

Charting a Path to STEM Belonging and Success for Every Student

You can't solve a problem you don't understand.

Guided by this insight, Beyond100K has engaged thousands of people in identifying and distilling the challenges holding back the PK-12 education system from preparing and retaining STEM teachers who can cultivate classrooms of STEM belonging, especially for schools serving majority Black, Latinx, and Native American students.

Solving a problem also requires focusing our energy and resources. The resulting map pinpoints the “keystones” or highest-leverage, highest-impact opportunities. These opportunities have the greatest potential to catalyze change across the system and end the STEM teacher shortage with equity, representation, and belonging.

We are focusing on Black, Latinx, and Native American students as our collective experiences and the [available data](#) show that at a national level, Black, Latinx, and Native American individuals have been historically and consistently excluded from STEM. Understanding the experiences of those most excluded will allow us to design solutions that will expressly benefit students and teachers from these backgrounds while also uplifting all students and teachers.

Our focus on belonging is driven by the voices of hundreds of young people across the country who shared their experiences with STEM learning through [the unCommission](#). We heard that students need to feel a sense of belonging in STEM if they are to succeed in STEM and that teachers are the most powerful force for fostering belonging in STEM.

HELPFUL TIPS FOR READING THIS DOCUMENT

- ▶ The map includes about 100 challenges organized into 8 themes. Page 2 gives an overview of the 8 themes and the following pages show the underlying challenges in each theme. Because the challenges are interconnected, there is no single or correct way to organize the challenges. The themes should be understood as orienting structures to help users navigate and take action on the map.
- ▶ “Keystones” are high-leverage, high-impact challenges that have the greatest potential to catalyze change across the system. Keystones are identified by ✨.
- ▶ We are continuing to deepen our understanding of STEM belonging, and we see many of the themes and challenges as components of belonging for both students and teachers. When we say “STEM belonging,” we mean individuals feeling like they are respected, valued, and accepted by others; have agency; can show up without betraying their authentic self; know they can succeed in their STEM pursuits and are supported to do so by those who care about them; and feel a connection to STEM and see a purpose for themselves in the content. Belonging is a critical part of teachers leading and students experiencing joyful, relevant, and rigorous STEM learning.

Themes

01 Robust and Representative Teacher Pipeline

02 Next Generation Teacher Preparation

03 Teacher Work Environment and Expectations

04 Teacher Professional Development and Advancement

05 Student Experience in STEM and School

06 Joyful, Relevant, and Rigorous STEM Instruction

07 Foundational STEM Teaching and Learning

08 Equitable STEM Pathways and Opportunity

Robust and Representative Teacher Pipeline

* The cumbersome and numerous requirements to become a teacher can prevent people from pursuing STEM teaching

* There can be insufficient compensation (including salaries and bonuses) to attract people to enter or stay in the STEM teaching profession, especially over other STEM industries

* The financial burden of becoming a teacher (including the cost of preparation programs, limited scholarships and loan forgiveness, feasibility of paying off loans on a teacher salary, and lost earnings from not working) can deter people from teaching or compel people to choose less-expensive and often less-effective preparation pathways

* States and districts can waive valuable degree or other qualification requirements in STEM and/or teaching in an effort to relieve acute teacher shortages

* States and districts can lack sufficient data or data systems to understand current or predict future teacher shortages

STEM teaching can be discouraged or perceived as an unprestigious profession

The teaching profession can be undesirable for younger generations and others who want more flexible working arrangements, especially when many jobs offer greater choice in working hours and location

People can have negative experiences with or perceptions of STEM, including that it is elitist or too difficult, that can discourage them from pursuing STEM, including STEM teaching

Students can have negative experiences in school or with teachers that discourage them from pursuing teaching

Teachers can explicitly discourage students from pursuing teaching (due to their own negative experiences in the profession)

There is a lack of racial diversity in STEM teaching that can make it an unattractive profession to enter or remain in

There are insufficient targeted, effective recruitment efforts to increase the racial diversity of the STEM teaching profession (so that it reflects the racial diversity of students)

Black, Latinx, and Native American individuals who want to become STEM teachers often do not have role models of STEM teachers who look like them and/or share a cultural identity with them

There are insufficient programs and policies at the local, state, or federal level that focus on preparing and/or retaining Black, Latinx, and Native American STEM teachers

The "last-in, first-out" approach to teacher layoffs can lead to premature termination of early-stage teachers, which disproportionately impacts Black, Latinx, and Native American teachers

Students, especially Black, Latinx, and Native American students, can lack the PK-12 STEM learning opportunities that set them up to pursue STEM teaching as a career, in addition to other STEM degrees and professions

Next Generation Teacher Preparation

* There is not consensus about what constitutes effective teacher preparation (or how it factors into state approval of preparation programs)

