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The Intricacies of the STEM Teacher Shortage

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Introduction

When conducting an Internet search on the *national teacher shortage* in the popular media, words such as *crisis*, *colossal*, and *critical* appear. However, the nature of the teacher shortage in the United States is also complex (Barnum, 2022; McVey & Trinidad, 2019).[1] Factors including region of the country, district-type, and subject areas must be considered. For instance, states have consistently reported a teacher shortage in STEM subject areas (e.g., AAEE, 2023; McVey & Trinidad, 2019). The present editorial is the opening of a series addressing our role as science and mathematics teachers and teacher educators in addressing the STEM teacher shortage. We start by presenting the problem. The following sections share data and literature that substantiate the shortage of teachers in STEM subject areas as well as related issues including declining enrollment in teacher education programs, perceptions of the teaching profession, race/ethnicity of the teacher population, and out-of-field teachers.

Teacher Shortage

Evidence shows a teacher shortage in STEM subject areas in the United States. Over the last two decades, states have identified shortages of teachers in Mathematics and Science (McVey & Trinidad, 2019). In the American Association for Employment in Education (AAEE, 2023) report, school districts conveyed *Considerable Shortages* of qualified applicants in all STEM subject areas (Mathematics, General Mathematics and Science, Physics, Chemistry, Biology, and Earth/Physical Science) for the Academic Year (AY) 2022-2023 as well as over the previous eight academic years (with a transition from mainly *Some Shortage* to mainly *Considerable Shortage*). This finding held true across most regions of the United States (with three regions reporting *Some Shortage* in some of the STEM subject areas). Data of teacher shortages for the AY 2022-2023 from the U.S. Department of Education (U.S. DOE, 2023) documents 31 states with shortages of mathematics teachers and 34 states with shortages of science teachers.

Further, school districts overall reported that 25% of newly hired teachers did not have traditional preparation, and 80% of school districts described *having enough candidates for open positions* as a *Big Challenge* in the hiring process (AAEE, 2023). For the AY 2022-2023, the majority of public schools with a vacancy reported *Somewhat Difficult* or *Very Difficult* for the anticipated level of difficulty in filling positions in Computer Science, Mathematics, Biology or Life Sciences, and Physical Sciences (IES, 2022).

