

A university approach to addressing the STEM teaching shortage

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The challenge of recruiting and retaining highly-qualified science and mathematics teachers is intensifying today, particularly in high needs schools (Allen, 2005; National Academy, 2010). As the number of careers demanding a strong background in science, technology, engineering and mathematics (STEM) continues to climb, the number of individuals *steering away* from a career in mathematics and science teaching is increasing (Watt, Richardson, and Pietsch, 2007). The increased demand for school administrators to find high quality STEM teachers capable of engendering the interest and passion in high school students for majoring in STEM fields and pursuing careers in STEM-related occupations has never been higher than now (National Research Council, 2011; Zavadsky & Garbee, 2012).

Chronic teacher attrition and turnover in high need schools have negative consequences for students and teachers alike (Spradlin & Prendergast, 2006). In one Texas study, researchers estimated the annual cost of continually hiring and supporting new teachers was between \$329 million and \$2.1 billion (Texas Center for Educational Research, 2000). Darling-Hammond and Sykes (2003) concluded that the billions of dollars saved in schools by reducing new teacher departure would be sufficient to sustain new programs in schools and improve the stability and performance of the organization.

Strategies that work

Morgan and Kristonis (2008) recommended a proactive approach for recruiting teachers in hard-to-staff schools. They suggested university-school district partnerships offer job shadowing, field placements in high need schools, and teacher recruitment on college campuses while students are considering their career paths. In a national study on beginning teacher turnover and induction, Smith and Ingersoll (2004) concluded the most useful induction activities for reducing turnover included support in learning how to teach content, having a mentor in the content field, deepening teacher knowledge through professional learning communities, fostering a culture of collaboration, and developing extended networks beyond schools that support teacher development. With these findings and strategies in mind, the Talented Teachers in Training for Texas program was born.

Talented Teachers in Training for Texas (T4) (NSF 1136416), a Robert Noyce Scholarship program funded by the National Science Foundation, was conceptualized to offer attractive *experiences* from which university STEM majors can consider a career in high school teaching, to target aspiring teachers for *authentic engagement* into the STEM teaching community, and to document successful and replicable STEM recruitment and retention practices for use by university-school partnerships on a larger scale. The programs described here are intended to be replicable with little external funding.

Advertising Programs with an Eye to Raising STEM Teaching Awareness

The T4 recruiting effort was intended to raise awareness among a broad student population about careers and opportunities in STEM teaching. Our advertising centered around three *experiences*: a STEM Master Teacher Job Shadow Program, a STEM Day Event, and a NASA Aerospace Teachers Program. In 2009-2010, only 5% of the 72,073 bachelor's degrees awarded by 617 reporting American Association of Colleges for Teacher Education member institutions were in the fields of mathematics and statistics (AACTE, 2013). Cognizant that students in these majors were not being exposed to activities that would help them to intelligently consider STEM teaching as a career choice, we visited 20 science and mathematics college classrooms in the first year of T4 to explain these experiences and speak about the value of a career in teaching. We expanded to 33 visits in year two. Most significantly, half of the people making classroom visits after year one were not grant personnel. We were able to

incorporate university students who had participated in the programs and university faculty and staff who had worked as high school teachers before moving to higher education. Personal contacts with faculty advisors, printed fliers, and video testimonials on our website are also elements of our advertising strategy. Finally, we distributed our recruiting materials electronically to (nearly) all past participants and expecting this distribution network to grow over time. When speaking with applicants after the first year, the majority had heard about the T4 programs from someone who had previously participated in them. Over 100 students became involved in these programs over the first two years alone, and many more have heard about the T4 programs and the possibility of a career in STEM teaching.

Experience 1: STEM Teacher Job Shadow

The STEM Master Teacher Job Shadow was created to allow prospective teachers, called T4 recruits, a realistic window into the STEM teaching profession and at the same time develop an authentic working relationship with an accomplished science or mathematics teacher. The program consists of placing T4 recruits with Master Science or Mathematics Teachers, a large group meeting for orientation the week before the shadow, a full forty-hour week of working with the Master Teacher, and a half-day debriefing with T4 recruits and master teachers afterward. The actual shadowing is scheduled after the university's spring semester but while high schools are still in session. Access to such a high quality pool of master teachers is a direct result of three previous projects at our university: a Robert Noyce Master Teaching Fellows program (NSF0934878), a Math Science Partnership cohort of teacher leaders (NSF0227128) – both funded by the National Science Foundation, and a state-funded Math, Science & Technology Teacher Preparation Academy (P16EQ-MST2-08-1) for high school teachers. These programs provide a network of excellent teachers for the job shadow. Over time, we have expanded our pool of model teachers by asking teachers we believed to be excellent for recommendations. Our experience is that networks of teachers are developed over time by seeking opportunities to support teachers in the field and sustaining professional connections once contact is made.

