

The logo for 'Beyond 100K' features the text 'Beyond 100K' in white, with a stylized yellow sunburst icon to the right. The background is dark teal with a network of light green lines and teal circles of various sizes.

Beyond
100K

Charting a Path to STEM Belonging and Success for Every Student

Beyond100K is a national network of diverse organizations collaboratively working to end the STEM teacher shortage in the United States with equity, representation, and belonging by 2043. We launched in 2011 with the name 100Kin10, in response to a call from President Obama for 100,000 new and excellent STEM teachers in 10 years. Growing from several dozen partners to hundreds, we together prepared more than 108,000 STEM teachers by 2021. We are now making progress toward our second 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.

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Executive Summary

You can't solve a problem you don't understand. Guided by this insight, from the fall of 2022 through the summer of 2023, Beyond100K engaged hundreds of people to identify and distill the challenges holding back the PK-12 education system from preparing and retaining STEM teachers who cultivate classrooms of STEM belonging, especially for Black, Latinx, and Native American students.

Actually solving a problem also demands that we coordinate and focus our energy as a collective. The resulting map pinpoints the greatest opportunities or “keystones” to catalyze change across the system and end the STEM teacher shortage with equity, representation, and belonging.

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In 2017, we released the “[Grand Challenges](#),” a map of the challenges underlying and the opportunities with the greatest potential to impact the STEM teacher shortage. The map supported the network to achieve the first moonshot goal of preparing 100,000 STEM teachers in 10 years and spur major advancements in STEM teaching and learning.

In 2022, we announced a second decade-long 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. Achieving this goal is the next step en route to ending the STEM teacher shortage in two decades. 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 by answering the question: **“What are the challenges holding back the PK-12 education system from preparing and retaining STEM teachers who can cultivate classrooms**

of STEM belonging, centering the experiences of Black, Latinx, and Native American students and teachers?”

This comprehensive map, drawing on insights from our 2017 mapping process and this more recent research, includes about 100 challenges we need to solve to end the STEM teacher shortage with equity, representation, and belonging. The process to expand the map prioritized listening to Black, Latinx, and Native American STEM teachers and STEM teachers who work with majority Black, Latinx, and Native American students.

Though the map identifies about 100 challenges, we don't need to solve all of them at once to end the STEM teacher shortage with equity, representation, and belonging. Twenty challenges stand out as the most strategic places for action and can create a tipping point toward change. We call these “keystones” because, similar to keystone species in natural ecosystems, they have an outsized

impact on the system. While all of the challenges are important to solve, these 20 keystones are the highest-leverage and highest-impact opportunities with the potential to create a positive, domino-like effect across the system.

Over the next decade, we will mobilize our collective efforts to make meaningful progress on these challenges, and in particular on the keystones. **By concentrating our network's energy and resources on these areas, we are charting a path to a future where everyone, especially those who have been most excluded from STEM opportunities, experience STEM belonging and success.**

In the natural world, everything is connected — but not equally or randomly connected. Because of this, ecologists are able to map an ecosystem and identify species that have a disproportionately large influence on the systems they inhabit. They call these species “keystones.”

Mapping Process Overview

CREATING THE GRAND CHALLENGES

In our first decade, we set out to not only add 100,000 STEM teachers to U.S. classrooms but also to tackle the persistent reasons for the STEM teacher shortage head-on. Recognizing that you can't solve a problem you don't understand, we led a massive and participatory process to create a map of the STEM teacher shortage. We asked thousands of STEM teachers and other experts: "Why is it so hard to get and keep great teachers, especially in STEM?" We asked "why" and "why" and "why" again until we had hit bedrock and stopped hearing new reasons. From this, we distilled dozens of challenges.

We knew that solving this problem required focusing our efforts, as distributing them across so many

problems would not add up to meaningful change. But how could we determine where to prioritize, with each of the challenges being important to address? We turned to ecology and network science for answers, in particular to the idea of the keystone, the species that has a disproportionately large influence on an ecosystem. We invited the field to help find the relationships between the challenges, much like the relationships among organisms in nature. From this emerged the highest-leverage, highest-impact keystones – the challenges that are the most powerful levers on which to focus our energy and resources. We called this map the "Grand Challenges."

Over the next several years, we focused the collaborative problem-solving capacity of our network on three areas, especially around the following keystones:

Nurturing Positive Work Environments for Teachers

BEYOND100K FOCUS School administrators are often not supported or required to cultivate positive work environments or belonging for teachers


BEYOND100K FOCUS Teachers often lack time to collaborate or participate in professional development during the school day

Enabling Joyful and Rigorous Foundational Math

BEYOND100K FOCUS Preparation programs often lack STEM-specific tracks and faculty with STEM expertise, especially for pre-service elementary teachers

Increasing Equity in High School STEM

BEYOND100K FOCUS High schools are not often required to have a robust offering of STEM courses



An independent evaluation conducted by Bellwether (Boone, Lambert, & King, 2022) found that our work on these areas has led to:

	IMPACT
Nurturing Positive Work Environments for Teachers	More teachers benefitting from quality STEM professional growth opportunities and collaborative work environments via Beyond100K partners
Enabling Joyful and Rigorous Foundational Math	Beyond100K partners increasing emphasis on preparing and supporting elementary teachers with STEM skills for both pre-service and in-service elementary school teachers
Increasing Equity in High School STEM	More teachers and students having access to meaningful, authentic, and rigorous STEM learning via Beyond100K partners

Read more about the collective impact of the network [here](#).



LOOKING TO YOUNG PEOPLE TO GUIDE OUR NEXT MOONSHOT



In 2021, we surpassed our decade-long goal to prepare 100,000 STEM teachers in 10 years. Through the network, partners also made progress on the keystones, ensuring that more teachers thrived because of collaborative work environments, more elementary teachers had the skills and support to engage students in foundational math, and more high school students who were often left out of STEM had the chance to succeed in it.

This could have been the summit, but we knew that this was just the first peak towards our ultimate goal of ending the STEM teacher shortage by 2043. There are still too few STEM teachers nationwide, particularly in schools serving Black, Latinx, Native American students, and too few of those teachers represent the students they teach or cultivate classrooms of belonging for each student. We can see from a [range of national data sources](#) that Black, Latinx, and Native American individuals have been historically and consistently excluded from STEM learning and opportunity from early childhood through the workforce. In order to really solve the STEM teacher shortage, we recognized that we must center our attention on those most marginalized. Doing so will allow us to design solutions that will expressly benefit students and teachers from these backgrounds while also uplifting all students and teachers.

With these racial inequities in focus, we embarked on a unique and powerful listening journey called [the unCommission](#) to define our next ten-year goal. We heard from young people across the country about their experiences in STEM education. In three months, nearly 600 young people shared their personal stories with STEM learning.

