Smithsonian
Science Education Center

Zero Barriers

in K-12 STEM Education

SOURCEBOOK

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Zero Barriers in K-12 STEM Education

SOURCEBOOK

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ABOUT THE SMITHSONIAN SCIENCE EDUCATION CENTER

The Smithsonian Science Education Center (SSEC) is an organization of the Smithsonian Institution dedicated to *Transforming K–12 Education Through Science™* in collaboration with communities across the globe. To achieve our mission, we have four goals: (1) we promote authentic, inquiry-based, integrated K–12 science, technology, engineering, and math (STEM) teaching and learning; (2) we ensure all students and teachers are included in STEM opportunities and recognize themselves in STEM; (3) we advance STEM education for a more sustainable future; and (4) we translate the research and collections of the Smithsonian into meaningful tools and convenings for K–12 teachers and students. We achieve our goals by: (a) building awareness for science education among school leaders; (b) promoting Leadership and Assistance for Science Education Reform (LASER); (c) supporting the professional growth of K–12 teachers and school leaders; (d) developing exemplary K–12 curriculum materials and digital resources (including our comprehensive research-based science curriculum programs: *Smithsonian Science for the Classroom; Science and Technology Concepts for Middle School (STCMS); and Smithsonian Science for Global Goals);* and (d) engaging in research. The Smithsonian, through the Smithsonian Science Education Center, plays an active role in sparking students' and teachers' interest in STEM to ensure a scientifically literate and sustainable planet.

ABOUT THE ZERO BARRIERS IN K-12 STEM EDUCATION PROGRAM

In 2020, the Smithsonian Science Education Center initiated the Zero Barriers in K-12 STEM Education program. The goal is to empower teachers to structure lessons to address the needs of all students, including those with disabilities. In the school year of 2020–2021, the Smithsonian Science Education Center partnered with District of Columbia Public Schools (DCPS) to pilot the program. Starting in 2022, the Smithsonian Science Education Center extended an invitation to educators across the nation to participate in the Zero Barriers in K-12 STEM Education Program. The program convened teams of educators representing schools, districts, and state education agencies across the U.S. for an education summit, to develop logic models that use the principles of Universal Design for Learning to address a problem of practice related to accessible STEM programs for all students, including students with disabilities. The program also provides midyear professional development to educators selected for the program. Between 2022 and 2023, the Zero Barriers program supported 37 teams across 14 states and Puerto Rico. Those teams represent 66,000 teachers, 7.8 million students, and 1 million students who identify as having a disability. In summer 2024, the participants of the 2022 and 2023 Zero Barriers teams attended a Reconvening Workshop, where they shared their reflections and the resources they used to promote K–12 STEM education for all students, including those with disabilities.

DISCLAIMER

Authors of this sourcebook reference their own lived experiences and may highlight resources from third party entities. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the Smithsonian nor should they be viewed as an endorsement by the Smithsonian.

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Thank you for your generous support!

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A LETTER FROM THE DIRECTOR

Purpose and Motivation: What's our why?

The Smithsonian Science Education Center's (SSEC) mission is to transform K–12 education through science, in collaboration with communities across the globe, because we believe every student needs a basic understanding of scientific concepts to thrive in our technology-driven world.

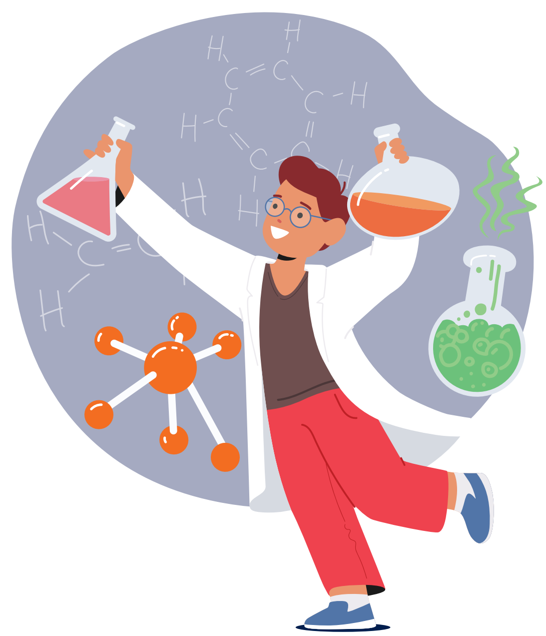
> "To us, a robust science education is a conduit for joy and creativity that encourages students to discover, understand, and act to solve real-world problems they care deeply about."

However, to ensure students can fully benefit from a high-quality science education, they must be presented with opportunities that do not compromise their ability to show up as their authentic selves to engage in their learning. The goal of the Zero Barriers in K-12 STEM Education program is to empower teachers to structure lessons to address the needs of all students, including those with disabilities.

AUDIENCE

Who is this resource for?

As a leader in science education reform for 40 years, the SSEC has a long-standing history of serving schools, districts, states, and ministries of education throughout the world. We support these stakeholder groups by providing programming and resources that are relevant for today's classrooms. Whether it's focused on promoting authentic, inquiry-based K–12 science, technology, engineering, math (STEM) teaching and learning, with a focus on the arts (STEAM); ensuring all students and teachers are included in STEM opportunities and recognize themselves in STEM; or advancing STEM education for a more sustainable future, our work revolves around providing key stakeholders with the information and tools they need to drive positive change in the education communities they serve.



CONTEXT AND RELEVANCE

What are the current challenges?

Approximately 15% of the U.S. public school student body identifies as having a disability. This means that we must ensure that STEM instruction is designed to meet the needs of ***all*** students — no matter their ability level. Otherwise, we may effectively discount a sizeable population of our students from the education they deserve. With an earnest effort to create more accessible STEM learning opportunities for students across a continuum of needs, we can develop the often-untapped talents and potential of students within the disability community. For instance, the increased prevalence of artificial intelligence (AI) integration within commonly used technologies has led to an increased demand for specific skills and traits (e.g., hyperfocus and detail-oriented tasks) that neurodivergent individuals may inherently possess (Dunne, 2023).

GOALS AND OUTCOMES FOR THIS RESOURCE

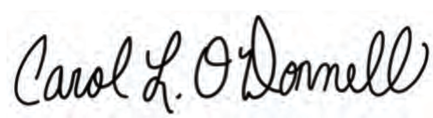
What do we hope to accomplish by sharing this information?

My husband was a special education teacher for 30 years before he retired. This ***Zero Barriers in K-12 STEM Education Sourcebook*** shares insights into the various strategies that K-12 educators — like my husband — have used to integrate accessible instructional practices into their classrooms, schools, districts, and state education agencies to ensure that all students, including those with disabilities, have increased access to STEM opportunities and can recognize themselves in STEM. This Sourcebook is meant to inspire and inform educators, but it does not aim to be prescriptive and in no way should it be considered comprehensive, because there is still so much more we must learn! To that end, this educator Sourcebook should be used as a foundational tool that encourages you to ask questions about how to bridge potential opportunity gaps for students with disabilities in your education community. We hope it provides you with strategies you can adopt in your education system to improve STEM learning conditions for all students, but especially students with disabilities.

ACKNOWLEDGEMENTS AND INSPIRATION

Who are the key contributors and supporters?

From autonomous vehicles to AI-supported language modeling, our students are growing up in a world that needs science, technology, engineering, and math (STEM) now more than ever. As the sole entity within the Smithsonian Institution whose mission is focused exclusively on improving formal K–12 STEM education, it is our duty at the SSEC to be responsive to the evolving and complex needs within our nation's education landscape. To effectively do this work requires support from key stakeholders. So, we want to first thank our funder, General Motors, for their consistent investment in this critical initiative, because we know that if students with disabilities have more positive learning experiences in their classrooms, they are more likely to develop the skills they need to solve future challenges. We also want to thank the educators who contributed to this endeavor by writing about their real experiences of implementing accessible STEM projects and initiatives in their classrooms, schools, districts, and states. Without their commitment of resources and expertise, this resource would not be possible.



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CHAPTER 1
Introduction

This chapter provides background for why this work is important, orients readers to universal design for learning, which is integral to the work, and offers a theoretical framework for the Zero Barriers in K-12 STEM program.

Why Is This Work Important?

Sherrell Williams

The Smithsonian Science Education Center is motivated by our desire to remain responsive to the needs in K–12 STEM education. There is no shortage of educational resources available to educators, even when filtering for materials themed around science, technology, engineering, and math (STEM). What is lacking, however, is a consideration for students with disabilities and how many existing STEM education resources, materials, and programs are not designed to meet the needs of individuals who display a wide range of abilities and lived experiences.

Society has developed in such a way that there is not a day that goes by in which most of us do not interact with something that has been enhanced by advancements in STEM. Around the world, technology has redefined our relationship with inanimate objects by making them "smart," which has increased our general consumption of technology and the global dependence on it for a variety of tasks. This suggests that foundational STEM concepts have become some of the most important content for students to learn if we wish them to successfully navigate the future workforce and activities of daily living. To ensure that today's learners are adequately equipped with the skills and tools they need to solve future challenges, we must ensure that every educator is equipped with the resources and tools they need to educate every student. Acknowledging that an estimated 7.3 million U.S. public school students (about 15%) identify as having a disability, we have a responsibility to not just create high-quality STEM content but also ensure that it is designed with the disability community in mind (Schaeffer, 2023).

That is where accessibility comes in. According to the American Alliance for Museums (AAM, 2017), accessibility is the idea that by removing barriers, we are "giving equitable access to everyone along the continuum of human ability and experience." It affords us a mechanism to engage all learners, particularly students with disabilities, so they can experience less friction along their pathways to STEM education programs and careers.

We are also driven by the expertise we have acquired through our Zero Barriers in K-12 STEM Education Program, which we believe provides critical support to practitioners as they work to improve STEM education for students with disabilities. Since the autumn of 2020, at our Zero Barriers in K-12 STEM Education Summit, we have observed and learned from hundreds of educators nationwide about the challenges they face in creating better STEM opportunities for students across a range of human abilities. Those educators' contributions have helped us identify trends across individual classrooms, schools, districts, and state education agencies to gain a better understanding of the state of education as it pertains to accessibility in K-12 STEM education. The information we have gathered from our summit programs has enabled us to position ourselves as a trusted source of information for educators seeking to broaden participation in STEM for individuals with disabilities.

Finally, when we reflect on our mission, it articulates an operational framework from which we can think about how we can best serve and work in collaboration with our stakeholders. As we continue to think about the future of the Smithsonian Science Education Center, we are intentional about elevating the lived experiences and knowledge of the stakeholders we collaborate with and who are in closest proximity to the challenges and opportunities K-12 STEM educators face. We trust educators, as leaders and content experts whose knowledge contributes to the development of invaluable resources, like this *Zero Barriers in K-12 Education Sourcebook,* to support other practitioners who may also desire to initiate change in their own communities.

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Universal Design for Learning in Education

Addy Allred

In U.S. public schools, 15% of students receive special education or specific services, per the Individuals with Disabilities Education Act (National Center for Education Statistics, 2024). Some of these students may identify as neurodiverse—the idea that humans are on a continuum of neural differences (Armstrong, 2010). Others may have a physical disability, varying language proficiencies, or diverse learning preferences. When we account for the inevitability of neurodiversity, physical disabilities, language proficiency, and diverse learning preferences in our classrooms, we ensure every student can thrive. Every student will absorb, process, and disclose information; engage with scientific phenomenon and real-world experiences; and engineer solutions to problems in a multitude of ways.

Universal Design for Learning (UDL) is an instructional framework (Meyer et al., 2013) that takes these differences into account. The framework recognizes that creating a robust learning environment for students with differing abilities and proficiencies cannot be accomplished by checking a list. Instead, it offers an instructional scaffold that promotes consistent observation and planning to design learning experiences that are accessible to all learners.

UDL is a pedagogical approach and concept coined in the early 1990s by *CAST*,[1] a nonprofit education research and development organization. The concept consists of three main components: engagement; representation; and action and expression (Meyer et al., 2013). These components together are assessed and configured so that students are offered flexibility in the way information is presented, how the students respond or decode knowledge, and the way students are engaged. Essentially, UDL affirms that no two students learn the same way; every mind and body has variability.

UDL provides flexible goals, methods, materials, and assessments to implement effective instruction for all learners, including those with diverse needs. Students who are engaged in UDL may be given a lesson in multiple forms of media, including verbal instructions, written directions, and demonstrations. And even through all the instruction, the goals and expression for students may not all be equivalent. A student who is nonverbal may not present their learning in the same way as a student with low visual acuity. While one may need assistance or encouragement to write out their ideas, the other may prefer to use a tactile method to participate in the same lesson.

For example, a teacher, *Katie Novak*,[2] aimed to explore imagery through the text of ***Beowulf***, but understood that different expectations and skills would come into play in her classroom. Instead of diving straight into the text, she tried to set up her students for success by creating a lesson plan that optimized autonomy and relevance (guidelines specifically noted in the UDL framework). Students were put in pairs, one was given a tactile object in a bag, such as a figurine or a piece of dishware, and asked to describe it using descriptive imagery, while a second student (from whom the object was hidden) was asked to draw the object based on the description. Students were able to write or verbalize their descriptions and understood the importance of using vivid language to paint a detailed picture of what they were trying to get across. Through this practice, students were then able to analyze the text of ***Beowulf*** to point out where imagery was present or lacking. Novak even gave students the opportunity to create their own visual, tactile, or descriptive interpretations of certain characters.

Teachers like Novak understand that to effectively implement UDL, multiple means of representation, engagement, and action and expression cannot be afterthoughts or amended to a curriculum. UDL must be applied from the beginning. Just as physical spaces can be universally designed to include features such as ramps and sensory elements that all people can access, learning materials can be created to meet the needs of multiple students, along the continuum of human ability.

Creating accessible spaces and curriculum is changing the fabric and mindsets of classrooms. This includes increasing the amount of technology present in schools and during lesson planning. Rose and Meyer (2000) examine how technology and media can assist students and teachers in multiple means of representation and provide a way, for example, to assess the competency and neurodiversity of students.

> **“[T]he more differentiated use of media for instruction reveals that individuals who are defined as “learning disabled” within print-based learning environments are not the same individuals who are defined as “learning disabled” within video- or audio-based learning environments.**
>
> **Such revelations splinter the old categorical divisions between “disability” and “ability” and create new descriptors that explicitly recognize the interaction between student and environment in the definition of strengths.”**
>
> *(Rose & Meyer, 2000, p. 5)*

With the use of more assistive/interactive media, technology, and curricula, students are less likely to form negative associations with the learning environment and more likely to feel a sense of belonging. Scaffolding learning to be inclusive for all learners only affirms the identities across the spectrum of neurodiversity and ability.

