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

TEACHERS OFTEN LACK PREPARATION FOR DIVERSE LEARNING NEEDS.

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01 CONTEXT AND TRENDS

In schools around the country, many teachers are struggling to meet the diverse learning needs of the students in their classrooms (National Academies of Sciences, Engineering, and Medicine, 2015). Evidence of this appears when diverse students — including underrepresented minority students, girls, students eligible for free and reduced-price lunch, English language learners, and students with disabilities — consistently perform below the level of their white or high-income peers, particularly in STEM subjects (science, technology, engineering, and mathematics; National Assessment for Educational Progress [NAEP], 2015). Additionally, in many of the nation's schools, the teaching staff is not representative of the students they teach with respect to race, ethnicity, and linguistic background (Boser, 2011; National Education Association [NEA], 2014; National Academies of Sciences, Engineering, and Medicine, 2015).

In many cases, teachers face these challenges because they are not well prepared to teach students who have a diverse range of teaching needs that exist in classrooms today. This underpreparation is particularly troubling given the realities that many new teachers encounter in their practice. Data show that teachers new to the field are often placed into classrooms where at least 25 percent of their students live in poverty, oftentimes lacking access to basic food, shelter, and health care. Ten percent to 20 percent have identified learning differences, and 15 percent are English language learners (Darling-Hammond, 2006).

For STEM education, this issue is even more pressing. STEM job opportunities in the United States are expected to grow nearly twice as fast as other fields by 2018, meaning that we'll need more STEM-qualified citizens to fill these positions. However, there is a dire shortage of young people, especially ethnically and culturally diverse students interested in and prepared to meet this demand (National Science Board [NSB], 2002; NSB 2016). As many as 40 percent of our nation's students are members of racial and ethnic minority groups, and an overwhelming majority are recent immigrants from countries which have varying educational

systems and cultural traditions (Darling-Hammond, 2006). Recent population projections clearly indicate that minorities and women are becoming our nation's demographic majority. Therefore, persistent underparticipation in high-demand scientific fields is troubling (President's Council of Advisors on Science and Technology [PCAST], 2010). In order to meet the needs of this new kind of workforce, we must ensure that we reach all students with STEM, regardless of their diverse needs.

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DISCUSSION

As stated earlier, in many of the nation's schools, the teaching staff are not representative of the students they teach with respect to race, ethnicity, and linguistic background (Boser, 2011; NEA, 2014; National Academies of Sciences, Engineering, and Medicine, 2015). Museus, Palmer, Davis, and Maramba (2011) suggest that students who lack STEM teachers who share their cultural and/or racial backgrounds may become disinterested in STEM subjects. As a result, many diverse students have limited to no exposure to role models who both understand their racial, ethnic, cultural, and linguistic backgrounds and who can share and provide insight into the realities of pursuing STEM careers — a role which a teacher who shares a student's background can help provide (Klein, 2016). According to Ingersoll and May (2011), the lack of teachers in STEM fields who are culturally and racially diverse is a civil rights issue. All youth, no matter their background, should have the opportunity to pursue the career of their choice, and without qualified STEM teachers they can relate to, students are denied such opportunity.

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Moreover, diversity in the STEM teacher workforce benefits not just diverse students but all students. According to Klein (2016) in a *Huffington Post* article, students of all races discussed how they preferred teachers of color because they generally feel more supported and motivated by them, especially since these teachers bridge their own identities with the experiences of their students.

In many cases, research shows that limited or negative exposure to STEM in PK–12 discourages diverse students from pursuing STEM teaching in college or career, including STEM teaching. Students, particularly youth who are historically underrepresented in STEM, generally receive limited pre-college STEM education preparation (Tyson, Lee, Borman, & Hansen, 2007). For example, between 10 percent and 25 percent of high schools do not offer more than one of the core courses in the typical sequence of math and science education at the high school level (e.g. Algebra I, II, geometry, biology, and chemistry). Moreover, nationwide, only 50 percent of high schools offer calculus, and only 63 percent offer physics courses (U.S. Department of Education Office for Civil Rights, 2014). There is even less for Black, Latino, American Indian, and Alaska Native students; one-fourth of the schools with the highest percentage of Latino and Black students don't offer Algebra II courses, and of these same schools, one-third do not offer courses in chemistry. For American Indian and Native Alaskan students, this is even more pressing: Fewer than half of these students have access to a full

range of mathematics and science courses in their high schools (U.S. Department of Education Office for Civil Rights, 2014).