Across their stories, two themes emerged:

01

Young people need to feel a sense of belonging if they are to succeed in STEM.

94% of storytellers discussed belonging or non-belonging. Stories revealed a positive correlation between feeling a sense of belonging and pursuing STEM, and often a single event that brought about feelings of belonging often outweighed experiences of non-belonging.

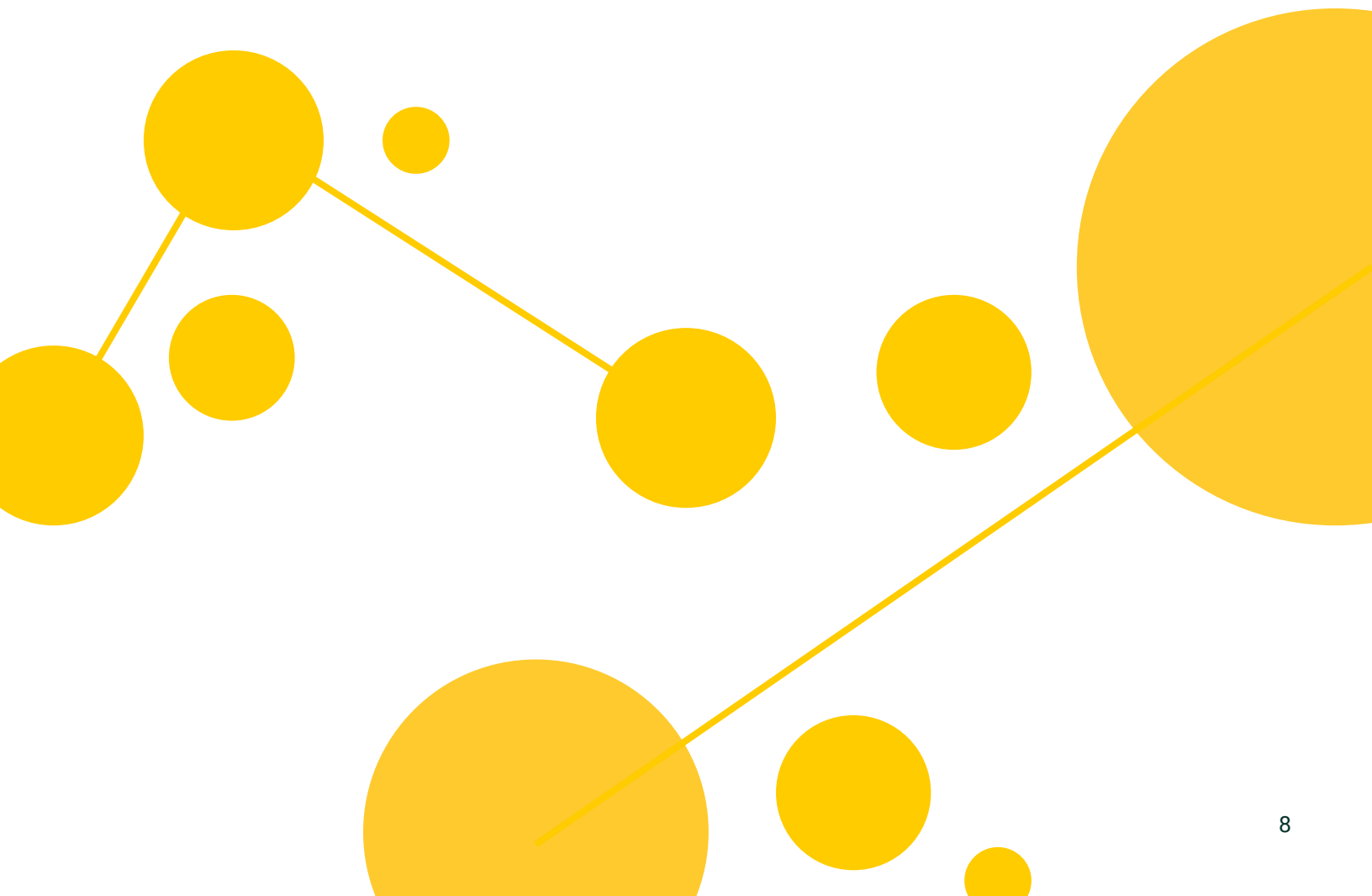
02

Teachers are the most powerful force for fostering belonging in STEM.

68% of the time when storytellers reported a shift towards belonging, a teacher facilitated that happening. Storytellers said their teachers fostered belonging 25 percentage points more than any other individual or experience in their lives.

In 2022, guided by these stories and the clear call for belonging, we announced our new moonshot goal: We will prepare 150,000 and retain 150,000 STEM teachers who cultivate classrooms of STEM belonging by 2032, especially for schools serving majority Black, Latinx, and Native American students. We will support our network to prepare teachers who reflect and represent their students and to cultivate workplaces and classrooms of belonging, creating the conditions for every student to thrive in STEM learning.

We are continuing to deepen our understanding of STEM belonging, which began with a **review and analysis** of the research base. 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.



EXPANDING THE MAP

One of the first steps in taking action on this decade’s goal was expanding the Grand Challenges map to reflect it. We asked hundreds of people across the field: “What are the challenges holding back the PK-12 education system from preparing and retaining STEM teachers who can cultivate classrooms of STEM belonging, centering the experiences of Black, Latinx, and Native American students and teachers?” Through this process, we prioritized listening to individuals closest to these challenges: Black, Latinx, and Native American STEM teachers, and STEM teachers who work with

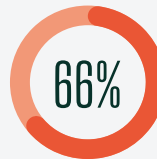
majority Black, Latinx, and Native American students.

With these perspectives, the map now includes about 100 challenges and 20 keystones. 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.

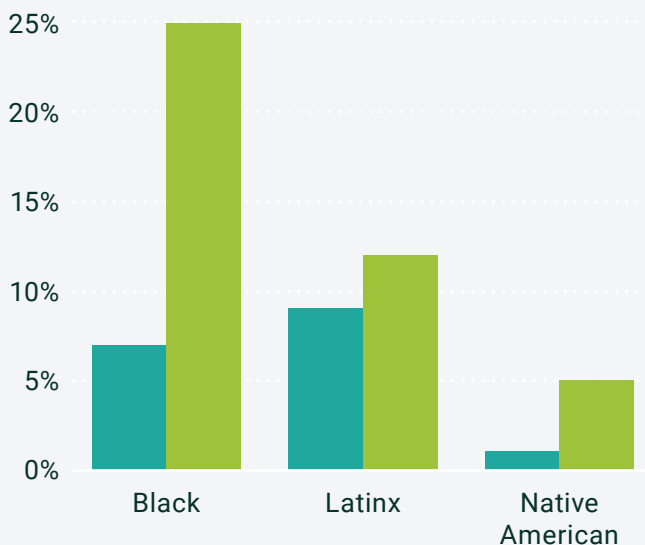
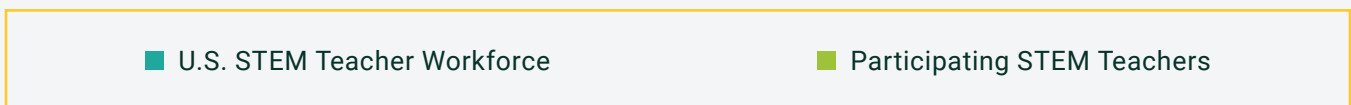
WHO WE HEARD FROM:



