

A magazine for mathematics
and science educators

TERC

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Four Currents

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A Message from TERC's President

Dear TERC Community,

Each day at TERC, I see our mission in action: continuous efforts to advance STEM learning for all. That has been my key takeaway during my first months as TERC's President. After more than 30 years in STEM education, I can say without hesitation that the passion, creativity, and commitment of this team are extraordinary. TERC's team recognizes that if innovation is at the heart of STEM, it must also be at the heart of STEM teaching and learning. If science, technology, engineering, and mathematics are evolving at an unprecedented pace, so must the ways we foster STEM learning.



For more than 60 years, TERC has advanced STEM learning through its educational research and development. While our history is long, our entrepreneurial spirit remains strong. We are a learning organization—one that evolves as the needs of our communities change. At this moment, we are asking not only how STEM is changing, but how we as a society want to change—and how STEM learning can help lead that transformation.

Over the past several months, we have taken a close look at our work. We have engaged staff and the Board in deep conversations about impact. We have spoken with partners—both long-standing collaborators and new voices—and asked a simple question: How can TERC best work with you to advance STEM learning?

The result of that reflection is the introduction of four new “currents” that will guide our work moving forward. These currents represent areas where we see the convergence of urgent opportunities for impact and TERC's deep expertise. They are not a departure from who we are; they are a sharpening of our focus and a deepening of our commitment to STEM learning for everyone, everywhere.

CURRENT Highlighting STEM Across the Community

STEM is not confined to classrooms or workplaces. It is ubiquitously present in our homes, our neighborhoods, our cultural practices, and the issues that shape our communities. Yet too often, its role in our everyday lives goes unrecognized.



Through this current, we center STEM learning in and with communities. We embed STEM experiences in family activities, informal learning spaces, arts organizations, and community-based initiatives. Whether through dance that illuminates physics, maker-centered math experiences, or environmental stewardship projects grounded in local concerns, we connect STEM to lived experience.

Equally important, we are committed to co-design—working not simply for communities but with them. By drawing on cultural strengths, curiosity, and local priorities, we make STEM learning more relevant, more joyful, and more deeply rooted in everyday life.

CURRENT Leveraging Emerging Technologies for Inclusivity

Emerging technologies, including artificial intelligence (AI), are transforming education. It is not, however, the technology itself that determines who succeeds—it is how those technologies are implemented and how the learning experiences are designed.



At TERC, we approach emerging technologies as tools to broaden participation in STEM learning. Through co-design with educators and learners, we develop experiences that strengthen critical thinking, problem-solving,

collaboration, and agency. Our goal is to support educators—not replace them—and we work together to deepen STEM learning for all.

CURRENT Growing Mathematical Identities and Understanding at Every Age

For too long, mathematics has been framed as exclusive—something reserved for the few. These narratives shape who participates and who gets counted out. At a time when algorithms and large data sets guide decisions at every level of society, we need everyone to see themselves as capable mathematical thinkers.

Mathematical identity is not fixed but is developed through experience. When learners of all ages—children, youth, adults, families, educators—engage in mathematics as a creative, sense-making, and culturally connected endeavor, confidence grows and participation expands.

This current takes a community ecosystem approach, supporting authentic mathematical experiences in schools, public spaces, family settings, and workforce contexts. By redefining what counts as math—and who gets to do it—we aim to cultivate strong mathematical identities across generations.



CURRENT Expanding Career Opportunities through STEM

Today, STEM knowledge and skills shape opportunity in nearly every sector of the economy—healthcare, agriculture, manufacturing, AI, and even the arts, entertainment, public service, construction, and more. Yet, expanding access to career pathways requires more than delivering STEM content in the classroom. Learners must see themselves as capable STEM thinkers, recognize the many ways STEM shows up across professions, and engage in learning experiences that foster belonging, agency, and joy.

From K–12 classrooms to adult education and university systems, TERC designs and studies approaches that reduce structural barriers and strengthen pathways into meaningful careers. We address identity, pedagogy, and systems together—because lasting change requires coordinated efforts that enable learners not just to enter STEM pathways, but to persist and thrive within them.



In this issue of Hands-on, you will see these currents in action as each article represents work that connects to at least one of them. Collectively, these articles also paint a picture of how TERC is working in partnership with others to intentionally shape the future of STEM learning. If the currents resonate with your work, your research, or your community, we invite you to join us in affecting change. Together, we can reimagine STEM learning—and advance a future where science and mathematics truly serve everyone, everywhere.

Sincerely,

Christine Reich
President

Reach out and let us know which current captures your interest in collaborating with TERC. We'd love to bring your expertise into the conversation.



We Build the Road As We Go

Supporting teacher leadership
in an emerging field

B. DRAYTON, A. SUSSMAN, G. PUTTICK, F. SOLOMON

*Caminante, son tus huellas
el camino, y nada más;
caminante, no hay camino,
se hace camino al andar.*

*Traveler, your footprints
are the path, and nothing else.
Traveler, there is no road,
we build the road as we go.*

— Antonio Machado

The John D. and Catherine T. MacArthur Foundation invited the authors of this article to develop a summer institute for high school teachers who are teaching climate science with an equity lens.



There were several objectives behind the Institute initiative. First, anecdotal information suggested that the number of such teachers is increasing, but that they tended to be isolated from each other. Thus, the first goal for the institute would be to bring some of these teachers together each summer, and to begin to build a network of colleagues. The second goal was to facilitate teachers sharing their practice, as part of their professional learning, and the third was to begin to identify possible “best practices” for the teaching of climate and equity. Researchers and policy makers are focusing on the interaction of climate change with social justice, but there is no settled academic field of “climate and equity” at the high school level.

How should we design a professional learning experience for teachers who are pioneering in a field that does not really exist in any systematic way, and for which guidelines or standards, materials or techniques, are still in the developmental stage? We designed a workshop based on 3 key ideas: Biocomplexity, Equity, and Pedagogy (Puttick and Drayton, 2024). The first week-long institute in 2022 was a success — many participants reported that it was different from any PD they had attended before, and some called it “transformational.”

With some improvements, this design has been the basis of institutes in succeeding years, and soon two teacher teams will begin co-designing institutes with us that they will lead in their regions. As we support their work, two critical questions are,

What has made the pedagogy distinctive and powerful for the participants?

Can we identify “essential ingredients” that should shape future institutes?

We believe that we can.

Five principles for pedagogy

The foundation of our approach is respect for the teachers as experts and as learners. Moreover, we believe that pedagogy for teachers should reflect the way that students should learn about climate change science and its indispensable connection with equity — in their own lives and communities, as well as across the world. This learning should equip both students and teachers to engage constructively and with durable hope as climate change reshapes our world. The key principles we identified are described below.

1. “The process of authority.”

John Dewey wrote: “Asking other people what they would like, what they need, what their ideas are, is an essential part of the democratic idea. We are so familiar with it as a matter of democratic political practice that perhaps we don’t always think about it even when we exercise the privilege of giving an answer, every individual must be consulted in such a way, actively not passively, that he himself becomes a part of the process of authority” (2008a).