Everyone requires something different to thrive in an educational environment. UDL is a tool to transform education and “personalize it, to build achievement on discovering the individual talents of each child to put students in an environment where they want to learn and where they can naturally discover their true passions” (Robinson, 2009, p. 238). UDL aims to cater to the needs of each child throughout the learning process, to reach the same goal through representation, engagement, and action and expression.

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Background Theoretical Framework of the Zero Barriers in K-12 STEM Education Program

Dr. Hyunju Lee

Classrooms, schools, school districts, and state education agencies that integrate UDL practices into their teaching and learning are doing it in the context of systems. A system is a group of components that are related and interact with one another, and that carry out functions together (National Research Council, 2012). An education system includes various components, such as K–12 schools, districts, a state department of education, institutions of higher education, and local community education partners; as well as human components such as students, classroom teachers, principals, administrators, parents, family, informal and nonformal educators, and researchers. An education system is an activity system (Engeström, 1987) in which people are culturally and historically situated and carry out functions together under the common goal of education.

Cultural-historical activity theory (CHAT, or simply activity theory) was originally suggested by Vygotsky (1978), who argued that human development is a socially and culturally mediated process, and learning is how individuals make meanings through social interactions in communities. While Vygotsky focused on individual development and learning, Leont'ev (1978) expanded Vygotsky's perspective from an individual action to a collective activity, taking more of a systems approach. And Engeström (1987) articulated that human activity is interrelated with the community, culture, and history in which the human is situated.

Engeström (1987) explained this concept using the six elements of the second-generation CHAT model:

1 | Subject is a person or people who are engaged in activity.

2 | Object is the goal of an activity.

3 | Tool is an instrument or a socially shared cognitive resource that subjects use to achieve the object.

4 | Rules are formal or informal conditions that regulate subjects' activity.

5 | Community is a social and historical context to which the subjects belong.

6 | Division of labor is how work is divided among the participants in the activity.

Engeström further elaborated his activity theory to include multiple systems that network with a shared object, which is called third-generation CHAT model (2001). The Zero Barriers in K-12 STEM Education program is based on this activity theory. Each team that participated in the Zero Barriers in K-12 STEM Education program represented an individual activity system. The participants of each team (*subject*) identified a goal (*object*) for their school, district, or organization and developed an action plan using a logic model (*tool*) throughout the Zero Barriers program. They

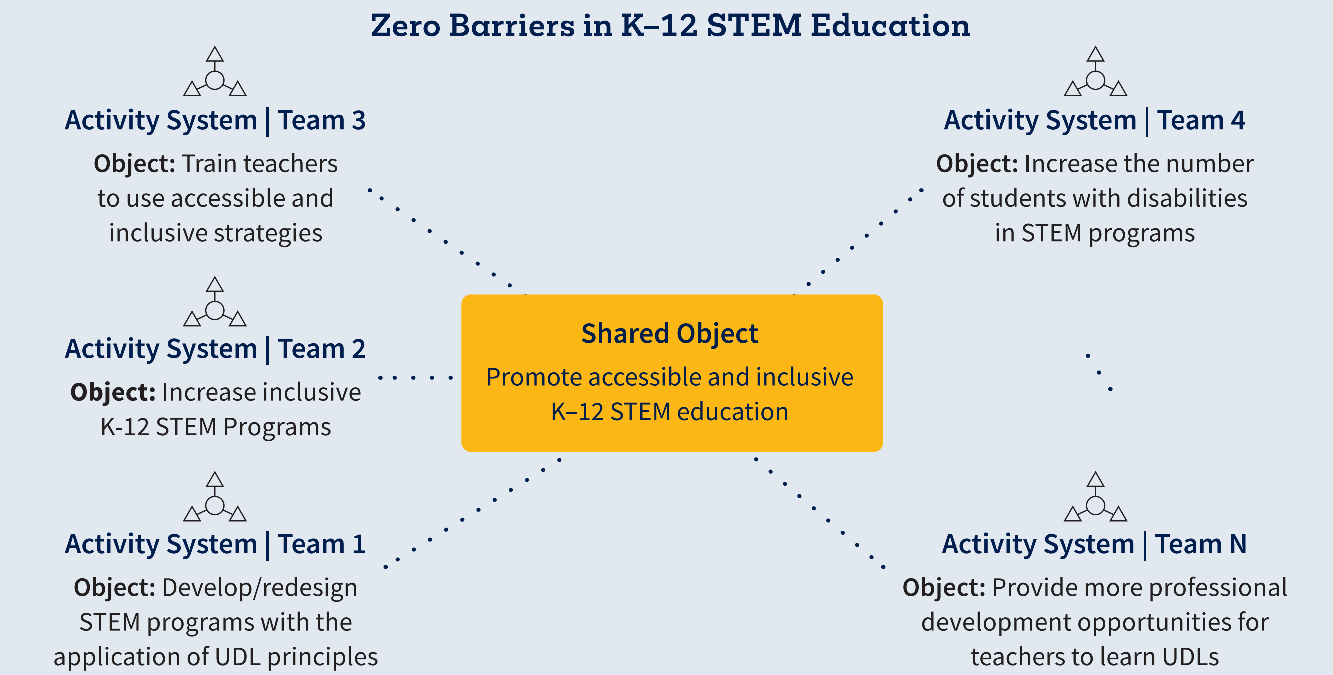

Figure 1. Multiple activity systems and their subsystems shared a common object to promote accessible and inclusive K–12 STEM education at the Zero Barriers in K-12 STEM Education program.

implemented their plans by carrying out responsible tasks (*division of labor*). However, they also needed to consider various factors in their school, district, or state (*community*) and may have encountered challenges from existing policies and regulations (*rules*).

From a larger perspective, each team that participated in Zero Barriers pursued their own goal (*object*), which varied from increasing the accessibility of K–12 STEM programs to providing more professional development opportunities for teachers to learn about Universal Design for Learning (UDL) strategies. Figure 1 summarizes the overall framework of the Zero Barriers in K-12 STEM Education program. While each participant attended the Zero Barriers program with their own goal, they also shared an overarching common goal (*object*), which is to promote accessible and inclusive K–12 STEM education. Additionally, as each team consisted of a group of teachers, administrators, faculty members of local colleges, and/or educators from local community partners, each team member can be thought of as representing the subsystems of the activity system, which are shown as smaller triangles in the figure.

The ultimate goal of the teams that participated is to bring about a change in their system. But, as a system is quite complicated, with many parts interwoven and interacting with one another, making a change in such a complex system is not easy. There could be different priorities among different stakeholders, lack of resources and support, or resistance to change among the system members. The next chapter shares a few stories from our teams that offer more details about their work and experiences.

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CHAPTER 2
Stories from Our Teams

In this chapter, authors from teams in the Zero Barriers in K-12 STEM Education program share their stories about their efforts, journeys, and outcomes to promote accessible and inclusive K-12 STEM education for all students, including those with disabilities.

Wicomico County Public School's Efforts to Increase Access to K-12 STEM Resources and Opportunities for All Students

Hemalatha Bhaskaran

Wicomico County Public Schools (WCPS), located on Maryland's Eastern Shore, serves a diverse community across suburban, rural, and small urban areas. The district comprises 20 schools and approximately 13,500 students. The student demographic reflects a rich tapestry of backgrounds, with about 50% identifying as students of color and nearly 20% as English language learners (ELL). Additionally, about 15% of students receive special education services (SPED), and approximately 60% qualify for free or reduced-price meals, indicating a significant portion of students experiencing financial instability (FIT). WCPS is committed to expanding STEM opportunities for all students, including those from historically underrepresented groups. Recognizing a key challenge in achieving this goal, the district has identified a lack of accessible STEM resources and professional learning opportunities for teachers, which has limited student access to advanced science courses. Addressing these gaps is critical for WCPS as it strives to build pathways into STEM fields for all students.

WCPS educators have limited opportunities to engage in professional development focused on "accessibility in STEM"—that is, how to ensure all students have opportunities to engage in advanced STEM learning and recognize themselves in STEM. A lack of professional learning on how to include all students in STEM results in lower enrollment in advanced science courses among our secondary school student body, who are typically underrepresented in the STEM fields. Without proper support, students from ELL, SPED, FIT, and other backgrounds face barriers that hinder their academic growth in STEM fields. To address these challenges, WCPS has set a goal of increasing the enrollment of students from populations underrepresented in STEM fields in advanced science courses by 5% by the 2026–2027 school year. Additionally, the district is focused on increasing the availability of STEM and science resources for all students, both within the curriculum and through extracurricular opportunities.

PROFESSIONAL DEVELOPMENT AND TEACHER TRAINING

A cornerstone of WCPS's strategy has been professional development. Between January 2024 and August 2025, WCPS rolled out Universal Design for Learning (UDL)–based professional development. Twenty high school science teachers received training on creating accessible lessons using the UDL template, while 70 secondary school math teachers were trained in coteaching strategies. This training is critical to ensuring that lessons are inclusive and meet the diverse needs of students. The district has also placed a strong emphasis on coteaching approaches, combining the expertise of general and special education teachers to enhance lesson delivery for all learners.

A key challenge the district has encountered is finding adequate time for ongoing professional development. To address this, WCPS is exploring opportunities for teachers to earn professional development points that can be used toward the renewal of their teaching certification. This initiative aims to incentivize participation and ensure that teachers remain up to date with the latest instructional strategies.

FOCUS ON ARTIFICIAL INTELLIGENCE (AI) IN STEM TEACHING

The 2024 back-to-school professional development for science teachers included an "AI in STEM Summit." It had a particular focus on integrating artificial intelligence (AI) into STEM education. Teachers learned how to use AI to design more inclusive STEM lessons and create opportunities for all students. Teachers received training on education *tools*[3] in addition to Claude, Copilot, and Chatbot 4.0. Feedback from teachers highlighted that the most valuable part of the training was "using AI to differentiate lessons" and "revamping PowerPoints with Gamma to make them accessible." One teacher shared that "being able to use AI to enhance my lessons and engage students in science" has already improved classroom engagement. Another teacher stated the importance of the "continued integration of AI in the education setting, especially in science and STEM."

EXPANDING STEM RESOURCES

WCPS has made significant strides in incorporating new STEM resources to support its diverse student population. Among these resources are *BrainPop Science*,[4] an engaging platform that offers animated videos and interactive quizzes to help students understand scientific concepts; *Mosa Mack*,[5] which provides inquiry-based learning experiences through real-world science applications; *Generation Genius*,[6] a resource that combines video lessons with hands-on activities to enhance students' understanding of key science topics; and *Newsela*,[7] which offers a range of leveled articles on current events and various subjects, similar to *Clusive*,[8] enabling students to access content tailored to their reading levels. Additionally, WCPS will pilot a STEM resource specifically designed for students on the non-diploma pathway, further expanding access to STEM learning for all students.

CURRICULUM DEVELOPMENT AND UDL INTEGRATION

To further enhance STEM teaching, WCPS is recruiting a coalition of willing teachers to develop curriculum supplements using the UDL framework. This effort will ensure that instructional materials are designed to be accessible and adaptable to all students' needs. Teachers participating in this initiative will work collaboratively to create resources that align with the principles of UDL, supporting learners from all backgrounds, abilities, and proficiencies across the district.

INCREASING ENROLLMENT IN ADVANCED COURSES

Another major success has been the introduction of new guidelines for high school science teacher recommendations. As a result, there has been an increase in teacher recommendations for students from a wide range of backgrounds to enroll in AP and honors courses, leading to a rise in the number of students from populations typically underrepresented in STEM fields participating in advanced science classes.

ONGOING PROFESSIONAL DEVELOPMENT

WCPS is committed to offering continuous professional learning opportunities focused on integrating UDL and engineering design into science instruction. These sessions will help teachers create science learning experiences that support learners who receive special education services. Furthermore, the district is planning ongoing professional development centered on using *STEM teaching tools*,[9] including how to create inclusive science learning experiences for all students.

CONCLUSION

WCPS is actively addressing the barriers to STEM education for K-12 learners by expanding professional development opportunities, increasing accessible STEM resources, and focusing on inclusive teaching practices.

STEM Education in North Carolina: The STEM Schools of Distinction

Howard Ginsburg

STEM education in North Carolina public schools is rich and multifaceted, reflecting the state's commitment to preparing students for a globally competitive world. Some of the earliest foundations for recognizing and supporting high-quality STEM education were fostered through a triad of universities in central North Carolina, forming what is now known as the Research Triangle Park (RTP). Established in the 1950s, this hub for research and innovation marked an early step in North Carolina's focus on science and technology, significantly transforming education in the state. This collaboration attracted top-tier faculty and researchers, enhancing the universities' reputations and education offerings. Additionally, the influx of high-tech companies and research institutions provided students with valuable internship and employment opportunities, further integrating education with industry needs.

Overall, RTP played a crucial role in elevating the quality and scope of higher education in North Carolina during this period. Since then, our state has recognized the need for staying ahead of the curve in a technologically advanced society by homing in on educational experiences that are equitable, engaging, and universally designed to further the unique strengths all students possess. Significant effort has been made to identify and implement high-quality pedagogical practices that build opportunities for all students to grow collaboratively, think critically, and emerge as contributing members within their communities. Specifically, schools in North Carolina are encouraged to carry out intentional practices focused on increasing long-term participation by students from groups historically underrepresented in the STEM education pipeline.

North Carolina defines STEM education through the STEM School Progress Rubric, which is summarized in Table 1. The rubric is a strategic planning tool intended to support educators, schools, and districts seeking to deliver high-quality STEM education to all students, including students with disabilities. Developed through a partnership with the North Carolina Science, Mathematics, and Technology Education Center, the Friday Institute at North Carolina State University, and the North Carolina Department of Public Instruction (NCDPI), the rubric emphasizes five overarching principles of a STEM school: student opportunities, classroom environment, school structures, school culture, and community connections. Each of these overarching principles are further divided into three to five key elements, consisting of one or more quality indicators that describe specific attributes of high-quality STEM education. These indicators are presented across four levels of achievement (Early, Developing, Prepared, Model) which allow schools to grow across a continuum. (See the *North Carolina STEM Schools Progress Rubric* for detailed information[10])

TABLE 1. OVERVIEW OF THE NORTH CAROLINA STEM SCHOOL PROGRESS RUBRIC COMPONENTS

Overarching Principles	Key Elements
1. Student Opportunities	1.1 Students Designing 1.2 Students Working in Teams 1.3 Learning Connected to the Real World 1.4 Students Using Digital Technology 1.5 Opportunities with STEM Organizations
2. Classroom Environment	2.1 Instruction Integrating Content 2.2 Varied Learning Approaches 2.3 Multiple Assessment Types 2.4 Teacher Collaboration 2.5 Comprehensive Advising*
3. School Structures	3.1 Professional Learning Focus 3.2 Professional Learning Format and Structure 3.3 Physical Space for Projects 3.4 Strategic Staffing for STEM 3.5 Variety of STEM Courses*
4. School Culture	4.1 STEM Education Plan 4.2 Data-Informed Continuous Improvement 4.3 Vibrant STEM Culture 4.4 Serving Underrepresented Students
5. Community Connections	5.1 STEM Schools Network 5.2 STEM Business Advisory Council 5.3 Communication Strategy

**Applies only to high schools*

Successful STEM implementation, therefore, aligns with the rubric, integrating the core subjects of science, technology, engineering, and mathematics in a cohesive learning paradigm that encourages inquiry, creativity, and critical thinking. STEM schools leverage both internal and external resources to integrate STEM content into daily instruction. Internally, this includes making use of existing technology, fostering teacher collaboration, and supporting the needs of all students, including those with disabilities, integrating STEM across all subjects. Externally, partnerships with local businesses, universities, and STEM organizations provide additional resources and real-world connections.