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



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



37% of participating STEM teachers identified as Black, Latinx, and/or Native American (compared to 17% of STEM teachers nationally):

- ▶ 25% of participating STEM teachers identified as Black (compared to 7% of the national STEM teacher workforce)
- ▶ 12% of participating STEM teachers identified as Latinx (compared to 9% of the national STEM teacher workforce)
- ▶ 5% of participating STEM teachers identified as Native American (compared to 1% of the national STEM teacher workforce)

CHARTING A PATH TO STEM BELONGING AND SUCCESS



Over the next decade, we will mobilize our collective efforts to solve these challenges and in particular the keystones. Specifically, the Beyond100K network will take on five of the keystones, including four that we are continuing to prioritize from the first decade (read more about how partners have made impact to date in the [Themes Deep Dive](#) section):

BEYOND100K FOCUS School administrators are often not supported or required to cultivate positive work environments or belonging for teachers

BEYOND100K FOCUS Teachers often lack time to collaborate or participate in professional development during the school day

BEYOND100K FOCUS Preparation programs often lack STEM-specific tracks and faculty with STEM expertise, especially for pre-service elementary teachers

BEYOND100K FOCUS High schools are not often required to have a robust offering of STEM courses

BEYOND100K FOCUS **NEW FOCUS** 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

The Beyond100K network is uniquely positioned to catalyze progress on the new focus keystone. Network partners are already doing field-leading work to develop and support the uptake of engaging and meaningful curriculum. This has created a strong foundation to expand impact by developing and supporting the identification and use of curriculum that help create the conditions for STEM belonging.

While we will prioritize these keystones because of their power to unlock change, the Beyond100K network will also continue to work across the map, as we know that all of the challenges are important to solve. The ~100 challenges are organized into eight themes and introduced in the [Themes Deep Dive](#) and [Appendix](#) sections of this report.

Many of the problems depicted on this map are rooted in and perpetuated by systemic and institutionalized racism. We will continue to strengthen the map to better represent how these challenges are experienced by Black, Latinx, and Native American STEM teachers and how the intersectionality of individuals' identities impact their experiences, with the aim of making this map an even more actionable tool. However, 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.



Themes Deep Dive

Distilling what we heard from thousands of people, we have identified about 100 challenges, including 20 keystones, that must be solved to end the STEM teacher shortage with equity, representation, and belonging. These challenges represent the barriers experienced by STEM teachers and students in the United States broadly. This does not mean that every STEM teacher or school will encounter each of these challenges. How a challenge manifests may shift depending upon geography, local culture and politics, population demographics, and other factors.



HOW TO READ THIS SECTION

We have organized these challenges into eight overarching themes. 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, not definitive lenses through which to understand the map:

- 1 Robust and Representative Teacher Pipeline
- 2 Next Generation Teacher Preparation
- 3 Teacher Work Environment and Expectations
- 4 Teacher Professional Development and Advancement
- 5 Student Experience in STEM and School
- 6 Joyful, Relevant, and Rigorous STEM Instruction
- 7 Foundational STEM Teaching and Learning
- 8 Equitable STEM Pathways and Opportunity

This section provides an overview of the full map by describing each theme, including:

- ▶ A brief explanation of the challenges in the theme
- ▶ A list of the keystones in the theme
- ▶ A “Model to Learn From,” highlighting the work of Beyond100K partners currently working to address one or more of the challenges in the theme (some of which are at later stages of development than others)
- ▶ For themes that include focus keystones, a section called “Partners Making Impact,” sharing some of the progress partners have made thus far on the keystone

Robust and Representative Teacher Pipeline

Ending the STEM teacher shortage with equity, representation, and belonging requires a more robust teacher pipeline, but simply increasing the number of people entering the profession is insufficient. Students need teachers who reflect the racial diversity of their communities. 43% of public school students are Black, Latinx, and Native American compared to 17% of public school teachers (Schaeffer, 2021). According to a review from [The Education Trust](#), “access to a racially and culturally diverse teacher workforce is beneficial for all students, particularly for students of color, who often thrive in classrooms led by teachers that share their race and culture” (The Education Trust, n.d.). Schools need more Black, Latinx, and Native American teachers to reach every student, but in particular those who have been most excluded from STEM learning. States and districts have the opportunity to engage community members to enact policies and pathways that will bring more teachers of color into the profession, and it’s essential to maintain requirements around teacher

qualifications as they do so. Such initiatives would be enabled by more coherent and connected data systems and tools that would support states to better understand current and predict future teacher hiring needs.

Paying attention to this data is crucial, particularly as younger generations are opting out of a career in teaching. This is due to the overall unattractiveness of the profession, inadequate STEM preparation and negative experiences with STEM during PK-12 schooling, cumbersome certification requirements, and the heavy financial burden of becoming certified (which includes both the costs of becoming a teacher and the lost income during the preparation period). In many cases, younger generations are choosing to instead pursue more flexible roles with higher compensation (Grose & Weinberger, 2023). We must address these factors to cultivate a more robust and representative teacher pipeline.

Keystones in this theme:

- * 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 sometimes waive important 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

Jump to a list of all challenges in this theme 

MODELS TO LEARN FROM

EnCorps Inc. is a Beyond100K partner on a mission to advance educational equity and belonging in STEM by equipping traditionally underrepresented students with the education and confidence to choose a STEM career. Their **STEM Teachers Program** is an innovative solution to ending the STEM teacher shortage as they work specifically to recruit and support STEM professionals and advanced degree holders to transition to a career in teaching. EnCorps STEM Teachers Program is working to mitigate the costs of becoming a teacher; fellows continue working full-time in their industry during the program—which is free of charge—and the program assists fellows in finding ways to offset the financial burdens of obtaining a teaching credential via grants, scholarships, and financial aid.

EnCorps is also committed to helping fellows navigate the often cumbersome and numerous requirements to enter the classroom. Once accepted, fellows are guided and supported by a dedicated program coordinator to create and carry out an individualized plan to enter the teaching profession.

