



Designing and Scaling Evidence-Based STEM and Special Education Instructional Systems to Strengthen Learning Outcomes in Underserved U.S. School Districts

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Introduction

Underserved school districts in the United States, often those with high poverty rates, rural locales, or predominantly minority enrollments, face persistent challenges in delivering high-quality STEM (science, technology, engineering, and mathematics) education and special education services. Achievement data reveal longstanding inequities. Even before the COVID-19 pandemic, nationwide student performance in core subjects was stagnant or declining. For example, the 2019 National Assessment of Educational Progress (NAEP) showed that only about one-third of U.S. fourth- and eighth-graders scored “proficient” in reading or math, with overall proficiency around 34% and signs of lower scores compared to 2017¹. In science, roughly 35% of eighth-graders were proficient in 2019², and performance gaps between subgroups remained large—for instance, Black eighth-graders scored an average of 30 points lower than their White peers². International assessments likewise reflected stagnation; the 2018 Programme for International Student Assessment (PISA) ranked the U.S. 36th in math, trailing most other industrialized nations³. These statistics highlight an urgent national problem: many students, especially in underserved communities, are not gaining the STEM skills and knowledge needed for college and careers.

The disruptions of the COVID-19 pandemic exacerbated these academic challenges and widened disparities. Pandemic-era NAEP data show steep declines in achievement that set progress back decades. The 2022 assessments found that fourth- and eighth-grade math scores dropped by 5–8 points compared to 2019, erasing gains made since the early 2000s⁴. Learning loss was not evenly distributed; it hit vulnerable groups hardest. Students from low-income families and historically marginalized racial/ethnic groups experienced disproportionately large declines⁵. In eighth-grade science, the 2024 NAEP revealed average scores falling to their lowest level since 2009, with the gap between high- and low-performing students the largest on record⁶. More students scored below the basic level, and fewer achieved proficiency⁷. In short, the pandemic intensified inequities in educational opportunity, leaving underserved districts with even greater hurdles to improving STEM outcomes.

Students with disabilities are among those most affected by weaknesses in instructional systems. Approximately 7.5 million children ages 3–21 receive special education services under IDEA (15% of public-school enrollment in 2022–23, up from 13% a decade earlier)⁸.



Yet outcome indicators for these students lag significantly behind. Only about 28% of eighth-grade students with disabilities scored at or above the “Basic” level in NAEP math, compared to 67% of students without disabilities⁹. Proficiency rates for this subgroup are often in the single digits. Moreover, the adjusted high school graduation rate for students with disabilities was 71% in 2021–22, far below the 87% rate for all students¹⁰. These disparities highlight systemic issues in how schools serve learners with special needs. Many students with disabilities in underserved districts lack consistent access to the individualized, evidence-based instruction required to meet state standards and close achievement gaps.

The twin challenges of bolstering STEM achievement and improving special education outcomes are tightly interrelated. Underserved districts frequently contend with resource gaps, fewer qualified teachers, limited access to advanced coursework or modern labs, and higher student needs, which undermine both general and special education. A recent analysis found that schools serving predominantly low-income or minority populations have more difficulty staffing core subjects with certified, experienced teachers. Most U.S. states report annual shortages of STEM teachers, and schools struggle to fill math and science positions at 3–4 times the rate of other subjects¹¹. In the special education arena, the shortages are dire: in the 2022–23 school year, 21% of schools had at least one special education teacher vacancy, and over half reported great difficulty hiring for those roles¹². High-poverty and high-minority districts are especially impacted—they are more likely to have uncertified or novice teachers in special education positions¹³. This staffing crisis means that students with disabilities in underserved areas often do not receive the complete services or quality instruction mandated by their Individualized Education Programs (IEPs). A 2024 federal report documented cases where staff shortages led to delayed or denied services, prompting legal findings that such lapses violate students’ right to a “free appropriate public education”¹⁴.

In sum, underserved U.S. school districts face a convergence of challenges: low overall performance in STEM subjects, wide achievement gaps for disadvantaged and disabled students, exacerbated learning loss from COVID-19, and capacity constraints such as teacher shortages. However, research also provides reasons for optimism. A growing body of evidence indicates that when students in these contexts are given access to high-quality, evidence-based instruction, their learning outcomes improve markedly. The key lies in designing and scaling instructional systems—encompassing curriculum, pedagogy, assessment, and professional development—that are grounded in proven strategies and tailored to meet the needs of all learners. This white paper examines how districts can develop such evidence-based STEM and special education instructional systems to strengthen learning outcomes in underserved communities. It draws on recent statistics, academic studies, and federal reports to identify best practices and implementation strategies, offering a roadmap for sustainable improvement that is both ambitious and attainable.

