Recruiting, Preparing, and Retaining High Quality Secondary Mathematics and Science Teachers for Urban Schools: The Cal Teach Experimental Program

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Introduction

Recruiting, preparing, and retaining high quality secondary mathematics and science teachers are three of the most critical problems in our nation's urban schools that serve a vast majority of children from socially and economically disadvantaged backgrounds (Council on Science and Technology and the Center for the Future of Teaching and Learning, 2007; EdSource, 2008; Rumberger, 1985). Although the factors contributing to these problems are complex, one area that has caught the attention of leaders of the teacher education community centers are the alternative pathways (or routes) through which teachers are trained and allowed into the profession (Hanushek, Kain, O'Brien, & Rivkin, 2005).

Many of these alternative pathways, teacher educators argue, aim to move teachers into teaching on a fast track and thereby short-change the necessary training that candidates need to have to become adequately prepared as classroom teachers (Darling-Hammond, 2006).

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To strengthen teacher preparation and keep teachers in the teaching profession, leaders of the teacher education community have advocated for teacher preparation programs (traditionally housed in a School of Education) to provide strong preparation during the pre-service period and to sustain support during the beginning teaching and induction years (Beck & Kosnik, 2001; Darling-Hammond; Darling-Hammond, Chung, & Frelow, 2002; Feiman-Nemser, 2001).

Despite efforts focusing on strong preparation and support, the teacher education community at large has been criticized for the teacher quality problems. Critics of traditional[1] teacher education have cited an array of problems, one of which is the low admission standards or weak recruitment of teacher candidates (Levine, 2006). In response, proponents of alternative routes such as Teach for America (TFA) have focused their effort on recruiting undergraduates from elite universities and providing these students with a fast-track opportunity into teaching through an intensive yet short period of pre-service training. Further, proponents of alternative routes argue that, in subject areas with a severe teacher shortage problem, such as secondary mathematics and science, there should be a deliberate effort to open up alternative channels so as to attract strong candidates (e.g., undergraduates who major in science, technology, engineering, and mathematics—STEM) into teaching (Rumberger, 1985).

An examination of the arguments on both sides (i.e., proponents and critics of traditional and alternative pathways of teacher education) suggests that each side has valid points. Attention to and quality control of recruitment and preparation of teacher candidates as well as creating mechanisms to help retain them in the teaching force are all important (Darling-Hammond, 2003; Ing & Loeb, 2008; Levine, 2006). Programs striving for strong recruitment, adequate preparation, and deliberate effort in teacher retention are needed for training teachers for secondary mathematics and science, especially teaching in urban schools that face perennial shortages, which is a national issue and an acute problem in California.

California faces persistent shortages of mathematics and science teachers (Center for the Future of Teaching and Learning, 2008). To respond to California's need to prepare and retain high quality secondary mathematics and science teachers, particularly for work in urban schools, we have proposed to the California Commission on Teacher Credentialing an experimental credential program based on emerging promising practices to be implemented Fall 2010 at the University of California, Berkeley.[2] This program, which we will refer to as Cal Teach, provides a unique and excellent opportunity for experimentation in alternative approaches to math and science secondary teaching credential programs.

We believe that the factors contributing to the problems of teacher recruitment, preparation, and retention are complex, and solutions to them are likely to require coordinated efforts from many sectors, including the teacher education/educator community, teaching profession, K-12 school system, and higher education community (Levin, 1985; Monk, 1994). We focus on what higher education institutions can do to address some of the problems inherent in the recruitment, preparation, and retention of high quality secondary mathematics and science teachers to work in urban schools. We anchor our discussions of challenges and promising solutions in these three areas through our Cal Teach experimental program.

In the sections that follow, we first describe the distinctive design of Cal Teach compared to the traditional pathway through which teachers are prepared. The design of Cal Teach provides a basis for our subsequent discussions. We then discuss challenging issues in recruiting strong candidates (i.e., STEM majors) into teaching and how Cal Teach addresses these challenges. We then focus on the preparation of candidates, highlighting what we perceive are some of the problematic aspects of traditional teaching education programs and describing how Cal Teach is modeled and designed to overcome these problems. Following this, we describe mechanisms through which Cal Teach attempts to help retain graduates in the teaching force. Through sharing the Cal Teach effort, we hope to provide some fruitful thoughts and spark further conversations among teacher education community members as a means to address the key issues of math and science teacher recruitment, preparation, and retention.