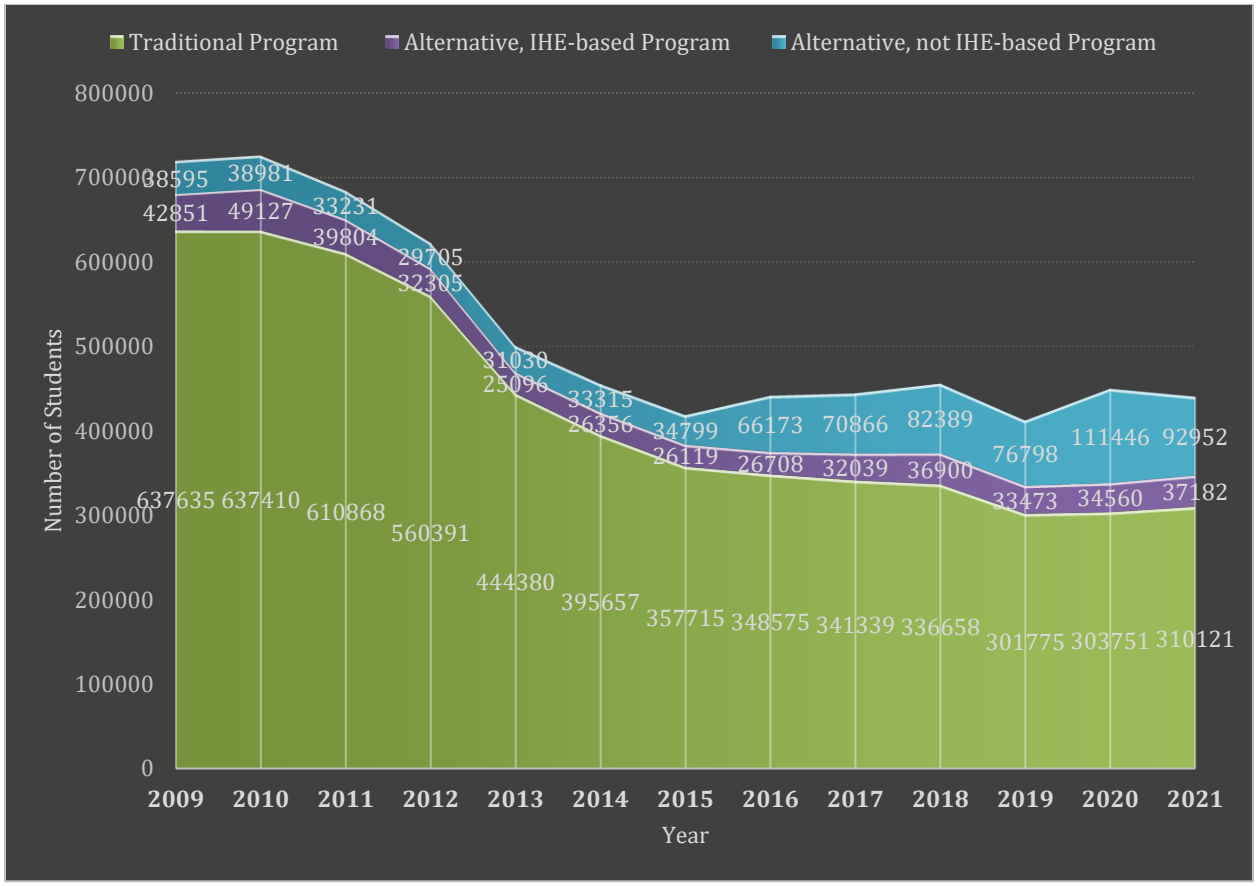
[1] We want to acknowledge that the editorials focus on data and literature reflecting the situation in the United States, which may differ from other countries (e.g., Fray & Gore, 2018; Han et al., 2018).

Declining Enrollment in Teacher Education Programs

One possible reason for the teacher shortage could be that enrollment in Teacher Education Programs (TEP) in the United States has been declining (AAEE, 2023; U.S. DOE, 2022a). Figure 1 shows enrollment by program type (Traditional Programs; Alternative, Institute of Higher Education [IHE] Based Programs; and Alternative, not IHE-Based Programs). Across all program types, enrollment has decreased by 39% for AY 2008-2009 through AY 2020-2021. Specifically, enrollment has decreased in Traditional Programs by 51% and in Alternative IHE-Based Programs by 13%. In contrast, enrollment in Alternative not IHE-Based Programs has increased by 141% (U.S. DOE, 2022b). Much of this growth is due to the enrollment in Alternative not IHE-Based Programs in Texas (e.g., 75% of the total enrollment in AY 2019-2021) as well as the growth in enrollment in Texas. For additional data by state, refer to the report, *Preparing and Credentialing the Nation's Teachers* (U.S. DOE, 2022a), and associated data sets (U.S. DOE, 2022b).

Figure 1

Teacher Education Program Enrollment from 2008 to 2021 by Program Type (U.S. DOE, 2022b)



Similar trends exist across STEM fields in the United States. Table 1 presents the percent change (between AY 2012-2012 and AY 2018-2019) in program completers in STEM subject areas by the three program types (U.S. DOE, 2022a). Overall, the percent change shows a decrease in program completers for all STEM subject areas except for Computer Science. In particular, the

percent change indicates a decrease across all STEM subject areas in Traditional Programs and across most STEM subject areas in Alternative not IHE-Based Programs. Alternatively, the percent change demonstrates an increase in Alternative IHE-based Programs in all subject areas apart from mathematics. The findings of the AAEE (2023) report likewise align, with Colleges and Universities reporting a *Considerable Shortage* in qualified candidates in STEM degree programs (Mathematics, General Mathematics and Science, Physics, Chemistry, Biology, and Earth/Physical Science).