As part of EnCorps drive to close the opportunity gap, all fellows commit to teaching in under-resourced areas after the program. EnCorps also has a focus on recruiting, training and supporting diverse and committed STEM professionals. To date, 54% of their EnCorps teacher fellows are persons of color.

Next Generation Teacher Preparation

Time and again, research demonstrates “teachers matter more to student achievement than any other aspect of schooling” (Opper, 2019). Moreover, one of the key findings of [the unCommission](#) was that teachers are the most powerful force to impact students’ STEM belonging in school. Teacher preparation programs, therefore, play a critical role in ensuring STEM educators have the knowledge and skills to facilitate joyful, relevant, and rigorous STEM learning and cultivate classrooms of belonging.

Unfortunately, there is a lack of consensus around the kind of teacher preparation that would best support this goal. Regardless of the type or method

of teacher preparation, not enough programs are preparing graduates to deeply understand and joyfully embrace STEM subjects and their content. Furthermore, too few teacher candidates enter classrooms with a solid repertoire of instructional tools and practices to support their students’ STEM learning. Preparing graduates to understand STEM curricula and pedagogy is necessary but insufficient; teacher preparation programs must also work to be racially, culturally, and linguistically responsive to the needs of the students, schools, and communities in which their graduates will be teaching and prepare them to foster belonging in STEM, particularly for Black, Latinx, and Native American students.

Keystones in this theme:

- * 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

Jump to a list of all challenges in this theme [→](#)

MODELS TO LEARN FROM

Beyond100K partner [PEBC](#) (Public Education and Business Coalition) is working to support comprehensive teacher preparation through [Colorado's largest teacher residency program](#). Based on the medical residency model, teacher residents are embedded in a school community (public, private, or charter) for an entire year through a unique collaboration between the schools and PEBC. In this model, residents experience joyful, relevant, and rigorous STEM instructional strategies being modeled for them, first hand! One of the ways STEM comes to reality in the residency program is through activities and lessons that affirm curiosity, investigative thinking, and collaborative problem-solving. From challenges like "stepping through a notecard" to strategically reviewing and planning lessons that showcase cross-curricular connections, residents have several opportunities to engage in STEM opportunities.

The summer prior to entering the classroom, residents take a deep dive into Culturally Responsive Pedagogy, and during the school year, continued field-based training and coaching supports their success. Mentors, coaches, and faculty members regularly model engaging, high-quality STEM instruction that residents then implement in their own classrooms.

30% of PEBC's residents identify as people of color compared to 10% in the greater Colorado teacher workforce. Residents of color receive support through affinity groups (through the BEST Conference and program-based affinity groups) and a culturally responsive instructional curriculum. 81% of PEBC residents are still teaching after five years, compared to the national average of 55%. PEBC attributes this retention rate to high quality preparation, community connections provided through the residency model, and ongoing support graduates receive from PEBC.

Teacher Work Environment and Expectations

Teacher retention is key to ending the STEM teacher shortage, and cultivating work environments where teachers feel belonging is core to retention. Research indicates teachers are more likely to stay at their current school when they have positive perceptions about their working conditions than those who are more negative about their work environment (García & Weiss, 2019a). However, educators often have unrealistic workloads and additional responsibilities placed on them both inside and outside the classroom, which has only been exacerbated by the COVID-19 pandemic. Meeting these expectations typically requires teachers to work after hours and on weekends, which can negatively impact teachers' mental health and work/life balance. In addition, teachers do not always have the trust, time, or support to be innovative with instructional strategies or collaborate with peers, which leads to negative experiences with the profession and in schools. These problems are not prioritized in enough schools, as too few school administrations focus on

cultivating positive work environments of belonging for teachers.

Nurturing positive work environments of belonging is especially important for Black, Latinx, and Native American teachers, as research consistently shows that teachers of color and Indigenous teachers have higher rates of attrition than their white counterparts (Gist, 2021). Too often, schools can feel like unsafe and unwelcome places for Black, Latinx, and Native American STEM teachers. They can be pressured to change the way they speak or engage and often have their abilities and expertise questioned. Additionally, they witness bias and racism toward their students, which can lead teachers of color to become disillusioned with the profession and ultimately leave the classroom. Addressing the challenges related to a robust and representative teacher pipeline requires that we focus on how to do so specifically for Black, Latinx, and Native American teachers.

Keystones in this theme:

BEYOND100K FOCUS School administrators are often not supported or required to cultivate positive work environments or belonging for teachers

BEYOND100K FOCUS Teachers often lack time to collaborate or participate in professional development during the school day

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

Jump to a list of all challenges in this theme 

Partners Making Impact

Informed by the original Grand Challenges map, the Beyond100K network has been working collectively to nurture positive work environments for teachers, with a particular focus on the highest-leverage keystones associated with this theme.

In 2018, guided by over 20 partners, we dug into the research around teacher work environment and published the report, “[Teachers at Work: Designing Schools Where Teachers and Students Thrive](#)”. In 2021, we released an update to the original report in light of the network’s progress to date, the COVID-19 pandemic, and renewed calls for racial justice. The report, “[Teaching During the Great \(un\)Equalizer Rebuilding Teacher Work Environments with Equity at the Center](#),” provided recommendations for creating more supportive teacher work environments, along with specific tactics and strategies for beginning to implement these recommendations.

Since first mobilizing the network around teacher work environment, more than 70 partners have worked collaboratively across 20 learning and problem-solving teams to develop solutions to some of the keystone challenges. Two teams

tackled the keystone “school administrators are often not supported or required to cultivate positive work environments or belonging for teachers.” The [Measuring Positive Work Environment and Culture in Schools](#) Project Team began to think about how to quantify teacher work environments. This team investigated publicly viewable measures of work environment, and then analyzed 14 of those measures using an equity framework to determine the extent to which the measures addressed conditions that promote equity and positive working conditions. They then created a [set of recommendations](#) for school and district leaders, as well as researchers working on nurturing a positive work environment for teachers. The [Partnering with Schools to Nurture Positive Work Environment](#) Project Team focused their work on exploring how external, capacity-building organizations (i.e. organizations that partner with schools and districts) can promote positive work environment in the schools and districts in which they work. This team then worked to create an [asset inventory survey](#) and [interview protocol](#) to be used by external organizations to assess the school climate and maximize their impact in terms of helping to create a positive workplace environment.

MODELS TO LEARN FROM

In 2019, Beyond100K partners formed the [Integrating Professional Growth Into the School Day](#) Project Team around the keystone challenge “teachers often lack time to collaborate or participate in professional development during the school day.” This team investigated opportunities for schools to incorporate professional learning as a part of regular school-day operations and explored how innovative leadership roles for teachers and non-traditional school schedules might allow them to meet this need. The team created a [research brief](#) summarizing their findings on effective job-embedded professional development in STEM and suggestions for school leaders. They highlight three exemplary cases and summarize the benefits to students of increasing opportunities for teachers to collaborate during the school day.