The Cal Teach Experimental Program Model

The essential components of Cal Teach are aligned with the most current thinking on the principles underlying excellent teacher education programs, including (a) strong recruitment with attention to diversity (EdSource, 2008; National Research Council, 2001; Zeichner, 2003); (b) a firm integration of content, pedagogy, and field placement training with an interdisciplinary approach that engages faculty from mathematics, sciences, engineering, and education (Feiman-Nemser, 2001; Labaree, 2006; Shulman, 1986; Taylor & Nolen, 1996); and (c) a painstaking effort of creating a professional community among various stakeholder groups who share responsibilities for education, support, and retention of our Cal Teach students (Cochran-Smith & Zeichner, 2005; Guarino, Santibañez, & Daley, 2006; Little, 2002).

The structure of the Cal Teach program, however, is organized differently from most existing teacher education programs. Traditionally, in California, as in many states, teacher education occurs in three separate and distinct parts: subject matter preparation, associated almost exclusively with the undergraduate major; a teacher training program, often in the form of a one-year credential program culminating in a student teaching experience; and an induction period during the first several years of teaching. Research has shown that teachers tend to return to the teaching methods that were used when they were K-12 students instead of applying the practices that they learned in their one-year teacher education program (Lortie, 1975). To address this lack of cohesion, Cal Teach turns the traditional model on its side, thereby integrating the three key components. The key element of this approach is the introduction of early and frequent field placements during which students work directly in urban classrooms from their earliest engagement with Cal Teach. This is shown schematically below in Figure 1.

The Cal Teach model covers the same time period, but the components are taught simultaneously and integrated into one program. In this way, students learn their content knowledge and pedagogy and have a variety of field experiences teaching in different classrooms throughout the program. Thus, all of the experiences inform, build on, and support each other. Because we have created an extended but integrated program, we expect Cal Teach graduates to sustain and practice the inquiry approach to teaching that they learn in our program. Additionally, our integrated program emphasizes job-embedding training, as graduates in their intern year will receive training while working full time as teachers of record.

This extended but integrated model is an appealing, practical alternative route in terms of attracting undergraduate sciences, mathemat-

Figure 1
Schematic representation of program model: Traditional vs. Cal Teach

<table>
<tr><th colspan="2">Traditional Teacher Education Program</th><th></th><th colspan="4">Cal Teach Integrated Program</th></tr>
<tr><td rowspan="4">Subject Matter Preparation</td><td rowspan="4">Undergraduate Major</td><td>Year 1</td><td rowspan="4">Undergraduate Major</td><td rowspan="7">Subject Matter Preparation</td><td rowspan="7">Teacher Education</td><td rowspan="7">Induction</td></tr>
<tr><td>Year 2</td></tr>
<tr><td>Year 3</td></tr>
<tr><td>Year 4</td></tr>
<tr><td>Teacher Education</td><td>Credential Program</td><td>Year 5</td><td>Credential Program</td></tr>
<tr><td rowspan="2">Induction</td><td rowspan="2">Teaching/BTSA</td><td>Year 6</td><td rowspan="2">Teaching/BTSA</td></tr>
<tr><td>Year 7</td></tr>
</table>

ics, and engineering majors into teaching[3] for the reasons that will be discussed in the following section.

Strong Recruitment with Attention to Diversity

Teachers' subject matter knowledge, signaled as having an undergraduate major (or completing coursework equivalent to an undergraduate academic major or passing a subject matter test) in the subject area that teachers teach, is one of the underpinnings of the *No Child Left Behind* (NCLB) requirement for highly qualified teachers (Darling-Hammond & Youngs, 2002). Teachers' subject matter knowledge is critical because teachers need to understand, beyond basic formulas and rules, a rich conceptual and connected knowledge of the subject they are to teach (Shulman, 1986). A growing body of research suggests that teachers' subject-matter knowledge is one of the most important elements of teacher quality and that students benefit most from teachers with a strong subject-matter background, particularly in the higher grades (Goldhaber & Brewer, 1997, 2000; Monk, 1994; Rowan, Chiang, & Miller, 1997).

Efforts to recruit candidates with strong subject matter knowledge into teaching face several challenges. First, STEM majors have a wide variety of career options, many of which come with much higher pay than a teaching job. Second, most non-teaching careers will provide STEM majors with immediate financial benefits upon graduating from 4-year colleges or universities, through earned salaries. In contrast, if these STEM majors were to pursue a teaching career, they would have to enroll in and complete a teacher training program, which generally means that they have to pay tuitions and fees, and many would have to take on additional debt to go through their teacher training program (Monk, 1994). From a financial perspective, therefore, these disincentives are potential barriers to making teaching an appealing career option for STEM majors. These financial barriers, to a great extent, are reflective of (or attributable to) the structural problems inherent in traditional teacher education programs. Structurally, traditional teacher education credentialing programs in California are disconnected from the undergraduate education. This disconnection puts traditional teacher education programs at a further disadvantage when recruiting STEM majors, as many potential STEM candidates are not made aware of teaching as a viable career option or do not have the opportunity to try teaching as an apprentice and thus choose other lucrative careers upon graduation.