Learners come to the “classroom” with intentions, desires, prior experience and knowledge. By incorporating these into learning experiences to make learning meaningful and significant, the process of authority in learning is shared.



Kelli Grabowski, a Fellow in 2023, is one of several Fellows who have returned to help lead in subsequent Institutes.



A teacher takes some time to journal during the intense week of the Institute.

When the inquiry includes a social issue in which the outcome relates to human betterment, needs, and desires, the “stakes” are intensified by the desire for a solution that results in positive and meaningful change.

How This is Enacted at the Climate and Equity Institute

First, institute facilitators ask for teachers’ input before the Institute begins to make sure that all their interests in teaching and learning about climate and equity are touched upon. Second, participants’ needs and desires, as well as their skills and expertise, are both recognized and deployed on an emergent basis in institute sessions. By providing continued feedback to the Institute facilitators, and by sharing and discussing their experiences of addressing climate change and equity with students, the participating teachers take ownership of the Institute and shape its direction over the course of the week. Third, we collect in-depth feedback on participants’ experiences and ratings of each session. We reflect on this data and make changes for the next Institute cohort.

2. Learning is growth.

“The value of...education is the extent in which it creates a desire for continued growth and supplies means for making the desire effective in fact.” (Dewey 2008b, Ch. 4).

In meaningful learning, the learner is in charge, as they identify a purpose, a need, or question they wish to address, and move towards addressing it by identifying skills or knowledge they need; getting and deploying these in a reflective manner; and reflecting on the activity and its context so as to see or imagine new learning and action that have become possible. Our goal is to engage participating teachers in learning that will enhance their capacity to respond creatively to new situations and emerging opportunities in their work as climate change and equity teachers – whether in their work with students, other teachers or their communities.

How This Is Enacted at the Climate and Equity Institute

Institute sessions are designed to bring together different teacher voices and provide diverse perspectives on the local and global inequitable impacts of climate change, with substantial time for reflection and discussion built in. Participating teachers consider and discuss best practices for teaching about these impacts. During the discussions, teachers identify and get input on new ideas, themes or questions that are surfacing. In the final two days of the Institute, the participating teachers form small groups around a common purpose, need, or question for or about their practice and together outline plans to address them. Many of these projects subsequently involve work with colleagues in their schools and with local community partners.

3. Teaching for growth.

If learning is growth, then as Institute facilitators, we need to support the participating teachers to engage the process of learning outlined above. Our goal is to modify the Institute learning context in response to the learners’ intentions, desires, prior experience and knowledge. These modifications, which are informed by what the teachers in each cohort bring as well as conjectures based on our own research, are continually revisited, carefully examined and revised as needed. Consequently, much of the content that teachers work on during the Institute is from the teachers themselves, rather than a pre-determined curriculum. Each Institute is an experience of shared active inquiry.

How This is Enacted at the Climate and Equity Institute

The role of facilitators is to shape the context and the environment for learning. Therefore, facilitators provide framing for each session, monitor the ensuing conversation, asking questions, and sharing observations when appropriate, and leave most of the conversational space for the teachers. We meet to debrief and reflect together daily, adapting the session structure and focus as needed based on our observations and the feedback from the participants.

4. Teacher leadership is teaching for change.

We view all teachers who participate in the Institute as teacher leaders in the field of climate change and equity education. We define teacher leadership as a process of inquiry and learning in which the leader is engaged in supporting others in the same kind of learning. In this way, teacher leaders are change agents. The nature of the change they facilitate will be determined, to an extent, by the scale at which they apply their learning — in their own practice, or within their school, outside the school with other educators, or in the community.

How This Principle is Enacted at the Climate and Equity Institute

The Institute centers teacher expertise and leadership. The setting, daily schedule, and session structure are designed to support the development of a community of practice in which teachers learn from each other as they exchange expertise, ask questions, and share new or evolving ideas and work on them together. This community is enriched by the diverse backgrounds and experiences that each teacher brings.

5. Diversities of outcomes.

While we encourage participants to consult or collaborate with each other, each one will define how they will begin to implement and continue their learning after the Institute concludes. The Institute discussions that have stimulated or inspired the learning will continue; the teachers, their students and colleagues at home, and the Institute facilitators continue the work together as some continue to collaborate, build new partnerships, or present or publish about the work. This is a natural consequence of our respect for the “process of authority.”



An evening session during which teachers sketched from nature.



Conclusion: A Community of Practice Emerges

To the extent that the Institute embodies these 5 principles, in word and in deed, the teachers and learners (and this includes the Institute facilitators) are members of an emerging community of practice. Such a community of practice can continue to articulate what its “practices” are and discuss how to improve them (Milks et al. 2024). The members of the community continue to build networks and partnerships, seek opportunities to exercise new strategies and techniques and find ways to involve new members. Thus, community members have opportunities for further learning or for applying their knowledge and experience, creating continuing and renewed opportunities for learning, work, service, and growth.

The Institute’s quarterly newsletter serves as a way for participants to share presentations, articles, news, or resources. See what the fellows have been up to:

terc.edu/climateandequity/newsletters/

To learn more about the project and the upcoming 2026 Institute, visit terc.edu/climateandequity

ACKNOWLEDGEMENTS

We are grateful to the teachers, MacArthur Climate and Equity Fellows, who have made the Institutes come alive and continue to share their expertise and learning with their students and the Climate and Equity community.

AUTHORS

Brian Drayton, a plant conservation ecologist, has worked with and for teachers at TERC for almost 40 years. He thinks that just about nothing is more fun than being in the field with plants and animals, except doing it—and talking about it—with others. And what more amazing and fascinating creatures are there than learners and teachers?

Gillian Puttick is a senior scientist at TERC who works with teachers to develop and research innovations in science teaching and learning. She currently focuses most of her efforts on climate change education. She feels privileged to be working with teacher-leaders from across the country on the critical work of developing guidelines for effective climate and equity education.

Folashade Cromwell Solomon (Ed.D.) is a senior researcher here at TERC. She has over 30 years of experience in education as a public-school elementary teacher, professional developer, researcher, and college professor. Her teaching and research focus on learning, identity and exploring the interdisciplinarity and multimodal learning for teachers and youth. Her recent work explores how movement and the arts can be a tool for learning science.

Annie Sussman is a Senior Research and Curriculum Development Specialist at TERC. She has 18 years of experience in education and has worked as a classroom teacher, curriculum developer and researcher. Her current work focuses on teacher leadership in mathematics and science education and on the ways in which student and teacher reflection can inform the creation of equitable learning communities in elementary mathematics classrooms.