A deeper understanding of the first overarching principle, **Student Opportunities**, conveys what STEM learning looks like through a student lens. Teachers encourage students to work in teams by delivering content via project-based learning or inquiry-based learning, where students collaborate on solving real-world problems. Educators encourage design thinking and provide maker spaces where students can prototype and test their ideas. Teachers often support students through the introduction and use of digital technologies, allowing students to integrate coding, robotics, and other digital tools into the curriculum.

Partnering with local STEM organizations for mentorship programs, internships, and field trips furthers real-world technology exposure and application. To keep learning connected to the real world, schools use community-based projects and tie in local issues as the basis for STEM challenges. By integrating these principles into their teaching, educators can create a more inclusive and effective learning environment that supports the academic and personal growth of all students.

Fostering a culture of inquiry and innovation depends on creating a learning space that supports and enhances the classroom environment. The second overarching principle, **Classroom Environment**, identifies the ideal STEM classroom as both dynamic and flexible. The physical setup of the classroom should be conducive to STEM learning for all students, including those with disabilities. This includes flexible seating arrangements, access to technology, and resources that support hands-on activities. Effective instructional practices involve using various teaching methods that engage students in active learning and critical thinking. To maximize this, class discussions integrate content across areas, reinforcing students in using interdisciplinary approaches to solving problems. A teacher can create these opportunities by themselves, through their lesson plans, or in collaboration with other teachers.

A variety of learning approaches ensures that lessons are authentic, relevant, and student-centered. Assessments, both formative and summative, are developed to provide ongoing feedback and measure student growth. This may include projects, portfolios, performance-based assessments, and traditional quizzes and tests. Effective STEM teachers use team and vertical collaboration to ensure continuity and progression in STEM learning. Ultimately, learning outcomes are an intentional component within the classroom environment.

The third overarching principle, **School Structures**, emphasizes that schools have professional learning communities that are focused on STEM, providing continuous professional development for teachers. Teachers must be given time, support, and resources to grow their own content knowledge and stay abreast of the recent developments in STEM-related fields. Applied learning experiences are essential for teachers to be in the position to best empower their students. Such experiences may include study trips, fellowships, or internships. Staff surveys and evaluations can help identify professional learning needs, not only for teachers but also for the administration.

Within a quality school structure, the school has implemented formal processes for identifying and developing current and future teacher-leaders for STEM education. School leadership must prioritize hiring practices that seek educators with strong STEM backgrounds and a passion for innovative teaching. School administrations must also prioritize effective use of school space to include dedicated STEM labs and areas for students to collaborate and engage in face-to-face and virtual collaboration. Additionally, exhibition spaces celebrate student achievements and foster a culture of STEM excellence, igniting within students a greater passion for learning and a desire to achieve.

Sustainable STEM programming is at the heart of the fourth overarching principle, **School Culture**. Effective schools develop a unique STEM education plan that establishes innovative and attainable outcomes aligned with a vision that incorporates the five overarching principles of the NC STEM School Progress Rubric. The plan is developed considering the input of all stakeholders, including students, teachers, parents, administrators, business/community partners, and local higher education institutions, when applicable. The plan, by design, is data-driven and equitable. Proper monitoring of the plan will ensure all students, including under-represented populations and students with disabilities, have access to high-quality STEM education. Achieving a high-quality school culture is characterized by a commitment to honoring innovation, supporting instructional risks, celebrating high-quality student work, modeling problem-solving by administrators, and promoting the STEM vision to ***all*** stakeholders.

The fifth and final overarching principle is **Community Connections**. Strong community connections are vital for a thriving STEM program. Schools actively seek partnerships with local businesses, higher education institutions, and STEM organizations. Both direct as well as online relationships support an advisory council that examines and builds upon the successes and challenges at the school. Efforts to network with similar STEM schools (both in and out of state) facilitate strategizing and exchanging resources, expertise, and real-world learning opportunities that enrich the STEM curriculum and prepare students for future careers. For transparency and feedback, the school uses both one-way (e.g., websites, newsletters) and/or two-way information sharing (e.g., social media, webinars, meetings) to maintain open communications both internally and externally.

During the 2014–2015 school year, the NCDPI recognized the first cohort of NC STEM Schools of Distinction. These schools demonstrated exemplary leadership and instruction in STEM education, based on the quality indicators identified throughout the STEM School Progress Rubric at either the Prepared or Model levels of achievement. Schools undergo a rigorous application process, including self-assessment and site visits, to earn this recognition. As of fall 2024, 54 schools have received these designations. *EducationNC has summarized the process and has shared a few examples of these schools in action*.[11]

North Carolina's commitment to STEM education is evident through its strategic initiatives, recognition programs, and continuous efforts to provide high-quality STEM learning opportunities for all students, including students with disabilities. The NCDPI continues to support K–12 educators and leaders with integrated approaches to STEM teaching and learning. The detailed framework of the STEM Schools Progress Rubric and the NC STEM Schools of Distinction program further underscores the state's commitment to excellence. As we look to the future, growing STEM ecosystems (e.g., regional partnerships, nonprofits, STEM alliances) and increasing national attention on STEM initiatives promise an era of unprecedented innovation and educational advancement. North Carolina stands poised to lead the nation in cultivating the next generation of STEM leaders and problem-solvers.

For more information:

- *NC STEM School Progress Rubric*[12]
- *NC STEM Schools of Distinction Program*[13]
- *Recognized Schools of Distinction*[14]

CHAPTER 3

Challenges to Promoting Accessible and Inclusive K–12 STEM Education

This chapter shares the challenges the teams encountered in the implementation of their plans. Authors provide individual insights from the perspective of K–12 schools, the district and state level, and local community organizations.

Challenges and Struggles in the K–12 Classroom

Kayla Jackson

The goal of accessible and inclusive science, technology, engineering, and mathematics (STEM) education (as defined in Chapters 1–2) is to ensure opportunities for all students to engage in STEM and to recognize themselves in STEM, regardless of their background and abilities. However, achieving this goal is a challenge for many schools. Below are some of the primary obstacles educators and institutions encounter in their efforts to make STEM education accessible and inclusive.

My role as a mentor for the Zero Barriers in K-12 STEM Education program revolved around helping two schools—a high school and an elementary school—create equitable and accessible tools for students with different abilities to be able to experience STEM and recognize themselves in STEM-related fields. With the high school, the focus was on having students who received special education services get more STEM endorsements on their diplomas. The elementary school had the challenge of trying to incorporate STEM kits into their English and Math classes for students.

RESOURCE LIMITATIONS

One of the most significant challenges is the lack of adequate resources. Schools often struggle with limited funding, which affects their ability to provide the necessary technology, materials, and tools for inclusive STEM education (21stCenturyEd, 2024). This limitation in resources hampers educators' ability to offer universally designed, experiential learning opportunities that are crucial for engaging all students in STEM subjects. In my observations as a Zero Barriers mentor, I learned that sometimes teachers must make STEM kits for their students to ensure all students have access to STEM opportunities. In my teaching experience, I've been allotted minimal funds to teach and engage my students in STEM activities. Unfortunately, kits and consumables are expensive, and the resources are not easily accessible. When we add in factors to make learning accessible for students with disabilities, it requires more money to be spent on specific resources for those students. A well-functioning STEM classroom needs up-to-date technology and materials that will engage the students.

TEACHER TRAINING

Effective implementation of accessible and inclusive STEM practices requires teachers to have specialized training. However, many educators lack access to professional development opportunities that focus on accessible and inclusive teaching strategies. For example, educators may require training that covers how to differentiate instruction, culturally responsive teaching, and the Universal Design for Learning (UDL) framework. Without proper training, teachers may find it challenging to adapt their instructional methods to meet the diverse needs of their students. Since STEM is such a constantly evolving field, teachers will need ongoing professional development and constituent collaboration and support from peer mentoring programs and professional learning communities. These professional communities can provide support and promote a culture of continuous improvement.

INSTRUCTIONAL MATERIALS

Some science classroom instructional materials may not present regular opportunities for accessible and inclusive practices to be used. Adapting existing curriculum materials to be more adaptive and inclusive can require significant

effort and additional resources, because teachers may need to develop supplemental materials or modify lesson plans to ensure that all students can participate fully in STEM activities (21stCenturyEd, 2024). Teachers may also be tasked with creating cross-curricular connections to make learning experiences relevant to their students. Often, educators are trying to manage these additional tasks while simultaneously ensuring they cover state standards so that students pass required state tests, and juggling between the two things can feel overwhelming.

Traditional science assessment methods may not accurately reflect the capabilities of all students, particularly those with different learning needs. Developing alternative assessments that are fair, inclusive, and reflective of students' true understanding and skills can be challenging. Assessments must be designed to accommodate various learning styles and abilities. Accounting for diverse learning styles and abilities adds a layer of complexity, but failing to do so within lesson planning and assessments can have an impact on a student's success.

DIVERSE LEARNING NEEDS

Students come to the classroom with varied learning styles, abilities, and backgrounds. Creating a STEM curriculum that is accessible and engaging for all students is a complex task. This challenge includes accommodating students with disabilities, language barriers, and different academic preparedness levels. Tailoring instruction to meet these diverse needs requires careful planning and flexibility.

PARENTAL AND COMMUNITY INVOLVEMENT

Gaining support from parents (and other caregivers) and the community is crucial for the success of accessible and inclusive STEM practices. However, engaging parents, other caregivers, and community members can be difficult, especially if they are unfamiliar with or skeptical about the benefits of accessible and inclusive education. Building strong partnerships with families and communities requires ongoing communication and collaboration.

CONCLUSION

Implementing accessible and inclusive STEM practices in schools is a multifaceted challenge that requires a concerted effort among educators, administrators, policymakers, families, and the community. Addressing resource limitations, providing adequate teacher training, adapting curricula, meeting diverse learning needs, ensuring cultural relevance, developing fair assessments, and engaging parents and the community are all critical steps in creating an accessible and inclusive STEM learning environment for all students.

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Insights from District and State-Level Teams

Dr. Yujia Ding

The Zero Barriers in K-12 STEM Education program has supported educators to remove barriers in STEM education for students with disabilities. The district-level and statewide approaches to creating more accessible STEM opportunities reinforce the fact that there is no one-size-fits-all solution for ensuring every child gets the education they need and deserve. It is important to note that the challenges educational leadership teams participating in the Zero Barriers program seek to address are not exclusive to a specific U.S. region—shifting priorities, changes in administrations, and new policies. Despite these challenges, the individuals and teams who participate in the Zero Barriers program have the best interests of the students in their district or state in mind, and when faced with adversity, they persevere by revisiting the problem and taking a new path to the solution.

HOW THE ZERO BARRIERS PROGRAM ADDRESSED THESE CHALLENGES

Teams at Zero Barriers worked on developing logic models to address a core issue they identified in their jurisdictions related to barriers to K-12 STEM education for students with disabilities. After developing and implementing their logic models in the first year of participation in the program, teams returned during the 2024 reconvening to examine and evaluate the work that had been accomplished.

> **“I had the pleasure of working with two state-level teams in my time as a mentor for the Zero Barriers Program. The work of both state-level teams I mentored centered around the unique yet universal challenge of providing support for the vast array of diverse constituents that make up a state’s K-12 student population.”**

In 2022, the team I worked with consisted of representatives from a state department of education. In addition, representatives from two elementary schools located in different parts of the state joined the work. The team had the collective goal of ensuring all students in the state had access to STEM education opportunities by providing training and resources centered around the principle of Universal Design for Learning (UDL). However, the context of each school varied, so the team had to keep these differences in mind when developing their logic models.

In 2023, I worked with another state-level team, but this time, the team was comprised of individuals from different departments within the state department of education, each with their own operating procedures. This led to difficulties in finding time to meet as a team once the summit was over and needing to understand the nuances of the needs and expectations of each office. The problem that this team identified was the deployment of resources for STEM teachers statewide, aligned with the adoption of new science standards.

At the reconvening in 2024, teams were tasked with examining the outcomes of implementing their logic models and to better understand their organizational structure using the Four-Frame Model developed by Bolman and Deal (see Chapter 4 and appendix C). In this model, teams sought to understand organizational dynamics through four distinct frames that lend unique perspectives and insights to gain a holistic view, rather than choosing any one frame over another (Glasser, 2023). In the model, the four frames are Structural, Human Resources, Political, and Symbolic. Despite the unique challenges of individual districts and states, there was a realization that a collective challenge across state and district teams was the structural and political barriers they faced during the implementation phase of their work.

For both teams I mentored, understanding organizational dynamics through the structural framework helped put into perspective the unforeseen challenges that each team encountered. Whether it was working with different offices within the department or working across organizations, navigating the roles, policies, and operational procedures was sometimes a task of its own. Upon reflecting on the experience of implementing their logic models, teams realized that understanding the structure of each organization at the beginning could help mitigate some of the challenges that came up during the process. In addition, and more so for the team from 2023 composed of individuals all from the state department of education, was the challenge of understanding that a change in the leadership

of the department could lead to a change in the direction and priorities of the department. Even though the team from 2022 experienced challenges resulting from shifting power dynamics at the state department, the impact was less directed towards the work being done and rather more towards knowing who to communicate with when there was a shift in leadership.

Facing the challenges is an accepted part of the work that each team embarked on. Knowing how to navigate the challenges and preemptively having a contingency plan in case road bumps are encountered helps prevent delays in the implementation of the work. It is critical to understand that navigating a change is a part of being in education, and once that is accepted, tackling challenges becomes less daunting.