Prior to the shadow, we provide time for Master Teachers and the T4 Recruits to become acquainted and for Master Teachers to clarify their professional expectations for the week (dress code, parking, office check-in, etc). Additionally, Master Teachers are engaged in discussion as a group about approaches to authentically include T4 recruits in the teaching enterprise. Finally, we review our Master Teachers' interaction with T4 recruits after each job shadow to ensure we are offering prospective teachers the most outstanding experience possible.

During the job shadow experience, T4 Recruits complete reflection journals each day. Along with assisting students in critically evaluating the profession and their own strengths and weaknesses relative to teaching, these journals allow us to capture a wealth of perspectives that might otherwise have been unknown to us. After the experience, Erica, a T4 recruit participating in the job shadow, wrote "I am now, more than ever, inspired to teach and pursue this career. I saw things (abilities and creativity) in myself that I didn't see before." (All participant names are pseudonyms.)

An unexpected benefit was that the Master Teachers found the job shadow tremendously encouraging. The Master Teachers appeared to prefer the job shadow's teaching exposure to traditional observations. "They got five day's work... they got to see the reality of it. Not just 'this hour' every single day," Joe explained. Nearly all Master Teachers indicated an eagerness to be included for participation in future events and incorporate other Master Teachers' ideas in the future.

Initially, both Master Teachers and T4 recruits were compensated by the grant via a one-time \$450 stipend. However, in the second year some participated with no compensation and described the experience as outstanding. At the debriefing following the second year, 100% of Master Teachers indicated a willingness to participate in the program again even after funding ended. Establishing a network of committed practicing Master Teachers is vital to the success of our program.

Experience 2: STEM Day for High School Students

STEM Days events are a day focused on the careers and opportunities which exist in Science, Technology, Engineering and Mathematics. Faculty at our university had discussed holding a high school STEM Day for years, but the T4 project catalyzed the event to *actually happen*. Whether it be internal or external, we recommend writing a grant as a way to articulate vision and put a deadline on getting a STEM Day in place. In the end, T4 funding paid for about a third of the costs (\$3000) related to STEM Day, but more importantly it served as an incubator. The vision was to bring in hundreds of local high school students to our university to do exploratory activities and hear speakers from a variety of STEM fields. Although recruiting future STEM majors is an endeavor any university administrator would value, the T4 project's approach was to utilize the event to expose university STEM students to the possibility of a career in high school teaching at the same time as exposing high school students to STEM disciplines.

Our university's first STEM Day consisted of 12 school districts, 243 students, and 34 teachers. Additionally, about a dozen attendees from community colleges and educational support centers visited to investigate the model. Following the experience, 81% of high school students indicated that their *interest in STEM* had increased and 96% indicating their *knowledge about STEM careers* had increased. Unfortunately, our success appeared to be meager among the university students involved in STEM Day as guides and co-presenters. We included over 80 college students in STEM Day but many participated for as little as 5-10 minutes. In the follow-up survey, 96% indicated that their interest in high school teaching had not changed, and 52% of the university students involved were either seniors or graduate students – not prime targets to change career plans.

For the second annual STEM Day, the number of university students participating was reduced to 55 students with more clearly defined roles and more sustained activities. Guides were assigned to a single cohort of students throughout the morning activities, acting as leaders and mentors. This proved to have a significant impact on our teacher recruiting efforts. Only 4% of university student participants report increased interest in high school teaching the first year, while 42% indicated their interest had increased the second year. This increase coincided with an overall increase in attendance (266 high school students) and high school student interest levels remained strong.

Hosting a STEM Day is helpful as a public relations move for your university, an opportunity to collaborate with colleagues across the sciences, a recruiting tool for STEM majors, *and* an experience for STEM majors to consider high school teaching without ever leaving the university.

Experience 3: NASA Aerospace Teachers Program

One of the greatest successes of the T4 program is a dynamic partnership established between the program and NASA. NASA's High School Aerospace Scholars (HAS), a twelve-year-old outreach program, identifies talented high school students from across Texas, trains them remotely during the school year, then facilitates a week of team collaboration on STEM challenges at NASA's Clear Lake facility. Each team is assigned a certified classroom teacher, a NASA professional, and has access to a wide variety of other NASA personnel. T4 partnered with HAS by providing and funding college students to work as junior teachers alongside existing certified teachers.

Thus far, 23 T4 junior teachers from our university and partner junior college have participated. The experience affirmed some junior teachers' interest in teaching and pushed others to seriously consider the teaching profession. Aleisha raved that it opened her eyes to the bonds that teachers and students develop. Afterward Carol wrote, "Before I started the HAS program, I already knew I did not want to teach, but having such a great group of kids has confused me." Overall, roughly 60% of junior teachers reported in exit interviews either that their interest in teaching had increased or their previous commitment to teach had solidified.

