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and science educators

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1 A Framework for Using Mathematics Curriculum to Support Equity

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Letter from the President

Welcome to Spring and our latest edition of *Hands On!* The articles in this issue have a key tenet woven throughout — the importance of a well-thought-out design process developed to achieve an intended goal. Whether the goal is to learn critical math concepts, build strong teams, identify career trajectories previously seen as impossible, or guide teachers to use mathematics as a tool for equity, design is critical.

In *A Framework for Using Mathematics Curriculum to Support Equity*, the *Investigations* Center for Curriculum and Professional Development team designed a framework with four categories to guide equitable mathematics education. Based on this framework, they have made important changes to their work and hope the four categories will help others reflect and use mathematics as a tool for promoting equity.

STEM Workforce Stories for Adolescents Who Are Deaf or Hard of Hearing is attempting to remedy one of the biggest challenges that young people who are deaf or hard of hearing face — not having role models in the STEM workforce to help them see that they can work and succeed in STEM fields. This article shows how a unique multi-step design process for recording videos created a Web interface of STEM career stories with options for personalized use by deaf or hard of hearing viewers. The work will soon be extending to sets of career stories from professionals of different races and ethnicities.

We learn from the evaluators of *Math and Computational Thinking Through 3D Making* (MPACT) that students who use the MPACT units to design and make objects on a 3D printer showed statistically significant gains in geometry, spatial reasoning, and computational thinking skills. MPACT students also learned how 3D printing is used in fields from agriculture to aerospace to housing for the homeless.

The design of a playful new philosophy showed unexpected broader impacts in *If it Has to Last, NASP*. This article takes a lighthearted look at how Not a Scratch Philosophy (NASP) helped people learn proper use and handling of expensive equipment when in the field and lab. NASP soon also became a way of working and helped build relationships to create a cohesive team comprised of national park rangers, educators, scientist, artists, and designers.

As displayed in these fascinating articles, when emphasis is placed on an attentive design process, success emerges in all aspects of our work.

Laurie

Laurie Brennan, *President*

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A Framework *for* Using Mathematics Curriculum *to* Support Equity

By the *Investigations* Equity Team

For the past three years the project staff of the *Investigations* Center for Curriculum and Professional Development, along with consultants whose work focuses on equity and inclusion, has been studying literature that addresses issues of equity, access, identity, and agency in mathematics education. During this study, we have been asking ourselves:

- How can a mathematics curriculum be a tool for anti-racist work?
- How can *Investigations* or any mathematics curriculum, better support students who have been historically marginalized, especially Black and brown students, to be doers of mathematics?

Based on our reading and discussions among ourselves and with others who are engaged in equity work in different contexts, we developed a framework for our own work as we develop enhancements to the *Investigations* curriculum and to professional development that supports the curriculum. We were also guided by Aguirre et al.'s (2013) equity-based practices, and the implementation steps from the NCSM/TODOS joint position paper, *Mathematics Education Through the Lens of Social Justice* (2016).

We have identified four categories for reflection and action as we think about how mathematics curriculum can be a tool for promoting equity:

1. **Deep and Rigorous Mathematics**
2. **Equitable Participation in a Collaborative Mathematical Community**
3. **Strength-based Assessment and Accommodation**
4. **Connections to Students, Their Families and Communities**

This article introduces the four categories of the framework and their importance for equity and access in mathematics teaching and learning. A more detailed description of the framework is on the *Investigations* website — investigations.terc.edu/equity

Four Categories to Guide Equitable Mathematics Education

1. Deep and Rigorous Mathematics

Equitable teaching and learning of mathematics can only proceed in an environment where students engage deeply with significant mathematical ideas, develop conceptual understanding of those ideas, participate in mathematics activities with high cognitive demand, and experience the joy and beauty of mathematics. Development of students' identity and agency as mathematicians requires consistent, ongoing opportunities to think through unfamiliar problems, build and use a repertoire of representations, recognize connections among mathematical ideas, look for patterns and regularities, make conjectures and mathematical arguments, and ask new questions, as well as confidently apply known procedures to familiar problems.

Why consider this topic in relation to issues of equity?