In 2020, members from this team continued to work on solutions to this challenge and created a [Job-Embedded Professional Growth Toolkit](#). This database includes resources for bridging research to practice, exemplary models, and potential roles and job descriptions to support school leaders in designing and developing job-embedded professional development for teachers. The toolkit also includes resources related to school culture including promoting and sustaining learning and change.

Teacher Professional Development and Advancement

Alongside a workplace of belonging, teachers need effective professional development and pathways for career advancement in order to stay and thrive in the classroom. Like teacher preparation, however, the field lacks consensus about what constitutes effective professional development. There is work to be done to connect teacher evaluation systems with teacher professional development, and for professional development providers to collaborate with schools and districts to be sure offerings are aligned with teacher needs, relevant standards, STEM content, and effective STEM teaching strategies.

Additionally, the field lacks a clear trajectory for providing differentiated opportunities at different stages of teachers' careers. Too few early-career STEM teachers have sufficient and relevant

professional learning opportunities and supports—a major factor in teacher retention (García & Weiss, 2019b). Veteran teachers also lack professional growth opportunities aligned to their needs and interests, in particular those related to career advancement. According to the National Education Association, “teacher leadership is at the heart of transformation in any school” (Teacher Leaders, n.d.), as empowered teacher leaders can advocate for social justice and push the profession, their schools, and communities toward excellence. Despite its importance, there are too few pathways for teachers to both remain in the classroom and advance in leadership roles. Ensuring that teachers have meaningful opportunities for professional growth and advancement is essential to increasing retention.

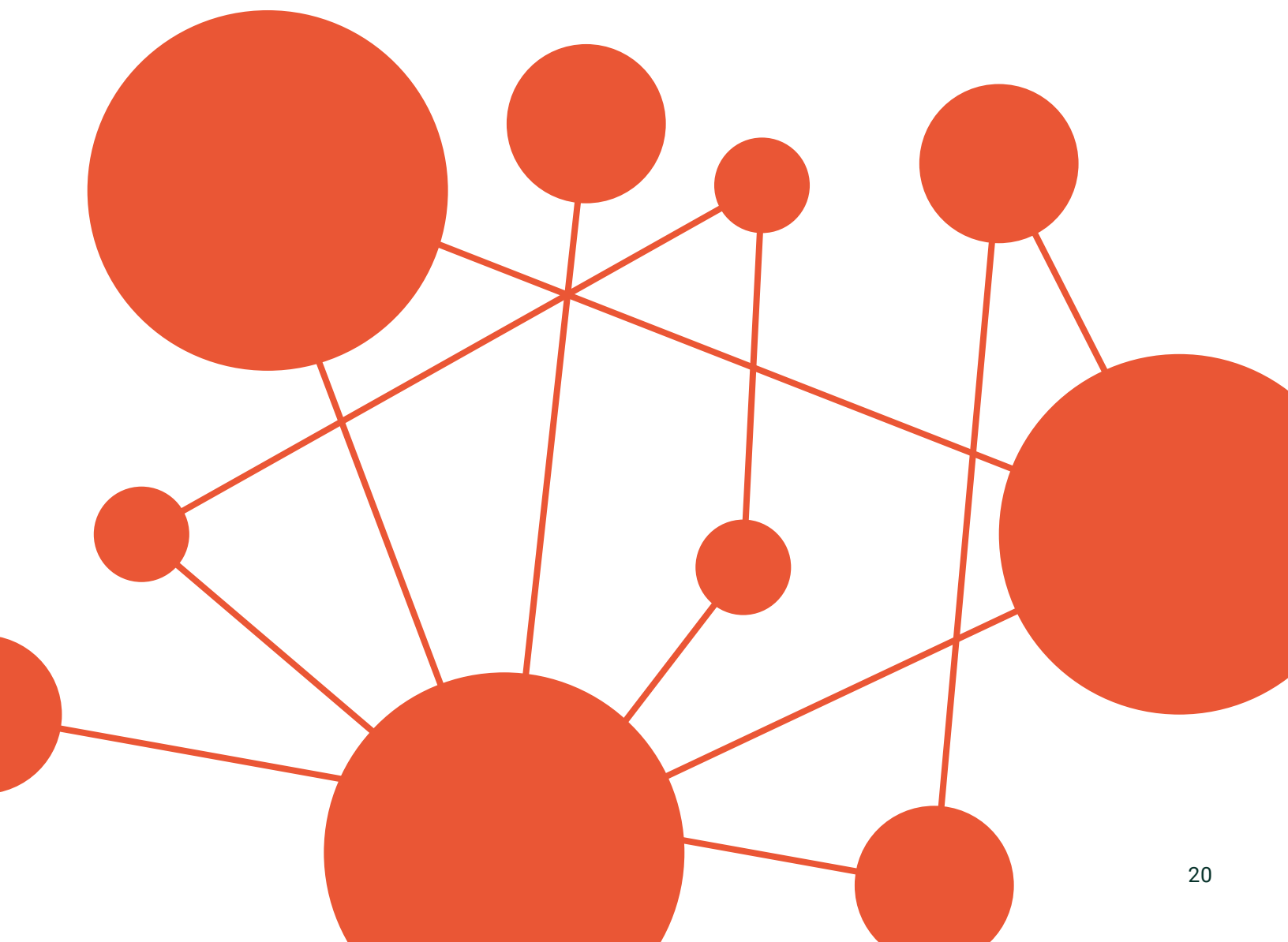
Keystones in this theme:

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

Jump to a list of all challenges in this theme 

MODELS TO LEARN FROM

NYC Public Schools, a Beyond100K partner, has collaborated with United Federation of Teachers to create an innovative approach to expand leadership opportunities for teachers with NYC Teacher Career Pathways (TCP). They have established four differentiated pathways for teacher leaders to expand their reach beyond their individual classroom including Model Teacher, Peer Collaborative Teacher, Master Teacher, and Teacher Team Leader. At all stages, teachers support and strengthen instruction through engaging with colleagues, as well as advocate for change within their school community. Their website provides resources for others who may want to consider adopting similar pathways for career advancement including overviews of the leadership roles, guidance for implementing these pathways, tools and literature to support both teacher and school leaders and their school communities, and model case studies. You can also [subscribe to their newsletter](#) to stay abreast of their work.



Student Experience in STEM and School

In story after story shared through [the unCommission](#), we heard from young people that to succeed in STEM, students need to feel they belong in STEM. This is particularly true for Black, Latinx, and Native American students. “Research shows how a sense of belonging in rich and rigorous classrooms is directly correlated to students’ long-term academic success. Moreover, the Department’s Civil Rights Data Collection continues to demonstrate that students of color and students with disabilities are disproportionately excluded from learning opportunities in STEM,” said U.S. Deputy Secretary of Education Cindy Marten (U.S. Department of Education, 2022).