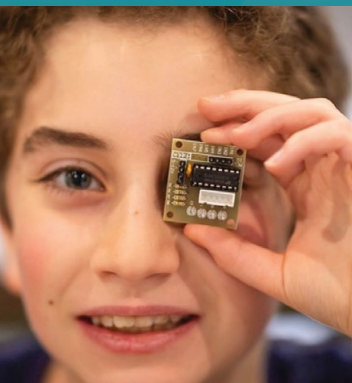
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Brainpower *Squared*

*Exploring
Brain-Computer
Interfaces to
Bring Diverse
Brains to STEM*

The demand for STEM-literate workers is growing rapidly as fields like artificial intelligence, neuroscience, and robotics become central to the economy and society. With these shifts comes a pressing question: Who will step into these roles and shape the future of technology?





NeuroVivid campers explore the power of their brains by building circuits and using EEG headsets to control a fan and guide a ball through an obstacle course.

Neurodivergent students are underrepresented in STEM, yet many of these students bring strengths that are needed for emerging STEM fields, including creativity, systems thinking, and strong pattern recognition. Traditional learning environments don't always fully recognize or support their abilities, leaving students feeling excluded or unseen.

An exciting initiative from TERC is working to change that. **NeuroVivid** introduces middle school-aged neurodiverse learners to brain-computer interfaces (BCIs) through an immersive maker camp experience. Early findings show statistically significant increases in students' interest in STEM and more expansive perceptions of what STEM can look like. Campers also demonstrated stronger STEM self-efficacy, a key predictor of whether students will pursue science and technology over time.

Building Skills, Identity, and Future Opportunity

At the heart of **NeuroVivid** is a unique opportunity: students use simple electroencephalogram (EEG) headsets to visualize and interact with their own brain activity. These headsets measure brain activity associated with attention and focus, allowing participants to build circuits that respond to the activity in real-time. They then use a block-coding language to

control lights, sound, and more in their circuits, culminating in interactive projects of their design.

These activities are paired with engaging lessons in neuroscience, neuroplasticity, and human-computer interaction. The goal is not only to teach technical skills but also to help students understand how the brain works and how it can connect to technology. This opens new pathways for exploring careers in fields like neurotechnology, computer programming, biomedical engineering, software development, and AI-integrated design.

While using the EEG headset to control an LED, one camper exclaimed, "Look at how powerful my brain is!" Another camper described the camp as "a fun scientific journey with wiring and coding...and the brain!" Participants gain hands-on experience in:

- Coding and algorithmic thinking
- Circuit design and engineering
- EEG technology and human-computer interaction
- Brain and nerve structure and function
- Collaborative design and STEM communication

Yet the greatest impact may be how students see themselves.

Many participants said it was the first time they felt truly successful in a STEM space. Students began to develop a STEM identity and, for some, a new sense of belonging.

Designed With Neurodivergent Voices at the Center

What makes **NeuroVivid** especially notable is its co-design process. The project team worked with 10 high school and early college students who self-identified as neurodivergent. The curriculum, activities, and materials were shaped by their lived experience, helping to ensure the program was inclusive, flexible, and authentically aligned with the needs and strengths of neurodivergent learners.

One co-designer described the experience this way: “I felt being a co-designer was really good because it helped me see other positions [viewpoints]... the fact that you could just get to work with others and have combined brain power towards a single goal..And then the other rewarding part was seeing it all come together at NYSCI (New York Hall of Science). That was just amazing!”

The co-design approach is central to the project’s goal of ensuring students are not just accommodated but empowered. It reflects a broader shift in STEM education toward valuing diverse ways of thinking and learning as essential to innovation.

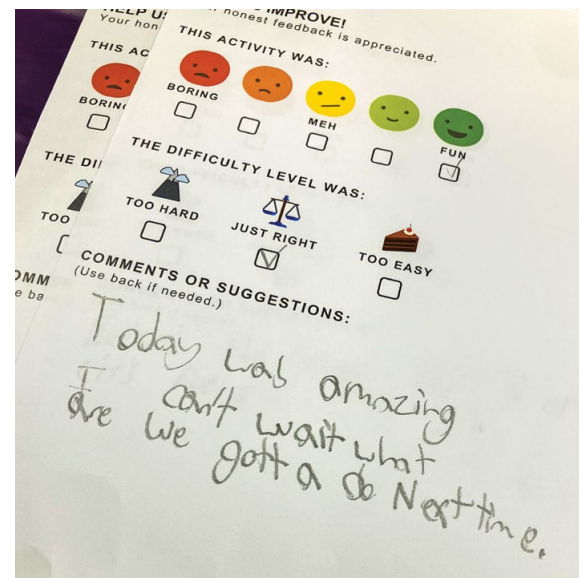
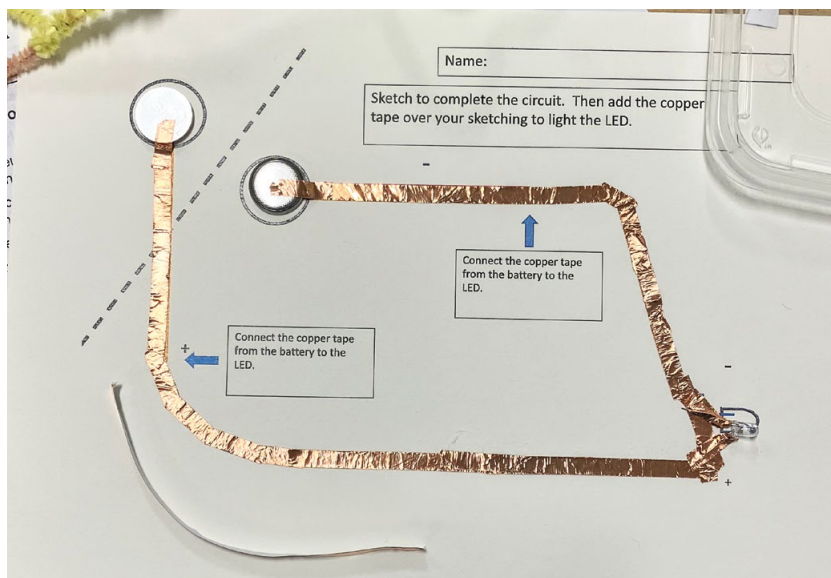
A Scalable Vision for Inclusive STEM

With new funding from Britebound, the **NeuroVivid** team is expanding this work through NeuroVivid Pathways, which builds on the NSF ITEST-funded NeuroVivid project to broaden access to meaningful STEM experiences for neurodivergent middle school youth. After piloting several 5-day NeuroVivid camps at NYSCI, the team is refining the BCI maker curriculum into an adaptable experience that can be used in a range of informal learning environments. NeuroVivid Pathways will bring the model to new sites and communities while laying the groundwork for a sustainable and expandable approach that can reach students across the country. The long-term vision is to integrate the model into Career and Technical Education (CTE) programs that reach an even broader range of students.

As artificial intelligence and neurotechnology continue to grow in importance, programs like **NeuroVivid** offer a glimpse of what a more inclusive approach to STEM education can look like. By helping neurodivergent learners visualize their own brain activity, build with cutting-edge tools, and see their ideas come to life, educators can send a powerful message: the future of technology belongs to everyone.