Mathematics is often assumed to be a field for only select people who are born with a "math gene." In particular, Black and brown students have been historically excluded from engaging in rigorous mathematics. Rochelle Gutiérrez notes how a focus on an "achievement gap" rather than a focus on excellence and advancement results in "a static notion of student identity (as quantifiable in terms of race, class, gender, language, etc.) and ignores the multiple identities and agency of students (2008, p. 359)." As Lisa Delpit says in *Multiplication is for White People* (2012), "What happens when we assume that certain children are less than brilliant? Our tendency is to teach less, to teach down, to teach for remediation (p. 6)."

The first guiding principle of the *Investigations* curriculum, which has remained our primary principle since the first edition was published in the 1990s, is: "Students have mathematical ideas." In part of the description of that principle (*Implementing* Investigations, p. 4, at each grade level), we state, "if given the opportunity to learn in an environment that stresses making sense of mathematics, students build on the ideas they already have and learn about new mathematics they have never encountered." Without the opportunity to engage with interesting, deep, and rigorous mathematics content and an orientation in instruction to building on how students make sense of that content, there can be no equity.

2. Equitable Participation in a Collaborative Mathematical Community

A strong collaborative mathematics community gives students the opportunity to work together to solve problems**,** to learn from each other, to take risks, to support and encourage others, and to be supported and encouraged by others in their growth as math learners. In a collaborative learning environment, students play an active role in their learning. Students have opportunities to decide how they are going to solve problems, to select tools and materials, and to choose

which activities they work on. They are invited to keep thinking about mathematical ideas that come up in class and to ask their own mathematical questions. Equitable participation in this community means that all students have the opportunity to express their ideas, to revise and build on them, to have others respectfully listen to and engage with their ideas, and to be seen as mathematical thinkers who make meaningful contributions to classroom conversations. Having one's ideas taken seriously and taken up publicly supports students' identity and agency as mathematicians.

Why consider this topic in relation to issues of equity?

Students who have been historically marginalized in mathematics may not see themselves as powerful in relationship to mathematics and may not be perceived as having mathematical ideas that contribute to the community. The classroom environment can have a particularly large impact on these students: "Students experience mathematics classrooms as racialized spaces, where Black and Latina/o students are subject to negative stereotypes about their ability to do mathematics (Nasir, 2016, p. 11)." Teachers and students alike may have unexamined, implicit biases about whether students of color, emergent bilingual students, girls, or neurologically diverse students can be "good at math." This can impact whose ideas are shared, taken up, and treated as mathematically powerful. Therefore, we need to consider how to create a classroom community where students who have been subjected to these stereotypes feel their ideas are respected, are comfortable sharing their ideas, and feel safe taking risks.

3. Strength-based Assessment and Accommodation

All students come to the classroom knowing and understanding some aspects of mathematics. Work with students begins with what they know and understand, with what makes sense to them, with what they are able to do. Having someone recognize and appreciate one's knowledge and ability as a math thinker develops and builds one's mathematical identity. In addition, this information is what enables teachers to support the range of learners in the classroom, to provide responsive accommodations that are truly (and not overly) helpful. Such accommodations help students engage deeply with the mathematics. Because students come to any classroom with a range of different experiences, needs, strengths, and challenges, strength-based accommodations are designed to support and extend the student's competencies, contributions, and modes of communication.

Why consider this topic in relation to issues of equity?

Strength-based approaches to student learning build on students' knowledge and experience. Labels, such as "low group," "high flyers," and "gifted," support a deficit view of certain students and "perpetuate static views about children and their mathematics competencies. Eliminating the deficit discourse by focusing on learning rather than labels is a key step toward a more just and equitable mathematics education (NCSM/TODOS, 2016, p. 2)." Students who have been historically marginalized are more often deemed in need of interventions that focus only on facts and memorization rather than deep mathematics. Over-scaffolding for these students results in tasks with low cognitive demand and a lack of opportunity to learn rigorous mathematics. Aguirre et al. (2013) point out that "Equity does not mean that every student should receive identical instruction. Instead, equity demands that responsive accommodations be made as needed to promote equitable access, attainment, and advancement in mathematics education for each student (p. 9)."

4. Connections to Students, Their Families and Communities

Students need to see themselves, their families and communities—as well as those from other communities—as doers of mathematics. In other words, math class should provide students with mirrors for seeing themselves in the mathematics, and windows for seeing the lives of others (Gutierrez, 2007). When students feel connected to and invested in the mathematics they are engaging in, this personal connection positively impacts their mathematical identities and sense of agency. This sense of agency is critical in order "to nurture a democratic society where

all can use, know, and understand mathematics to comprehend and critique the world through mathematics and to experience its wonder, joy, and beauty (NCTM, 2020, p. xiv)."