To alleviate the above noted financial barriers caused in large part by the structural problem inherent in traditional teacher credentialing programs, Cal Teach is designed to make it easier for STEM majors to enter teaching by allowing them to study for their majors while being trained for teaching (Figure 1). In addition, recruitment efforts start when STEM students enter the university as freshmen or transfer students. This early intervention strategy helps to build awareness of teaching as a possible career option among undergraduate STEM majors. Finally, the design of the Cal Teach removes the financial barrier with respect to additional tuition and fees by allowing STEM students to study for their majors while being trained to become a teacher. Upon graduation, Cal Teach graduates work full time as teachers of record to earn a salary. To facilitate Cal Teach graduates' transition into teaching, Cal Teach currently has partnerships with six local school districts that regularly have a need for math and science teachers. Cal Teach staff work with our partner school districts and Cal Teach students to match students as interns or student teachers with appropriate classroom placements as well as to support the placement throughout the intern year with a teaching methods course and regular school site visits.

Our preliminary statistics have shown that Cal Teach has been successful at recruiting strong candidates. As shown in Figures 2 and 3, Cal Teach students are on par with other university students in terms of the SAT math test, and both groups (i.e., Cal Teach and other university students) have higher scores than the national average (Figure 2). In terms of average GPA, Cal Teach students are similar to students in the College of Letters and Sciences (where most of the STEM majors are housed) or to university students in general (Figure 3).

Figure 2
SAT Test, Math 2008

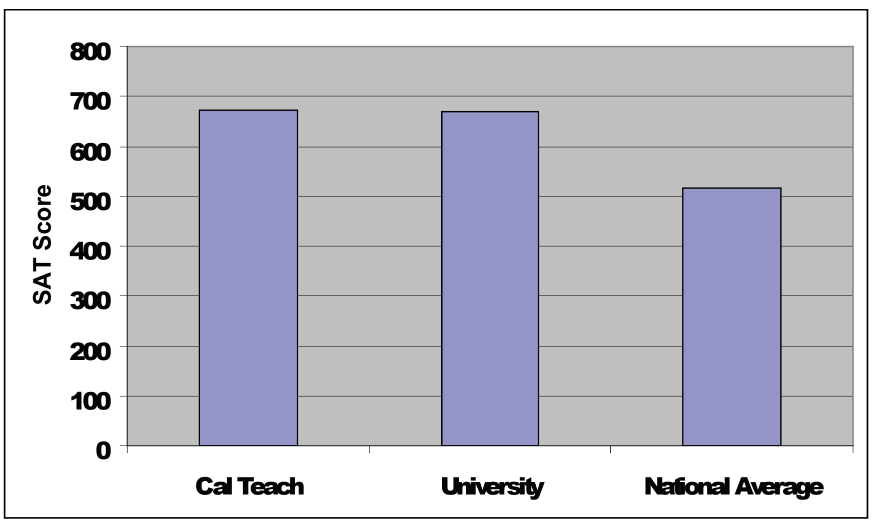
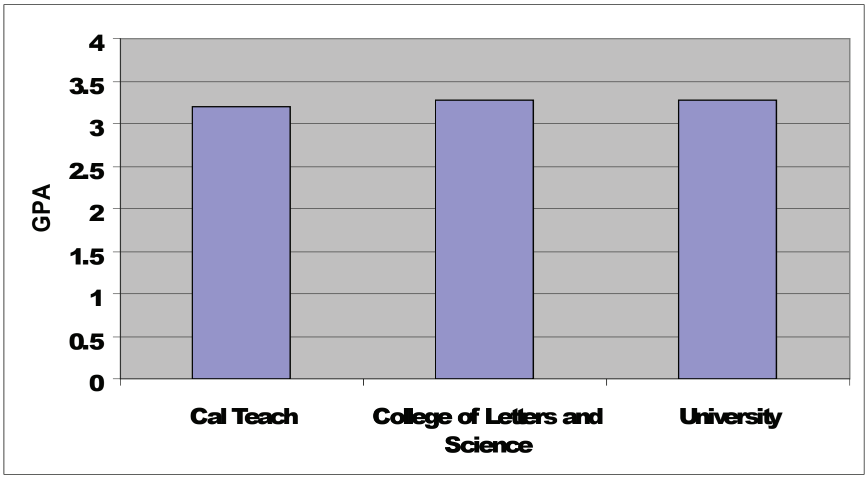


Figure 3
Average GPA, 2008



In addition to candidates' aptitude and academic background, we also attempt to attract diverse students into Cal Teach. One of the central tenets of Cal Teach is our commitment to equity in education for every student, promoting social justice through mathematics and science learning. Our students do their field placements predominately in the three local school districts near campus. Having field placements in urban schools allow Cal Teach students to see the need for quality mathematics and science teachers. As part of our field placement orientation, our Cal Teach students and mentor teachers look at issues of equity related access to college. One of the expectations of the field placement is for Cal Teach students to act as college-going role models for the K-12 students in the classroom.