* Preparation program faculty can fail to model joyful, relevant, and rigorous STEM instructional strategies

Preparation programs can lack field-based training and mentorship in PK-12 schools similar to those where pre-service teachers will teach full-time

Preparation programs do not sufficiently nurture curiosity or a love for learning among prospective teachers

Preparation programs often do not explicitly prepare teachers to teach students who do not share their racial identities, cultural identities, and/or languages

Preparation programs do not sufficiently teach strategies for delivering STEM content in ways that are connected to other subjects

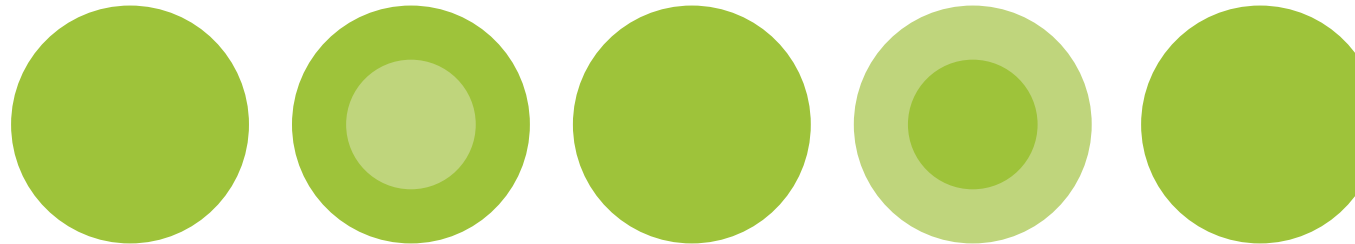
Early-career teachers often do not feel ready to teach STEM after completing their preparation program

Teacher preparation programs and local districts/schools often do not collaborate or coordinate about how new teachers are prepared and onboarded (e.g., sharing data about teacher vacancies and teacher retention, coordinating on curricula)

States can lack rigorous STEM coursework requirements for pre-service teachers

There are not often high admission standards for preparation programs

Universities can find it difficult and expensive to reform preparation programs



Teacher Work Environment and Expectations

- * Teachers can have unrealistic workloads and too many different kinds of responsibilities

- * Teachers often lack time to collaborate or participate in professional development during the school day

- * School administrators are often not supported or required to cultivate positive work environments or belonging for teachers

The impacts of disruptive events (such as the COVID-19 pandemic and effects of climate change) on teachers, including on their mental health, have not been adequately attended to in the context of school

Set, in-person working hours and workloads that often require teachers to work after hours and on weekends can make it difficult to balance teaching with other personal responsibilities (e.g., maintaining a healthy lifestyle, taking care of family members)

Teachers can be expected to provide wrap-around support for students' unique academic, linguistic, and mental-health needs, without sufficient support

Teachers often are not given the trust, latitude, or support to be creative or innovative with instructional strategies

STEM teachers often lack the time, structures, and/or support of school administrators to meaningfully connect and collaborate with peers inside and outside of their own school

Teaching can be isolating and lonely, especially for those who do not have peers who share their racial identity or teach a similar subject

Teachers can be penalized for confronting bias and inequity by other adults in the school (e.g., passed over for promotions, perceived as aggressive or adversarial, pinpointed as the "problem" teacher)

Schools can feel like unsafe places to work and learn, especially for Black, Latinx, and Native American individuals

Black, Latinx, and Native American teachers can experience added expectations beyond those of other teachers to engage, manage, and connect with students who look like them, speak the same language, or share aspects of culture

STEM teachers, especially Black, Latinx, and Native American STEM teachers, can be discouraged from applying to school administrator roles (because it can be hard to replace STEM teachers, especially Black, Latinx, and Native American STEM teachers)

Black, Latinx, and Native American teachers can witness bias and racism toward students that causes trauma, disillusionment, and a desire to leave teaching

Teachers, especially Black, Latinx, and Native American teachers, can have their ability or intelligence questioned by school administrators or peers

Teacher Professional Development and Advancement

* Pathways for teachers to advance in their careers and increase their leadership while continuing to teach can be lacking or obscure

Teachers often lack professional development that is aligned with state standards

Teachers often lack the opportunity to choose their own professional development that aligns with their specific needs and interests

Teachers often lack professional development that is inclusive of up-to-date STEM content

Teachers often lack professional development informed by student assessment data

Teachers often lack professional development focused on effective instructional strategies, such as active or inquiry-based learning

State and district re-licensure requirements can focus more on the number of hours of professional development attended than demonstration of knowledge

There is not consensus about what constitutes effective teacher professional development, including its purpose at different stages of teachers' careers, how it aligns with teacher evaluation criteria, or how to measure it