Educators and program leaders can find more about bringing inclusive STEM learning into their own communities by visiting terc.edu/projects/neurovivid-pathways/

NeuroVivid campers learn the basics of circuitry by building paper circuits and document their daily learning through exit tickets, capturing their engagement with the experience.



Bridging the SCHOOL/HOME MATH GAP Through SENSEMAKING

ZAOZAO (ANNIE) LIN,
STEM PROGRAM TEACHER

AUDREY MARTÍNEZ-GUDAPAKKAM, ED.M.,
SENIOR RESEARCHER

SABRINA DE LOS SANTOS, ED.M.,
RESEARCH ASSOCIATE

Mi Primer grado
Fue muy difícil
Porque no tuve
la oportunidad
de ir Al
Knd.



Primaria
Elementary
Sch. 1

Fueron momentos divertidos pero conforme iba creciendo y pasando de grado se iba haciendo más difícil.

6to grado
-Cambio de escuela.
-Clases prioritarias de matemáticas



Administración X
Docencia ✓
UNI-VERSIDAD
Cree que no tendría más matemáticas en mi vida pero sí.

Ahora tengo 2 hijos y estoy volviendo a cursar la primaria.



En Segundo Grado enpese Contando Con frijoles.

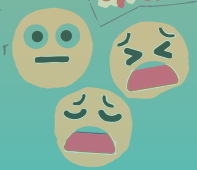


en kinto yo ya estaba feliz porque ya sabia como trabajar en Matematicas

In the summer of 2025, TERC piloted **Doing the Math with Families**, an adaptation of the U.S. National Science Foundation-funded **Doing the Math with Paraeducators** project. This version extended the original professional development—designed to strengthen paraeducators’ math confidence, knowledge, and teaching strategies—to bilingual parents through playful, engaging math games.

Secundaria y Preparatoria

Tuve cursos de matemáticas antes de entrar a secundaria



Los matematicas fueron subiendo de nivel.



ya ahora Heay madre yo deseo he mi hijo pueda estudiar y ser afortunado en la vida inotenga que sufrir como me toco.

The following reflection was written by Zaozao (Annie) Lin who volunteered on the project. The participants recruited for this project were invited because they were either supporting the childcare for families attending English classes or they were taking English classes and expressed interest in becoming educators. Four Spanish-speaking mothers and one aunt participated in a six-week program, meeting for two hours each week to learn tools and games that support children's math learning. Each session was co-facilitated by two bilingual former paraeducators, previous participants in the *Doing the Math for Paraeducators* training. Sessions focused on building caregivers' math confidence and knowledge through concepts such as subitizing, number sense, patterns, and place value, as well as tools like number lines and hundred charts. Caregivers practiced playing TERC *Investigations*TM math games with their children (PreK–Grade 3) and ultimately helped lead math games for families at a Boston Public Schools back-to-school event.

Impressions from Annie

This summer, I had the chance to join TERC's *Doing the Math with Families* project—a six-week professional learning series with Spanish-speaking families. Each week, five mothers and one aunt arrived with their children, ready to explore math in ways that felt nothing like school and everything like community.

At first, I thought I was there simply to observe. But what I actually witnessed was a transformation—not only in how families interacted with math, but in how I understood the gap between school teaching and parent teaching and, more importantly, how sensemaking begins to close that gap.

Where the School–Home Gap Begins

The gap isn't because parents “don't know math,” it's because school math and home math speak fundamentally different languages. In school, mathematics is often presented through procedures, rules, and specialized vocabulary. At home, math lives in the routines of daily life — counting eggs while cooking, dividing snacks among siblings, estimating time before leaving the house, or measuring laundry soap. These moments are rich with mathematical thinking, yet they rarely get recognized as such within school settings. Likewise, parents seldom see the reasoning and pedagogical intentions behind school activities, which can make formal math feel distant or inaccessible.



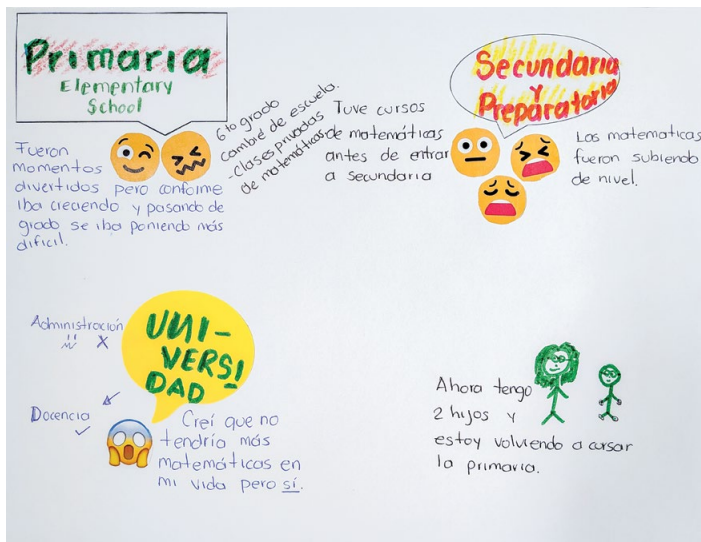
Parents playing math card games with their children.

This project made that divide visible in compassionate and powerful ways. As families engaged in games, drawings, and shared sensemaking, I saw how much mathematical insight already existed in the home, and how quickly parents could re-enter mathematics when the entry point honored their backgrounds and ways of knowing. Effective teaching begins with knowing learners, valuing their prior knowledge, and building bridges rather than barriers. By grounding math in storytelling, visuals, and familiar routines, the project began to translate between the two languages of school math and home math, creating a shared space where both could coexist, enrich each other, and ultimately support children's learning.

Math Journeys: A Window into the Gap

One of the first activities invited parents to sketch their math journeys using emojis. This was a deceptively simple prompt that turned out to be a small emotional roller coaster. For most of the parents the page was at first filled with cheerful suns, smiley faces, and bright colors. But as their drawings wandered into middle and high school, the emojis started to droop: straight-line mouths, confused squiggles, even one completely blank face that a mother placed beside her high-school years. I didn't need to understand every Spanish word to feel the shift. And yet, the room didn't sink into sadness. Instead, parents chuckled softly, leaned toward one another, and nodded as if to say, “Yep ... that was me too.” Their stories were different, but the pattern was unmistakable, somewhere along the way, math stopped feeling like theirs and started belonging only to school.

That moment became the spark for the gap between school teaching and parent teaching. These playful drawings weren't just doodles; they were clues to a much deeper disconnect. Parents hadn't lost their ability to think mathematically. They had simply stopped being invited into the story. By letting families use emojis, humor, and memories to make sense of their past, the activity gently reopened a door that had been shut for years. It showed me that before parents can support



Two “Math Journey” drawings about parents’ prior experiences with mathematics.

