How might we ensure teachers enter the classroom well-prepared to teach STEM?

MANY TEACHER PROGRAMS HAVE LOW ADMISSION STANDARDS, ARE RELUCTANT TO CHANGE, AND DO NOT TRACK THE QUALITY OF THEIR GRADUATES

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01 CONTEXT AND TRENDS

Among the most prominent issues facing education improvement in the United States is the level of teacher quality in the classroom. Studies show that teacher quality is directly linked to student academic success (Greenwald, Hedges, & Laine, 1996; Cochran-Smith & Zeichner, 2009; Engler, 2012; Science Pioneers, 2010).

Teacher preparation programs are the primary factor influencing the quality of beginning teachers (Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2009; Hill, Rowan, & Ball, 2005). Regrettably, teacher preparation programs have not been entirely successful in preparing high-quality teachers at a large scale, particularly STEM teachers. Former U.S. Education Secretary Arne Duncan states, "It has long been clear that as a nation, we could do a far better job of preparing teachers for the classroom ... New teachers want to do a great job for their kids, but often, they struggle at the beginning of their careers and have to figure out too much for themselves" (U.S. Department of Education, 2014, para. 3).

02 DISCUSSION

The rigor (or lack thereof) of teacher preparation programs can be attributed to some key features that are characteristic of many preservice institutions. Historically, a large portion of these institutions have low barriers to entry, use dated educational techniques, and do not present a clear or uniform methodology for ensuring student teacher quality upon exiting the program (Greenberg, McKee, & Walsh, 2013; Almy, Tooley, & Hall, 2013; Freeman et al., 2014; Coggshall, Bivona, & Reschly, 2012). While many of these difficulties apply to teacher preparation programs generally, the consequences may be exacerbated with respect to ensuring the excellence of new STEM teachers by the rapidly growing importance of developing a foundational core of STEM skills among our future generations.

Preparation programs' low barriers to entry are apparent in the National Council of Teacher Quality's (NCTQ) 2013 Teacher Preparation Review. In an assessment of teacher preparation program selectivity, NCTQ finds that in 2013, only 36 percent of undergraduate programs and 7 percent of graduate programs targeted their student teachers from the top performing half of the college-going population, as measured by standardized testing and GPA admission requirements. These data indicate that teacher preparation programs are drawing a significant portion of their incoming classes from the bottom half of the college-going population, perhaps owing to the low or nonexistent bounds on admissions standards. This may be problematic, given that some research has shown that preparation programs that enroll students who attended more selective prior institutions or who have higher SAT scores and higher undergraduate GPAs are more likely to become effective teachers, as measured by their effect on student achievement (Boyd, 2008; Chingos & Peterson, 2010; Goldhaber, 2007).

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Furthermore, this type of approach to admissions results in a wide range of academic backgrounds and preparation among student teacher populations in preparation programs. Given the varying academic abilities and needs of student teachers, preservice programs may be challenged with differentiating program offerings and content supports to sufficiently prepare student teachers to be effective classroom leaders as they enter the profession (Greenberg et al., 2013).

The pedagogical methodologies used in most teacher preparation may be partially to blame as well. The overwhelming majority of college courses are taught by lecturing, despite overwhelming evidence that active learning increases student performance when compared to traditional lecturing. In a meta-analysis involving 225 previous studies comparing student outcomes in STEM courses that used lectures versus active learning strategies, students in active learning classrooms were found to score an average of 6 percent better on examinations than students who attended lecture-based classrooms. Furthermore, lectured students were 1.5 times more likely to fail the course than their peers in active learning classrooms (Freeman et al., 2014). Beyond their own performance as students, when teaching their own classes, student teachers who are being taught using active learning strategies are likely to draw on how they were taught, thereby helping encourage the more widespread implementation of these more effective active learning techniques.

Compounding the challenges associated with relative nonselectivity in admissions policies and the predominantly lecture-focused approach used among faculty, the rigor of the accountability and oversight methods to which teacher preparation programs are subject has been questioned. The three primary methods for regulating and affirming the quality of preparation programs are: (1) program approval by panels of educators across the state; (2) program accreditation from a nongovernmental agency, such as the National Council for the Accreditation of Teacher Education (NCATE), or the Teacher Education Accreditation Council (TEAC); and (3) evidence of program graduates meeting state teacher certification requirements via state tests of basic skills, subject area degrees, and domain knowledge. Research suggests that these accountability mechanisms are largely insufficient and do little to accurately measure the extent to which a program is doing a good job of producing high-quality teachers who are ready to enter the classroom. For example, one study found that these mechanisms "vary widely, are rarely evidence-based, and are monitored infrequently" (Coggshall et al., 2012, pp. 2). In addition, certification requirements based on teacher testing are faulty measures of a teacher's actual effectiveness in the classroom. They have been found to be merely "a crude proxy for teacher quality ... based on poor indicators of quality" (Coggshall et al., 2012, pp. 3).