Another cause of concern leading to limited exposure to STEM coursework for minority students is academic tracking. In one study, Zuniga, Olson, and Winter (2005) examined the tracking policy of a high school with a more than 11,000 percent increase in Hispanic student enrollment within 10 years. The researchers found that Latino students were often placed in lower-level science and mathematics courses because they were tracked very early into low-level programs. The same students were then unlikely to take courses required for college admission, limiting their abilities to pursue and aspire to post-secondary STEM pathways compared to their non-Hispanic white counterparts. These lower-level courses are often discouraging to diverse students, partly because they are not meaningful and/or connected to their personal lives and pursuits (Basu & Calabrese Barton, 2007). In many cases, this is because teachers lack access to culturally relevant teaching strategies and resources. Even where they do have access, Gay (2013) discusses that although there is significant research on preparing teachers with instructional strategies for diverse students, there are still teacher attitudes and beliefs that resist embracing and building upon the cultural, ethnic, and racial diversity in our nation's classrooms. Sometimes teachers hold low expectations for their students because of holding unexamined stereotypes of diverse students (p. 48).

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Among the most important challenges facing our nation is providing high-quality STEM learning to English language learners (ELLs) and students with disabilities. Although there are myriad factors that can affect students' engagement and achievement in schools, research shows that teacher quality is one of the most influential on school success, surpassing even socioeconomic status, class size, family background, school context, and all other factors that influence achievement (Hollins & Guzman, 2005). Research shows that not all teachers are prepared to teach to individual student needs, and so it is necessary for teachers to provide those opportunities for students. For example, providing accommodations for students with disabilities can help give all students equal access to learning in the classroom. Preparing to teach for universal design, a method of design focused on instructional goals, materials, and assessment, is one strategy that benefits all learners regardless of ability (National Center on Universal Design for Learning, at CAST, 2012). In science and mathematics education, accessible content has been developed through various applications for students with both high-incidence and low-incidence disabilities, such as manipulating digital texts, providing accessible videos that have captioning for all learners, captioning in various languages, accessible websites with audio and video, and even using objects such as Legos, concept maps, charts, and graphs to explain scientific ideas or models (Curry, 2003). These all provide equitable opportunities for students to achieve and engage meaningfully in their STEM education.

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BRIGHT SPOTS

Efforts to improve the extent to which all students' needs are being addressed and met in STEM education are not idle. Fortunately, there are innovative programs to which the nation and education community can turn to as potential models of adaptation or for scale.

The Edgerton K–12 Program, a part of Edgerton Outreach Programs out of the Massachusetts Institute of Technology (MIT), has hands-on science and engineering challenges that educate and inspire kindergarten through 12th-grade students. It aims to increase their drive and desire to pursue STEM careers in the future by providing them both with increased exposure and positive STEM-related experiences. Focused on schools in the Boston area, the Edgerton program supports over 150 on-campus classroom workshops annually, with intensive summer programs, innovative curriculums, and teacher professional development. These school-year opportunities include three-hour classes available during the school day and are free of cost to students. These classes are meant to reinforce scientific concepts learned and discussed by teachers' during in-class lessons and/or the broader STEM curriculum.

In providing the most recent technology at MIT in an out-of-school environment that is free of cost to students, students from all backgrounds have access to the latest technology, research, and development in STEM. The program also has innovative teacher professional development opportunities, where teachers are welcome to use any of their materials in their own classroom. Programs like these, which are housed at research institutions and/or libraries, museums, and out-of-school spaces with the latest technologies, should help support local teachers in their teaching, learning, and development of STEM experiences. These experiences also provide access and opportunities in STEM for their students, by engaging them in nontraditional ways where there is reduced burden on teachers who don't have the resources or the monetary support from their districts to provide these opportunities for their students in the classroom. Through these out-of-school opportunities, social and cultural connections can be opened between teachers and students.

With a focus on increasing teacher preparation to differentiate instruction based on individual student needs, the University of California, Los Angeles, Center X (UCLA Center X) focuses on providing high-quality preservice and in-service education to teachers to improve urban schooling for California's racially, culturally, and linguistically diverse children. The preparation program aims to develop teachers for social justice by attending to the moral, cultural, and political dimensions of teaching, providing collaborative supports within teacher communities of practice even beyond their time at UCLA Center X.

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CONCLUSION

To more equitably serve the diversity of the nation's students, we need to more strongly ensure teachers have the knowledge and tools they need to meet the diverse learning needs of young people, starting with their professional preparation. To ensure teachers are better prepared and supported to meet the needs of diverse students, policies and programs that focus on both recruiting more teachers of color into the profession and better preparing all teachers to implement culturally relevant, culturally sustaining, and equitably consequential ways in school and out-of-school settings is the key to merging youths' backgrounds, cultures, and experiences with their STEM learning (Basu & Calabrese Barton, 2007; Banks, 1995; Ladson-Billings, 1995; Paris, 2012; Nazar, Calabrese Barton, & Rollins, 2017).

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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