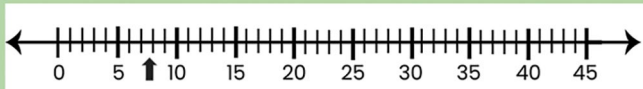
children’s learning, they first need a way back into math themselves. This was the beginning of the bridge: a reminder that sensemaking—whether through drawings, laughter, or shared recognition—can bring math out of the school-only box and return it to a place where everyone gets to play.

Sensemaking as the Bridge Between Two Worlds

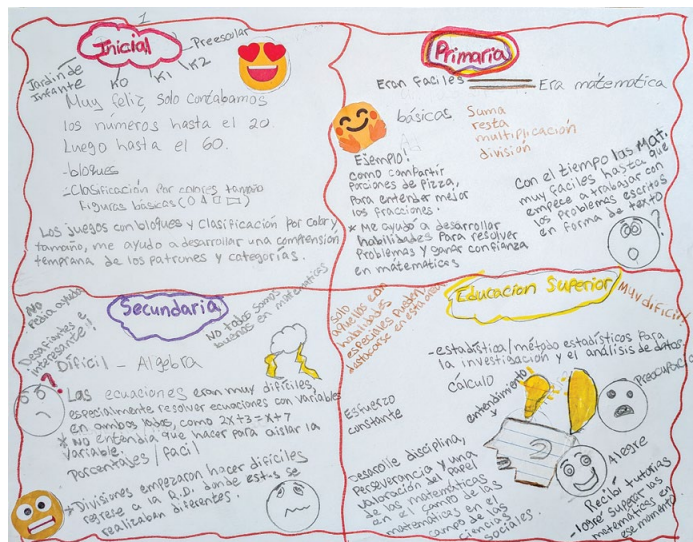
If traditional school math feels like being told the “right” answer, sensemaking feels like being invited to wonder. It values noticing, explaining, questioning, predicting, which are skills families already use every day. In our sessions, I watched these abilities resurface almost instantly.

THE NUMBER LINE GAME: SIMPLE, BUT TRANSFORMATIVE

Utilizando la línea numérica para encontrar el número misterioso



When the parents were asked, “What number is between 3 and 8?” parents didn’t just answer. They discussed. They modeled thinking aloud for their children. They gestured with their hands, moved their bodies, or used the number line in ways that showed deep intuition.



“It’s important that children not only know numbers in order but understand what ‘1’ means.”

— FACILITATORS CONNIE AND BIANKA

That single sentence reframed the entire project for me, helping me see that while schools often teach the sequence and families instinctively teach the meaning, it’s only when those two perspectives meet that children gain true number sense.

NUMBER CARDS: MATH WITHOUT LANGUAGE BARRIERS



We also used number cards during the session, each decorated with small images beneath the numerals—one rocket under the number 1, two rockets under the number 2, and so on. These simple visuals did far more than look cute; they grounded quantity in something concrete and immediately understandable. I could see how powerful they were for both parents and children, especially for families navigating multiple languages. The cards acted like tiny translators, connecting symbols to meaning without needing any words at all.

One mother smiled and reflected, “I’ve seen cards like this before, but now I finally understand how to use them at home.” Moments like that made me realize how small tools—when paired with sensemaking—can completely dismantle the idea that helping with math requires perfect English or high-level vocabulary. Sometimes, a rocket and a number are all the language you need.

**PUPPET PLAY:
WHEN MATH BECOMES RELATIONSHIP**



My favorite activity of all was the puppet-making game, a wonderfully chaotic blend of glue sticks, yarn hair, and imagination. Once the puppets were complete, families used them to act out counting stories, with parents deliberately “getting confused” so their children could gleefully set them straight. Even without catching every Spanish word, I could feel the clarity of the moment — the pride in a child’s correction, the laughter in a parent’s pretend mistake, the mutual joy when the puppet finally “got it right.” What I witnessed wasn’t just a math activity, it was sensemaking in its purest form. Parents and children were building understanding together, not by memorizing steps, but by negotiating meaning, noticing patterns, and explaining their thinking in ways that felt natural and alive.

This is where the deeper bridge-building happened. Sensemaking didn’t only help parents explore mathematical ideas—it reshaped communication itself. Parents began talking about math the way teachers hope students will talk in classrooms, and children responded with the kind of confidence usually reserved for home. One parent later said, “I learned that children can complete math tasks by teaching through play,” and another shared that she finally saw “many different ways to form numbers.” Their reflections revealed something important: the puppet activity wasn’t simply a game; it was a moment where school math and home math met in the same language.

Voices From the Room: What Families Taught Me

Throughout the project, different people’s voices deepened my understanding of what real learning looks like.

PARENTS’ VOICES

As the sessions unfolded, parents began offering insights that revealed not just what they were learning, but how they were redefining themselves as mathematical thinkers. One mother observed, “There are many ways to make numbers ... not just one order.” Another told us, “Now I understand the 10-square table. I had seen it before, but now I know how to use it.” Someone else added, “Games make math easier to talk about,” which to me captured exactly what was happening: math stopped feeling like a performance and started feeling like a conversation. These weren’t comments about mastering content, they were reflections of agency, belonging, and the realization that math could be something they actively make sense of rather than something done to them.

FACILITATORS’ VOICES (BIANKA AND AUDREY)

“What stood out was how parents asked each other questions. The learning wasn’t just happening for the kids—it was happening for the families.” – BIANKA



Parents learning how to play math games with their children.

Bridging the School/Home Math Gap Through Sensemaking



Bianka's words helped me see that these sessions were never about parents "catching up" to school math; they were about reclaiming their voices as thinkers and co-teachers.

Audrey added a perspective that stayed with me even more closely. She shared that her goal was simply "to do something that helps the moms and dads in the room," starting not with formal math instruction but with meaningful interactions between parents and their children. She believed that when caregivers feel connected, curious, and confident while engaging with their kids, math becomes a natural extension rather than an intimidating subject. "There are so many possibilities," she told me—possibilities for joy, for discovery, for families to see themselves as powerful partners in learning. Audrey's vision reminded me that sensemaking is not just about reasoning; it's about creating the emotional and relational conditions that allow reasoning to flourish.

CHILDREN'S VOICES VS. PARENTS' VOICES

The evolving dynamic between children and parents revealed its own story of sensemaking. In the first week, children shouted answers with enthusiasm, while parents spoke cautiously, as if unsure they could take up space. But over time, something shifted. Parents grew more confident, and children slowed down, explaining their thinking instead of rushing. Gradually, their voices met in the middle. This balance of confidence and reflection signaled that sensemaking was happening—not just in strategies, but in relationships and identity, as math became a shared conversation between parent and child.

The Meaning of These Moments

As I looked back on all these interactions—the drawings, the games, the puppet stories, the shared laughter—I began to

understand the school-home gap in a new way. It became clear that the gap isn't created by a lack of knowledge on the parents' part, it grows out of a lack of shared practices and shared language between schools and families. Parents don't need more worksheets or more formal explanations of curriculum—they need opportunities to think mathematically with their children, to make sense of ideas together in ways that feel natural and familiar. When families engage in these sensemaking conversations, math becomes something they can inhabit, not something they must perform.