Challenges in STEM and Special Education for Underserved Districts

To design effective solutions, one must first understand the nature of the problem. Underserved school districts often face systemic inequities that hinder student learning in STEM fields and limit the effectiveness of special education programs. Key challenges



include persistent achievement gaps, resource and capacity shortages, and historically siloed instructional practices.

STEM Achievement Gaps and Limited Opportunities: By many measures, students in high-poverty or otherwise underserved schools perform significantly below their peers in affluent settings on math and science assessments. The “achievement gap” in STEM begins early and widens over time. For instance, among eighth-graders in 2019, 67% performed at or above the Basic level in science nationally, but only 35% reached the Proficient level¹⁵. In high-poverty schools, proficiency rates were substantially lower (often only one-quarter or fewer students proficient), reflecting the compounded effects of socioeconomic disadvantage on learning. Racial/ethnic disparities also persist: in the 2019 NAEP, Black and Hispanic 8th graders trailed White and Asian peers in science by 20–30+ points on the NAEP scale¹⁶. These gaps correlate with inequities in access to rigorous coursework and enrichment. Underserved schools are less likely to offer advanced math and science classes (like Algebra I in 8th grade, calculus, or physics) and often lack updated laboratories or technology for hands-on learning. The result is fewer opportunities for students to engage deeply with STEM content, which in turn depresses achievement and interest in STEM careers. A Johns Hopkins University Press analysis noted the “urgent national problem” that many students, particularly those in underserved schools, are not provided a quality STEM education and thus struggle to compete in our technology-driven economy¹⁷.

Post-Pandemic Learning Loss: The COVID-19 pandemic magnified STEM learning disparities. In spring 2020, when 77% of schools abruptly shifted to remote instruction¹⁸, students in disadvantaged communities often faced greater obstacles (from a lack of internet access to greater COVID-related disruption at home). NAEP results confirm that pandemic disruptions set back progress for all students, but especially those already behind. By 2022, average math scores for 9-year-olds had fallen 7 points from 2020, erasing two decades of gains¹⁹. For fourth and eighth graders, 2022 math scores fell to levels last seen in the early 2000s²⁰. The National Science Board reports that these declines hit poverty-stricken schools hardest, widening the gap between low-income students and their more affluent peers²¹. Eighth-grade science scores in 2024 similarly showed larger drops among low-performing students, who are disproportionately from underserved groups²². Many of these students missed critical in-person learning experiences—for example, fewer reported doing hands-on experiments or inquiry activities during pandemic schooling, which correlates with lower science engagement and achievement²³. In sum, COVID-19 disruptions not only caused general learning loss but also exacerbated pre-existing inequities in STEM education.

Special Education Needs and Outcomes: Within underserved districts, students with disabilities face compounded challenges. These learners often attend schools that already struggle with limited resources, and they require specialized supports that are not consistently delivered. Federal data show that the proportion of students receiving special education services has grown (15% of enrollment in 2022–23, up from 13% in 2012–13)²⁴, reflecting improved identification and broader eligibility (including more students diagnosed with autism, learning disabilities, etc.). However, outcomes have not kept pace. On national assessments, students with disabilities (SWD) perform far below grade-level standards: for example, in eighth-grade math, only 28% of SWD scored at least Basic in recent NAEP results, versus 67% for students without disabilities²⁵. In reading and science, similarly large gaps are observed. While many SWD can learn the same content as their peers with



appropriate accommodations and instruction, the reality is that they often receive a diluted curriculum. In underserved schools, SWD may spend substantial time in remedial or separate settings that focus on below-grade-level work, limiting exposure to the full rigor of STEM subjects. Compounding this, graduation rates for SWD remain roughly 16 percentage points lower than the overall average (71% vs 87%)²⁶, and those who do graduate are less likely to have taken advanced STEM courses. This indicates that current instructional systems are not adequately supporting SWD in meeting college- and career-ready standards, particularly in math and science. The underlying issues include shortages of skilled special educators, insufficient training for general teachers on inclusive practices, and lack of alignment between general education curricula and special education goals.