Moreover, for an in-depth exploration of equity issues in mathematics and science, all Cal Teach students are required to take the course: *Teaching Mathematics and Science: A Focus on Equity and Urban Schools*. This course concerns the historical, economic, political, and legal foundations that frame many of the equity challenges in our public schools. It examines the opportunity and achievement gaps that separate urban youth from their peers in non-urban/suburban schools, especially in the subject areas of mathematics and science. It also examines current conditions and measures of equity. It concludes with a close-up view of schools that, despite the odds, are making a difference for students of color and students in poverty. The course also trains students to examine issues of curriculum, pedagogy, and assessment of student learning in mathematics and science and allows students to explore promising practices for their relevance and practicality in advancing equity-focused teaching and learning.

STEM students enrolled in Cal Teach courses tend to be more diverse than are the regular undergraduate STEM[4] majors on campus. As shown in Figure 4, we have higher percentages of African American, Hispanic, and other ethnic background students enrolled in Cal Teach courses than regular STEM majors. In addition, we have a higher percentage of female STEM students enrolled in the Cal Teach courses than regular STEM majors (Figure 5). We consider having more female STEM students who are interested in teaching as a positive thing because, at the high school level, we need more female role models as mathematics and science teachers. One point worth mentioning is that a significant portion of Cal Teach students are first-generation college students who are interested in giving back to their community.

While some might argue that we are pulling needed diversity out of future professionals in the STEM fields, this concern is not warranted from a cost-benefit perspective. In other words, a role model mathematics or science teacher could potentially inspire dozens, if not a hundred-plus, secondary students each year. These students, in turn, could pursue

Figure 4
Ethnicity distribution: Cal Teach vs. the University STEM

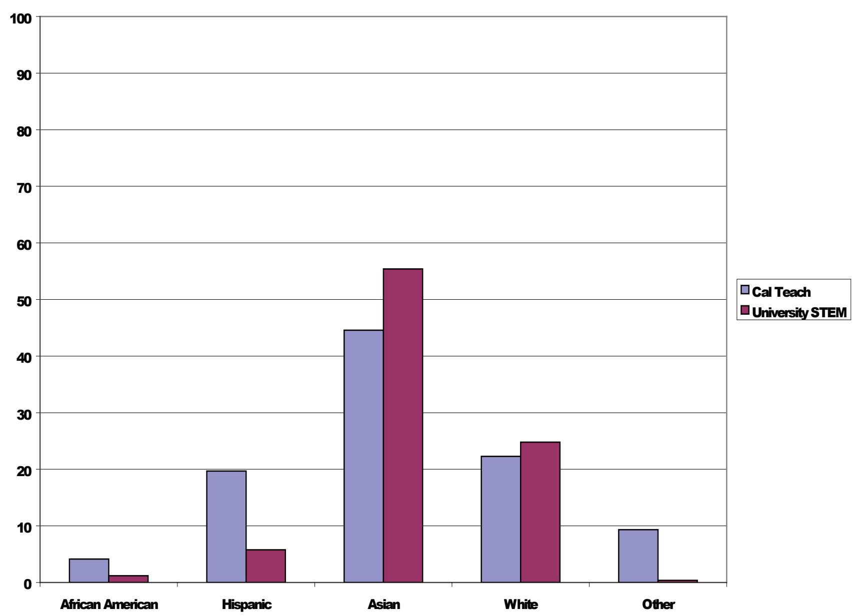
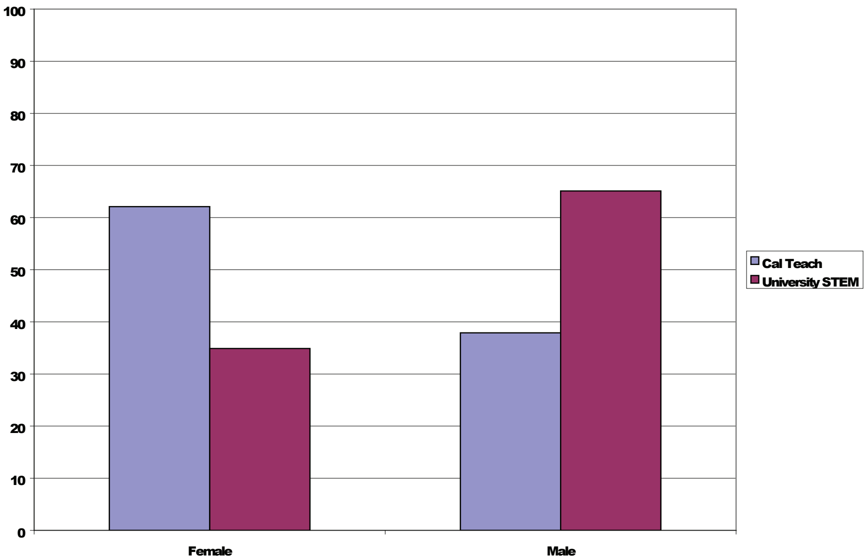


Figure 5
Gender distribution: Cal Teach vs. the University STEM



different STEM career pathways (e.g., future mathematics and science teachers, STEM professional). Therefore, attracting one high quality STEM undergraduate into teaching will benefit many more future STEM professionals through his or her teaching in K-12 classrooms.