I also saw how sensemaking dissolves fear. When math is framed as noticing, predicting, wondering, and explaining—not merely arriving at the right answer—the entire tone of learning shifts. The anxious question of "Do I know this?" transforms into "What do I see? What do I think? How do I know?" And in that shift, confidence grows almost effortlessly. Parents who once whispered answers began offering ideas with certainty; children who rushed to shout out answers began pausing to explain their reasoning. Sensemaking turned math from a test into an exploration, and I watched families step into that exploration together.

Perhaps the most powerful realization was that families are not simply helpers on the sidelines—they are co-teachers. At the final event, when parents began teaching other parents how to play the same games they had learned, something clicked for me. They weren't just demonstrating activities; they were stepping into leadership, modeling curiosity, joy, and mathematical thinking for others. This was not the temporary excitement of a single session. This was the beginning of a sustainable bridge between school math and home math—one built not through formal instruction, but through agency, identity, and shared ownership of learning.

Families as Partners, Not End-Users

As we continue partnering with organizations across Boston Public Schools, I keep returning to this idea of families as true partners in learning. Our goal is no longer to “support” parents in a one-directional sense, but to recognize them as experts in their children’s learning lives and as contributors to the broader educational community. When families learn, teach, and lead alongside us, the cycle becomes self-sustaining: parents build confidence, children see themselves as thinkers, and schools begin to recognize the powerful knowledge that already exists at home.

Sensemaking is the thread stitching all of this together. It turns math into a shared language that flows in both directions—school to home, and home back to school. It transforms families from passive recipients of information into active partners. It turns teaching into relationships, learning into conversation, and mistakes into possibilities. This project changed the way I see education: no longer as something that lives only in classrooms, but as something woven into homes, gestures, stories, and everyday interactions. And I realized that when learning begins in these places—where people already feel connected and curious—it becomes deeper, more joyful, and far more enduring. That, I believe, is where the real learning begins.

The Future of Doing the Math with Families

Currently TERC is seeking ways to replicate and expand this cycle of learning and teaching with other families. We continue to work closely with the families who participated in the summer training. In addition to leading games at a back-to-school event attended by over 100 families, recently three of these six parents helped lead three training sessions for approximately 35 parents participating in the Parent Mentor program at St. Stephens Youth Program in Boston, MA. Another three of these parents are currently teaching games to students who attend a math club every Tuesday while their parents attend English classes. We see these parents as experts that can help us find ways to make math learning accessible and joyful for all.

These examples point to the potential for broader expansion, as more schools and families take on leadership roles in sharing math game experiences and strengthening a peer-driven model grounded in families’ commitment to their children’s success.

To learn more and explore partnership opportunities visit: terc.edu/projects/doing-the-math-with-families/

ACKNOWLEDGEMENTS

I am deeply grateful to Audrey Martínez-Gudapakkam, Sabrina De Los Santos, Judy Storeygard, Connie Henry, Bianca Cruz, and Amarilys Patrone for welcoming me into this project with such generosity and care. Their guidance shaped not only my observations but also the way I learned to listen—to families, to moments of sensemaking, and to the stories held in the room. I especially want to thank Connie, whose insights as a facilitator helped me understand how joyful and relational math learning can be when families are centered as partners. Special thanks to the parents and children who allowed me to learn alongside them; their voices and laughter made this work come alive. I am also grateful to the Boston University faculty who encouraged me to pursue this opportunity and helped me grow as both a learner and a future educator. Most of all, I want to thank my own family, whose everyday math—however informal—continues to remind me where true learning begins.

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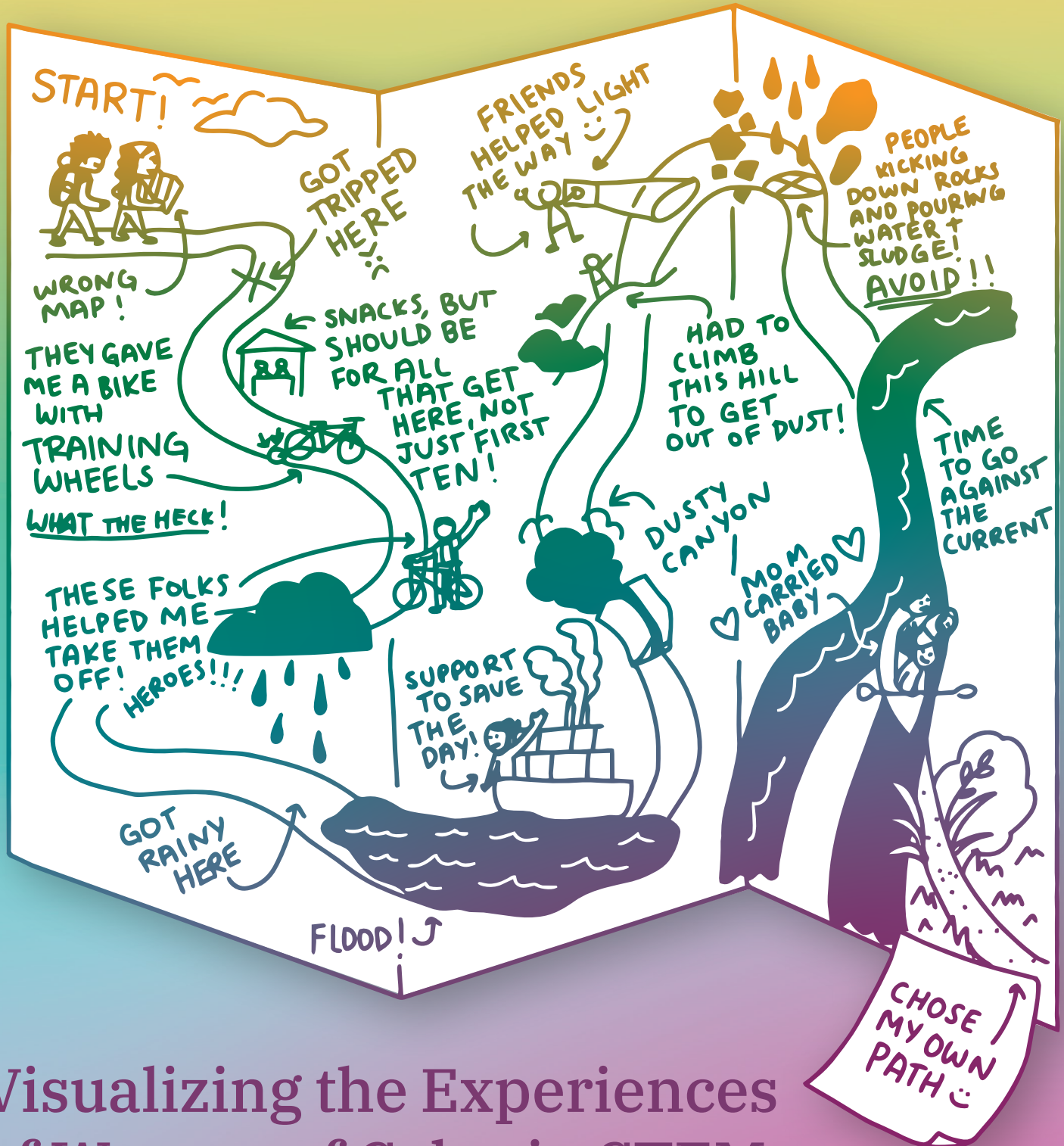
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AUTHOR