Why consider this topic in relation to issues of equity?

The joint statement from NCTM and TODOS (2016) challenges us to think more deeply about how to make these connections: "A social justice approach to mathematics education assumes students bring knowledge and experiences from their homes and communities that can be leveraged as resources for mathematics teaching and learning (p. 2)." Students who have been historically marginalized in mathematics often do not have opportunities to see themselves in the mathematics they are engaging in and therefore do not see connections between the math and their lives. They are not encouraged to bring their full selves and the experiences of their families and communities into school and do not have the opportunity to develop what Su (2020) calls "mathematical affection": "To miss out on mathematics is to live without an opportunity to play with beautiful ideas and see the world in a new light. To grasp mathematical beauty is a unique and sublime experience that everyone should demand (p. 8)."

One way to achieve this is to help students see their own experiences as part of the mathematics they are doing and to see mathematics as useful to their lives. Working on mathematics set in contexts that are familiar or of special interest can help students engage with and make sense of the math and see math as useful and powerful. As Gutierrez (2007) writes, "students [should] find mathematics not just 'real world' as defined by textbooks or teachers, but also meaningful to their lives (p 3)."

The Framework and Additional Resources

The framework is offered as a resource for reflecting on issues of equity, identity, and agency in mathematics learning and teaching. Just as we've found it helpful to engage with colleagues for support and challenge in our discussions, school-based educators may find it generative to discuss this framework with colleagues and apply it to their own context. The full framework along with additional equity resources, including blogs about supporting equitable mathematics communities are available on the *Investigations* website — **investigations.terc.edu/equity**

Authors

The *Investigations* Equity Team, above:
Top row, from l to r: Karen Economopoulos, Keith Cochran, Susan Jo Russell. Middle row: Lynne Godfrey, Megan Murray, Marta Garcia. Bottom row: Arusha Hollister, Lorraine Brooks, Annie Sussman.

The *Investigations* staff, together with consultants whose work focuses on equity, are developing resources designed to support teachers and educators in thinking about issues of equity, access, identity, and agency in the *Investigations* classroom.

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STEM WORKFORCE STORIES

for Adolescents Who Are Deaf or Hard of Hearing

BY JUDY VESEL & TARA ROBILLARD

The **STEM WORKFORCE STORIES** (SWS) are career stories told by the deaf or hard of hearing STEM professionals depicted on the following pages. They were researched and developed for deaf or hard of hearing adolescents for use in out-of-school settings. The purpose of the stories is threefold: to contribute to audience members' interest in STEM, to generate career awareness, and to recognize that they might, as other professionals who are deaf or hard of hearing have done, pursue and succeed in a STEM career.

Why Are STEM Career Stories Needed?

While progress has been made in broadening participation of underrepresented groups in STEM, data shows that persons with disabilities remain underrepresented in STEM education and employment compared to their representation in the U.S. population (NCSES 2021). Specifically, individuals with disabilities experience a lower level of career success when compared with their nondisabled peers and are less likely to complete a college education (Bureau of Labor Statistics 2021; Newman et al. 2010).

Pharmacologist, A. Ogunjirin

UX/UI Designer, M. Manak

Workplace barriers include limited expectations; a dearth of opportunities; lack of on-the-job support; workplace discrimination; and, for students who are deaf or hard of hearing, language, and communication issues (Raue & Lewis 2011, Kekelis 2019; Bellman, Burgstahler, & Chudler 2018).

With regard to persons who are deaf or hard of hearing, they very often have little or limited awareness of the range of STEM career opportunities available or of examples of persons who have pursued and succeeded in STEM careers. This situation is eminently clear from comments made by attendees at an NSF-funded Workshop for Emerging Deaf and Hard of Hearing Scientists. A common theme that emerged was that one of the biggest challenges young persons who are deaf or hard of hearing face is not having role models who are members of the STEM workforce (Gallaudet 2012).

Peter Hauser, a psychologist at the Rochester Institute of Technology and who is deaf underscores this when he states: "One big challenge is that young people who are deaf often don't see a deaf scientist. [T]hey don't have a role model growing up to help them see that they can actually go in and work in these fields." (Madhusoodanan 2016). Several studies reveal that seeing other people with disabilities having success in STEM boosts self-confidence (Jenson et al. 2011), and "exposure to deaf role models allows deaf students to identify with successful deaf people and consequently believe they themselves could accomplish goals they previously thought out of their reach" (Interlandi 2005, p.16).