Content, Pedagogy, and Field Placement Integration

The quality of the teacher is the most important factor within the control of K-12 schools that contributes directly to pupil learning and achievement (Darling-Hammond, 2003; Hanushek, 1992; Rockoff, 2003; Sanders, 1998; Sanders & Rivers, 1996; Wright, Horn, & Sanders, 1997). While what defines the quality of a teacher varies among researchers and teacher educators (Darling-Hammond & Youngs, 2002; Izumi & Ever, 2002), there has been growing agreement on the essential knowledge, skills, and attitudes that excellent teachers should possess (Darling-Hammond; Shulman, Hammeress, Grossman, & Frances, 2005). Knowledge essential to teaching includes subject matter knowledge, pedagogical knowledge, and pedagogical knowledge specific to subject matter, often referred to as pedagogical content knowledge (PCK) (Shulman, 1986). Coined by Shulman, PCK refers to the special kind of knowledge "essential to teaching that arises not from subject matter understanding alone, nor from pedagogy alone, but requires competence in both for its formation" (Carnegie Corporation of New York, 2001, p. 14).

One implication of PCK is that aspiring teachers need to develop a deep subject matter understanding along with exemplary pedagogical skills. Another closely associated implication is that higher education institutions committed to quality teacher education and preparation must engage faculty from the content areas as well as from education (e.g., Goodlad, 1990). This interdisciplinary approach to teacher preparation is most urgently needed in the context of preparing secondary math and science teachers for our nation's urban schools, where high quality teachers are severely lacking (Darling-Hammond, 2003; EdSource, 2008; Education Trust, 2006; Ingersoll, 2001; National Commission on Teaching and America's Future, 2003; Zeichner, 2003).

Despite the recognition of the importance of balancing content and pedagogy and the need for an interdisciplinary approach to teacher education, the structural design of standard teacher education pathways has an inherent weakness. This weakness lies in the distinct disconnection typically between the disciplinary content and pedagogy training of teacher candidates. The assumption embedded in such an approach is that teacher candidates obtain their training in content (i.e., signaled by obtaining a major or earning course credits in the disciplinary content) and then go through their training in pedagogy (e.g., obtain a degree in Education along with a preliminary teaching credential). This content and pedagogy separation runs against the PCK idea (Shulman, 1986) widely accepted among the teacher education community.

In contrast, the Cal Teach program is based on an underlying framework of integration between subject matter content, pedagogy, and field experiences. This integrated framework allows Cal Teach to provide undergraduate STEM majors with a sequence of pedagogy courses and field placements in urban classrooms to introduce them to classroom teaching and to develop their teaching skills, while simultaneously completing the requirements of their undergraduate STEM degrees. As shown in Figure 1, the main source of cohesion throughout Cal Teach is the integration of content knowledge development, pedagogical course work, and field placements. While gaining a deep appreciation of foundational principles, Cal Teach students are exposed to cutting-edge research and come to understand the underlying concepts and practices of their discipline areas and how to integrate their content knowledge with pedagogy.

Additionally, one of the key tenets of the program is that Cal Teach students must be science, mathematics, and engineering majors. Therefore, Cal Teach is necessarily a collaborative effort between the Cal Teach staff members who have extensive K-12 teaching experiences, the faculty in the science, mathematics, and engineering departments, and the faculty in the Graduate School of Education. The Cal Teach program was brought to UC Berkeley by a group of STEM faculty interested in preparing quality math and science teachers for Bay Area schools. The program director has a Ph.D. in chemistry and 10 years of teaching experience, so the Cal Teach program director is respected by and able to work with diverse stakeholder groups in developing the collaboration. From the very first semester, Cal Teach was a collaborative effort between STEM departments and the Graduate School of Education to work toward developing a teaching credential program.