Despite what may seem like an impossible uphill battle, there is movement. Every district, every county, and every state that begins to look deeper at the disparities and break down the data is putting a dent in the façade that average, aggregate data creates. Statewide teams are going into their localities and speaking with the teachers, with the individuals who live in the communities they serve, to better understand the unique challenges they face. The information is being taken into account when the work is being brought back to a broader audience.

Though the work may be complicated by changing administrations that have differing priorities, it remains a priority for those who started it. The work may seem like it is not making headway, yet by acknowledging the challenges, by naming the roadblocks that prevent the work from moving forward, teams are beginning to find ways to circumvent and dismantle them. And as each challenge and roadblock begins to come apart, the work moves forward.

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Reaching Out to Support All Through Community Connections

Dr. Jodi Zeis

When leading accessibility and inclusion efforts for school-aged people who are differently abled, nonprofit organizations and community organizations face multiple challenges implementing such programs. Funding, political agendas, knowledge of clientele, and membership and retention all present unique problems for such organizations. Often, many of these organizations are grassroots entities, serving specific needs within their communities. Sometimes, these nonprofits serve small populations spread out across vast rural areas. Others serve a specific group within large urban areas. Most of these organizations serve underrepresented groups in STEM engagement and education, so their work is not only essential to grow the STEM workforce, but it also serves as a foundation for many who would otherwise receive less STEM training and, more importantly, less support.

As part of the Zero Barriers in K-12 STEM Education work, mentors meet with an assigned group before the summit. The groups may represent a school, district, region, state, or nonprofit, depending upon their specific focus. While data and background information are provided to the mentor, contact through phone calls, emails, and online meetings provides an opportunity for relationship building, context of their goals and reason for joining the summit, and a better overall collaborative connection. The mentors, along with each group, attend virtual pre-conference learning opportunities through the Smithsonian Science Education Center to better frame the upcoming learning experiences and work. Upon arrival at the Summit, mentors join each group as they all immerse themselves in learning and start their work toward change. Together, the team learns about influential strategies to best create effective growth in their organization's goal. They take deep dives into inclusivity and what that means for all when engaged in learning, especially STEM. As such, mentors then lead their groups through a process to determine the root cause of the initial problem they wanted to solve. This allows each group to take a closer look at what really causes the disparities in STEM opportunities. Each group then considers what they can control and what they cannot. From there, they develop a measurable problem at the root of the concern. The goals created are specific, measurable, achievable, relevant, and time-bound. Throughout the process, mentors coach the teams to guide them through a metacognitive process as they consider all aspects of the problem, goal, and actions to solve the problem and achieve success. Over three days, the team, along with the mentors, collaborate and share, learn from differently abled citizens about their experiences with learning, and design a Logic Model for action around their identified problem. Through the Logic Model, each team considers resources to help achieve each step of the goal, as well as short- and long-term steps to complete along the way, to ensure the goal is achieved.

> **"Following the Summit, mentors continue to communicate with their group, coaching them, listening to their efforts and goal progress, and offering insight and support for a year or more. Through this ongoing support, each mentor helps their organization focus on the goals they set forth at the Summit in an effort to help them most effectively influence the accessibility to STEM for all learners. The efforts these organizations lead address opportunity gaps for those in each community. By focusing not only on *what* to do to influence STEM engagement but *how* to do it, these organizations serve to better prepare students in their communities."**

How, then, do nonprofit and community organizations serve their communities by participating as part of the group? Within the intention to meet the complex needs of all students in the community, there remains the challenge to address such complex needs while maintaining high expectations (Ladson-Billings, 2011). Some organizations work as their own entity by advertising and marketing directly to the public. In this scenario, all activities take place at their designated building or out in the field. Other organizations completely push into a school model, providing STEM extension activities at a school site. Additionally, some STEM nonprofits blend their model, conducting their own brand of STEM outreach, along with including some activities integrated into school environments. Each model offers pros and cons regarding program traction and success.

CONCERNS AND STRUGGLES

Organizational Models

Regardless of the model they follow, many similarities exist between nonprofit and community STEM organizations that work to support all students in STEM education. First, the structure of the organization presents challenges. Many of these STEM organizations are small. Therefore, each employee serves a variety of roles within the organization. This affects the amount of time each person is able to spend on their myriad tasks. It also creates a steep learning curve for all involved to learn the job responsibilities. At the very least, there needs to be community outreach, marketing, planning, teaching STEM, financial documentation, and leadership. Additionally, nonprofits typically pay at a lower rate than large companies or even schools. As a result, turnover is high. This causes a significant amount of time and effort to be spent onboarding, as well. It is also difficult to create momentum with ongoing change among employees. The human resources strain affects all aspects of running such an organization.

Limited Resources

Part of the concern with turnover is fueled by funding. Nonprofits rely heavily on donors and grants. Depending on the political agenda of the current fiscal cycle, such organizations may struggle to obtain funding to continue their daily work, let alone offer their employees a more competitive wage.

The struggle for funding affects the type of programming available and an organization's ability to spread its programs and ideas. Many funders fail to see the potential in students who learn differently. In marginalized communities, such as those in high minority areas, high poverty areas, or in regions where the native language is not English, many nonprofits struggle for community and financial support.

Protection of Student Confidentiality

Another struggle when serving those who learn differently is the inability to obtain accurate and insightful information about students. Strict privacy laws govern the disclosure of disabilities and accommodations. The very plans that students receive at school through Individualized Education Plans and 504 plans are considered private. The very laws designed to protect privacy also create barriers to best supporting these students outside of school. As a result, nonprofits, whether they are working through the school or not, are not privy to the information in these plans. This means that nonprofits and community organizations are often not prepared to support students who struggle to learn, both because they are not aware of learning differences and needs, and they cannot prepare to support the students appropriately. This, coupled with the frequent turnover of nonprofit employees, means it is a struggle to develop accessible and inclusive activities that ultimately lead to student learning and success while engaging with the programs. While some organizations do strive to work proactively with families by advertising their desire to create an inclusive learning environment, some parents may deny their students' clinical diagnoses or fail to report them.

Staff Training

To best support students with learning differences, training staff is of the utmost importance. Because students' needs are often unknown in advance, it is all but impossible to train and prepare employees to best serve students and their unique needs ahead of time. Many nonprofit employees are not formally trained educators, and they are unfamiliar with the scope of learning needs, strategies, and dispositions that are required to adequately support neurodivergent and physically divergent students. Organizations face challenges in providing such training. With such a small staff, most nonprofits and community organizations need to seek support outside their place of business for training. This often takes money, which is difficult for such small organizations to budget for.

Community Support

Many nonprofit and community organizations struggle with recruiting and retaining participants. Often, the communities these organizations seek to support don't understand the value, need, or opportunity that STEM affords them. Factors that determine success in STEM include the academic mindset and the cultural principles of a student (Rattan et al., 2015; Walton & Cohen, 2007). As an added concern or frustration, when unique learning needs are not adequately addressed during STEM program participation, this leads to additional stress and frustrations for parents and students alike. Therefore, students with unique learning needs often leave the program early or do not sign up for the next opportunity because of negative engagement experiences.

While Universal Design for Learning (UDL) works to alleviate some of this, it is essential for the organization to work with parents to best understand the learning needs of each child. Of course, with limited staff and training, this always presents a challenge. UDL offers strategies for those who are teaching and leading to implement so that all learners receive optimal approaches to teaching and learning. These strategies address systems of exclusion in order to further engage all learners in ways they most successfully learn and participate (CAST, 2024). However, some learners require very specific accommodations and modifications that they receive at school in order to connect most effectively with learning activities. Even though teaching with UDL strategies offers greater opportunities for students participating in the learning process, students may find more success if those leading the activities at the non-profit are able to include those specific accommodations and modifications. With or without accommodations and modifications, when working with such a variety of students, nonprofits need to show their ability to accommodate all learners through inclusive practices such as UDL. As parents see progress and success, it becomes easier for the organizations to advertise their abilities to grow STEM learners of all backgrounds and needs. Organizations can then show parents that they are prepared to meet the needs of students with different learning and support requirements.

MOVING FORWARD

Nonprofit organizations must focus on learning and implementing UDL concepts into STEM to improve outcomes for students. UDL, serves “as a framework developed by CAST to improve and optimize teaching and learning for all people based on scientific insights into how humans learn” (CAST, 2024, para. 1). As such, it becomes less necessary to know about a child’s identified learning differences, since UDL focuses on the unique needs and learning preferences of all individuals. This allows all learners to engage in meaningful, personalized, and authentic ways. It also builds a sense of inclusivity and efficacy, as everyone receives such considerations and opportunities. As a result, it facilitates the development of meaning and opportunity, which transform into relevant learning experiences.

The cyclical nature of many of these concerns creates ongoing struggles for STEM-based nonprofits and community organizations to find continued success, especially as it pertains to successfully serving students with unique learning needs. It is essential for organizations to partner and collaborate to develop and understand best practices to meet these needs. At the epicenter, UDL provides inclusive strategies to deepen student engagement, build interest, and enable students to make more relevant connections to their learning. Integrating UDL practices in STEM learning will positively impact student interest, performance, and attitude toward STEM. If nonprofits and community organizations are able to show improvements in those key areas of their work, it could mean relief in other aspects of their operations, such as increased access to financial resources. Ultimately, when students with learning differences develop the capacity to successfully navigate and excel in STEM fields, there is an exponential benefit to the community.

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CHAPTER 4

Resources and Tips to Promote Accessible and Inclusive K–12 STEM Education

In this chapter, authors share tips and resources that they were developing, used in their work, or found helpful in promoting accessible and inclusive K–12 STEM education.

The Science Digital Equity Toolkit: Promoting Inclusive Science Education in Colorado

Tammy Law

The Colorado Department of Education (CDE) Inclusion Screener, a *digital equity toolkit*[15] for science/STEM instruction designed by a dedicated team of experts, serves a crucial purpose. The team was comprised of Shauna Moden, a CDE deaf education specialist; Liz Johnston and Eva Bridgeforth, both from Denver Public Schools as science instructional coaches and curriculum specialists; and myself, a middle school science teacher. I joined the team to advocate for equitable access to science instruction and representation for all rural students and staff, particularly those with varying abilities. We attended the 2022 Zero Barriers in K-12 STEM Education Summit and have created a toolkit that meets the diverse needs of learners. Initially developed by Maya Garcia, a former science content specialist for CDE and the team's first leader, the toolkit empowers teachers, administrators, and special education staff to evaluate and improve their instructional practices, ensuring every student can succeed in science regardless of background or ability.

BACKGROUND AND RATIONALE

Colorado has a unique education ecosystem that is coupled with beautiful yet complicated geography. Colorado has 179 school districts: 28 are urban/city, 40 are classified as rural (with student populations ranging from 1,000 to 6,500, based on distance from urban areas), and 100 are considered small rural, with fewer than 1,000 students. Colorado has one of the highest inclusion rates in the United States, with approximately 80% of students with individualized education programs (IEPs) being educated in general education classrooms (Garcia et al., n.d.). However, district and state data consistently reveal low proficiency and academic growth in science among these students, indicating a persistent achievement gap. The Science Digital Equity Toolkit is explicitly under development to bridge this gap, aiming to provide equitable access to grade-level science and engineering education for all students in Colorado, including those with varying abilities. Our intention is that the digital data tool will be used by local teams, such as teachers, schools, and districts, to identify the root causes of inequity and provide relevant resources to promote inclusive and effective science/STEM instruction for all students.

FOUNDATIONAL METHODOLOGIES

The toolkit is built on two primary methodologies that the team felt must be part of the equitable design. The first is Universal Design for Learning (UDL). This approach promotes flexibility in the learning environment by providing multiple means of engagement, representation, and expression to accommodate diverse student needs (CAST, 2018). The second is Specially Designed Instruction (SDI). This method ensures that content is specifically adapted to address the unique educational, physical, and emotional needs of students, particularly those with disabilities (Individuals with Disabilities Education Act, 2004). By blending UDL and SDI, the toolkit endeavors to equip educators with the tools to deliver grade-level, standards-aligned science instruction that is both inclusive and equitable, allowing all students to be successful.

KEY COMPONENTS

The Science Digital Equity Toolkit is based on the attributes of the Inclusion Screener shown in Figure 2, which focuses on six critical areas that affect equitable access to science education.

These six areas function together to screen for inclusion. They are:

1 | **Mindset:** Is there a strong belief that all students, regardless of ability, deserve access and can succeed in science/STEM programming at all levels?

2 | **Leadership:** Do decisions and messaging from leadership support science/STEM programming for students with various abilities?

3 | **Systems:** Do all teachers, leaders, and support staff have the best professional understanding to support student achievement in science/STEM in an educational learning environment?

4 | **IEP Creation and Progress Monitoring:** Are IEP goals intentionally written to support learning in science/STEM classes, and can they be effectively implemented and monitored?

5 | **Instructional Materials:** Are all students provided access to all instructional materials?

6 | **UDL/SDI for Learning:** Is learning in the science/STEM classroom designed so that *all* students can be successful?

Users can use this tool to evaluate their classroom, school, or district's performance in each area, using a scale of zero to three (such as the scale shown in Figure 3). The resulting evaluation helps identify areas that need improvement and provides relevant resources. For example, suppose the mindset of administrators is identified as a barrier. In that case, the Science Digital Equity Toolkit provides resources teachers can use to advocate for equitable access to quality science and STEM instruction for all students. These resources may help convince administrators that there is an issue or offer strategies that empower teachers to deliver the best possible instruction, even in the face of administrative obstacles. This flexible, solutions-oriented approach ensures educators have the tools and support they need to enhance education equity, regardless of their challenges. In addition, special education staff can use the survey data and provided resources to develop IEP plans that include modifications or adaptations specifically designed to support student advancement in science classrooms.

Figure 2. Attributes of the Inclusion Screener (Bridgeforth et al., 2024) on which the Science Digital Equity Toolkit is based.

The development team believes the design has to be flexible and adaptable, which allows schools to tailor each section to fit their specific context. This is especially valuable because it makes the toolkit more relevant to diverse education environments—rural, urban, or somewhere between. Schools can ensure better engagement and increase the likelihood of successful implementation by customizing elements such as indicators and rating criteria to reflect their unique needs.

Suppose stakeholders see that the toolkit addresses their specific challenges and realities. In that case, it can foster greater buy-in and lead to more effective implementation of content instruction designed with UDL and SDI methodologies.