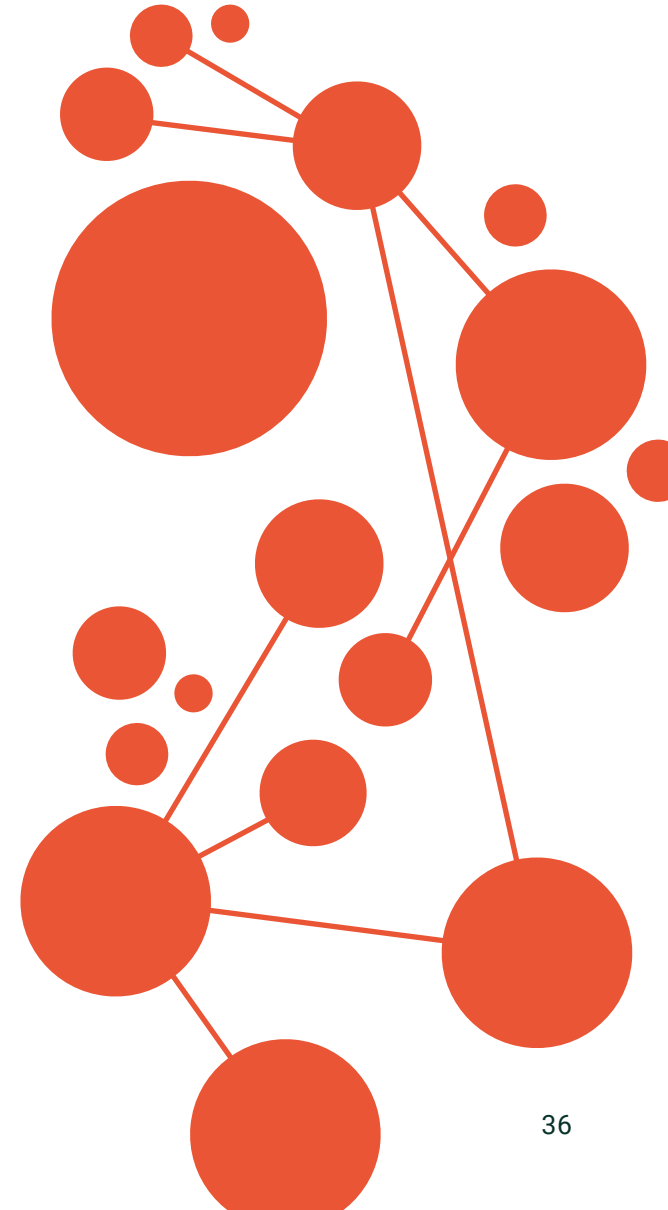
School administrators can be unaware of STEM teachers' professional development needs

Early-career STEM teachers often lack sufficient induction support when they start teaching full-time

Professional development providers and local districts/schools often do not collaborate or coordinate to ensure support is aligned to teachers' career stages

Teacher evaluation systems are often disconnected from teachers' professional development and instructional practices

STEM teachers, especially Black, Latinx, and Native American STEM teachers, often lack mentors who share their racial or cultural identity and/or teach the same subject



Student Experience in STEM and School

* The impacts of disruptive events (such as the COVID-19 pandemic and effects of climate change) on students' academic progress and mental health, which have been disproportionately experienced by Black, Latinx, and Native American students, have not been adequately addressed in schools

Belonging is not often evaluated or connected to measures of student achievement

Belonging can be associated with topics that have been restricted in some states, such as critical race theory and social emotional learning (which can make teachers and school administrators nervous that focusing on it could lead to community backlash, job loss, or other adverse experiences)

Teachers are not often supported or encouraged to understand or counteract their own biases

It can be hard for teachers and students to form meaningful relationships, especially when they do not look alike or share other identities

Girls and Black, Latinx, and Native American students often do not have peers who look like them in their advanced and college-level STEM classes

Students often do not have exposure to role models in STEM fields who are not white men

Teachers can be fearful to engage students in topics related to culture or identity, especially race or sexuality (because of a lack of competence in issues of race, criticism from peers or parents/caregivers, concern of conflation with topics that are restricted in some states)

There can be a perception that STEM is a rigid, objective, or "neutral" subject that is disconnected from culture and identity

Teachers can lack preparation, support, and tools to create a sense of belonging in STEM for their students

Teachers can have low expectations of certain students in STEM, especially girls and Black, Latinx, and Native American students

There can be a perception that innate abilities to succeed in STEM are natural to some people (often only white boys and men) and not to every person

Joyful, Relevant, and Rigorous STEM Instruction

- * It can be hard for teachers and districts to find and use joyful, relevant, and rigorous STEM curriculum that supports every student to know they belong

- * State standards can exclude emerging STEM areas including data, technology, computational thinking, and computer science

