THE CHALLENGE TREE

1 Teaching lacks prestige and is not widely perceived as a top career choice for STEM college graduates.

ROOT CAUSES

- There are insufficient financial incentives to enter the profession.
- Teaching is devalued by cultural norms.
- Teachers lack collaborative work environments.
- STEM professors devalue PK-12 teaching as a STEM career option and therefore do not encourage STEM students to pursue teaching.

2 Teachers are underprepared to effectively teach STEM subjects.

- Many teacher preparation programs have low admissions standards.
- STEM content and pedagogy are not integrated.
- Clinical preparation does not provide effective modeling and coaching for pre-service teachers.
- Teachers are not well-prepared to teach to diverse student learning needs.
- Many teacher preparation programs train STEM teachers without regard for local or regional district and school need.
- Many teacher preparation programs are reluctant to change their approach to training teachers.
- Teacher preparation programs do not track the quality of their graduates.

3 Many elementary teachers do not teach STEM subjects well.

- Elementary teacher preparation programs lack a STEM focus.
- There are limited STEM content supports and PD opportunities for elementary teachers.
- Elementary teachers have anxiety about teaching STEM subjects.

4 Professional development does not satisfy STEM teachers' professional learning and growth needs.

- There is no commonly-agreed upon trajectory for teacher professional growth.
- Teachers lack access to high-quality STEM PD opportunities.
- PD is often treated as an add-on or a compliance issue, rather than as the core part of a teacher improvement and retention.
- PD is used as a remedial tool for teachers walking into the profession under-prepared.
- Schools lack a collaborative environment to foster teacher growth.
- Teachers' voices are regularly absent from conversations about their professional growth.

5 STEM teachers lack leadership opportunities and flexibility to experiment.

- Teachers' voices are regularly absent from conversations about their professional growth.
- Teachers' voices are regularly absent from conversations about school-level leadership.
- The traditional school model discourages experimentation.

6 Science, technology, and engineering are undervalued in schools.

- Principals don't advocate for S, T, and E.
- Communities don't advocate for S, T, or E.
- Schools and principals aren't accountable for S, T, and E learning.
- Teachers lack access to opportunities to engage with current STEM content and STEM industry.

7 STEM teachers lack access to instructional resources, curriculum, and materials.

- Many teachers are not provided with necessary STEM curriculum.
- Teachers lack access to sufficient funding to offer high-quality STEM learning experiences to their students.
- Teachers lack access to opportunities to engage with current STEM content and STEM industry.

THE CHALLENGE TREE

1

Teaching lacks prestige and is not widely perceived as a top career choice for STEM college graduates.

ROOT CAUSES

There are insufficient financial incentives to enter the profession

- Starting salaries for STEM teachers are not competitive with starting salaries in other STEM careers.
- Lack of bonuses, both hiring and performance, discourage college students majoring in STEM fields from entering the profession.
- Long-term, low earning potential discourages college students majoring in STEM fields from entering the teaching profession.
- Student debt discourages college students majoring in STEM subjects from entering the teaching profession.
- Not enough states/districts use differential pay or other incentives to recruit and retain teachers in high-need STEM teaching positions.

Teaching is devalued by cultural norms.

- Families encourage their children to pursue other STEM professions, rather than STEM teaching.
- Teachers themselves discourage their students from becoming teachers.
- STEM teaching is not perceived as an intellectually rigorous career choice.
- STEM teaching is not considered a STEM job.
- Teaching is perceived as a "women's job."
- Men are underrepresented in the teaching profession.

Teachers lack collaborative work environments.

- Many districts do not hold school leaders accountable for creating positive working environments that attract and retain effective STEM teachers.
- There is a perception that teachers do not work with smart and supportive colleagues.
- Many teachers believe principals do not prioritize time for teacher-to-teacher learning and collaboration.*
- Some principals lack training to create school schedules that foster a collaborative learning environment for teachers.

STEM professors devalue PK-12 teaching as a STEM career option and therefore do not encourage STEM students to pursue teaching.

- Universities don't celebrate STEM teachers.
- The US Census Bureau considers STEM K-12 teachers to be non-STEM occupations in its job classification system.
- Because STEM teaching is not considered a STEM career by the census, nor by US News and World Report, universities discourage STEM teaching to prevent lower rankings around the number of graduates who pursue STEM careers.

Indicates root cause included more than once.