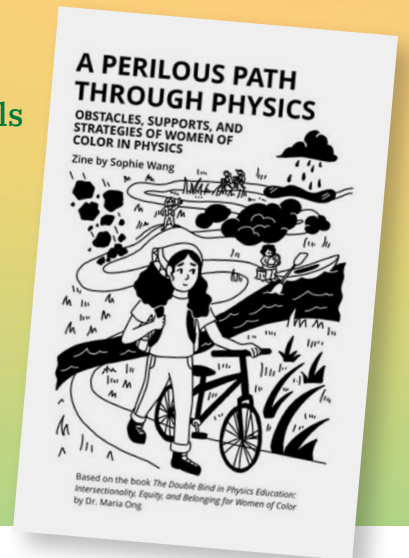
Zaozao (Annie) Lin is a third-year undergraduate student at Boston University’s Wheelock College of Education and Human Development, concentrating in STEM Education. Originally from China, she is an international student whose work is guided by a commitment to expanding access and opportunities in STEM—especially for women and girls. Annie’s interest in sensemaking was shaped and deeply inspired by her professor, Dr. TJ McKenna, whose teaching encouraged her to see science and math not as static bodies of knowledge, but as processes of wondering, noticing, and constructing meaning. In the summer of 2025, she volunteered with TERC as an observer and learning support member for the Doing the Math with Families project, where she witnessed firsthand how sensemaking can transform learning for both parents and children. Her experiences continue to shape her passion for family engagement, equitable STEM learning, and helping students experience sensemaking as the heart of their learning rather than a step after it.

A Perilous Path Through Physics:



Visualizing the Experiences of Women of Color in STEM

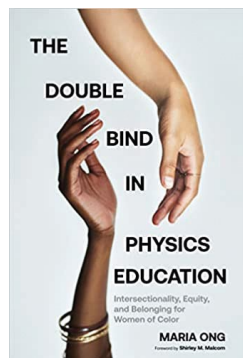
In a new comic zine developed in collaboration with TERC, researcher, educator, and artist Sophie Wang illustrates what it feels like to pursue education and careers in physics within a landscape that does not fully support one's identity. *A Perilous Path Through Physics: Obstacles, Supports, and Strategies of Women of Color in Physics* transforms findings from Dr. Maria Ong's 25-year study, detailed in her book *The Double Bind in Physics Education*. The zine turns those findings into metaphor-rich scenes that reveal how systemic conditions shape the trajectories of women of color in STEM.



Across the zine, barriers in physics appear not as abstract concepts but as physical burdens: steep cliffs, blinding dust, heavy loads, and treacherous terrain. These metaphors make visible what participants described in their own narratives, the additional obstacles they faced, the limited access to institutional norms, the harm created by exclusionary cultures, and the moments of support that helped them endure or redirect their paths.

Research Background

The Double Bind in Physics Education (Harvard Education Press, 2023) follows ten women of color from undergraduate studies through the early stages of their careers. Through interviews with the women and with people in their academic and professional networks, the research reveals patterns of bias, isolation, invisibilization, and harassment that shaped their opportunities in physics. The women also described critical moments of support, self-developed strategies, and community spaces that allowed them to continue, regroup, or reimagine their futures.



The zine distills these research-based themes into an accessible medium, offering people a starting point for reflecting on the conditions that influence who thrives in physics.

Wang drew heavily on the research but also on her own experiences as a former lab and field scientist and facilitator of workshops on systems of oppression. “Reading Dr. Ong’s book, I was struck by how familiar many of the experiences of the women of color participants were to me,” she writes in the zine’s introduction. “I was also reminded how many workshop participants had never considered the harassment,

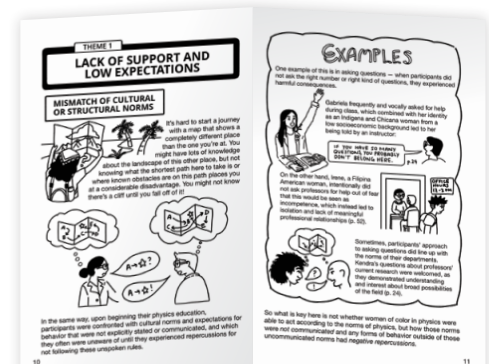
additional emotional and physical labor, and invisibilization that marginalized people in the sciences experience. I hope this zine can be an engaging and accessible introduction to some of those experiences in hopes of educating readers on what needs to change...”

Zine Structure and Design

The zine is organized around several themes that emerged in Dr. Ong’s research. Each section:

- names a specific theme,
- provides a brief description,
- shares one or more anecdotes from participants, and
- depicts the experiences through visual metaphor.

Obstacles appear as barriers along a path or heavy weights carried on participants’ backs; harmful cultural norms show up as restricted access to shortcuts or strong water currents; strategies and supports appear as helping hands, tools, or peer guides. Some sections include examples of counterspaces — academic or social safe spaces that allow students who are underrepresented in higher education to promote their learning, have their knowledge validated and viewed as valuable, vent frustrations, share stories of discrimination, and counteract many of the negative effects of exclusion perpetrated by majority peers and faculty (Solórzano et al., 2000).



Themes in the Zine

The illustrations and descriptions below represent only a sample of the challenges, forms of support, and strategies depicted within each theme.

Lack of Support and Low Expectations: PP. 10-15



Participants faced low expectations, competition, cues of unbelonging, and unspoken cultural norms. The zine shows these as a map that does not mirror the terrain, students tripping each other to get to resources, and unnecessary training wheels, with peers offering support by helping remove the training wheels.

Test Anxiety and Stereotype Threat: PP. 16-19



Test anxiety and stereotype threat are depicted as walking under a rain cloud, illustrating how the fear of validating harmful stereotypes adds increased stress and anxiety to academic experiences.

Invisibilization: PP. 20-29



Experiences of being overlooked and ignored appear in the zine as a cloud of dust that obscures the traveler and makes the journey more difficult, with support shown as peers shining a light to cut through the dust and reveal them.

Bringing the Zine into Educational Settings and Conversations

Because of its accessible visual storytelling, the zine can be used across a wide range of learning and community settings, from middle and high school classrooms to undergraduate and graduate courses, mentoring programs, professional learning for educators, and discussion groups exploring equity in STEM. Its metaphors help readers of all ages grasp complex systems and empathize with experiences that may differ from their own, opening conversations about belonging, support, and systemic change.