As indicated by a recent small preliminary study that examined influences that motivated or contributed to interest in STEM and STEM careers for deaf and hard of hearing middle and high school students and STEM professionals, this situation has changed little (Vesel, Robillard, & Nave 2021).

Given the lack of available resources, there is a pressing need, that is being addressed with the research and development of the STEM workforce stories, for ways to support the next generation of deaf or hard of hearing members of the STEM workforce.

How Were the Stories Created?

A new and unique multi-step process for recording the videos was developed and implemented. It allowed for the STEM professional, Bridge Multimedia (our organizational partner and content service provider), and the TERC team to be in graphically separate locations. It also enabled the recordings to be made during COVID workplace closures.

Nurse Practitioner, S. Hein

STEP 1

Professionals were given a list of questions to help them shape what they would like to share.

STEP 2 — PRE-RECORDING

The production team from Bridge Multimedia conducted a technical rehearsal to verify that the interviewee's computer (in Location A), Internet connection, the video recording environment, and lighting were recording-ready. Two sign language interpreters, the interviewer (in Location B) and the interviewee's back-translator (in Location C) were part of the process.

STEP 3 — INTERVIEW RECORDING

A Moderator/Interviewer who was ASL proficient was in Location A, the Interviewee was in Location B, the Interviewee's ASL back-translator/interpreter were in Location C, a Virtual videographer was in Location D, and individuals from Bridge Multimedia, located in New York City, were available for technical support. The interview process involved making video and audio recordings with the interviewee and interviewer (along with ASL interpreters) in ASL and spoken English on multiple computers over Zoom.

STEP 4 — MERGING, TRANSCRIPTION AND CREATION OF A ROUGH-CUT VERSION

The Bridge team merged the video and spoken recordings into a single Preliminary Version that included the video and a paper transcript of the English text.

STEP 5 — REVIEW, EDITING, AND CREATION OF THE FINAL VERSION

The interviewee and TERC team reviewed the Rough-Cut Version. A Final Version was created and reviewed for content, accuracy, and length.

STEP 6 — DIVISION INTO CHAPTERS AND INTEGRATION OF INTRODUCTORY & SUMMARY INFORMATION

The text was organized into chapters such as Beginnings, Reflections of the Professional, Challenges Encountered, and Advice for the Next Generation. An introductory piece about the STEM professional by a commentator who is ASL proficient and short summaries of what the professional shared were added.

STEP 7 — IMAGE INTEGRATION

The professionals provided images of them at work, the types of data they use or collect, equipment they use, interactions with colleagues, places they have studied, and of their family, pets, interests, and travels.

STEP 8 — INTEGRATION OF CLOSED CAPTIONS

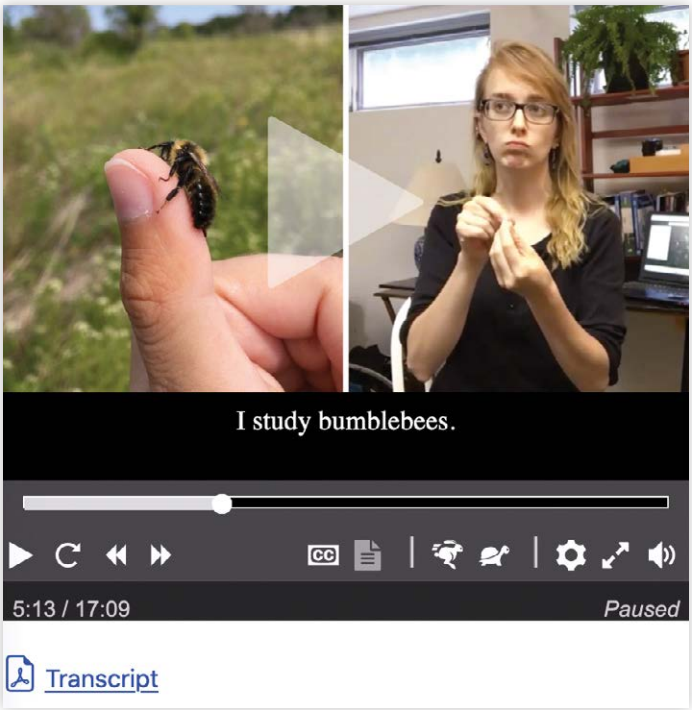
Closed captions to enable reading while viewing material presented in ASL, spoken English, or both were incorporated.