THE CHALLENGE TREE

2

Teachers are underprepared to effectively teach STEM subjects.

ROOT CAUSES

Many teacher preparation programs have low admissions standards.

+ Many applicants for teacher preparation programs are in the bottom half of their college class.
+ Most states do not insist that teacher preparation programs have rigorous admissions standards as part of the requirement for securing state approval of the program.

STEM content and pedagogy are not integrated.

+ College professors do not teach STEM subjects using the types of instructional strategies teachers would be expected to use in the classroom.
+ Universities often lack STEM-specific teacher education programs.
+ Collaboration between education departments and STEM disciplines within universities is weak.
+ Teacher preparation coursework provides little exposure to STEM content unless the pre-service teacher is majoring in a STEM field.
+ Teachers lack training to design and deliver active STEM learning experiences for their students.
+ Most states do not require adequate STEM content coursework for students in teacher preparation programs.

Clinical preparation does not provide effective modeling and coaching for pre-service teachers.

+ There is a lack of STEM mentor teachers.
+ Mentor teachers lack adequate training and support to translate their strong teaching practices into strong coaching practices for beginning teachers.
+ Pre-service teachers lack the time and opportunities as a part of their clinical preparation to observe high-quality teaching.
+ Pre-service teachers lack the time and opportunities as a part of their clinical preparation to practice their instruction in a classroom setting.
+ Most states do not require that teacher preparation programs have substantial clinical experiences as part of the requirement for securing state approval of the program.
+ Most states do not require that the clinical component of teacher preparation gives teacher candidates time to practice in schools with the support of high-quality STEM teacher mentors.

Teachers are not well-prepared to teach to diverse student learning needs.

+ Limited exposure to STEM coursework in PK-12 discourages diverse students from pursuing STEM teaching in college.
+ Many teachers do not share cultural or racial backgrounds with their students.
+ Teachers are not sufficiently prepared to teach to diverse learning needs (including ELL and SpEd students).
+ Teachers are not sufficiently prepared with culturally-relevant teaching strategies.
+ There are insufficient opportunities for teachers to access strong, culturally-relevant STEM curricula and resources.
+ There is a perception that poor and minority students, as well as girls, cannot excel in S, T, and E courses.
+ Teachers are not prepared for the unique challenges in rural schools.

Many teacher preparation programs train STEM teachers without regard for local or regional district and school need.

+ Too few teacher preparation programs and local or regional schools or districts collaborate around how new STEM teachers are trained.
+ Teacher preparation programs lack systems to forecast accurate numbers of future STEM teacher vacancies.
+ Most states do not track teacher supply and demand data to ensure that preparation programs are producing the right number of teachers in high-demand STEM content areas.

Many teacher preparation programs are reluctant to change their approach to training teachers.

+ Some teacher education departments generate revenue, so some universities are reluctant to change them.
+ State-level teacher certification policies discourage teacher preparation programs from innovating around STEM teaching.
+ Most states do not have alternative routes to certification for teachers in STEM subjects.

Teacher preparation programs do not track the quality of their graduates.

+ Teacher preparation programs do not have clear accountability measures for producing effective STEM teachers.
+ Pre-service teacher testing methods (i.e. Praxis) do not predict teacher effectiveness.
+ Most states do not connect their process of approving teacher preparation programs to measurable outcome data about programs' graduates on the job.

**Indicates root cause included more than once.*

THE CHALLENGE TREE

3

Many elementary teachers do not teach STEM subjects well.

ROOT CAUSES

Elementary teacher preparation programs lack a STEM focus.

+ States lack content area requirements for elementary teacher candidates.
+ Preparation programs lack rigorous STEM requirements for elementary teacher candidates.
+ Elementary teachers lack training to teach higher-order thinking skills, as required by science and math standards.
+ Many preparation programs lack clear STEM accountability measures for elementary teacher candidates.
+ There are few professors who are experts in elementary STEM education.
+ Most states do not require teacher candidates to demonstrate content knowledge through certification tests.

There are limited STEM content supports and PD opportunities for elementary teachers.

+ Elementary teachers are often viewed as generalists that do not require STEM-specific PD.
+ Most PD opportunities for elementary teachers focus on math, reading, and writing, rather than science, technology, engineering, or integrated STEM concepts and content.
+ Some school leaders do not allocate resources to science, technology, and engineering PD for elementary teachers because they do not believe that all students have the capacity to learn content beyond the basics of math and reading.
+ Families and communities are not aware that S, T, and E skills are as necessary as literacy skills for today's jobs.*

Elementary teachers have anxiety about teaching STEM subjects.