The relatively lax accountability systems for teacher preparation programs overall may be due in part to a lack of pressure from their housing universities to reform. Teacher education has historically been thought of as low-status in universities (Zeichner, 2002), and has been used as a revenue-generating means to fund other activities in research universities (Medina, 2009; Tom, 1997).

03

BRIGHT SPOTS

Despite the inadequacies in the system just described, recent efforts suggest promising new trends for STEM teacher preparation and preparation programs as a whole. Many independent organizations are motivating change by actively developing measures to better assess the quality of new teachers filling K–12 classrooms and suggesting avenues for preparation program improvement.

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NCTQ is one of these organizations. NCTQ publishes annual reports on the nation's teacher preparation programs using several indicators of program quality. While NCTQ's 2013 national Teacher Preparation Review documented deficiencies in many aspects of preparation programs, their 2014 report noted significant improvements in an assessment of how programs address classroom management skills and student teaching. Furthermore, NCTQ's 2014 report evaluated nearly 40 percent more programs than in 2013, leading to more widespread public accountability and incentivizing an increase in rigor for these programs (Greenberg, McKee, & Walsh, 2014). While NCTQ's annual report is still in its formative years, the organization's efforts to develop more rigorous methods for assessing and reporting on teacher preparation program quality can lead to increased preparation program effectiveness, including more stringent selectivity practices for prospective student teachers.

Even the strongest programs would be challenged to graduate good teachers if the caliber of the applicant pool and, in turn, admitted students is lacking. To that end, the National Math and Science Initiative's (NMSI) UTeach Expansion STEM program, currently housed in 44 universities across the nation, allows students to receive a degree in a STEM major and teacher certification simultaneously. This gives STEM graduates broader career possibilities and encourages them to join the teaching profession. The greater accessibility to education degrees for STEM majors helps develop a future teacher workforce with deeper content knowledge. Interested students are invited to take two one-credit recruitment courses to try out teaching STEM courses. If enrolled, student teachers will be guided through a rigorous program design – involving STEM education courses, specialized STEM content courses, apprentice teaching, and a portfolio – that leads to certification. Students enrolled also receive active support, including dedicated master teachers, ensuring the quality of their education.

In addition to accountability and selectivity practices, there are other ways to bolster pre-service teacher training. Bellwether Education Partners, a national nonprofit that provides strategic advising to education organizations, recently published a thorough analysis of teacher preparation programs. While there is evidence that current selectivity and course content practices are beneficial to future STEM instructors (Mitchel & King, 2016), Bellwether suggests other avenues for further improvement, including widespread data sharing, rapid-cycle performance evaluations of program effectiveness conducted by within-institution researchers, and state support of individual program innovation (Mitchel & King, 2016).

04 CONCLUSION

Students and teachers alike deserve a quality education in STEM. Striving for more effective instruction by actively searching for effective training strategies and increasing preparation program accountability, selectivity, and rigor, as described here, will help to prepare STEM teachers to better serve their future classrooms. As the ultimate consumers of STEM teachers in the labor market, school districts can and should play a critical role in helping teacher preparation programs improve, by sharing data between districts and preparation programs, co-creating programs, using student teaching opportunities as a district recruiting tool, and jointly urging state policymakers to hold districts accountable for preparation pipelines (Mead, Aldeman, Chuong, & Obbard, 2015).

ABOUT THE GRAND CHALLENGES WHITE PAPERS

In 2017, 100Kin10 released an unprecedented representation of the big, systemic challenges to preparing and supporting STEM teachers following over two years of extensive research alongside more than 1,500 STEM teachers and hundreds of other education experts. As a part of this work, 100Kin10 commissioned a series of short white papers from well-versed thinkers and practice-oriented researchers to synthesize the most relevant research around the specific challenge areas. Together, they compose a thoughtful and well-rounded examination of the systemic challenges currently facing STEM teaching.

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