IMPLEMENTATION CHALLENGES

Despite its potential, the toolkit has faced some development and implementation challenges. Educators in urban and rural districts have reported resistance due to heavy workloads, time constraints, and administrative resistance. Collaboration opportunities for the team are also a barrier to implementation opportunities and problem-solving due, in part, to physical distances from one another. However, ongoing evaluation by the Northeast Board of Collaborative Education Services offers hope for broader levels of professional input and professional resource opportunities.

Activity 3: Complete Implementation Self-Assessment

Priority Area 1: District Planning/Structural Implementation				**Rating:**
	No Implementation – 0	**Developing – 1**	**Progressing – 2**	**Leading – 3**
Inventory of Existing Science Resources	There is no current action in this area.	District is planning to conduct an inventory of existing science materials during the District calendar year.	District conducts regular annual science inventory and has documented science materials to determine level of CAS-SCIENCE-alignment.	District conducts regular annual inventory of science materials, has documented materials for alignment. District has purchased CAS-SCIENCE-aligned curricular materials.
Fiscal Planning	There is no current action in this area.	District is **planning** a budget for CAS-SCIENCE implementation. (Staffing positions, materials, curriculum, professional development, etc.)	District has **developed** a budget aligned to support **transition to CAS-SCIENCE** implementation (staffing positions, curriculum, materials, professional development, etc.)	District is **implementing** a budget aligned to **sustain** implementation of the CAS-SCIENCE. (Staffing positions, curriculum and materials, professional development, etc.)
Instructional Time* • **K–5 –** 225 minutes/wk. • **Middle School –** 60 minutes a day or 2.5 blocked periods • **High School –** 3 Lab Science Courses *Suggested based on	There is no current action in this area.	District schedule reflects equitable access to science instruction across all grade levels.	District schedule reflects equitable access to science instruction across all grade levels for the recommended timeframe.	District schedule reflects equitable access to science instruction across all grade levels for the recommended timeframe and supports extended periods for enrichment and independent projects.

Figure 3. 2020 Colorado Academic Standards (CAS) Science Standards Implementation Toolkit

CONCLUSION

Representing the rural voice on this project was incredibly important to me because it provided an opportunity to provide a voice that is often ignored. Every student—whether from a small rural town or a large urban center—deserves the chance to explore their potential and grow into a productive, capable citizen. The barriers we face in rural areas should not dictate the quality of education our students receive or the support our educators are provided. Equitable access to education is not just about the numbers; it is about ensuring that every student, regardless of their ability or where they live, has the chance to thrive.

The Science Digital Equity Toolkit represents a significant step toward promoting equity and inclusion in science education by allowing users to self-assess their implementation in the 6 key critical areas. By addressing the specific needs of students with varying abilities and providing educators with content-specific resources, the toolkit aims to help others close the achievement gap and open education and career pathways for all students in science or STEM fields. (An example of the Science Digital Equity Toolkit is shared in Appendix A.)

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Student Voice

Laura Lorenzen

There is a growing body of evidence that students do better personally, socially, and academically when they are encouraged to take ownership of their learning (Gordon, 2010). Students who believe they have a voice in school are ***seven times more likely to be academically motivated*** than students who do not believe they have a voice (School Voice Report, 2016). And academic motivation leads to greater effort and persistence, which are among the most important factors affecting student achievement (Gordon, 2010). Student voice has also been found to effect positive change in instructional practices, particularly when it intentionally incorporates voices of students, such as those with disabilities, who have historically been marginalized (Bridgeland et al., 2006). In other words, when teachers actively solicit input from their students about instruction and then act on that input, instruction gets better. Unfortunately, studies show that students with disabilities—the students who may be most in need of improved instruction—are less likely to be listened to and have their views considered than other students (Toshalis & Nakkula, 2012). Thus, the very students who need it most do not receive the benefits that could be derived if only the adults in schools listened.

The resources outlined in this section are designed to change that dynamic by supporting school staff looking to incorporate more student voice and choice into their classroom practices. Student voice practices can take many forms. They may include asking students for their opinions and feedback via surveys, focus groups, or class discussions, having students participate in meetings with decision-makers, or including students as copartners in decision-making and implementation.

Student voice can also be sought when determining professional development (PD) priorities for teachers; taking this a step further, students can lead PD for teachers. "Oftentimes, in traditional professional development sessions, students are talked about as an abstract while adults make guesses about what their students want and need in a learning community. Creating space and support for students to lead from their personal experiences and teach their teachers how to meet their needs radically disrupts that traditional PD dynamic" (Homrich-Knieling, 2023, section 4).

It is important to remember that simply asking students their views or having them take a survey is not sufficient. Adults need to act on the information and inform students how their input is being used, or include students in ways that allow them to see that they are truly partners in decision-making. Without this, adult actions can simply seem performative, and students may become less inclined to participate in the future.

RESOURCES

Reflection Activity

This exemplary *Classroom Shifts document*[16] can be used as a reflection activity by school teams. Read through the document, which shares artifacts from teachers engaged in a pilot program to elevate student voice, and highlight elements that help answer the following questions:

- What changes are happening with teachers and in those classrooms as a result of elevating student voice?
- How will those instructional shifts benefit students, especially students with disabilities, in STEM classrooms?
- What ideas does this give you?

The Spectrum of Student Voice Oriented Activity

The need for adults to share authority, demonstrate trust, protect against co-operation, learn from students, and handle disagreement **increases** from left to right.

Students' influence, responsibility, and decision-making roles **increase** from left to right.

Students articulating their perspectives ← **Students involved as stakeholders** → Students directing collective activities

Students as data sources ← **Students as collaborators** → Students as leaders of change

Expression	Consultation	Participation	Partnership	Activism	Leadership
Volunteering opinions, creating art, celebrating,, complaining, praising, objecting	Begin asked for their opinion, providing feedback, serving on a focus group, completing a survey	Attending meeting or events in which decisions are made, frequent inclusion when issues are framed and actions planned	Formalized role in decision making, standard operations require (not just invite) student involvement, adults are trained in how to work collaboratively with youth partners	Identifying problems, generating solutions, organizing responses, agitating and/ or educating for change both in and outside of school contexts	(Co-)Planning, making decisions and accepting significant responsibility for outcomes, (co-) guiding group processes, (co-) conducting activities

Most student voice activity in schools/classrooms resides at this end of the spectrum (Expression, Consultation)

Figure 4. The Spectrum of Student Voice-Oriented Activity (Toshalis & Nakkula, 2012)

Student Voice Continuum

The Spectrum of Student Voice-Oriented Activity chart (Figure 4) provides a visual of student voice activity, ranging from listening to students to collaborating and partnering with students. When seeking to enhance student voice in classrooms and schools, staff can start here, reflecting on the types of activities that are currently occurring and then looking at ways to expand on those activities.

For school staff who want additional ideas about concrete strategies and classroom activities for student voice, the resources below (*also available online*[17]) provide an easy access point.

An article by Homrich-Knieling (2023) provides insights on steps to have students lead professional development.

- *Making Space for Student Choice in Preschool*:[18] Sometimes teachers need to require kids to do things, and it's easier to get their buy-in if they know their voices are heard.
- *Young Voice, Big Impact*:[19] Teach young children (pre-K to 2nd grade) essential skills, such as asking questions and making decisions.
- *The Importance of Student Choice Across All Grade Levels*:[20] When students get to make decisions about their learning, it can be powerfully motivating.
- *5 Ways to Give Your Students More Voice and Choice*[21]
- *Simple Ways to Promote Student Voice in the Classroom*:[22] Giving students some say over what happens in class can promote engagement and a strong sense of community.
- *Student Voice in the Classroom*:[23] Elevating student voice in the classroom through offering feedback and collaborating on decision-making is critical for young people to thrive.
- Student Voice Key to Unlocking Inclusive Educational Practices (Gordon, 2010): A review of the education policies and procedures across Canada's provinces and territories reveals that inclusion of students with disabilities in regular classrooms is supposed to be the main policy and school practice.
- *The Silent Epidemic* (Bridgeland et al., 2006): The perspectives of high school dropouts
- Motivation, Engagement, and Student Voice: Toolkit (Toshalis & Nakkula, 2013): The more educators use student-centered approaches to reinforce student agency, the more motivation and engagement are likely to rise.

Planning Template

School and district teams attending the Zero Barriers in K-12 STEM Education Summit or implementing their logic models can use this *planning template*[24] (see Appendix B) to brainstorm about areas for growth in elevating student voice, prioritize one to three achievable goals, and develop an action plan with specific steps and timelines.

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Applying Bolman and Deal's Four Frame Model to Support Decision-Making and Connections Across the Zero Barriers Network

Sherrell Williams

Every observable action and defined characteristic of an organization can be tied to a decision that has been made, which is why making good decisions is critical to an organization's outcomes. Bolman and Deal's Four Frame model is a tool that can help leaders consider different perspectives when making important decisions. The Four Frame model invites individuals to gain clarity in four aspects of an organization—structural, human resources, political, and symbolic—when making decisions.

The first frame is the **structural frame**, which focuses on the different core elements of an organization, such as rules, roles, policies, and procedures. It emphasizes all these elements working together cohesively to create optimal workflows, clearly defined roles, and guidelines to complete work.

The second frame is focused on **human resources**, which prioritizes personnel needs in the organization. This frame emphasizes the importance of staff perceptions

The Four Frame Model

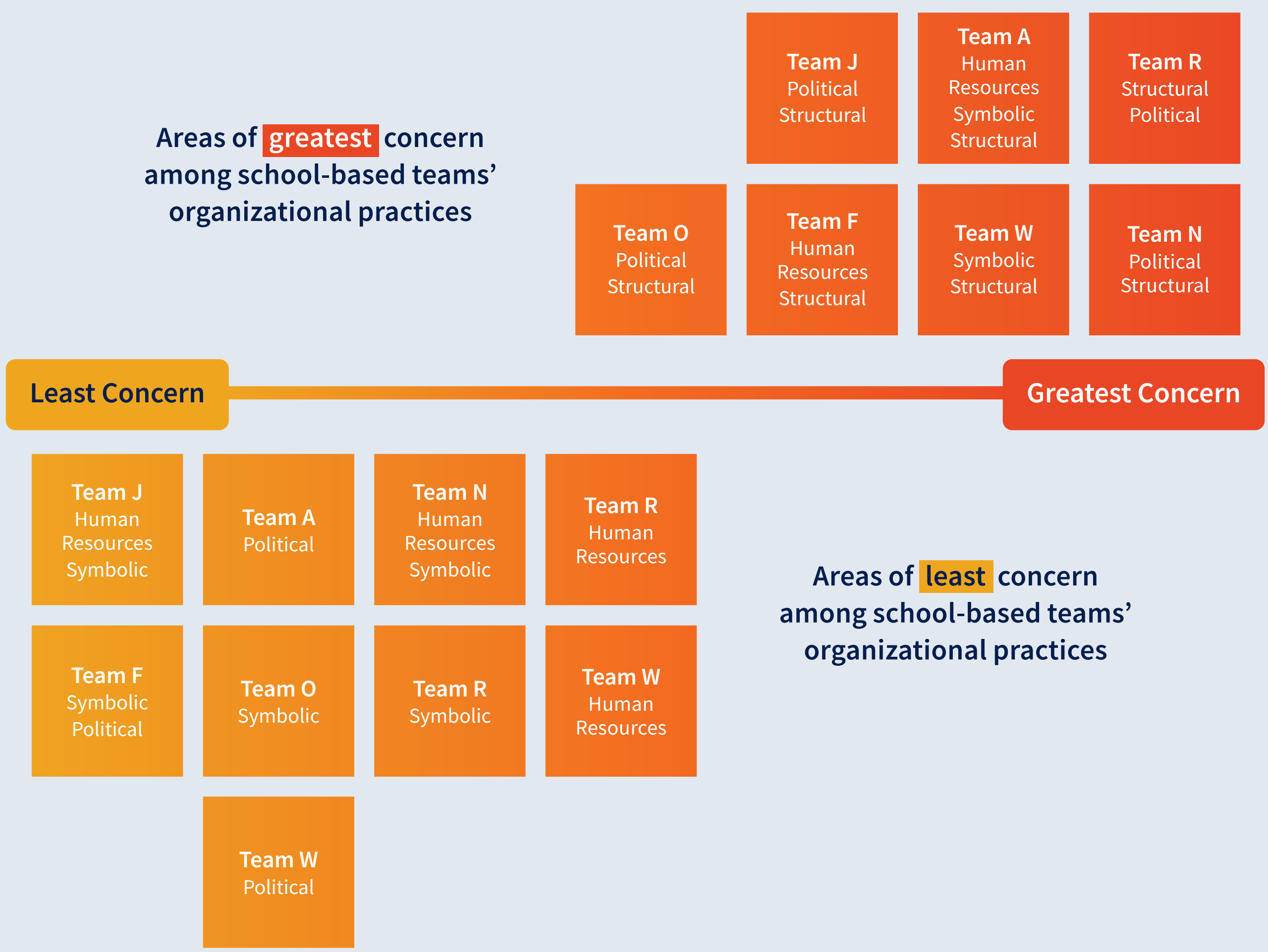

Figure 5. The school-based team's results during a planning period exercise using Bolman and Deal's Four Frame model

and opportunities to develop within an organization, because staff attitudes can impact their engagement and overall productivity.

The third frame considers the **political** aspects of an organization. This frame is concerned with perceived power dynamics and influence among individuals and groups within the organization. It recognizes that the way power is wielded and yielded within an organization contributes to the organization's ability to achieve its goals.

The fourth frame is focused on the **symbolic** nature of an organization. This frame emphasizes the culture, traditions, and values within an organization and says that these aspects provide people within an organization with a sense of purpose. (More detailed information about Bolman and Deal's Four Frame model can be found in Appendix C.)

The Four Frame model enables leaders to analyze their organizational decision-making behaviors, which is why the model was integrated into the Zero Barriers in K-12 STEM Education Reconvening, allowing teams to reflect on their existing practices. It was important for SSEC to provide dedicated time for team reflection and planning during this convening, because feedback from our network members has consistently mentioned that one of the key attributes of our K-12 STEM Education Leadership summits, which includes the Zero Barriers in K-12 STEM Education Summit, has been the ample time members receive to strategically plan with their colleagues. However, we wanted to elevate the conversations that teams could expect to have by supporting them to have structured dialogue as a team ***and*** across the network.

The Four Frame model was used during a planning period at the Zero Barriers in K-12 STEM Education Reconvening 2024 to support team discussions regarding areas of greatest and least concern in the decision-making processes within their education system. During these discussions, teams named and categorized challenges, in alignment with the domains of the Four Frame model, to determine which of the four frames had the greatest and least impact on their team's accessibility goals. Teams were asked to consider which perspective(s) their organization typically focuses on (these are the area(s) of least concern), and which perspective(s) receive less attention (these are the area(s) of greatest concern) in their solution-finding and decision-making approach.