In the beginning, the STEM faculty did not know very much about teaching or the teaching credential process and had very little interaction with faculty from the School of Education. Initially, there were meetings every other week to work toward developing a credential program, which was the foundation of the collaboration. We continually work at reinforcing these relationships, including instructor meetings every semester, an annual retreat, staff academic support in all courses taught by STEM and GSE faculty, team-teaching a number of our courses, teaching Cal Teach and graduate credentialing students together in our final capstone course, and collaborating on evaluation and research efforts, including weekly joint meetings. Figure 6 displays various stakeholder groups involved in the Cal Teach, whereas Figure 7 shows university colleges represented by the Cal Teach faculty and staff.

Figure 6
Stakeholders represented: Number of faculty members and staff

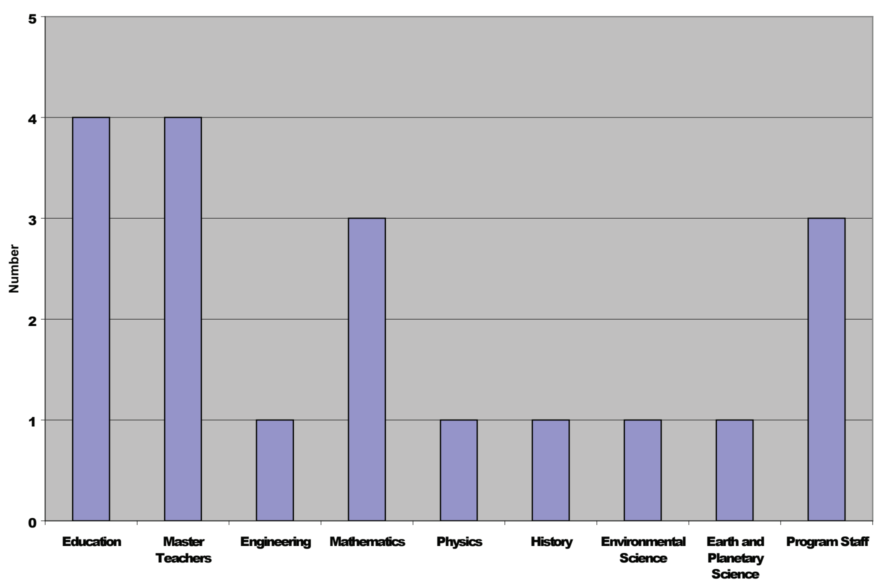
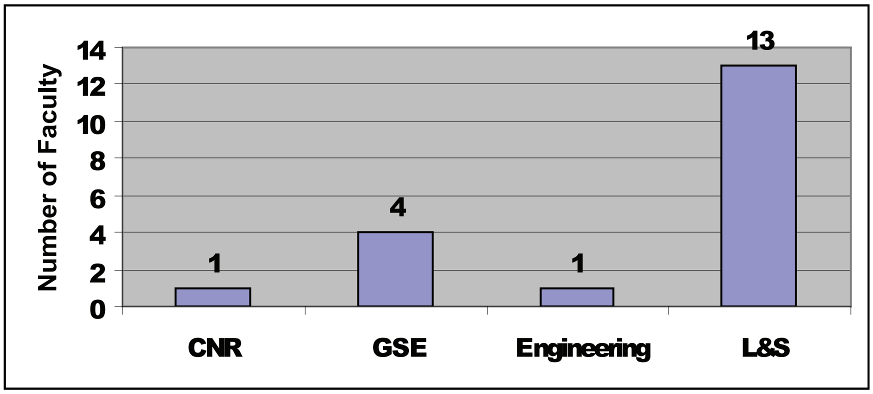


Figure 7
The university colleges represented: Number of faculty members and staff



Note. CNR—College of Natural Resources; GSE—Graduate School of Education; L&S—College of Letters and Science.

In addition to bringing together various stakeholder groups to share the responsibility for preparing teachers, the Cal Teach model of content, pedagogy, and field placement integration has the advantage of addressing several additional challenges inherent in teacher preparation. First, students in teacher education programs often perceive a disconnection between how their classes are taught and the practices that they are told that they should adopt in credentialing programs. For example, college professors tend to lecture predominately, while K-12 teaching standards strongly advocate for a variety of teaching strategies, including an inquiry approach to teaching. As a result, many of the teachers' prior conceptions about what teaching "should" look like are retained or made permanent (Adams & Krockover, 1997; Lortie, 1975).

To overcome this problem, Cal Teach infuses pedagogical content and other education classes with varied teaching styles, cultural literacy, hands-on experiences, inquiry-based and technology-driven lessons, cooperative learning, active learning, and virtual field experiences (Ross & Weidner, 2002). This infusion benefits undergraduates in that they see a model of innovative teaching techniques and gain a deeper first-hand understanding of teaching and the practices that they may implement themselves.

Further, typical programs of teacher education are, in general, criticized for not being designed to promote complex learning (Feiman-Nemser, 2001). Most pre-service students enter the program with strong views about what teaching is supposed to be based on an "apprenticeship of observation," which is the learning that takes place by virtue of being a student for at least 12 years in classrooms (Lortie, 1975). The lack of coherence in a teacher education curriculum in which separate courses are rarely built on or connected to one another does little to change these preconceptions about teaching.