STEP 9 — FINAL MASTERING

Video and audio components were balanced to optimize playback across systems and media formats.

What Universal Design Elements Are Incorporated?

The Web interface and universal design of the stories allow options for personalized use by deaf or hard of hearing viewers as well as those who are hearing. To enable this flexibility, the Web interface incorporates an upper navigation bar that allows users to return to the Stories Home page, Story Selection Options, and Implementation Strategies. Universal Design for Learning (UDL) features (CAST 2018) incorporated into the stories enable viewers to select a story of interest. Once selected, the story, as shown in the figure to the right, will appear based on the user's chosen preferences—in sign with captions or listened to in English with or without simultaneous sign interpretation or voice overlay. Additional options include the ability to increase or decrease text size, loudness, and contrast, to play and replay all or parts of a story as often as needed, and to select different options at any time while viewing a story. A link from the selected story allows users to submit questions to the professional that emerge from viewing the story. There is also a place for viewing the answer and the accumulating list of questions and answers.



Examples of the UDL Story Features

Microbiologist, D. Braun

What Have We Learned to Date?

Formative evaluation with members of our audience at the Boys & Girls Club of Lynn and in homes, after being interrupted due to COVID, is now underway. Findings will enable us to learn how adolescents who are deaf or hard of hearing, parents, and club leaders use the stories; what kinds of learning outcomes occur in terms of knowledge of STEM careers, interest in STEM, and pursuing a STEM career. They will also provide insight into dissemination strategies, and changes that would improve the stories. Findings from the evaluation promise to add to the existing knowledge base. They will also inform subsequent development.

In addition to our planned research, review of the stories highlighted a point that is propelling our development in a new direction. They made it clear to us that since persons who are deaf or hard of hearing are not a homogeneous group and have intersectional identities (Medeiros, Thomas, & Wohl 2020; Renken, Scott, Enderle, & Cohen 2021; Dunn & Anderson 2019), one set of resources will not fit all students who are deaf or hard of hearing. Therefore, in addition to stories from

professionals of different ages and genders, there is a need for sets of career stories from professionals of different races and ethnicities.

To this end, the team recently hosted a virtual roundtable discussion that included six Black professionals who are deaf. Discussion focused on their experiences in and out of school, the job-seeking process, life on the job, and advice for students. A final universally designed video is being prepared.

The team will also conduct a research study later in 2022 to look at the effects of Pharmacologist, Ogunjirin's and Naturalist, Schrage's career stories when implemented with middle-school Black students who are deaf or hard of hearing and use American Sign Language (ASL) as their primary mode of communication. Outcomes of these efforts will inform directions for a set of career stories from Black deaf or hard of hearing STEM professionals.

WHERE ARE DOWNLOADS AVAILABLE?

The stories are available upon request from signsci.terc.edu/SWS/prototype.html.

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Judy Vesel is the Principal Investigator for TERC's "Signing Math & Science" initiative — funded by NSF and the U.S. Department of Education. The SWS project and related initiatives are part of this body of work. Ms. Vesel has presented her work at many recent conferences including annual meetings of the Center for Advancement of Informal Science Education (CAISE), American Association of Museums (AAM), Assistive Technology Industry Association (ATIA), and Closing the Gap. E-mail: judy_vesel@terc.edu

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CREDITS

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3D Making as a Context for Learning Math, Spatial Reasoning, and Computational Thinking

By Jennifer Knudsen

> ***"I really appreciate MPACT because it has been a really positive, engaging activity that we could be doing with the kids in a crazy, crazy time."***

That's what one teacher said about the MPACT (Math and Computational Thinking Through 3D Making) projects her students did in the school year 2020-2021, during the coronavirus pandemic. MPACT is a set of materials that structure "making" projects for middle-grades students, developed by TERC mathematics curriculum experts. Making is defined as "a class of activities focused on designing, building, modifying material objects, oriented toward making a 'product' of some sort that can be used, interacted with, or demonstrated" (Martin, 2015, p. 31).