The model was a helpful scaffold that aided teams in having honest conversations about the complex nature of their organization's decision-making practices and behaviors, while simultaneously observing points of commonality across the Zero Barriers network. For example, Figure 5 is a reproduction of the results from the school-based team's planning period designed around Bolman and Deal's Four Frame model.

As can be seen in Figure 5, a majority of the seven school-based teams listed structural and political aspects of their organization's decision-making practices as areas of greatest concern. This suggests that at the school level, trending challenges are the policies, insufficient workflows and operations, and influential individuals and groups. At the school level, these factors may not have been given enough consideration and have proven to be disruptive in the team's ability to progress with an existing idea. Also listed, but with less frequency across the school-based teams, were human resources and symbols, suggesting that a few network members representing schools may not have been adequately equipped with the staff they needed to effectively make significant progress, and the school settings where their teams wished to do work may have had to compete against other school-wide priorities.

A majority of teams listed the symbolic frame as an area of least concern, suggesting that for the most part, school settings were conducive environments for accessible STEM programming initiatives to take place. The highlight of this exercise was that it allowed educators to think about their own successes and challenges, and then share those experiences with other attendees, so that learning started at the individual level and expanded to support teams in making connections that enabled them to begin identifying with others in their affinity group.

In summary, Bolman and Deal's Four Frame model is a useful tool for leaders to consider multiple perspectives before deciding to act. It adds tremendous value to discussions related to change management because it asks individuals in positions of power to reflect on their strengths and their areas that need improvement during the decision-making process to ensure they are taking a multifaceted approach in their action planning.

Using Technologies and AIs to Support Students with Varying Needs

Dr. Gina Saenz

In today's digital world, technology is reshaping how educators teach and how students learn — especially in STEM, where complex topics often require innovative and inclusive approaches. The Zero Barriers in K-12 STEM Education Program has played a pivotal role in supporting educators to meet these challenges head-on. It was designed to help teachers create more accessible STEM learning environments for all students, regardless of their abilities.

As a participant in the Zero Barriers program, I received high-quality science materials, targeted professional development, and training in Universal Design for Learning (UDL) strategies. This experience empowered me as a science campus administrator to guide and support teachers in implementing inclusive practices. The knowledge I gained has helped me lead initiatives that foster equitable access to STEM education, ensuring that every student — regardless of learning style or need — has meaningful opportunities to engage in hands-on, real-world learning.

Since completing the program, I've worked to apply these principles within the Rio Grande Valley, Texas, expanding the reach of Zero Barriers through both direct instruction and school-wide support. I've also integrated sustainability education into our STEM curriculum, helping students make connections between science and global challenges, while preparing them to become informed, compassionate, and capable global leaders.

Building on the foundation laid by the Zero Barriers initiative, I've seen how technology — particularly emerging tools like artificial intelligence (AI)—can further enhance accessibility and inclusion in STEM education. As a science campus administrator, I recognize that students bring a wide range of abilities, learning preferences, and needs to the classroom. Technology offers powerful solutions to differentiate instruction, support diverse learners, and remove obstacles that might otherwise hinder student engagement and achievement.

AI-driven tools, adaptive learning platforms, and assistive technologies can provide personalized learning experiences that adjust to individual students' pace and comprehension. These tools are especially impactful for students with cognitive, sensory, physical, or emotional differences, enabling them to fully participate in STEM learning alongside their peers. In my role, I've worked closely with educators to integrate these technologies thoughtfully and effectively, ensuring that they complement strong pedagogy and inclusive design principles.

This chapter explores the potential of technology, particularly AI, to support inclusive STEM learning environments. Drawing from both research and real-world classroom applications, I'll share examples of how technology can transform instruction, highlight success stories, and examine the ongoing challenges we must navigate to make STEM education truly equitable for all learners.

TECHNOLOGIES TO PROMOTE ACCESSIBLE AND INCLUSIVE K–12 STEM EDUCATION FOR STUDENTS WITH VARYING ABILITIES AND NEEDS

Accessible and inclusive education seeks to ensure that all students, including those with varying needs, are fully integrated into mainstream education and have access to the same opportunities as their peers. In STEM education, technology is key to making this possible. Technologies such as adaptive learning platforms, assistive tools, and AI-driven systems are making it easier for educators to meet the diverse needs of their students.

Adaptive Learning Platforms

Adaptive learning platforms use sophisticated algorithms to adjust instruction based on a student's progress. These platforms continuously analyze a student's strengths and weaknesses and adjust the difficulty and content of lessons accordingly. This is particularly valuable in STEM education, where concepts can be layered and complex. For example, platforms like *DreamBox*[25] Math uses adaptive technology to meet students where they are, offering them support that is aligned with their learning pace (Aleven et al., 2016). By assessing and adjusting in real time, these tools help students with varying needs avoid becoming overwhelmed, while still challenging them to grow.

Assistive Technologies

Assistive technologies have transformed accessibility for students with varying needs. These tools are designed to help students engage more effectively with content, whether through reading, writing, or communication assistance.

- **Text-to-Speech (TTS) Tools:** Programs like *Kurzweil3000*[26] read digital or printed text aloud, enabling students with reading challenges to access content in an auditory format (Marino, 2010). This technology helps students with varying abilities engage with STEM materials by converting complex written information into a more accessible form.
- **Speech-to-Text (STT) Tools:** *Dragon NaturallySpeaking*[27] is an STT tool that allows students to dictate their thoughts rather than typing or writing. This tool is valuable for students who struggle with motor skills or who find it easier to verbalize their thoughts than to write them.
- **Screen Readers and Magnifiers:** Tools like *JAWS (Job Access With Speech)*[28] that read screen content aloud are essential for students with visual impairments. Magnification tools like *ZoomText*[29] enlarge text and images, enabling students with low vision to access digital resources. These technologies ensure that students with physical or sensory challenges can fully participate in STEM education.

With these tools, students are empowered to work independently and interact with learning materials in ways that match their abilities. Technologies like these promote equity by ensuring that students with varying needs can participate on an equal footing with their peers.

AIs THAT SUPPORT ACCESSIBLE AND INCLUSIVE K–12 STEM EDUCATION ACROSS THE SPECTRUM OF HUMAN ABILITY

AI has opened new possibilities for supporting students across the spectrum of human ability in STEM education. By providing personalized instruction, real-time feedback, and predictive analytics, AI tools offer solutions that can transform the learning experience for students with varying needs.

AI-Powered Personalized Learning

Personalized learning is one of the most impactful applications of AI in education. AI-powered platforms analyze vast amounts of data to create tailored learning experiences for each student. These platforms continuously assess student performance and adapt the content to meet their unique learning styles and needs. For example, *Carnegie Learning's MATHia*[30] is an AI-driven tutoring system that offers personalized math instruction. The platform dynamically adjusts the difficulty of problems based on a student's progress, providing hints and feedback as needed (Aleven et al., 2016). MATHia's personalized approach can be particularly beneficial for students with varying needs, allowing them to work at their own pace and receive support exactly when they need it.

AI also enables real-time feedback. Programs like *Gradescope*[31]use AI to analyze student work and provide instant feedback on assignments. This is especially valuable for students who may need extra guidance or reinforcement. For students with varying needs, timely feedback helps reinforce learning, correct mistakes, and build confidence.

AI in Communication and Collaboration Tools

AI is also playing a significant role in improving communication for students with varying needs. For instance, Microsoft Teams uses AI to provide real-time captioning and translation services during video calls, breaking down communication barriers for students with hearing impairments or those who speak different languages. This ensures that all students can engage fully in collaborative STEM projects and classroom discussions. Moreover, AI-powered virtual assistants are now being used to support students who need additional help with social communication. These tools can simulate conversations and offer students practice in a low-pressure environment, helping them develop essential skills for both academic and social success.

CASE EXAMPLES OF USING TECHNOLOGIES AND AIS TO SUPPORT STUDENTS WITH VARYING NEEDS

Several case examples demonstrate the effectiveness of using technologies and AI to support students with varying needs in STEM education. These case studies highlight how tailored interventions using advanced technologies can improve learning outcomes for diverse students.

Case 1: *The Use of AI for Personalization at Montgomery Middle School*

Montgomery Middle School in San Diego, California, implemented AI-driven tools in its STEM curriculum to support students with varying needs. Using the *Smart Sparrow*[32] platform, the school provided personalized instruction in science courses. The platform adapted lessons based on each student's performance, offering additional resources and explanations for students who struggled with specific concepts. The result was a significant increase in student engagement and improved performance across all levels of ability. Students who typically struggled with complex material were able to work through problems at their own pace, receiving support when necessary, while more advanced students were challenged to explore higher-level concepts.

Case 2: *AI-Powered Personalized Tutoring at The Branch School*

At The Branch School in Houston, Texas, an AI-powered tutoring platform called *Riveting Results*[33] was integrated into the curriculum to support students across academic subjects, including STEM. The platform delivers real-time, personalized instruction by adapting to individual student performance and learning styles. This customization allowed students to progress at their own pace while focusing on areas where they needed the most support.

Teachers used the platform alongside traditional instruction to enhance classroom learning and receive data-driven insights into student progress. As a result of this AI integration, students at The Branch School achieved remarkable gains on standardized assessments—placing in the top 2% nationally. The success of the platform demonstrates the potential of AI-driven tools to elevate academic achievement and provide inclusive, differentiated instruction for all learners.

Case 3: *Enhancing Biology Education with Classcraft Gamification*

In a study conducted by Perry Angelo Manlapaz (2024), *Classcraft*[34] was utilized as a gamified intervention tool to improve students' affective constructs and mastery levels in a General Biology 2 course. The quasi-experimental research involved Grade 11 students, comparing an experimental group using Classcraft with a control group receiving traditional instruction. Findings indicated that the gamified approach significantly enhanced student motivation, engagement, and preparedness, leading to improved mastery of challenging biological concepts. This case exemplifies how integrating gamified AI learning systems like Classcraft can effectively support students with varying needs in STEM education.

CHALLENGES AND CONSIDERATIONS IN IMPLEMENTING AI AND TECHNOLOGIES FOR INCLUSION

While technology and AI hold great promise for supporting students with varying needs, there are important considerations and challenges that must be addressed to ensure successful implementation.

Equitable Access

One of the primary challenges is ensuring that all students have access to the necessary technology. Students from low-income backgrounds or underfunded schools may lack access to devices, high-speed Internet, or assistive tools, further exacerbating the digital divide (Katz, 2017). To achieve true inclusivity, schools must prioritize providing equitable access to these technologies for all students.

Privacy and Data Security

AI and other digital tools rely on large amounts of data to function effectively. Ensuring that student data is protected and used responsibly is critical. Schools must comply with regulations such as the Family Educational Rights and Privacy Act to protect sensitive student information (Williamson, 2017). Careful consideration must be given to how data is collected, stored, and shared to safeguard student privacy.

CONCLUSION

Technology, including AI, has transformed the landscape of K–12 STEM education, offering powerful tools to support students with varying needs. Through personalized learning platforms, assistive technologies, and AI-driven solutions, educators can create inclusive learning environments that empower all students to succeed. While challenges remain in ensuring equitable access and protecting privacy, the potential for technology to enhance STEM education for students across the spectrum of abilities is undeniable. By thoughtfully integrating these tools into the classroom, educators can help break down barriers and provide every student with the opportunity to excel in K-12 STEM education.

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AI-Driven Technologies That Support Accessible and Inclusive K–12 STEM Education among Neurodiverse Students and the Sensory-Impaired

Dr. Alina Nico West

Neurodiversity is natural variation in the function of the human mind and brain (Botha et al., 2024). Such diversity can be described in relation to the brain's structure and function. Varied abilities can arise due to genetics or may be acquired from other medical causes, including illness and injuries. Because of this variability, individuals may have changes in their ability to understand and process information (cognition) from their environment through sensory experiences (van Rijswijk et al., 2024).

Science, technology, engineering, and math (STEM) education is becoming more inclusive and accessible for everyone. However, the current model of a "traditional" teacher-centered didactic learning environment (e.g., in traditional school classrooms) does not accommodate every child's educational needs (Azuka et al., 2024). The traditional classroom and catalogued resources for children assume a one-size-fits-all model of learning, whereas the ideal gold standard of accessible STEM education implements a truly individualized learning plan that includes resources accommodating every child. Artificial intelligence (AI) is a multi-purpose resource with the capability to provide all children, including those students who are not successful in a traditional learning environment, and teachers, with solutions for ever-changing individualized learning requirements (Friedman & Nash-Luckenbach, 2024).

AI is a platform that models human interaction and learning and allows advanced systems to interact with humans in many ways. In education, AI can facilitate human learning, no matter the environment in which the information is being taught. Artificial Intelligence has emerged as a transformative force in addressing challenges, offering personalized, adaptive, and engaging solutions. Most importantly, AI, among other technologies, enables student empowerment in any learning environment.

AI strategies can be implemented using Universal Design for Learning (UDL), which is a pedagogical framework that aims to include all students with a range of abilities, backgrounds, and learning preferences in K–12 education. UDL recognizes three main principles: recognition networks that provide multiple means of representation (The "What" of Learning); affective networks that provide multiple means of engagement (The "Why" of Learning); and strategic networks that provide multiple means of action and expression (The "How" of Learning) (CAST, 2018).

A framework has been proposed to use AI in implementing UDL principles in educational settings (Song et al., 2024). In this framework, students should explore ways of using AI in problem-solving and community-based engagement to strengthen their literacy of the technology. Self and peer evaluations are needed to create autonomy in the use of AI. Visualization, demonstrations, and simulations are necessary to address how AI is represented to the student (the "what"), to clarify their understanding of the practical uses of AI. Students should be able to explain how AI works, especially the decision-making capability of the algorithms within different learning technologies. Alternatives should be available for students who cannot engage in computer-based activities. Students should also be allowed to develop their own artifacts from their use of AI. Authentic assessments, including a summative evaluation, can help students express their knowledge and comfort with using AI (Song et al., 2024).

In this section, we will explore AI tools that are able to accommodate all K–12 learners inside and outside of the artificial learning environment, based on (1) accessibility and inclusivity; (2) personalized adaptive learning; (3) social skill development; and (4) executive function and organization. Recommendations were identified using OpenAI (OpenAI, 2024).

1 | ACCESSIBILITY AND INCLUSIVITY

Assistive Sensory Technologies

AI tools can tailor educational content to the individual needs of neurodiverse and sensory-impaired learners. Customizable, individualized assistive technologies for communication include AI-integrated technological tools such as screen magnifiers and readers, and speech recognition. For students who are visually impaired, AI-assistive screen readers can read the computer screen aloud, with adaptations of speech output that include reading speed and language (Chen et al., 2023; Vescio, 2023). With AI assistance, these screen readers can also interpret the meaning of the text and are trainable to student behavior and preferences.