Cal Teach addresses this issue by providing pre-service teachers with the opportunity to make their preconceptions about teaching explicit through ongoing self-reflections and talking about them regularly as they progress through the program. Because our students take course work in their majors, along with the Cal Teach courses that focus on pedagogy, they have the opportunity to reflect on their own learning and the teaching practices used in their discipline. Further, the newly launched Cal Teach research method course, *Integrating Research Methods into K-12 Teaching in Mathematics and Science*, is designed to provide connections between research methods and science and math content, learned during a summer internship sponsored by Cal Teach in a research lab with teaching in the K-12 classroom. Students write research proposals, create posters demonstrating their research accomplishments, develop K-12 lesson plans that align with their research, and assemble digital portfolios on standards-based teaching and assessment.

Finally, the pedagogical approach that teacher educators use also has been problematic because teaching is often taught theoretically and disconnected from the context of practice (Taylor & Nolen, 1996). The assumption is that pre-service teachers first learn theory in university coursework and then apply the theory to practice during their fieldwork in K-12 schools (Wideen, Mayer-Smith, & Moon, 1998). Although student teaching is viewed as a venue to bridge theory and practice, as well as pedagogy and content, this process of integration is often left to the individual efforts of pre-service teachers (Taylor & Nolen). These disconnections between theory and practice on the one hand, and between pedagogy and content on the other, often create conflicting goals and contradictory visions about what good teaching should look like.

By contrast, Cal Teach works to integrate theory and practice as well as content and pedagogy, through the early and continuous field placement of pre-service teachers in classrooms with mentor teachers, so that learning is grounded in the context of real classrooms. Cal Teach undergraduates participate in early and extensive field placements in urban schools throughout the program and enter their student teaching or intern credential year with well over 100 hours of experience in schools. All of the field experiences are conducted in conjunction with Cal Teach coursework and require journals in which Cal Teach students document their experiences and reflect on what they are learning in their courses on campus and how they relate to what is happening in their field placement classroom. Additionally, Cal Teach students are given the opportunity to reflect on their own learning experiences in their K-12 education as well as their college education. In this way, Cal Teach is committed to ensuring that there is a sense of continuity within the different elements that compose the program. This continuity ties together the various faculty members, instructors, staff, Cal Teach students, and mentor teachers as well as the curriculum within the courses.

In summary, by integrating content knowledge development, pedagogical course work, and field placements throughout the program, Cal Teach brings together STEM faculty, Education faculty, and K-12 professional educators in the training of future teachers. This integration addresses some of the problems that traditional teacher education programs face due to the separation of undergraduate and graduate education on the one hand, and graduate education and field placement on the other.

Mechanism for Retention: Creating Professional Community

Some researchers argue that the shortage of high quality teachers in poor urban schools is not a supply problem but a retention problem (EdSource, 2008; Guarino et al., 2006). Although higher education institutions alone cannot solve the retention problem, they can improve it through mechanisms such as (a) providing early and extensive opportunities for teacher candidates to work in urban classrooms (Colbert & Wolff, 1992; Irvine & Collison, 1999; Schultz, Jones-Walker, & Chikkatur, 2008; Settlage, 2004); (b) continuing the strong support for graduates of the program during the critical beginning and induction years (Cochran-Smith & Zeichner, 2005; Feiman-Nemser, 2001; Howey, 1996); and (c) building an extensive network of professional communities among teacher candidates, between teacher candidates and graduates of the program, and between higher education institutions and K-12 teachers, schools, and school districts (Beck & Kosnik, 2001; Little, 2002).

A sense of community is often cited as an instrumental part of achieving success in the classroom (Peterson, 1992; Shulman & Sherin, 2004; Shulman & Shulman, 2004). Moreover, research on teacher resiliency frequently cites lack of support from one's peers and community as a barrier against continuing to teach in the field (Schlichte, Yssel, & Merbler, 2005). Community can take shape in a variety of forms, including collegial relationships, administrative support, and access to shared resources. Recognizing this persistent issue within teacher education, Cal Teach addresses this concern through creating community in each individual course across the whole program and with our alumni to provide Cal Teach students and teachers with the resources that they need to have a successful teaching experience.

To build community throughout the courses and the program, Cal Teach encourages instructors to use community building strategies to get to know their students and for their students to get to know each other. Once a semester, all of the Cal Teach instructors get together to discuss how the courses went during the previous semester and to plan for the courses for the upcoming semester. Cal Teach strengthens this instructor community through an off-campus retreat followed by ongoing regular meetings whereby instructors can share best practices and learn from each other. Cal Teach students are invited to actively participate in the retreat and are thus an integral part of the overall Cal Teach professional learning community.