Resource Inequities and Teacher Shortages: A foundational challenge across STEM and special education in underserved districts is a lack of equitable resources and human capital. Teacher quality is the most influential in-school factor for student learning. Yet, disadvantaged students are less likely to be taught by fully qualified, experienced teachers in STEM and special ed. Research confirms that teachers are inequitably distributed. According to a 2023 study, the supply of new teachers has declined by 30% since 2009, creating widespread vacancies, especially in math, science, and special education²⁷. Most states report chronic STEM teacher shortages each year²⁸. Schools in high-poverty or rural areas often cannot compete in salaries or working conditions, leading to positions filled by out-of-field instructors or long-term substitutes. National survey data found that schools are 3–4 times more likely to have difficulty filling STEM teaching roles than other positions²⁹. In special education, the situation is dire: high turnover (about 15% of special educators leave their school each year) and declining numbers entering the field have resulted in widespread unmet demand³⁰. The U.S. Government Accountability Office (GAO) and U.S. Commission on Civil Rights sounded alarms in 2024 about these shortages³¹. Critically, the shortages are most acute in underserved schools. For example, 28% of schools serving predominantly minority students reported at least one extraordinary ed teacher vacancy in 2022–23, compared to 17% of low-minority schools³². High-poverty schools likewise have fewer certified special educators. The percentage of special ed teachers without proper preparation is 5 points higher in those schools, and the share of fully certified teachers is 7 points lower, relative to more affluent schools³³. These gaps translate into less expertise available to adapt instruction for struggling learners and overcrowded caseloads that reduce individualized attention. The downstream effects on students include delayed services, as documented by GAO: some students did not receive the interventions in their IEPs because no teacher was available³⁴. In other cases, schools resorted to online or group services in place of intended one-on-one help³⁵. This resource crunch undermines any instructional improvement effort unless addressed in tandem.

Fragmented Systems and Lack of Coherence: Finally, a less visible but pivotal challenge is the fragmentation of instructional systems in many districts. Traditionally, key drivers of instruction—curriculum materials, assessments, and professional development (PD) for teachers—have often been handled in isolation, without a coherent strategy³⁶. General education and special education, in particular, frequently operate on separate tracks. For example, a district might adopt a new inquiry-based science curriculum (to meet Next Generation Science Standards) for general classrooms, but special education teachers are not trained in it or lack the resources to adapt it for students with learning difficulties. Professional development might focus on generic teaching strategies one year and on test



preparation the next, with little continuity. Assessments may not align with the curriculum or with what teachers are being trained to do. This lack of alignment leads to “shallow implementation of academic standards, which disproportionately affects already underserved communities”³⁷. In other words, high-poverty schools often get only superficial changes (e.g., cursory adoption of new standards without supporting changes in teaching practice), resulting in minimal impact on learning. The silos between general and special education further mean that interventions for struggling students are not well integrated into the core instructional program. A student with disabilities might receive pull-out support that isn’t coordinated with what happens in the STEM classroom, causing gaps and redundancies. Such systemic incoherence limits the effectiveness of even evidence-based components, because students do not experience consistent, reinforced learning. It also places extra burdens on teachers to bridge the gaps on their own, which is especially hard for novice or underprepared educators.

Evidence-Based Instructional Systems: Key Design Principles

Addressing the challenges above requires moving beyond piecemeal reforms to implement intentionally designed, evidence-based, and scalable instructional systems. An instructional system refers to the integrated set of curriculum materials, pedagogical approaches, assessments, and teacher support (including professional development and coaching) that together shape student learning experiences. Decades of research suggest several key design principles for effective instructional systems, especially in STEM and special education. These include: (1) grounding teaching practices in evidence-based methods proven to raise achievement; (2) ensuring alignment and coherence across curriculum, assessment, and professional learning; (3) centering the role of the teacher while equipping them with the tools and training to succeed; and (4) embedding supports for diverse learners (such as multi-tiered interventions and universal design) so that the system works for all students.