Screen magnifiers can enlarge text and graphics. Speech-to-text and text-to-speech software (e.g., Dragon NaturallySpeaking) support learners with dyslexia by converting spoken words into text or reading written content aloud (Ayeni, 2024; Matre & Cameron, 2022). Current software may or may not include both speech-to-text capability and screen magnification. However, with the addition of AI, screen magnifiers and readers are integrated. Built-in AI speech-to-text platforms, such as programs that assist with lecture transcription, are also included in web services such as Google web browser and on virtual meeting platforms to accommodate learners (Ayeni et al., 2024; Schloesser, 2023). Smart tutoring systems like those offered by *DreamBox*[35]and *Carnegie Learning*[36] adapt lesson difficulty in real time, based on a learner's performance.

Sensory-Friendly Interfaces

Many neurodiverse learners are sensitive to sensory stimuli. AI-powered platforms often include features such as adjustable font sizes, background colors, and reading speeds (Wallace et al., 2022). These tools can be found in screen magnifiers used by visually impaired students, for example. Gamified learning environments, such as *BrainPOP*,[37] use interactive visuals and sound effects to engage learners without overwhelming them.

Sensory Adaptive AI

AI enables learning through multiple sensory channels. Visual learners can benefit from tools that include Khanmigo by *Khan Academy*,[38] which uses AI to recommend video tutorials and exercises. Auditory learners can use AI podcasts and audiobook services such as *Audible's WhisperSync*.[39]

Augmented reality technology combines the real world with interactive environments using digital visual elements, sounds, and other sensory stimuli through holographic technology. This technology creates a partially digital environment, with the output generated as 3-D content, which can facilitate interactive simulations (Dechsling et al., 2022). Virtual reality creates a simulated, immersive learning experience, enabling students to interact with an artificial 3-D environment (Javaid et al., 2024).

Coding platforms use a set of specialized instructions to communicate with computers and promote improvement in computational thinking (Asbell-Clarke et al., 2024). Three-D printing is a rapid prototyping method used to create complex models, but can be used by students with sensory sensitivities due to the highly tactile nature of 3-D objects. Three-D printing can be used to create customized fidget toys, utensil grips, and other visual aids. Learning the process of 3-D printing also allows neurodiverse students to deeply engage and focus (Buehler et al., 2015).

Assistive Communication Devices

For non-verbal learners or those with speech delays, AI-enhanced augmentative and alternative communication tools like *Proloquo2Go*[40] offer customizable vocabulary and sentence construction features. Other generative AI programs, such as *Co-Writer*,[41] can be used to create informational diagrams.

Real-Time Translation

For learners with multilingual needs, AI-driven translation tools such as Google Translate and Microsoft Translator make content accessible across languages.

2 | PERSONALIZED ADAPTIVE LEARNING

Interactive Learning and Predictive Analytics

Adaptive learning platforms (also called learning management systems or e-learning systems) provide an equitable digital space where students can pace their learning and actively engage with the educational information (Katsaris & Vidakis, 2021). These platforms allow teachers to create an alternative environment where students can further use their skills while accommodating preferred communication styles. Adaptive learning platforms also enable teachers to embed and implement customizable learning strategies and lesson plans that include ULD. Using this technology allows teachers to develop a very inclusive environment for all students learning STEM. Finally, platforms such as *Lexia Learning*[42] provide feedback analytics to educators that predict challenges and will suggest interventions and learning resources to enable preemptive support, allowing customization of the student's learning experiences.

3 | COMMUNICATION AND SOCIAL SKILL DEVELOPMENT

Conversational Socio-Emotional Development

Virtual tutors and chatbots provide real-time interaction with learning resources to accommodate learners of social conversation. Tools like *ChatGPT*[43] and *Replika*[44] simulate social interactions, allowing learners to practice conversations in a low-pressure environment.

Emotion Recognition/Socio-Emotional Development

AI can also help learners recognize and manage emotions. Apps like *Emotiplay*[45] use AI to teach emotional recognition through games and facial expression analysis, benefiting learners with autism spectrum disorder. Learners can use AI-assist devices such as smart glasses by *Empowered Brain*[46] to help them identify facial and other cues, sharpening their socio-emotional skills.

Language Processing

AI tools such as *Grammarly*[47] and *WordQ*[48] assist with writing by providing real-time feedback on grammar, sentence structure, and tone, supporting learners who struggle with language-based tasks.

4 | EXECUTIVE FUNCTION AND ORGANIZATION

Task Planning

AI-powered organization apps support learners with ADHD and other executive function challenges. Tools like *Todoist*[49] and *MyHomework*[50] and AI-powered calendars such as *Motion*[51] offer reminders, priority-setting features, and visual task breakdowns.

Enhancing Focus and Memory

AI tools can reduce distractions and enhance focus. Apps like *Focus@Will*[52] use AI to generate music tailored to improve concentration, while browser extensions like *StayFocusd*[53] block distracting websites. AI-based apps such as *Quizlet*[54] leverage spaced repetition algorithms to engage learners with memory retention to reinforce information.

CHALLENGES AND CONSIDERATIONS

AI tools offer a wide variety of features and significant potential in engaging neurodiverse learners and creating space for their success in the traditional classroom and beyond. However, key challenges must be addressed, including (1) avoiding algorithm bias and ensuring that AI is inclusive across the neurodiversity range; (2) preventing digital fatigue by managing screen time and preventing over-reliance and sensory overload; and (3) making advanced AI tools affordable and widely available.

CONCLUSIONS

The use of AI in the classroom is a paradigm shift in education across the spectrum of neurodiversity and human ability. It fosters inclusive, effective, and personalized learning experiences. By addressing the challenges of AI use, students will be empowered to reach their full potential no matter what their learning environment. However, collaboration among the neurodiversity community members, including students, educators, parents, AI developers and researchers, and others, is critical to optimize the educational impact and ensure equitable access and success.

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Empowering Access: Assistive Technology in K–12 STEM Education

Trinity Dovan and Elle Satterthwaite

Assistive technology (AT) expands opportunities in K-12 STEM education by amplifying diverse voices, enabling idea-sharing, and fostering inclusivity. Given these significant possibilities, it is essential to examine how AT has been used previously in STEM education and how it is currently implemented to understand the scope of its present and future impact. This section provides a brief overview of AT in education.

TYPES OF ATs IN EDUCATION

AT is divided into two categories—low technologies and high technologies—depending on whether or not the type of support requires programming (Fernández-Batanero et al., 2022). Low technologies include equipment or objects that provide alternative ways to perform actions, such as adapted pencils to support various grip strengths and sensory objects the student can manipulate during a lecture. High technologies are more complex and often more expensive, as they use electronic technologies such as electronic communication boards or speech recognition software on a device (Israel et al., 2014). Both categories of ATs have long supported individuals in adapting to their environments, particularly in education (Viner et al., 2019). In the classroom, AT is typically used to help students overcome learning challenges related to hearing, vision, and mobility.

In addition to including both low-tech and high-tech tools, AT can also be categorized as hardware or software. Examples of AT hardware and software include visual aids such as photos and illustrations, text-to-speech and speech-to-text software, Braille readers, adaptive keyboards and mice, augmentative and alternative communication devices for non-verbal students, and mobility aids, all of which enhance accessibility and learning (Jacob et al., 2023).

These various technological supports have undoubtedly increased access to STEM education for students of all abilities. As more individuals begin to integrate them into academic spaces and people become aware of these resources, everyone has more opportunities to advance in STEM (Guzman-Orth et al., 2021). Keeping accessibility in mind when designing curriculum and resources for students has become more normalized, and educators must continue this mindset (Reinholz & Ridgway, 2021). Incorporating AT and innovative learning environments into STEM classrooms promotes inclusion of students with disabilities by providing tailored resources and adapting teaching methods. AT enhances educational experiences by breaking down access barriers and improving academic and social participation (Jacob et al., 2023). Educators need to embrace the incorporation of AT, as it helps provide access to education spaces that allow every student a chance to thrive in STEM (Page & Charteris, 2023).

CHALLENGES AND SUGGESTIONS

While AT benefits students, there are challenges that prevent widespread adoption in STEM classrooms, such as access and affordability (Milanovic et al., 2023), infrastructure limitations (Torrado et al., 2020), and lack of awareness (Fernández-Batanero et al., 2022).

A major challenge with ATs is ensuring that students can access and use them. This is often the most complex issue surrounding AT implementation (Milanovic et al., 2023). High-tech solutions can be expensive, and students frequently encounter policy and socioeconomic barriers when trying to access them. Systemic barriers, such as disparities in funding for schools serving marginalized communities, exacerbate these access and affordability issues. Moreover, physical spaces must have the necessary infrastructure, which requires supportive policies, while classrooms must actively counteract social biases and stereotypes concerning the use of ATs (Torrado et al., 2020).

Building a truly inclusive environment demands cooperation from the entire community to ensure that all students can fully engage with STEM education. Even when students gain access to devices—such as those enabling speech-to-text or text-to-speech software—their use can be challenging for teachers, educators, and families to navigate effectively (Israel et al., 2014). Compounding this issue is a general lack of awareness about available resources, which stems from insufficient prioritization of AT at a societal level, despite its increasing adoption over the past 15 years (Fernández-Batanero et al., 2022).

Previous research highlights several strategies to address the challenges associated with widespread AT adoption in education. These include improved teacher training and professional development (Guzman-Orth et al., 2021); policy and funding initiatives (Viner et al., 2019); and collaborative development (Jacob et al., 2023). All are described in more detail below.

Improved Teacher Training and Professional Development with ATs

A key strategy is helping educators gain the knowledge and skills they need to use ATs effectively in their classrooms. Ongoing training and professional development are important to close gaps in understanding the different ATs available and how to use them in practice in the classroom (Guzman-Orth et al., 2021). Teachers also need to learn inclusive teaching methods that make the best use of these technologies to ensure fair access to STEM education. When teachers have the right tools and training, inclusive education becomes more possible, and ATs are more likely to be accepted and used successfully (Fernández-Batanero et al., 2022).

Targeted Policy and Funding Initiatives for ATs

The high cost of ATs remains a significant barrier to their widespread use in STEM classrooms. To overcome this challenge, it is necessary for policy reforms and government funding programs to be better aligned. This would provide schools with the financial resources necessary to integrate these technologies effectively (Viner et al., 2019). Strategic investments in AT infrastructure, such as the devices themselves and physical spaces to support their use, can ensure that students with disabilities have equitable access to the tools they need to succeed (Viner et al., 2019).

Collaborative Development of ATs

The development and implementation of ATs requires collaboration among educators, technology developers, and policymakers to address systemic barriers (Jacob et al., 2023). Through collaboration, stakeholders can better design and produce affordable, practical, and effective tools that meet the diverse needs of students with disabilities in K-12 STEM classrooms. Working together through all stages also ensures that these technologies are grounded in real-world classroom needs, making them more accessible and impactful in fostering inclusive learning environments (Jacob et al., 2023).

RECENT TRENDS IN ATs

Recent developments in ATs are changing how educators support students of all abilities, especially in STEM classrooms. These trends highlight efforts to make learning more inclusive, accessible, and engaging through innovative tools and strategies. These trends include increased integration of digital tools (Page et al., 2023); increased use of ATs for social integration (Guzman-Orth et al., 2021); and greater integration of artificial intelligence and machine learning (Jacob et al., 2023).

Increased Integration of Digital Tools

There is a growing focus on incorporating interactive and adaptive digital tools into STEM classrooms, offering significant benefits, especially for students with disabilities (Page et al., 2023). These technologies allow for more personalized learning experiences by tailoring content delivery to individual needs, improving both student engagement and accessibility. Digital tools also provide greater flexibility in how educational material is presented and accessed, helping all students participate meaningfully in STEM learning.

Increased Implementation of AT for Social Integration

ATs are now being designed not only to support students' academic success but also to foster social inclusion in the classroom (Guzman-Orth et al., 2021). These tools aim to improve collaboration and peer interaction, enabling students with disabilities to participate fully in classroom activities. By enhancing communication and building stronger connections among students, ATs contribute to better STEM learning outcomes and create a more inclusive classroom environment (Guzman-Orth et al., 2021).

Increased Integration of AI and Machine Learning

Artificial intelligence (AI) and machine learning are expected to play an increasing role in assistive technology design and implementation (Jacob et al., 2023). These advancements are leading to the development of more personalized and customizable tools, tailored to the specific needs of each student. AI-powered systems can make real-time adjustments based on a student's progress, offering targeted support to help students with disabilities stay engaged and succeed in STEM subjects (Guzman-Orth et al., 2021).

SUMMARY

While AT has caused significant advancements in accessibility and inclusion in STEM education, there are clear challenges, such as access and affordability, infrastructure, and a lack of awareness, that affect widespread adoption of the use of these technologies in STEM classrooms. To overcome these barriers to buy-in, there is a need for enhanced teacher training and professional development, policy and funding support, as well as collaboration from stakeholders at all stages of development. Recent trends, such as increased integration of digital tools, social inclusion-focused AT, and AI-driven innovations, offer promising solutions to address these barriers and enhance the current practices. Addressing these barriers to entry will help ensure that all students, regardless of ability, can fully participate in and benefit from STEM education.

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CHAPTER 5
Shared Vision for Zero Barriers in STEM Education

This chapter explores the perspectives of participants in the Zero Barriers in K-12 STEM Education. With a restored understanding of Universal Design for Learning, empowering advocacy and constantly improving technology—participants were able to come to a sense of consensus for creating accessible spaces for all students.

Dr. Alison Lockwood Dossick

The Zero Barriers in K-12 STEM Education Reconvening provided an opportunity for cohorts to examine and rethink their shared visions for promoting accessible and inclusive K–12 STEM education. Prior to attending the reconvening, participants submitted their vision for accessible and inclusive K–12 STEM education. An analysis of the comments shown in Figure 6 reveals four common words: All Students Learning STEM. These concisely summarize the focus of the Zero Barriers in K-12 STEM project. The consensus of the participants was that the goal remained largely unchanged from prior workshops. This was to foster an environment where all students are equipped to reach their full potential, both academically and personally, within the realm of STEM education.