Too often students of color and girls are discouraged from pursuing advanced STEM courses due to perceptions about STEM and who

is able to be successful, and when they do, they have few classmates or role models who share their race, ethnicity, gender identity, or culture. The COVID-19 pandemic has only exacerbated this issue. It has also disproportionately impacted the schooling experiences of Black, Latinx, and Native American students, both their academic opportunities and their social emotional wellbeing (e.g., sense of belonging, feeling of safety, mental health.) Focusing attention on the student experience in STEM and in schools is crucial as we think about the future STEM workforce, including the STEM teacher pipeline. We must prepare and support teachers to cultivate classrooms of STEM belonging, which includes providing teachers with practical tools and resources and encouraging them to understand and confront their own expectations and implicit biases.

Keystones in this theme:

* 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

Jump to a list of all challenges in this theme [—————>](#)

MODELS TO LEARN FROM

In 2019, Beyond100K partners formed the [Addressing Implicit Bias in the Classroom](#) Project Team, with the goal to develop a strong perspective about how to raise educator awareness of bias in STEM classrooms, explore its effects, and interrupt it. In this post-COVID era, this team's work is even more crucial. The team noted that culturally-responsive classrooms promote a sense of belonging among students and enhance their self-perceptions as successful learners. 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, racial/ethnic, and gender diversity in our nation's classrooms. Research shows that teachers can engage in deficit-based and fixed-mindset thinking about their students, often due to social biases they may not even be aware of holding.

This team aimed to support educators in taking actions in their classrooms that promote students' identities as STEM learners who know that they belong and can excel in STEM classrooms. In their [report](#), the team shares effective professional growth materials, resources, and experiences that engage educators in research and practices that address and interrupt bias by exploring key concepts behind biased classroom interactions and the outcomes that can result.

Joyful, Relevant, and Rigorous STEM Instruction

Too few STEM teachers are prepared and supported to teach in joyful, relevant, and rigorous ways, despite knowing that students thrive and feel a sense of belonging when learning experiences are connected to their cultures, interests, and future careers. In 2022 the U.S. Department of Education launched the [YOU Belong in STEM](#) initiative to strengthen STEM education nationwide through “rigorous and relevant educational experiences that inspire and empower them to reach their full potential as productive, contributing members of our nation’s workforce” (U.S. Department of Education, 2022). There are several obstacles to this kind of effective instruction. For one, there is not agreement on the meaning of STEM, which is often related to STEM instruction being siloed into individual subject areas. Other structural issues include accountability measures, as they can drive

school administrators to prioritize highly-tested subjects (like mathematics) at the expense of other STEM subjects, including science, engineering, data science, technology, computational thinking, and computer science. The focus on assessment scores and correct answers often results in an overreliance on teach to the test methods that can be in conflict with engaging and culturally responsive instructional strategies, particularly in schools with majority Black, Latinx, and Native American students. Even when structural elements are in place, STEM teachers and districts have difficulty finding and using STEM curricula that support every student to know they belong in STEM. In order for every student to have STEM opportunity, it is critical that they experience joyful, relevant, and rigorous STEM learning.

Keystones in this theme:

BEYOND100K FOCUS 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

- * There is not agreement on the meaning of STEM
- * 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

Jump to a list of all challenges in this theme [→](#)

Partners Making Impact

We are excited to build on the strong work that partners are already leading to further mobilize the Beyond100K network to take on the keystone: “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.” The Texas-based [Empowering Teachers to Close STEM Opportunity Gaps with a Culturally Responsive Education Toolkit](#) Project Team worked to support the creation of curricula that validate and reflect the diversity, identities, and lived experiences of all high school students. This team created a [toolkit](#) that can help equip schools and

teachers to better reflect the cultural and linguistic diversity of their students in order to empower them to succeed in STEM courses. The [Social Justice through Critical STEM Pedagogy](#) Project Team, which began as the [Statistical Literacy, Computational Thinking, and Social Justice](#) Community of Conversation, worked to specifically address making STEM content exciting and relevant by taking a social justice approach. These teams worked to create a kit of practical tools for STEM teachers to use as they design learning experiences that will lead students to change the world in equitable and personally relevant ways.

MODELS TO LEARN FROM

Rebecca Vieyra and her team from [PhET Interactive Simulations at University of Colorado Boulder](#) received an Implementation Grant from Beyond100K to support their work to advance the availability of joyful, relevant, and rigorous STEM instructional materials, and support teachers in utilizing their materials. PhET creates fun, interactive, and research-based simulations for exploring over 100 STEM topics including the greenhouse effect, the science of skate parks, and the probability behind the game Plinko. Recently, the team developed an [equity framework](#) that centers relevance, representation, and accessibility to evaluate and refine their simulations; this framework is available to the public on their new [DEIB in STEM Education webpage](#).

With the Beyond100K funding, PhET has designed three new modules that are in the process of being embedded to their [Virtual Workshops](#) for teachers focusing on topics like establishing a teaching and learning classroom climate to support joyful, relevant, and rigorous teaching and learning. Since the initial grant from Beyond100K, they received additional funds from the William and Flora Hewlett Foundation, Bill and Melinda Gates Foundation, and Verizon to expand upon their equity-related work.

Foundational STEM Teaching and Learning

Research shows that early exposure to STEM can not only increase interest in pursuing STEM careers in the future, but lays the foundation for success in these fields (Nesmith & Cooper, 2020). Moreover, it is also a major predictor of success later in school and in life (Duncan, et al., 2007). Pre-K and elementary STEM teachers can “help students connect with their natural curiosity and experience the joy of experimentation, problem-solving, and inquiry; see that puzzling, attempting, stumbling, learning, and improving are about growth, not failure; and grow into confident and emboldened drivers of their own educations and futures” (100Kin10, 2019).

Too many Pre-K and elementary teachers, however, are prepared as generalists and do not have access

to STEM-specific faculty through their preparation experience. This is aggravated by the fact that they often have not had the opportunity to develop their own STEM identity (either before or while they were being prepared to teach), can lack comfort with STEM content, and rarely feel a strong sense of belonging in STEM fields. To further exacerbate matters, Pre-K and elementary teachers can be led by school administrators who lack STEM background and expertise, making it difficult to access STEM instructional resources and prioritize dedicated STEM time in their classrooms. Preparing and supporting teachers to facilitate joyful, rigorous, and relevant STEM learning at the elementary level is crucial.

Keystones in this theme:

BEYOND100K FOCUS 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
- * 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)

Jump to a list of all challenges in this theme 

Partners Making Impact

Informed by the original Grand Challenges map, Beyond100K partners have been working collectively to enable joyful and rigorous foundational STEM, and in particular math, with a focus on the highest-leverage keystones associated with this theme.