Table 1

Change (and Percent Change) in Program Completers in STEM Subject Areas from 2012 to 2019 (U.S. DOE, 2022a)

	Subject Area						
Program Type	**Mathematics**	**General Science**	**Biology**	**Chemistry**	**Physics**	**Earth Science**	**Computer Science**
Traditional	-47774 (-42%)	-1212 (-30%)	-918 (-28%)	-295 (-29%)	-149 (-27%)	-202 (-36%)	-15 (-40%)
Alternative, IHE-Based	-95 (-8%)	141 (26%)	108 (21%)	45 (26%)	11 (12%)	43 (80%)	6 (300%)
Alternative, not IHE-Based	34 (2%)	570 (46%)	-123 (-23%)	-105 (-49%)	-60 (-41%)	-46 (-42%)	12 (67%)
Total	-4835 (-34%)	-501 (-9%)	-933 (-21%)	-355 (-25%)	-198 (-25%)	-205 (-28%)	3 (6%)

Perceptions of the Teaching Profession

The prestige of a profession "can be understood to mean the reputation and social standing that the profession holds in society as well as the respect and authority workers are afforded as professionals" (Kraft & Lyon, 2022, p. 7). In their examination of the state of the K-12 teaching profession in the U.S. over the last 50 years, Kraft and Lyon (2022) found that the prestige of the teaching profession experienced a decline in the 1970s, a rise in the 1980s, and a steady rate for 20 years prior to the most recent decline starting around 2010. Currently, the perception of the teaching profession is at its lowest.

The present trend pertaining to the prestige of the teaching profession has implications for student interest in pursuing a career in education. Since the public's view of professions influences students' choice of career (Christensen et al., 2019; Han et al., 2018; Kraft & Lyon, 2022), student interest in becoming a teacher has followed a similar pattern as that of the prestige of the profession. Since 2010, interest in the teaching profession has decreased to its lowest level in the last half century (Bartanen & Kwok, 2022; Kraft & Lyon, 2022).

Students' career interests are also influenced by family perceptions of professions (Christensen et al., 2019, 2022; Kraft & Lyon, 2022). With respect to the teaching profession, Christensen et al. (2022) found that one of the factors that predicted *whether parents believe teaching would be the best career option for their children* (p. 9) was parent perception of societal respect for teachers. Notably, in a Phi

Delta Kappan (PDK) Poll (2022), 62% of the adults surveyed indicated that they would not want their child to become a public school teacher in their community. In 2018, this percent was 54%, and all previous surveys the percent was less than 50%.

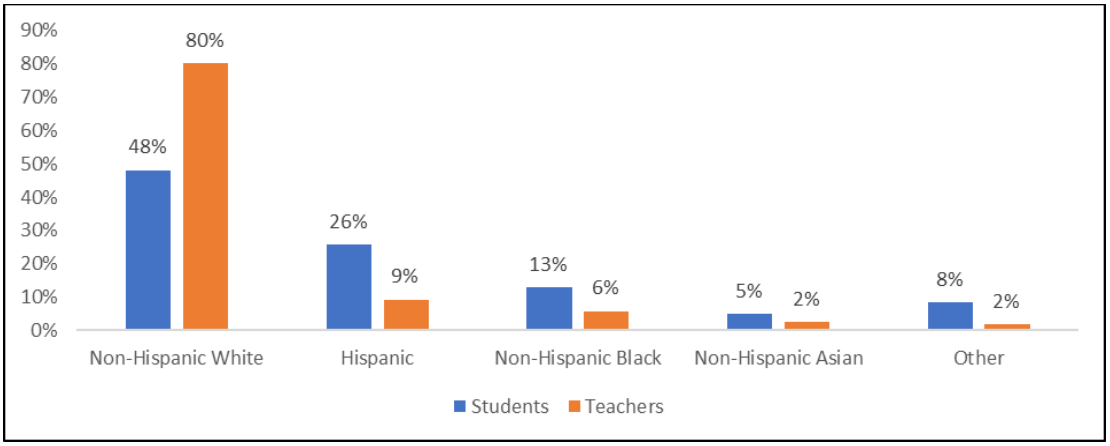
Race/Ethnicity of the Teacher Population