The participants agreed that further professional development in Universal Design for Learning (UDL) and inclusive practices would help them continue progressing toward this goal. One participant shared, "I think using UDL as a binding element of all teams' projects and work is a unifying principle that will help focus everyone" (P15, District Administrator). Recurrent training would help educators stay informed about best practices in inclusive education while supporting teachers and administrators in implementing these practices effectively. Specifically, another participant wanted "practical ways to be inclusive to other disabilities, such as ADHD, ODD, blind students, nonverbal, and severe intellectual disabilities" (P17, Secondary School Teacher).

Participants found that refreshing their understanding of UDL provided them with strategies that ensure all students, regardless of ability, can access and engage with STEM content. Ongoing reflection of professional development by continuously seeking feedback, focusing on student voices, and adjusting practices to ensure that all students and their abilities are fully supported is also a key aspect of continuing a shared vision. This supports the goal of what another participant saw as creating "a classroom where everyone feels welcome to learn and make mistakes and grow" (P05, unknown position), and where "focusing on the student at the center of the work" (P31, Secondary School Teacher) supersedes the past ways of teacher-centered education.

Figure 6. Common word analysis: This word analysis uses larger font sizes to show the most common words found in the comments from cohorts. The four most prominent words are: all, students, learning, STEM.

While accessible and inclusive practices are important when designing STEM lessons that meet the needs of all students, personalized support to accommodate diverse learning needs is also essential. Another aspect of professional development that cohorts felt was essential is keeping up with technological advances that make classrooms more inclusive—specific assistive technologies, artificial intelligence, or more general technologies that help provide access to STEM for all students.

The cohorts found that planning to increase student empowerment in their educational paths would result in creating positive STEM identities for all students. The planning could include creating a classroom atmosphere where students feel a sense of belonging, agency, and the ability to self-monitor their growth. The STEM space should encourage curiosity, collaboration, and empathy among students. One teacher stated, “My vision is for all students to use to the principles of STEM to become more informed citizens that use thinking, problem-solving, discernment, and teamwork” (P26, Nonprofit Organization/Community Partner Educator). Inclusive statements like this demonstrate the importance educators place on STEM literacy for all, regardless of ability. The participants encouraged schools to engage with underrepresented communities to broaden STEM opportunities and collaborate with students in their classroom setup and learning experiences.

The strategies to meet these shared visions and guide future work in STEM education emphasize creating inclusive, accessible environments for all students. The aim is to create a supportive, collaborative educational community that empowers all students to reach their full potential in STEM fields. An administrator shared that networking and exchanging ideas and resources with other schools and districts would be very helpful in moving the vision forward to “create a coalition of collaborators and sponsors” (P18, Nonprofit Organization/Community Partner Educator).

Establishing a student-centered approach that applies comprehensive inclusion for a full range of abilities would be another way to impact student learning more broadly. This could be combined with culturally sustaining pedagogy (CSP), which addresses identity and power dynamics to create a fully inclusive STEM program. This combination of UDL and CSP has been termed “cross-pollination” by Waitoller and King Thorius (2016).

Creating a sustainable vision begins with a commitment to research, implementing best practices, and continuous improvement to create a STEM education environment where every student can thrive and excel. Using the research generated by the SSEC, educators across the nation can advocate for changes in policies that currently create barriers to accessibility and support the inclusion of diverse needs, including disabilities, in educational settings. One administrator felt that “training school leadership, new principals and new teachers… in creating accessible and inclusive K–12 STEM education” (P27, K–12 Administrator) would make the biggest impact across the school district. Reaching out to all new stakeholders can facilitate district change. This administrator felt that support should be provided by site-based administrators who offer targeted feedback to teachers on these practices. “By observing classrooms and offering constructive feedback, we help teachers improve their practice, ensuring they can meet diverse student needs. This approach empowers all students to succeed and thrive in STEM subjects” (P15, District Administration). The shared vision of inclusive STEM practices allows parents, teachers, students, and administrators to continue the work that has begun at the Zero Barriers in K-12 STEM Education Summits.

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CLOSING

Dr. Amy D'Amico

This Sourcebook represents five years of the Zero Barriers in K-12 STEM Education program (2019–2024). While to date, we have been able to serve 37 leadership teams who represent states, regions, districts, and schools through our Zero Barriers program, we recognize that there is still a great deal of work to be done. As previously stated, the mission of the Smithsonian Science Education Center is to "Transform K-12 Education Through Science in collaboration with communities across the globe." This work embodies that mission.

The purpose of this Sourcebook is to share the lessons learned by the Smithsonian Science Education Center and those who have participated in this program. The trends highlighted in the stories shared here are analogous to other systemic transformation efforts in education. Systemic change is slow, and it cannot be accomplished alone. Our belief is that in sharing the challenges, successes, and resources from this work, we can encourage others to learn and grow, so that together we can create a more accessible and inclusive education system for all youth in classrooms today.

APPENDICES

Appendix A: An Example of the Science Digital Equity Toolkit by the Colorado Department of Education team

Each criterion is introduced with several indicators, each with varying degrees of evidence. The criteria are: Mindset (10 indicators), Leadership (4 indicators), Systems (7 indicators), IEP Creation and Progress Monitoring (9 indicators), Instructional Materials (3 indicators), and UDL/SDI for Learning (4 indicators). The Mindset part of the toolkit is shared as an example below. Currently, the team is working on finalizing the toolkit.

Mindset Is there a strong belief that all students with IEPs should be a part of STEM/science programming at all levels?					
Indicator	**Lack of Evidence**	**Minimal Evidence**	**Some Evidence**	**Strong Evidence**	**Notes**
Administrators believe that ALL students are general education students first, and that ALL students should have access to grade-level science/STEM curriculum and instruction.	Students with IEPs are intentionally excluded from science/STEM instruction due to pull-out/intervention schedules and/or behavioral/safety concerns.	Students with IEPs are excluded from grade-level-appropriate science/STEM instruction because they are enrolled in a science/STEM course that is below grade level OR are receiving below-grade-level instruction within a center-based, self-contained classroom.	Most students with IEPs are enrolled in a grade-level-appropriate science/STEM course, but are sometimes excluded due to behavior or scheduling conflicts.	Students with IEPs are intentionally included and scheduled to participate in grade-level science/STEM courses with appropriate supports to access grade-level standards and instruction.	
Parents want ALL students to have access to grade-level science/STEM instruction.	Parent voices are not included in decisions about science/STEM programming OR parents' voices that students with IEPs should not be included in grade-level science/STEM instruction.	Parents are included in discussions regarding science/STEM inclusion, but only as it pertains to their own child.	Parents are involved in decision-making that affects students with IEPs being included in science/STEM classes.	Parents actively advocate for students with IEPs to be included in grade-level science/STEM instruction, including celebrations and leadership roles within science/STEM classrooms.	
Science staff believe that ALL students should have equitable access to science instruction, including support both within and outside the general education science classroom.	Science/STEM instructors ask for students with IEPs to be removed from the science/STEM classroom, regardless of IEP goals.	Science/STEM instructors are aware of and held accountable for student IEP goals as they might pertain to science/STEM instruction.	Science/STEM instructors are included in IEP meetings/goal-setting and collaborate with special education providers.	Science/STEM instructors and special education providers routinely collaborate to ensure all students have access to grade-level science standards and three-dimensional learning. All teachers are advocates for STEM programming for all students.	

Mindset Is there a strong belief that all students with IEPs should be a part of STEM/science programming at all levels?					
Indicator	**Lack of Evidence**	**Minimal Evidence**	**Some Evidence**	**Strong Evidence**	**Notes**
Special education providers believe that ALL students should have instruction of grade-level science standards and are committed to supporting students' science knowledge in a variety of appropriate educational environments	Special education providers are unaware of and/ or uninvolved in students' science needs and/or learning.	Special education providers support science/STEM instructors in monitoring IEP goals.	Special education providers and science/STEM instructors regularly collaborate and consult to meet student needs in science/STEM.	Special education providers intentionally advocate for students with IEPs to attend science/STEM instruction daily in the least restrictive environment.	
Para-professionals and Other Support Staff believe that students should be part of the general education classroom and strive to create a meaningful and inclusive environment, specifically during science instruction	Support staff routinely remove or isolate students with IEPs during science/ STEM class due to behavioral concerns, lack of comfort with the content or a belief that science is not necessary or too difficult for students with IEPs	Support staff are included in science class activities for the purpose of supporting students with disabilities	Support staff, Special Education Providers, and Science/STEM Instructors regularly collaborate and consult to meet the needs of students with IEPs	Support staff actively participate in science/STEM learning and assist with science learning, and proactively advocate for the appropriate accommodations, scaffolds, or technology for students to participate fully with their peers	
Students without IEPs welcome students with identified needs in the classroom, specifically during science instruction	Students intentionally isolate, intimidate, or exclude students with IEPs from participating in science and STEM activities in the classroom	Students without IEPs may be polite to students with IEPs, but not necessarily inclusive. (i.e., students with IEPs are assigned to groups but do not actively contribute to learning)	Students with IEPs regularly and independently include students with disabilities in science learning activities when assigned to small groups or partners	Students routinely advocate for their peers with IEPs to be included in science/ STEM learning activities and see them as an asset to collaboration in the classroom community	
Students with IEPs believe that they are a vital part of the general ed classroom, specifically within the science classroom	Students with IEPs reflect the mindset that science or STEM learning is not important or "not for me"	Students with IEPs are engaged in science/STEM learning, showing curiosity and contributing to problem solving	Students with IEPs take on leadership roles in the science classroom when possible, showing contributions to classroom activities and culture equal to students without IEPs	Students with IEPs find importance, relevance, and joy in participating in grade-level science and STEM learning. Students understand the potential impacts of science education on their everyday lives and potential careers.	

Mindset Is there a strong belief that all students with IEPs should be a part of STEM/science programming at all levels?					
Indicator	**Lack of Evidence**	**Minimal Evidence**	**Some Evidence**	**Strong Evidence**	**Notes**
All staff frequently teaches and reteaches kindness expectations specific to understanding disabilities across all settings, particularly in the general education science classroom	Staff rarely or never proactively or reactively addresses expectations or strategies for welcoming, patience, or inclusiveness of students with IEPs in general education settings	Staff reactively address expectations for kindness and inclusion of students with IEPs in science/ STEM (i.e., address issues once they arise)	Staff proactively plans for teaching kindness and inclusion expectations and strategies for science/STEM instruction with support staff and student peers	General education students, teachers, and support staff show intentional kindness, patience, and inclusiveness for all students, especially those with disabilities. Students advocate for each other and intervene when they see others being unkind.	
Perspectives from **diverse community representatives** are included in routine reflection of various sources of data to refine classroom management strategies to increase culturally sensitive and asset-based, appropriate practices for all students and staff. (Administration, General Science/ STEM Instructors, Special Education Providers, Staff, Parents: Special Education, General Education, Multilingual Education, etc.)	There is low tolerance for behavioral needs and/or no identified strategies to help students meet behavioral goals or authentically participate in science/STEM learning	Staff reactively address behavior expectations and establish appropriate practices in response to behavioral needs	Staff proactively anticipate and establish classroom cultures that are culturally sensitive and asset based, leveraging universal design for learning environments appropriate for all students	There are multiple appropriate strategies in place to support students with behavioral needs participating fully in science and STEM classes. Teachers proactively plan and co-plan learning environments to support all students. Students are involved in planning the classroom environment.	
Science instructors and special education providers foster the belief that science and STEM are an integral part of all students' everyday lives and that students with disabilities can be a part of science and STEM careers.	Science Instructors actively exclude students with IEPs from science/ STEM learning or discourage students with IEPs from pursuing STEM curiosities or careers	Science Instructors include students with IEPs in general education activities and discussions that address science and STEM careers	Science Instructors include students with IEPs in conversations about STEM careers AND address each student's unique strengths for these careers in individual or classroom conversations	Science Instructors intentionally plan and implement science lessons and activities that make connections between students' everyday lives and the content and skills of science disciplines	

Appendix B: Elevating Student Voice Planning Template

STAGE 1: BRAINSTORMING

Where is student voice currently found in your classroom/school/district? (List as many as you can think of)		
Being Heard	**Collaborating with Adults**	**Leadership**

What opportunities exist to further elevate student voice, either through expanding activities that are already occurring or filling gaps where student voice is missing? (List as many as you can think of)		
Being Heard	**Collaborating with Adults**	**Leadership**

STAGE 2: FOCUSING

Using the "opportunities" list above, choose your top 3 high priority areas for elevating student voice in the coming school year

1.

2.

3.

Why did you choose these? What change/improvement do you expect to see?

STAGE 3: ACTION PLANNING

What action steps are needed in the coming school year to make this happen? (Be as specific as possible)		
What needs to happen?	**Who will do it?**	**Timeline?**

Appendix C: Bolman and Deals Four Frame Model

Resource adapted from "Key Concepts in Bolman and Deal's Four-Frame Model." HRDQ, December 20, 2023. *https://hrdqstore.com/blogs/hrdq-blog/concepts-four-frame-model?srsltid=AfmBOorCr18VeLu0EUJ1vGTZ4hPujAb0fWJifV_QovavU7kdnazu7F8N.*

Bolman and Deal's Four Frame Model is a way of looking at an organization to understand and manage it better. Understanding organizational behaviors on a deeper level can help leaders discover the root causes of challenges they are trying to navigate while implementing new and existing initiatives and address problems using a more multifaceted approach.

STRUCTURAL FRAME

Focus: Organization's structure, roles, rules, policies, and goals

Organizations have different parts that need to fit and work together. Elements such as clear roles, responsibilities, and processes help an organization run smoothly.

This perspective says that if there's a problem, you might fix it by changing the workflow, defining roles more clearly, or adjusting policies and goals.

HUMAN RESOURCES FRAME

Focus: People in the organization, their needs, skills, and relationships

Organizations are social networks. When members are happy and have positive attitudes about the organization, they perform better and contribute more to the network.

This perspective says that if there is a problem, you can address it by providing more training, improving communication, or creating opportunities for staff to feel valued and supported.

POLITICAL FRAME

Focus: Power, competition, and conflict within the organization

Picture the organization as a tournament where different groups and individuals are constantly competing for resources, influence, and power.

This perspective says that the solution to problems is in how you negotiate, build alliances, or use influence and persuasion to achieve goals.

SYMBOLIC FRAME

Focus: Culture, symbols, and meaning within the organization

What are the stories, traditions, and symbols that give people a sense of purpose and belonging?

This perspective says that the solution to problems requires a strong culture, meaningful practices, clear vision, and values.

Zero Barriers Reconvening 2024 teams were provided with this Bolman and Deal's explainer handout to support them in conversations about decision-making and behaviors in their organizations.

ENDNOTES

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8 *https://clusive.cast.org/*

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14 *https://www.dpi.nc.gov/recognized-nc-stem-schools-distinction*

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