After the initial year, we established clearer expectations for T4 junior teachers going into the program about what they would be doing by adding a pre-experience orientation and pre-experience

training with a faculty mentor. In the first year, we had several performance issues with junior teachers, but clarifying expectations and providing pre-experience relationship building improved performance. Each week that T4 junior teachers are at NASA, a college faculty mentor also attends the entire week to support those junior teachers and to help them process the possibility of teaching. These mentors now have extensive contact with the junior teachers they will be working with before they travel to NASA.

The Authentic Engagement Cohort Structure

Although T4 recruiting and awareness programs proved successful, the program's largest expenditures in both time and financial resources are focused on building an authentic community of STEM educators, called T4 Scholars, a group committed to teach science or mathematics in a high needs school in exchange for mentoring and scholarships. T4 Scholars commit to four years of STEM teaching in a high needs district in exchange for a \$30,000 scholarship, pre-service mentoring and 3 years of in-service induction mentoring and support once in the classroom. (Scholars can opt to only receive \$15,000 and only commit to 2 years of teaching, but none have.) Once in the program, these students meet with university faculty and teaching mentors biweekly to discuss aspects of teaching, examine content and explore challenges for new teachers, meet with practitioners from the field (both novice and experienced), and most of all develop a supportive, sustained academic community. Regular classroom observation and reflection is an integral part of the program, as are local, regional, and national conferences. (These conference attendances are also funded through T4.)

Demographically, of the 15 T4 Scholars, 53% are first generation college students, 46% have demonstrated financial need, 13% are ethnic minorities, 67% began at community college, 67% did not originally plan to teach, 40% are male and their average GPA is 3.4.

Typical teacher preparation programs provide a variety of mentoring (by an advisor, a student teaching mentor, etc.) but often these mentors do not communicate or even know each other. Similarly, school district administrators routinely assign mentors to new faculty, but these mentors (and their commitment level) can fluctuate and will terminate should the teacher change districts. Our mentorship is different. It begins at least four semesters before a future teacher graduates college; the same mentor follows the T4 cohort through teaching internship, student teaching, and in-service teaching. Even if the teacher changes districts in the second or third year, the mentor will not change which allows for a more authentic, sustained community of practice in which self-reflection, collaboration, and stronger confidence in one's teaching ability can flourish.

Predictably, this sustained academic community centered on a shared vocational interest has developed into a "family" as our T4 Scholars call themselves. In addition to biweekly meetings, online discussion, and travels to conferences and events, T4 Scholars began requesting opportunities to spend time together socially as well – bowling, dinner, a camping trip. Gathered in a coffee shop with 13 other prospective teachers, Carl captured it aptly: "I don't have anyone else in my life who I can talk to on [this] level – You all understand my passion."

Although formally unrelated to the T4 program, four T4 Scholars have recently begun a student organization called Passion Driven Teachers which targets college students considering STEM teaching. One of their stated goals is to share the STEM teaching community they experience with those outside the T4 program. By their second meeting, they had 30 attendees – predominantly individuals unassociated with T4. For gifted young academics lacking support systems who want to make a great contribution with their lives, our program has turned out to be a special haven.

Replication

As of September 2010, there were 935 active TEACH Grant institutions nationally (H. Myers-Wright, personal communication, September 30, 2013). Students at these institutions are already contractually obligated to teach, and our universities already have the students' information. We believe that there is tremendous national potential for successful integration of scholarship, teacher observation, and reflection into the pre-service teaching community using TEACH grants and similar funding sources.

What has been lacking is a cohesive network tying these aspiring teachers into the STEM teaching community. As an example, at our university 160 students received the TEACH Grant in the 2011-2012 school year (obligating them to teach), but since the inception of the TEACH grant, no one has made an effort to put all these students in touch with each other. The onus is on university faculty to harness the passion that those committed to teaching already have and introduce them to an authentic teaching community.

Replicating our university's teaching experience opportunities is also a tractable task: STEM Day is an excellent university endeavor that also serves recruiting. A job shadow simply requires sustained coordination with a cohort of highly qualified classroom teachers – relationships that will serve the university in a variety of projects. Finally, finding an existing experiential high school science program and offering additional adult supervisory support serves both university purposes and secondary programmatic needs.

Conclusion

The 2010 executive report by the President's Council of Advisors on Science and Technology recommended that our nation "recruit and train 100,000 great STEM teachers over the next decade who are able to prepare and inspire students" (page 12). The T4 program is one replicable model for accomplishing this task, increasing interest in STEM and in STEM teaching through the introduction of STEM Day for High School Students, our Master Teacher Job Shadow, NASA Aerospace Teacher Program, and the T4 Scholar Program. The most essential ingredient, however, is simply to start somewhere.

What strengths does your institution have that will support the effort? Ours was the cache of Master Teachers who were waiting for us to include them in the process. They now play a role in nearly all of the T4 recruiting and retention efforts. We foresee a day when our T4 scholars are members of our list of Master Teachers. Once you identify your niche, you too will be amazed at the students and Master Teachers who are awaiting your invitation to become a part of a vibrant and passionate STEM teaching community.

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