preparation, induction and ongoing professional learning programs. Faculty members control what happens in their courses, and they should be enlisted and empowered as leaders in this work. Use these conversations to jump-start a bigger conversation about changing teacher preparation overall so that it integrates content and pedagogy and includes in-depth clinical practice. Invite classroom teachers to participate.

- Consider ways to reward faculty for making changes.

- Collaborate with school districts and county offices of education to create a coherent, continuous and progressive system of teacher preparation, induction and ongoing professional learning.

- Collaborate with school districts and county offices of education to create principal preparation and training programs that include math and science literacy as well as child development knowledge and best practices in teaching ELLs, so they can create workplace conditions that support high-quality teaching in these areas.

- Have outstanding faculty — individuals who are expert in content and pedagogy — teach math and science courses for teacher-candidates, and ensure this role is highly valued within academic departments and in tenure and promotion.

- Retrain faculty to fluently incorporate technology into their teaching practice and to model the use of technology to teacher-candidates.

- Be savvy about forging strategic partnerships with businesses, cultural institutions, community organizations, nonprofits and government agencies so teacher preparation and induction programs can create best-practice clinical experiences for teacher-candidates in and out of school time.
What Districts Can Do

- Support teachers and principals in implementing the Common Core State Standards and the Next Generation Science Standards by providing high-quality professional learning opportunities and instructional materials.
- Collaborate with higher education institutions to design and implement teacher preparation and induction programs.
- Create district-wide policy and programs to support strong math and science programs, such as revamping staffing structures to accommodate mentor teachers, master teachers and math and science specialists.
- Increase the amount of time for science in the elementary grades. Find ways to teach math and language arts through science and provide teachers with related professional learning opportunities and instructional materials.
- Create space for teachers to work and learn in teams. Give teachers more time for planning, reflection and peer-to-peer learning.
- Allow students to use technology in the classroom, including smart phones and iPads, and secure in-service training for teachers to deploy technology in the service of learning.
- Require that elementary school principals know enough math and science to create a school culture that supports math and science teaching and learning.

What Philanthropy Can Do

- Commission experts to analyze funding streams and create a set of recommendations to re-allocate existing resources to revamped teacher preparation, induction and ongoing professional learning programs.
- Build the evidence base. Commission an in-depth review of the existing evidence. Commission evaluations and case studies and convene workshops to gather new evidence and analyze and share best practices from promising STEM teacher preparation, induction and ongoing professional learning programs.
- Fund multi-stakeholder convenings across the state to forge a common vision, build the movement and rally around implementation of the Common Core State Standards and Next Generation Science Standards. This will create the conditions for California to “hang tough” when the first assessment data come out in 2014.
- Support efforts to train current teachers to understand and communicate about the Common Core State Standards and Next Generation Science Standards and the new knowledge required to implement them.
- Provide support to higher education institutions to convene faculty to discuss implications of the Common Core and Next Generation Science Standards for their teacher preparation work, so they can revise what they teach and how they teach it.
- Support refinement, scale-up and spreading of STEM teacher preparation and induction programs that work to increase student learning.
- Support efforts to look at teacher quality and tie it back to teacher preparation, induction and professional learning programs, in order to create a cycle of continuous improvement based on data.
- Support the development of strategic communications and messaging about Common Core State Standards, Next Generation Science Standards and why we need to rethink teacher preparation for the 21st century, for a variety of target audiences.