+ Most states do not insist that teacher preparation programs ensure that elementary school teacher candidates in particular are given instruction in teaching STEM subjects (since few have degrees in math or science).
+ Elementary teachers lack adequate STEM instructional resources and supports.
+ Elementary teachers are expected to be experts in too many subjects.
+ Many elementary teachers lack experience with STEM content and practices.
+ There is a perception that elementary teachers have low levels of interest in STEM subjects.
+ Many elementary teachers had negative STEM experiences in school (including a lack of active STEM learning and low grades).

**Indicates root cause included more than once.*

THE CHALLENGE TREE

4

Professional development does not satisfy STEM teachers' professional learning and growth needs.

ROOT CAUSES

There is no commonly-agreed upon trajectory for teacher professional growth.

+ Many districts do not offer high-quality, targeted PD opportunities tailored to the needs of STEM teachers.
+ STEM PD is offered irrespective of individual teacher's needs.
+ Teachers are not clear on how specific PD opportunities will improve their STEM teaching skills, so there is less buy-in by teachers in their PD.
+ There is no agreed upon purpose for STEM PD at different stages of a teacher's professional life cycle.
+ Teacher evaluation criteria do not align with teacher professional growth needs.

Teachers lack access to high-quality STEM PD opportunities.

+ Teacher evaluation criteria rarely differentiate between stages of a teacher's professional growth trajectory, with clear and differentiated goals for new teachers, early-stage teachers, mid-career teachers, and advanced teachers.
+ Collaboration between preparation programs, PD providers, districts/schools, and community partners is weak as it relates to teachers' professional growth.

PD is often treated as an add-on or a compliance issue, rather than as the core part of a teacher improvement and retention.

+ There is not a reliable method to measure the quality and impact of PD.
+ Teachers lack access and opportunities to collaborate with STEM experts.*
+ Given the rapidity of change in STEM fields, it is difficult for PD programs to keep pace with current content in these fields.*
+ Principals have a limited understanding of teachers' STEM PD needs.
+ Teachers are unsure of how to identify high-quality STEM resources.
+ Teachers lack PD focused on designing and delivering active STEM learning experiences for their students.
+ Most districts do not offer new STEM teachers induction or mentoring supports by experienced STEM teachers who can help them improve their STEM teaching.

PD is used as a remedial tool for teachers walking into the profession under-prepared.

+ The regular school day does not allow time for teachers to receive PD.
+ Schools do not effectively use student assessment outcomes as a part of teacher PD to improve STEM teaching.
+ Teacher continuing education units are determined by seat time.
+ Many states rely on seat time continuing education units as a requirement for re-licensure, rather than incorporating competency-based measures that account for STEM teacher experiences and knowledge.

Schools lack a collaborative environment to foster teacher growth.

+ Teachers are underprepared for the challenges they will face in the classroom, demanding more of PD programs than they can reasonably fulfill.

Teachers' voices are regularly absent from conversations about their professional growth.

+ Many teachers believe principals do not prioritize time for teacher-to-teacher learning and collaboration.*
+ Regular school day schedules offer limited flexibility for teachers to collaborate.
+ Schools lack systems to support effective teachers to serve as coaches to their peers.
+ Few districts implement creative staffing and scheduling practices to maximize collaboration time for teachers so they can share effective means for improving achievement in STEM subjects.
+ Few districts implement creative staffing models to make better use of STEM teachers' time.

+ There is no clear method for identifying teacher PD needs.
+ There is no clear mechanism for teachers to communicate their PD needs to their principal, prep programs, PD providers, and community partners.
+ Teachers are rarely involved in the PD selection process.

Indicates root cause included more than once.

THE CHALLENGE TREE

5

STEM teachers lack leadership opportunities and flexibility to experiment.

ROOT CAUSES

Teachers' voices are regularly absent from conversations about their professional growth.

- There is no clear method for identifying teacher PD needs.
- There is no clear mechanism for teachers to communicate their PD needs to their principal, prep programs, PD providers, and community partners.
- Teachers are rarely involved in the PD selection process.

Teachers' voices are regularly absent from conversations about school-level leadership.