In 2019, we began this work with nearly 40 partners to analyze the issues surrounding foundational math, resulting in the report, [“Doing the Math: Building a foundation of joyful and authentic math learning for all students.”](#) In 2021, we released an update to this research in light of the network’s progress to date, the COVID-19 pandemic, and calls for racial justice. The report, [“Reigniting Joyful, Rigorous, and Equitable Foundational Math Learning,”](#) shares the results of interviews with math teachers, coaches, and interventionists about their experiences supporting low-income Black, Latinx, and Native American early STEM learners during 2020.

Since then, more than 50 partners have worked collaboratively across 10 learning and problem-solving teams to develop solutions to some of the keystone challenges. The [Standards for Culturally Relevant Mathematical Practice and Inquiry](#) Project Team worked to adapt the Common Core State Standards for Mathematical Practice through the lenses of culturally relevant teaching and social justice mathematics. They arrived at a subset of five practices that are inspiring, humanizing, and

joyful, supporting teachers and teacher preparation programs to see the work of liberation and education as inextricably linked. Check out the team’s [website](#) to learn more. The [Developing and Supporting STEM Mindsets in Elementary Teachers](#) Project Team worked to address belonging through teacher mindsets, confidence, and self-efficacy. This team researched and reported on proven best practices and instructional strategies to support PK-5 teachers in confidently and effectively implementing STEM curricula. As a final product, a [website](#) was published to provide both formal and informal education institutions research-based tools and resources that summarize effective elementary STEM mindset professional development resources and pedagogies.

Most recently, the 2023 [Beyond100K Foundational STEM CoLab](#) has been working together since April to explore the question, “How might we cultivate strengths and create opportunities to make connections between communities and learning while making math joyful for students and teachers?” The team created a website with a [repository of joyful mathematical experiences](#) featuring resources for teachers and parents, organized both by grade level and type of resource. The website also includes articles, books, podcasts, websites, videos, games, and opportunities for professional development to support joyful, relevant, and rigorous learning.

MODELS TO LEARN FROM

Beyond100K partners worked together from 2020-2021 through the [High Quality STEM Teaching and Learning](#) Project Team with the goal of helping both pre-service and in-service teachers increase their integrated STEM content knowledge as well as their repertoire of instructional strategies. This team recommended changes for elementary teacher preparation programs synthesized in their concept paper, [Principles of Effective STEM Teaching for ALL Elementary Students](#).

Building on their concept paper and principles, the team created a [website](#) that includes interactive Edpuzzles to prompt educators to reflect on each of these STEM principles for both Pre-K–2 as well as 1st–6th grades with a focus on ensuring historically marginalized students excel in STEM.

THEME

08

Equitable STEM Pathways and Opportunity

For students to feel belonging in STEM, they need to be able to access and engage in STEM learning across their PK-12 experience. As described in the Foundational STEM Teaching and Learning theme, early exposure to joyful, relevant, and rigorous STEM is crucial to encouraging students' natural curiosity and setting them up for future success. At the high school level, too few schools have robust offerings of STEM courses available to their students; for those that do, Black, Latinx, and Native American students are too often discouraged or excluded from these courses or relegated to lower-level coursework.

Since most school funding is tied to income and/or property taxes, schools in lower income communities can lack resources to support STEM teaching and learning. This can be especially problematic in schools in low-income communities that often serve students of color, and in rural or geographically isolated areas where there may be fewer external STEM resources available. We must prioritize addressing inequities in students' experiences with STEM both inside and outside the classroom, including through opportunities in career and technical education and diversified pathways for STEM learning and advancement.

Keystones in this theme:

BEYOND100K FOCUS High schools are not often required to have a robust offering of STEM courses

Jump to a list of all challenges in this theme [—————>](#)

Partners Making Impact

The Beyond100K network has been working collectively to increase equity in high school STEM, the highest-leverage keystone associated with this theme. Working together with nearly 40 partners to analyze the issues surrounding equity in high school STEM, we launched our joint efforts in 2020 by releasing the report, "[Shifting Courses: Achieving Equity in High School STEM](#)".

Since then, more than 90 partners have worked collaboratively across 23 learning and problem-solving teams to develop solutions. The [Instructional Strategies that Promote Classroom Equity](#) Project Team formed to learn about the best pedagogical strategies to enhance equity in the classroom that specifically target discourse, communication, and opportunities for all students

to participate in problem solving and engage in evidence based argumentation. The [Supporting STEM Education in Tribal Communities](#) Project Team explored how to support STEM teaching and learning in tribal communities, including how to support centering historically underrepresented Indigenous perspectives into STEM instruction. Co-produced with tribal members, the team released [FIRST STEPS: A Resource for Engaging with Indigenous Communities in STEM](#) to assist non-Native STEM educators and others who would like to begin outreach and engagement with Indigenous communities. The [Culturally Responsive Pedagogy and Online Instruction](#) Community of Conversation came together to explore how teacher preparation programs can guide their high school science candidates to incorporate culturally responsive pedagogy into their online instruction as a result of the COVID-19 pandemic. Together, they read “Science in the City: Culturally Relevant STEM Education” by Bryan A. Brown and created a [discussion guide](#) that includes probing questions for educators as they read the book.

This book stresses the importance of STEM educators incorporating a multi-cultural approach to urban science education so students can make meaningful connections between science and their culture.

Beyond100K partner [Ignited](#) made the most of the work of the [Unconventional STEM Career Pathways](#) Project Team with an Implementation Grant to train their curriculum coaches on the toolkit the team created, which provided tools to teachers who want to address broader societal issues and integrate inclusive pedagogy in STEM classrooms. Specifically, it offers support for learning more about social justice and incorporating it in the classroom as instructional leaders. The resources section includes suggestions for finding social justice in STEM supporters, anecdotes from other teacher advocates, research-backed data points related to equity and STEM, and a stakeholder letter template for teachers to use to gather support for their own classrooms.

MODELS TO LEARN FROM

[WeTeach_CS](#) at the University of Texas at Austin was launched in 2015 to increase the number of trained and certified computer science (CS) teachers in Texas. Leveraging support and funding from a Beyond100K fellowship, WeTeach_CS developed its nationally recognized online course to promote CS teacher certification, [Foundations of Computer Science for Teachers](#). The WeTeach_CS program, part of Expanding Pathways in Computing (EPIC) at the Texas Advanced Computing Center, is “dedicated to broadening participation in computing for every student regardless of race, gender, income, or location and leverages the TACC’s internationally recognized computing expertise to guide strategic improvement in computing education at a state and national level” (WeTeach_CS, n.d.). WeTeach_CS trains K-12 educators to improve access to high-quality computer science experiences for a broad and diverse range of students, and between 2015 and 2018, helped [more than 500 in-service teachers in Texas earn a computer science certification](#) – more than every university pre-service program in the nation combined. Due to this success in Texas, WeTeach_CS has shared its model and resources with partners in other states such as Alabama, Ohio, Indiana, Pennsylvania, South Carolina, West Virginia, New Jersey, and Tennessee to increase the number of certified computer science teachers across the country.