MPACT projects get students involved in designing and making a useful or beautiful object, such as a toy for a younger child. These activities serve as grounding for developing understanding of important mathematics topics that span fourth through seventh grade — in addition to spatial reasoning and computational thinking skills closely related to mathematics. For example, students have the opportunity to learn about volume as they model parts of the toy using a computer-aided design (CAD) tool, and then see their design take shape as a real object on the bed of a 3D printer. Then students combine this digital making process with more traditional craft materials, creating a more complete making experience.

MPACT's Design Conjecture

MPACT developers made a design conjecture that if students work with real 3D prototypes and plans, model them on a 2D digital device screen, and then 3D print the final product, it will provide support for learning math concepts such as volume, spatial reasoning skills such as mental rotation, and computational thinking practices such as making and testing algorithms. Results from an assessment of student learning and reports of teachers' understanding of the approach provide evidence to support this conjecture. One teacher participating in the study said, "I think the excitement of kids, being able to design something ... first on paper and then on a computer and then actually physically hold it — the kids bought into what we were trying to do immediately."

From Conjecture to Curriculum

In the curricular materials, MPACT supports standards-based mathematics that is embedded in students' design and making work. For example, in a cube-puzzle project, students complete the following tasks:

1. Make the puzzle out of linking cubes.
2. Digitally design the puzzle using Tinkercad™, Autodesk's kid-friendly CAD.
3. 3D print the puzzle based on their designs.
4. Compare the linking-cube puzzle, the digital design, and the 3D-printed object.

Important basic concepts of measuring volume are developed: A 3D measurement (cm^3) can be based on measurements of length (cm). Various methods can be used to find the volume of an object, from organized counting to formulas. Two objects that appear very different can have the same volume. The volume of two or more objects stuck together can be found by adding up the volume of each of them.

In another project, seventh graders modify a board game so that visually impaired and sighted children can play the game together. Students have the opportunity to learn about the mathematical concept of scale as they make game boards from cardstock to fit the game pieces they prototype, design on the computer, and 3D print. Teachers report the project also provides students a chance to further develop empathy for others.

The spatial reasoning that can arise in MPACT projects correlates with success in STEM college classes and careers (Wai, Lubinski & Benbow, 2009). One project that emphasizes spatial reasoning allows students to design a simple stamp of their name in Tinkercad™, including a base and raised letters that can be colored with ink.

After this first step, students should notice that the stamped names are printing backwards, so they can revise their approach. They can draw their designs on paper, creating a reflection of the letters they want on the stamp.

Finally, students test their 3D-printed stamps to check whether the reflected letters make "correct" prints (Figure 2). If not, students may continue to revise their designs until they get the desired text. Once the making process is complete, students are presented with paper-and-pencil brain-teasers, similar to those found on STEM aptitude tests, which allow them to try out their new skills.

MPACT projects provide opportunities to learn computational thinking (CT) as well. While CT was once found mostly in computer science courses, MPACT is among recent efforts to integrate CT into math classes. Each time students digitally model a 3D object, they have opportunity to engage in algorithmic thinking, a key CT practice. They must decide the best order for placing 3D objects on the screen and what functions to use to create a more complex shape with irregular surfaces. By recording that process so others can duplicate it and get the same results, students can verify that they have made an effective algorithm.

Figure 1. Students design a 3D model and print on a 3D printer

As part of the program, students also interact with professionals who design using a CAD and a 3D printer. In a series of interactive video conferences sponsored by the international chemical company Henkel, engineers and others shared their excitement over the new uses and advancements in this rapidly evolving technology. Students learned how 3D printing can build prosthetics for penguins and that it is used in everything from agriculture to aerospace to housing for the homeless.

Results

As part of a two-year evaluation study conducted by SRI International, more than 50 teachers in four states (CA, NC, SC, WV) are teaching with MPACT projects.

The feedback from teachers at the end of the first year of the evaluation, 2020-2021, was quite positive overall. According to one participant, "These are the type of activities that our students crave. They love to dive in and start manipulating and putting math into something real. They love this stuff."

SRI also reports that students using MPACT units showed statistically significant gains in learning geometry, computational thinking, and spatial reasoning. They developed assessments for fourth and fifth graders to measure students' learning and administered it in classrooms in fall 2020 and spring 2021. On average, MPACT students improved from pre- to post-test by an effect size of 0.62, roughly equal to a ten percentage-point higher score on the post-test (i.e., a letter grade difference). Results are presented in the graph (Figure 3), which displays the average student score at pre-and post-test, adjusted for grade level.