- Schools fail to provide vehicles for STEM teacher leadership.
- Principals do not prioritize STEM teacher leadership and peer coaching.
- Most states/districts do not have in place robust career ladder structures that recognize, develop, and reward excellent STEM teachers.

The traditional school model discourages experimentation.

- Teachers lack time to experiment with new STEM teaching strategies, particularly active STEM teaching strategies, in the classroom.
- Teachers lack autonomy to experiment with new STEM teaching strategies, particularly active STEM teaching strategies, in the classroom.
- Student testing requirements prevent teachers from thinking and acting creatively.
- Few districts implement creative staffing models to make better use of STEM teachers' time.
- Testing and accountability requirements discourage experimentation in the classroom.

**Indicates root cause included more than once.*

THE CHALLENGE TREE

6

Science, technology, and engineering are undervalued in schools.

ROOT CAUSES

Principals don't advocate for S, T, and E.

- Principals lack relevant STEM training and experience.
- There is a lack of appreciation among principals for S, T, and E as subject areas.
- Principals lack an understanding of how to integrate technology, engineering, and computer science into the curriculum.
- Principals struggle to recruit and hire enough qualified STEM teachers.
- Most districts do not have a way of ensuring that school principals have the skills and knowledge needed to effectively evaluate STEM teaching practices.
- Principals lack the funding necessary to purchase STEM supplies and resources.

Communities don't advocate for S, T, or E.

- Student testing requirements in math and ELA discourage teachers from focusing on S, T, and E.
- Schools are not held accountable for test scores that relate to S, T, and E (so schools don't advocate for these subjects).
- Traditional school instructional models do not prioritize teaching S, T, and E concepts.
- STEM curriculum is not integrated across subjects, units, and lessons.
- Districts do not always require that all high schools offer a broad range of STEM course choices, including AP courses.

Schools and principals aren't accountable for S, T, and E learning.

- Families and communities are not aware that S, T, and E skills are as necessary as literacy skills for today's jobs.*
- S, T, and E professions are not well-understood.
- Families and communities do not know how to contribute to students' S, T, and E learning.
- Rural communities have few examples of diverse STEM jobs, making it harder for parents and others to see the value of STEM.
- Many communities have few examples of women working in STEM fields, leading some parents and others to devalue STEM learning for girls.

Teachers lack access to opportunities to engage with current STEM content and STEM industry.

- States, districts, and schools lack a clear definition of S, T, and E teaching and learning.
- Districts and schools lack a clear definition of desired S, T, and E-specific student-level outcomes.
- Schools lack a clear accountability structure for S, T, and E teaching and learning.
- States lack PK-12 computer science standards.
- Some non-NGSS states lack engineering standards.
- Some non-NGSS states lack strong science standards.
- Most states do not specify comprehensive S, T, and E student learning standards at all grade levels.
- Most state accountability systems do not incorporate technology and engineering student learning outcomes, which may limit a school's willingness to support creativity and innovation in STEM teaching.
- Most states do not require teacher candidates to demonstrate content knowledge through certification tests.
- Districts, schools, and communities lack a coordinated approach to facilitate collaboration between teachers and STEM industry experts.
- Teachers lack access and opportunities to collaborate with STEM experts.*
- Teachers lack access to current content in fields that are rapidly changing, especially S, T, and E.*
- Most districts do not provide STEM teachers with business internship opportunities to keep their skills and knowledge relevant and ensure that students are being exposed to the latest industry trends.

Indicates root cause included more than once.

THE CHALLENGE TREE

7

STEM teachers lack access to instructional resources, curriculum, and materials.

ROOT CAUSES

Many teachers are not provided with necessary STEM curriculum.

+ Teachers are unsure of how to identify high-quality STEM resources.
+ Teachers lack the instructional resources they need to integrate technology and engineering concepts into their classrooms.
+ Teachers lack the instructional resources they need to integrate science standards into their instructional practice.
+ Districts struggle to identify high-quality engineering and technology curriculum.

Teachers lack access to sufficient funding to offer high-quality STEM learning experiences to their students.

+ Teachers lack funding to purchase STEM teaching and learning supplies.
+ Teachers, especially in less affluent schools, lack STEM teaching and learning labs.
+ Most districts do not designate funds for STEM instructional resources.

Teachers lack access to opportunities to engage with current STEM content and STEM industry.

+ Districts, schools, and communities lack a coordinated approach to facilitate collaboration between teachers and STEM industry experts.
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