Cal Teach has also established a new Teacher Resource Center that serves as the main hub for community building activities. The center houses classroom materials such as textbooks, kits, and hands-on manipulatives to promote inquiry in classrooms. In addition to classroom materials and shared meeting space, the resource center also provides relevant information focusing on the profession of teaching, such as a list of employment opportunities, teaching scholarships, guidance on how to apply for membership to professional teacher organizations, and programs leading towards obtaining teaching credentials or a master's in education. Student teachers have access to a number of advisers with experience in the educational field so that they may have the opportunity to receive advice about their teaching experiences, career trajectory, and recommendations for the periodic lessons that they are responsible for designing and implementing in their field placement classrooms. The purpose of this availability of information is for student teachers to view the resource center as a positive and supportive influence towards their development into a professional teacher.

Cal Teach views the Teaching Resource Center as an ongoing development that will continually attract pre-service teachers as well as in-service teachers during their professional experiences. The variety of resources that the center will offer will cater towards both audiences and will serve as an element of continuity for Cal Teach.

Summary and Discussion

We have discussed some of the challenges inherent in the recruitment, preparation, and retention of high quality secondary mathematics and science teachers to work in urban schools. We shared the Cal Teach effort aimed at addressing these challenges, and we acknowledged that, while it is widely agreed that teacher recruitment, preparation, and retention are severe problems that our nation's urban schools face

(Ingersoll, 2001; Levin, 1985; Zeichner, 2003), proposed solutions to these problems are often debated. For instance, teacher educators advocate for providing strong training during the pre-service stage and for sustaining support during the beginning teaching and induction years (Darling-Hammond & Bransford, 2005; Feiman-Nemser, 2001; Howey, 1996; Loucks-Horsley & Matsumoto, 1999; Shulman & Sherin, 2004). Critics argue, in contrast, that strong recruitment is important because low admission standards or weak recruitment of teacher candidates is one of the problems of teacher education (Levine, 2006).

We adopted a middle ground and designed the Cal Teach program according to the most current thinking on the principles underlying excellent teacher education programs, including (a) strong recruitment with attention to diversity; (b) a firm integration of content, pedagogy, and field placement training with an interdisciplinary approach that engages faculty from mathematics, sciences, engineering, and education; and (c) a painstaking effort to create a professional community among various stakeholder groups who share responsibilities for educating, supporting, and retaining our Cal Teach students.

These design principles reflect the deliberate effort of the Cal Teach program to address several issues inherent in recruiting, preparing, and retaining mathematics and science teachers and have implications for other teacher education programs that aim to achieve similar goals. With respect to recruitment, our program design highlights the importance of early advertisement informing undergraduate STEM majors to consider teaching as a viable career pathway and early exposure by providing them with opportunities to work in urban classrooms. In terms of preparation (i.e., pre-service training), our program emphasizes the simultaneous education of prospective teachers both in their mathematics and science majors and in education courses, and the opportunities to integrate university course work with classroom apprenticeship teaching through ongoing field placement. All this implies that teacher education is a shared responsibility among various academic departments of the higher education institutions on the one hand, and between the higher education institutions and K-12 school systems on the other hand. The more deliberate we are in working toward this collaborative effort, the better the service that we will be able to provide to prospective teachers. This call for shared responsibility in teacher education has been advocated by various education scholars (e.g., Goodlad, 1990). Our effort at creating a professional community among various stakeholder groups provides an example for higher education institutions committed to high quality teacher education.

While we strive hard for integrating these ideas into a cohesive program, we do not underestimate the amount of time and work that lie ahead of us. This is our first attempt to share the Cal Teach effort, through which we hope to spark further conversations among teacher education community members about how we can work together to address the critical issues of teacher quality and retention. As the program progresses, we look forward to sharing the triumphs and struggles of Cal Teach.

Notes

[1] What we mean by "traditional" encompass a wide array of teacher education programs. Following the literature, we use terms such as alternative and traditional, but these terms are not necessarily clear-cut or straightforward. For a thorough discussion, see Cochran-Smith and Zeichner (2005), Grossman and Loeb (2008), and Zeichner and Hutchinson (2008).

[2] The Cal Teach program described in this paper is not the same as the CSU online teacher credential program (i.e., CalState Teach).

[3] U Teach program at University of Texas, Austin is another alternative route program that encourages undergraduate STEM majors to consider teaching as a possible career choice while they study for their majors.

[4] Statistics on the University STEM majors focused on the 2007-08 year and included undergraduates from four colleges: College of Chemistry, College of Engineering, College of Biological Sciences, and College of Mathematical and Physical Sciences. We focused on these four colleges because the Cal Teach candidates come mainly from these fields.

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