Closing

Over the next decade, we will continue to mobilize the Beyond100K network to solve these challenges, especially the keystones, to end the STEM teacher shortage with equity, representation, and belonging. In particular, we will focus our energy and resources on the following keystones:

BEYOND100K FOCUS Teachers often lack time to collaborate or participate in professional development during the school day

BEYOND100K FOCUS School administrators are often not supported or required to cultivate positive work environments or belonging for teachers

BEYOND100K FOCUS Preparation programs often lack STEM-specific tracks and faculty with STEM expertise, especially for pre-service elementary teachers

BEYOND100K FOCUS High schools are not often required to have a robust offering of STEM courses

BEYOND100K FOCUS 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

We will also continue to strengthen the map to better represent how these challenges are experienced by Black, Latinx, and Native American STEM teachers and students, and how the intersectionality of individuals' identities impact their experiences, with the aim of making this map an even more actionable tool.

We invite you to join us, the Beyond100K network. Together, we can 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.

Appendix

ABOUT BEYOND100K

Beyond100K (formerly 100Kin10) unites the nation's top academic institutions, nonprofits, foundations, companies, and government agencies to co-develop and implement solutions that will end the STEM teacher shortage by 2043, especially for those most excluded from STEM opportunities.

We began in 2011, with 28 organizations banding together and making public commitments to respond to President Obama's call for 100,000 new, excellent STEM teachers in ten years. In 2021, now hundreds of partners strong, we exceeded that goal by together preparing more than 108,000 STEM teachers. To meet this goal, we developed an approach to social change called [Networked Impact](#), which brought our partner organizations together to form a unified identity under a common goal and work collaboratively to develop innovative solutions to shared challenges that none of us could solve alone.

To decide our next goal, we embarked on a unique and powerful listening journey called [the unCommission](#). We invited young people from across the country to share their experience with PK-12 STEM learning. More than 600 young people

responded to our call. They told us that when they felt excluded from STEM, they put aside their STEM dreams. When they belonged, their natural curiosity for STEM could take hold, and they pursued and persisted in STEM through college and beyond.

Guided by these stories, we announced our second moonshot goal in 2022: We will prepare 150,000 and retain 150,000 STEM teachers who cultivate classrooms of STEM belonging by 2032, especially for schools serving majority Black, Latinx, and Native American students. We are focused on these 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.

Learn more about Beyond100K and how you can join us at beyond100k.org.

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

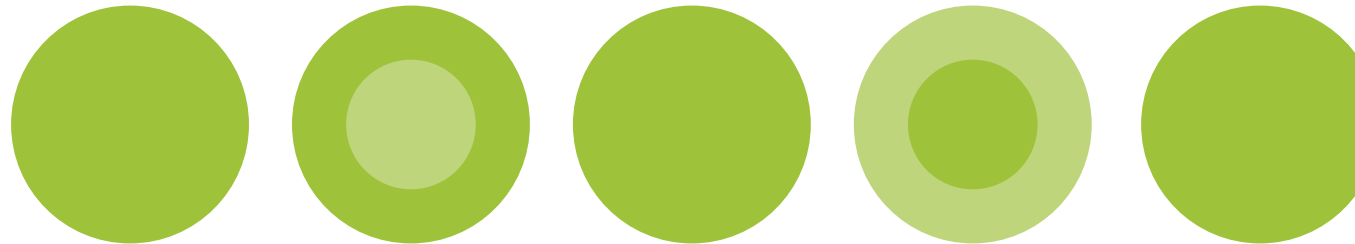
Early-career teachers often do not feel ready to teach STEM after completing their preparation program

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

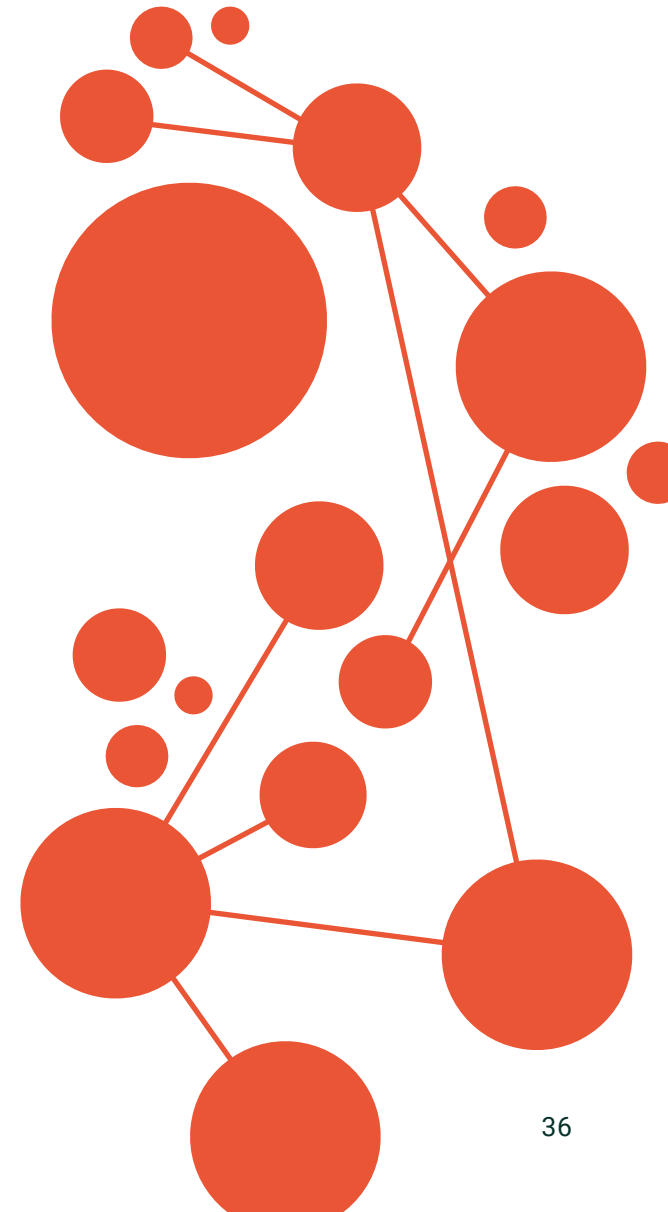
School administrators can be unaware of STEM teachers' professional development needs

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

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