Grounding Instruction in Evidence-Based Practices: The Every Student Succeeds Act (ESSA) of 2015 emphasized “evidence-based” interventions in struggling schools, defining them as practices backed by rigorous research (experimental or quasi-experimental studies showing positive effects)³⁸. This reflects a broader consensus that educational improvement should rely on strategies proven to work, rather than untested theories. In the context of STEM and special education, there is a robust knowledge base of what works. For example, high-dosage tutoring in math—providing regular, focused, small-group instruction—has strong effects on math achievement for low-income students, often equivalent to several additional months of learning³⁹. Project-based learning (PBL) is another strategy with mounting evidence: studies in diverse schools found that when underserved students engaged in rigorous PBL, they significantly outperformed peers in traditional instruction across multiple subjects⁴⁰. In one study, middle schoolers in high-poverty schools using a PBL science curriculum scored higher not only in science but also in math and English language arts, with English learners improving language proficiency as well⁴¹.

Other validated strategies include explicit instruction (structured, systematic instruction especially effective for students with learning disabilities), cooperative learning (small group work with structured roles), and formative assessment techniques (frequent, low-stakes assessments to guide instruction). An evidence-based instructional system deliberately incorporates such practices as core components. For instance, a district may adopt an inquiry-



based science program aligned to Next Generation Science Standards because research shows it enhances student engagement and concept mastery. In special education, evidence-based practices include phonics-based reading interventions for students with dyslexia and applied behavior analysis for students on the autism spectrum. A 2011 Council for Exceptional Children review emphasized the necessity of identifying and training teachers in evidence-based practices to improve outcomes for students with disabilities⁴². Federal guidance reinforces this principle: a 2025 U.S. Department of Education report on inclusive practices urges states to use high-quality, evidence-based multi-tiered systems of support and culturally responsive instructional strategies⁴³.

Alignment and Coherence of Curriculum, Assessment, and Professional Development: For instructional systems to succeed at scale, all components must function in harmony. Research on systemic reform shows that when curriculum, assessments, and teacher training align to common standards and goals, student outcomes improve⁴⁴. Incoherence, by contrast, leads to superficial implementation, especially in underserved communities⁴⁵. The Literacy Design Collaborative (LDC) model, initially created for literacy, integrates curriculum modules, assessments, and professional development into a single framework and has demonstrated statistically significant learning gains (e.g., effect sizes of 0.37 in middle school implementation)⁴⁶.

Applying this model to STEM means aligning curriculum materials (e.g., hands-on science or algebra curricula) with assessments that truly measure intended outcomes, such as inquiry-based skills rather than rote recall. Professional development must train teachers to use the materials and interpret the assessments effectively. High-quality PD includes workshops, in-class coaching, teacher collaboration, and a focus on specific pedagogy aligned with the curriculum⁴⁷. For example, a district launching a robotics program should train teachers in PBL coding strategies, provide rubrics for evaluating student projects, and offer time for co-planning, particularly between STEM and special education teachers. Evidence suggests that aligned and sequenced PD is key to large gains in school turnaround efforts⁴⁸. A coherent instructional system provides a streamlined experience—curriculum drives content, assessments gauge learning, and PD hones teacher delivery.

Teacher-Centered, Student-Focused Implementation: Past reforms that attempted to bypass teachers through rigid programs or technology-centered solutions often failed to scale. Research underscores that teachers must be central to instructional change, especially in underserved districts where they are critical mediators of student success⁴⁹. A well-designed system empowers educators through tools, training, and collaborative structures. This includes just-in-time supports like digital platforms with lesson plans and formative assessment data, or teacher learning communities that meet regularly to analyze student work and refine instruction.

Mentoring and coaching are crucial for novice teachers, who are more prevalent in underserved areas. Approaches such as video coaching (with feedback on recorded lessons) or peer co-observation can accelerate their development⁵⁰. Rather than scripting teacher moves, the system should build teacher expertise to adapt instruction based on student needs. Engaging pedagogies, such as math discourse protocols or structured collaborative work, boost student engagement and achievement, particularly in STEM.



Multi-Tiered and Inclusive by Design: Equity demands instructional systems be designed to accommodate learners with diverse needs. Multi-Tiered Systems of Support (MTSS) structure interventions into three tiers: core instruction for all (Tier 1), targeted support for struggling students (Tier 2), and intensive individualized help (Tier 3)⁵¹. Federal policy encourages MTSS adoption to reduce over-referral to special education by addressing issues early. A high-quality math MTSS, for example, might include 90 minutes of core instruction and a 30-minute daily intervention block for re-teaching or enrichment⁵².

Universal Design for Learning (UDL) complements MTSS by embedding multiple means of representation, engagement, and expression into lesson design, enabling access for students with disabilities and English learners⁵³. For example, a STEM lesson might feature visuals, oral explanations, and manipulatives (multiple representations), allow written or oral outputs (multiple expressions), and include real-world relevance or choice (engagement).