As Dr. Ong notes, "This visual companion to the *Double Bind in Physics Education* offers another way into the work. It supports reflection and dialogue in STEM spaces and helps more people engage with the lived experiences at the heart of the research."

Harassment: PP. 30-36



Identity-based harassment is depicted as buckets of sludge dropped onto participants that they cannot easily shake off, showing how stepping away at times became an essential strategy for safety, recovery, and clearing the sludge.

Exclusionary Cultural Norms: PP. 36-43



Exclusionary cultural norms in physics are represented as a strong river current that demands conformity, contrasting with participants' cultural values related to family, community, and seeing people as whole. This mismatch creates feelings of isolation and reveals how navigating or resisting these norms requires significant additional effort.

Making Their Own Paths: PP. 44-47



Creating their own paths appears as cutting new trails, underscoring how self-determined routes can be both liberating and taxing.

Conclusion and Ways to Access the Zine

A Perilous Path Through Physics offers a compelling bridge between long-term qualitative research and visual storytelling. By illustrating obstacles, supports, and strategies along the journeys of women of color in physics, the zine invites readers to consider how systemic inequities shape learning and career pathways, and what forms of intervention can make those paths more equitable.

The zine is free to download and share, and physical copies are available for purchase. Readers seeking deeper engagement with the themes introduced are encouraged to explore *The Double Bind in Physics Education*.

Download at info.terc.edu/a-perilous-path-through-physics-zine



Lessons Learned Creating

TERC Tech Talks

Educators are surrounded by bold promises about AI and learning technologies, but no one could realistically test them all. That's why we created **TERC Tech Talks**, a video podcast where STEM education researchers and guest experts test-drive emerging tools unscripted and with real learning contexts.

After nine episodes exploring tools from ChatGPT Study Mode to AI simulations that model student thinking, in conversation with six educators and a student, we've gained important insights. Here are the biggest lessons so far.

1. Educators don't need more tools. They need better support.

Educators are inundated with promises of transformation. What they need instead is help understanding how a tool fits into real instructional goals, classroom constraints, and student needs, not just what it can do in theory. Context matters and thoughtful framing makes it easier for teachers to decide what to try, how to use it, or when to skip it entirely.

2. Relationships remain central, no matter how advanced the tech

Even when AI tools supported differentiation, organization, or multimodal expression, we found its value depended on how teachers used it to support real relationships with learners. Technology can assist, but it cannot replace the work of noticing, responding, and building trust. Every episode reinforced that effective teaching is grounded in human connection.

3. Student perspectives are very important to the conversation

Hearing directly from a high school student about why peers use AI tools, what feels genuinely helpful, and what feels harmful surfaced insights that adults alone cannot provide. Students are already navigating these tools in their daily learning. Their experiences and perspectives are essential for understanding how AI is actually being used and experienced in educational settings.

4. Unscripted testing is more useful than polished demos

We test AI tools live and without scripts. When tools struggle, give unclear feedback, or behave unexpectedly, viewers see it happen and hear how we make sense of it in real time. Those moments provide information that polished demos can't offer. In a space crowded with marketing videos, honest exploration helps educators understand how a tool behaves and decide for themselves whether it fits their goals and constraints.

5. AI works best as a starting point, not a finished product

Whether generating lesson ideas or scaffolds, AI showed strength as an idea generator rather than a final answer. Again and again, our conversations returned to the importance of professional judgment. Teachers decide what is useful, what needs revision, and what does not belong in their classrooms. AI can offer multiple entry points, but it cannot replace the expertise that comes from knowing students and learning goals deeply.

Why we'll keep going

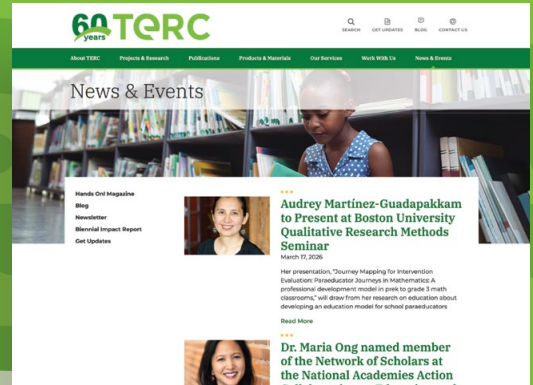
TERC Tech Talks is not about predicting the future of AI in education. It is about helping educators make informed, grounded decisions right now.

By testing tools honestly, centering classroom realities, and learning alongside our viewers, we aim to create a space where curiosity is encouraged. As AI tools continue to evolve, we will keep testing, ask hard questions, and share what we learn along the way.

New episodes of TERC Tech Talks are released biweekly on YouTube.



What's New at TERC?



Looking for the latest news in STEM education? Click on “News and Events” in the top menu. terc.edu/news-events

\$300,000 Grant Supports NeuroVivid Pathways Brain-Computer Interface Program for Middle Schoolers

TERC has received a **\$300,000 grant** from **Britebound** to expand **NeuroVivid Pathways**, a Brain-Computer Interface program offering STEM maker camps and educator training for neurodivergent middle school students. The initiative provides training, materials, and support to spark interest in STEM and prepare students for future careers



Viviendo Matemáticas Program Strengthens Early Math Learning and Shares Free Bilingual Resources

The **Viviendo Matemáticas** project shows that when educators and Spanish-speaking families learn together, young children build stronger early math skills through everyday conversations and hands-on activities. The program also strengthens relationships and expands what people see as “math” while offering free resources for use at home and in the classroom.



GBH and TERC Launch Early Childhood Data Science Learning Framework

GBH and **TERC** have launched a **new framework** that helps educators build on preschoolers' natural curiosity about data. It supports young children in seeing themselves as data scientists and using data to better understand the world around them.



Award-Winning Research on Strengthening Paraeducator Math Instruction Honored

Audrey Martínez-Guadapakkam and **Sabrina De Los Santos Rodríguez** received the **ICQE 2025 Best Poster Award** from the **International Society for Quantitative Ethnography** for their poster, *Paraeducator Journeys in Mathematics*. The work highlights how hands-on professional development can strengthen PK–3 paraeducators' confidence, sense of efficacy, and understanding of math instruction.



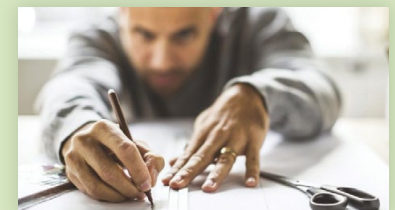
TERC Senior Researcher Named 2026 EDSAFE AI Catalyst Fellow

Michael Cassidy, Senior Researcher at TERC, has been selected as a **2026 EDSAFE AI Catalyst Fellow**. Through this fellowship, he will work with cross-sector peers to help ensure AI in education benefits all learners.



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