- * States and districts can lack accountability systems that support joyful, relevant, and rigorous learning

- * There is not agreement on the meaning of STEM

School administrators can prioritize student assessment scores over non-tested subjects and effective instructional strategies, such as active or inquiry-based learning, especially in schools in low-income communities and/or with majority Black, Latinx, and Native American students

Instruction in schools is often siloed into individual subjects and disconnected from other content areas, which can make the instruction shallow and rote

STEM instruction in schools can prioritize getting the “right answer” quickly over experimentation, failure, learning, and collaboration that is essential to STEM learning

Decision making about what students are learning and how they are learning it can exclude teachers, students, and parents/caregivers

Education research can exclude teachers and schools (e.g., by developing research ideas without teacher input, presenting findings in ways that aren’t useful for teachers, failing to incorporate learnings from implementation into further research)

Schools in low-income communities and/or that serve predominantly Black, Latinx, and Native American students are often disproportionately staffed by early-career teachers with little teaching experience

Teachers often lack preparation and support to connect STEM learning to their students’ cultures

Teachers often lack preparation and support to connect STEM instruction to students’ interests and future careers

STEM curricula often excludes Black, Latinx, and Native American leaders in and contributions to STEM

Foundational STEM Teaching and Learning

* There can be a perception that teaching, especially at the elementary level, is women's work (which tends to be undervalued and underpaid in our society)

* Preparation programs often lack STEM-specific tracks and faculty with STEM expertise, especially for pre-service elementary teachers

* School administrators, especially those working in elementary schools, can lack a background in and appreciation of STEM

Teachers, especially elementary teachers, often have not had the opportunity to develop their own STEM identity, comfort with, or belonging in STEM in their own educational experiences

There can be insufficient time dedicated to science, technology, or engineering at the elementary level

Elementary teachers can lack access to STEM-specific instructional resources and professional development



Equitable STEM Pathways and Opportunity

* High schools are not often required to have a robust offering of STEM courses

Students and their families often do not have exposure to how STEM manifests in careers, including how to enter STEM careers

School administrators can be unaware of and skeptical about the most effective strategies for teaching joyful, relevant, and rigorous STEM (e.g., active learning, inquiry-based learning)

Students can lack sufficient support at home or from their communities to navigate or pursue STEM learning

Students, especially Black, Latinx, and Native American students, can be discouraged or actively excluded from STEM classes and other STEM learning opportunities (e.g., tracked to lower-level or non-STEM courses)

School budgets can deprioritize materials, technology, or tools for STEM learning

Schools often lack the physical infrastructure and space for joyful, relevant, and rigorous STEM learning

School funding is often tied to property and/or income taxes, which can result in schools in low-income communities having fewer resources overall and to dedicate to STEM learning

Teachers in rural or geographically-isolated areas can face additional or exacerbated challenges in enabling joyful, relevant, and rigorous STEM learning (e.g., collaborating across distance, fewer students can mean smaller budgets, fewer local STEM partners such as museums and companies)

In Beyond100K's first decade, we created the Grand Challenges, a map of the challenges underlying and the opportunities with the greatest potential to impact the STEM teacher shortage. The Grand Challenges map supported our network to achieve our first moonshot goal of preparing 100,000 STEM teachers in 10 years.

In 2022, we announced our new moonshot goal to prepare 150,000 and retain 150,000 STEM teachers who cultivate classrooms of STEM belonging, especially for schools serving majority Black, Latinx, and Native American students. As a first step in acting on this goal, more than 900 people across the STEM teaching and learning system contributed to expanding the Grand Challenges map.

This expanded map reflects a more comprehensive picture of the problems standing in the way of our second moonshot goal, in particular because it reflects the challenges experienced by Black, Latinx, and Native American students and STEM teachers that were not previously represented. Many of the problems depicted on this map are rooted in and perpetuated by systemic and institutionalized racism. It is imperative that we not only recognize the impact of this on our schools, students, and educators, but also identify how to most effectively and powerfully focus our collective efforts to dismantle it. Without this, we will never end the STEM teacher shortage and ensure that all students, especially those who have been most excluded from STEM opportunities, experience joyful, relevant, and rigorous STEM learning and belonging.

WHO WE HEARD FROM



916 individuals from 48 states and Washington, D.C. contributed to the mapping process



of participating STEM teachers identified as Black, Latinx, and/or Native American

25% of participating STEM teachers identified as **Black** (compared to 7% of national STEM teacher workforce)



12% of participating STEM teachers identified as **Latinx** (compared to 9% of national STEM teacher workforce)



5% of participating STEM teachers identified as **Native American** (compared to 1% of national STEM teacher workforce)



■ Participating STEM Teachers
■ U.S. STEM Teacher Workforce



of participating STEM teachers teach majority Black, Latinx, and/or Native American students