High-Leverage Practices (HLPs) from special education—such as explicit instruction, metacognitive strategy teaching, constructive feedback, and family collaboration—also benefit all learners⁵⁴. Training all teachers in HLPs strengthens classroom inclusivity. Co-teaching models, in which general and special educators jointly instruct, provide differentiation within core classes. Frequent progress monitoring using curriculum-based assessments identifies students needing support, enabling timely, data-driven interventions. Inclusive systems ensure consistent, equitable learning opportunities for all subgroups.

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Conclusion

Underserved school districts across the United States continue to face entrenched disparities in STEM education and special education outcomes. These disparities—manifested in stagnant or declining test scores, wide achievement gaps, teacher shortages, and insufficient access to evidence-based instruction—have only worsened in the wake of the COVID-19 pandemic. However, this paper has demonstrated that these challenges are not intractable. Through deliberate design and strategic scaling of evidence-based instructional systems, districts can begin to close gaps and ensure that all students, including those with disabilities and those in under-resourced communities, have access to rigorous, inclusive, and effective instruction.

The path forward is both practical and evidence-grounded. The following recommendations summarize the central insights from this analysis:



- 1. Adopt Evidence-Based Practices at the Core:** Districts should prioritize interventions supported by rigorous research. These include inquiry-oriented science instruction, high-dosage tutoring in math, explicit instruction methods, and social-emotional learning supports. When implemented with fidelity, these strategies yield measurable gains, particularly for underserved populations⁶⁴.
- 2. Ensure Instructional Coherence:** Curriculum, assessments, and professional learning must be aligned to common learning goals. Fragmented initiatives—common in high-poverty schools often result in superficial implementation. A coherent system reinforces learning through consistent messaging, materials, and supports⁶⁵.
- 3. Invest in Teacher Development and Retention:** Teachers remain the most influential in-school factor for student achievement. Underserved districts must support both novice and veteran teachers through high-quality PD, in-class coaching, and collaborative structures. Addressing shortages, particularly in STEM and special education, through targeted pipelines and retention incentives is essential⁶⁶.
- 4. Embed Inclusivity and MTSS Principles:** Instructional systems should be designed for equity from the outset. Implementing multi-tiered systems of support, adopting Universal Design for Learning frameworks, and training all teachers in high-leverage inclusive practices ensures that students with disabilities and English learners are not left behind⁶⁷.
- 5. Use Data for Continuous Improvement:** Data should guide all phases of implementation from diagnosing needs and setting goals to tracking progress and refining practices. Disaggregated reporting allows districts to assess equity and transparency builds trust with stakeholders⁶⁸.
- 6. Scale Thoughtfully and Sustain:** Effective scale-up requires protecting the core components of successful interventions, adapting to local conditions, and embedding practices into policy and operations. Sustainable reforms are those that outlast leadership transitions and budget cycles⁶⁹.

Finally, this paper aligns with the broader national imperative articulated in the 2024 Federal STEM Strategic Plan: eliminating disparities in educational access and achievement is essential not only for equity but also for national competitiveness and civic vitality⁷⁰. Achieving that vision requires shifting from episodic reforms to systemic transformation rooted in research, inclusivity, and educator empowerment.

The evidence is clear: when students in underserved districts receive high-quality, evidence-based instruction, they thrive. The tools and knowledge are available. What remains is the collective will to act, invest, and stay the course.

About the Author



Dr. Ariel G. Belza is an experienced STEM and Special Education instructional leader whose work spans elementary, secondary, and higher education settings in both the Philippines and the United States. With a



professional portfolio grounded in evidence-based instructional design, inclusive pedagogy, and data-driven school improvement, Dr. Belza has served in key teaching and leadership roles across multiple underserved districts, including Nogales High School in Arizona, Crownpoint Middle School under Gallup-McKinley County Schools in New Mexico, Santa Fe High School, and Pine Hill Schools, where he continues to advance high-impact science education. His research contributions, including scholarly work on developing communities of practice for Filipino educators in the U.S., reflect his commitment to culturally responsive teaching and professional learning systems. Dr. Belza's expertise centers on designing scalable STEM and SPED instructional frameworks that promote equitable learning outcomes for diverse student populations, positioning him as a leading advocate for high-quality, accessible education in high-need school communities.

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