TEPs have made efforts to recruit and retain diverse teachers of color as they recognize the benefits that they bring to the education of students of color (Sleeter et al., 2014). Teachers whose race/ethnicity matches their students are better able to serve as mentors and role models and can better understand their students' cultural backgrounds (Egalite et al., 2015). As early as the pre-Kindergarten years, research has noted improved learning outcomes for students when they are matched with teachers who share their race/ethnicity (Downer et al., 2016). For instance, Gershenson et al. (2021) found that black students who had just one black teacher by the third grade are 13% more likely to graduate high school and 19% more likely to enroll in college than their same-race/same-school peers. The same study revealed that no such trend was detected among white students.

Despite the evidence that a diverse teacher workforce is better for a diverse student body, Figure 2 shows that a great disparity still exists between the racial/ethnic make-up of U.S. K-12 public school students (Fabina et al., 2023) and the corresponding teacher workforce (Taie & Lewis, 2022). In 2021, non-Hispanic white students made up only 48.1% of the total enrolled students, yet 79.9% of K-12 teachers were white. In all other racial/ethnic groups, teachers were underrepresented. Hispanic students comprised 26% of enrolled students and 9% of teachers were Hispanic; Black students made up 13% of enrolled students and 6% of teachers were Black; and Asian students accounted for 5% of student enrollment and 2% of teachers were of Asian descent. These numbers closely match the diversity among science teachers. Zippia Career Expert (2023) used a database of 30 million profiles to estimate the diversity among U.S. Science teachers and found the most common ethnicity of Science and Mathematics teachers to be white (72% Science, 72% Mathematics), followed by Hispanic (12% Science, 12% Mathematics), Black (8% Science, 8% Mathematics), and other (4% Science, 4% Mathematics).

Figure 2

Percent of Students and Teachers in K-12 Schools in 2021



On top of the racial disparity, teachers of color are also reported to be leaving the profession at a higher rate than their white counterparts. A study by the Massachusetts Department of Elementary and Secondary Education (DESE, 2019) found an attrition rate of 12.5% among white teachers in AY

2016-2017, but a higher rate of 17% for Latinx teachers and 24% for Black teachers. This trend appears across the country; Steiner and Woo (2021) found that one in four teachers indicated they planned to leave the profession by the end of AY 2020-2021, and that number was almost 50% among Black teachers.

Out-of-Field Teachers

This problem of teachers assigned to subjects that do not align with their area of expertise spans many subject areas but is especially challenging for Mathematics and Science teachers. As far back as 1990, the National Center for Education Statistics (NCES, 1996) found that among public school Mathematics students, approximately 25% were taught by Mathematics teachers who lacked even a minor in Mathematics or Mathematics Education. Similarly, 39% of public school Biology students had teachers who lacked even a minor in Biology or Life Science. The problem was even worse for Physical Science with 56% of public school Physics students in classrooms taught by teachers who lacked even a minor in Physics, Chemistry, Geology, or Earth Science.

The problem has not improved over time. Shaw et al. (2019) indicated that between 2003 and 2016, the number of out-of-field teachers in Chemistry and Physics classes has continued to increase. Among Mathematics teachers, only 58% were teaching in-field. Among those teaching out-of-field, 14% not only lacked an in-field degree, but also lacked in-field certification (Shaw et al., 2019). Further, Nixon (2017) identified that out-of-field teaching was much more prevalent among new teachers as compared to seasoned, long-term teachers. Their data revealed that among 100 new Science teachers, more than 60% were required to teach Science subjects for which they were not adequately prepared.

Conclusion

In the present editorial, we have acknowledged the ongoing shortage of teachers in general and the fact that current enrollment in TEPs do not indicate an end to this shortage. We have further identified the problems of a general decline in the public's perceptions of the teaching profession, a lack of diversity among K-12 teachers, and teachers assigned to subjects outside of their area of expertise. In the next editorial, we plan to discuss various reasons that have been attributed to the trends presented herein. We will then use the foundational knowledge from the first editorials to elaborate on practical ways in which we, as Mathematics and Science teachers and teacher educators, can contribute to building the STEM teacher workforce.

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