Next Steps

Once the evaluation of MPACT is complete, the projects will be available to all teachers nationwide at no cost. The program is currently funded by the U.S. Department of Education, through its Education Innovation and Research competition.

Figure 2. Student-designed 3D-printed stamp

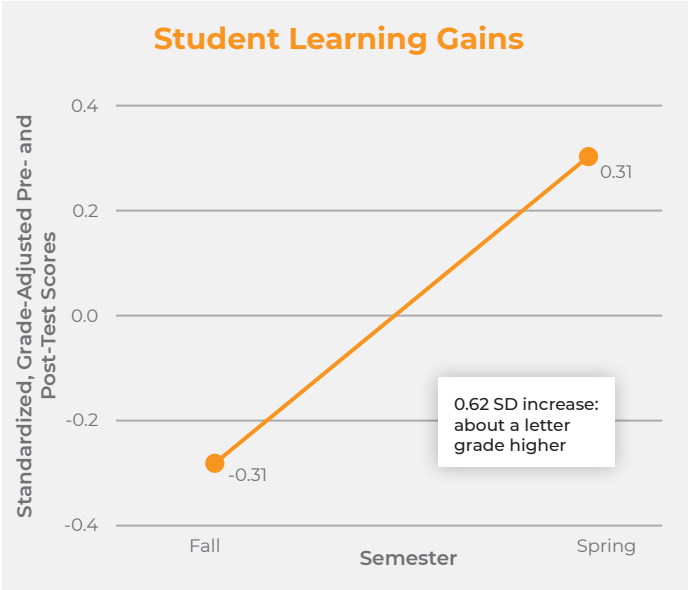

Figure 3. Students scored higher on math assessment after using MPACT modules

Learn more at **https://www.terc.edu/projects/mpact/**

Acknowledgements

MPACT is supported by the Office of Elementary and Secondary Education (OESE), U.S. Department of Education, through Grant U411C180070 to SRI International. The federal grant provides $3,926,461, or 90% of the total project funds. Ten percent of project funds are provided by additional donors. The opinions expressed are those of the authors and do not necessarily represent the official views of, nor an endorsement, by OESE, the U.S. Department of Education, or our other donors.

Author

Jennifer Knudsen is a mathematics educator at TERC whose work is at the crossroads of research and design. A veteran curriculum and professional development designer, Knudsen has led many projects, from mathematical argumentation to 3D modeling and printing for learning mathematics and computational thinking.

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If it Has to Last, NASP

By Nickolay Hristov,
Martha Merson and Louise Allen

With Nathan Knox, Trent Spivey, Betsy Towns and Lexy Brunnert

Illustrations by Chris Tullar

Are you the one in any group or room who feels most responsible for expensive equipment? Are you at risk of being a nag when binoculars or microscopes are in use? Any place can be a hazard zone for equipment: sand in the desert, moisture in wetlands and swamps, grit in the city, fingerprints and grease in the lab. We've been to all of those places, and we've lived with fears of wrecked gear for years. Now we want to share our philosophy for keeping equipment and teams at their best: NASP.

If this is your first time seeing the term, the first three letters stand for "**N**ot **A S**cratch." Our solution to saving time, expense, and sanity began as a **P**rotocol, then became something of a **P**olicy, ultimately maturing into a **P**hilosophy. NASP was first issued as a warning to assistants and students: *Equipment should be handled with utmost care.* As anyone who has tried knows, raising funds for equipment is not so easy to do. Once in hand, managing the bureaucracy associated with purchasing and maintenance contracts is a major time drain. Yet, in a single expedition, equipment can get trashed quickly.

NASP has been years in the making, growing and changing as we learned together, from our field sites on Maine's coast, Texas' Hill Country, California's Sierras, and Mexico's cloud forests, to our labs and studios in North Carolina, Massachusetts, and Maine. Prior to organizing research expeditions to remote caves in central Texas, we began a tradition of taking team members to a North Carolina pick-your-own strawberry field or cherry orchard. This low-key group activity built rapport among team members. As a bonus, it was the perfect place to emphasize gentle handling and careful packing. Once in Texas, both outside and inside caves, the team modeled meticulous care, preparing work sites and gear. The protocols prevented contamination of the fragile caves and preserved the delicate equipment that was essential to the work.

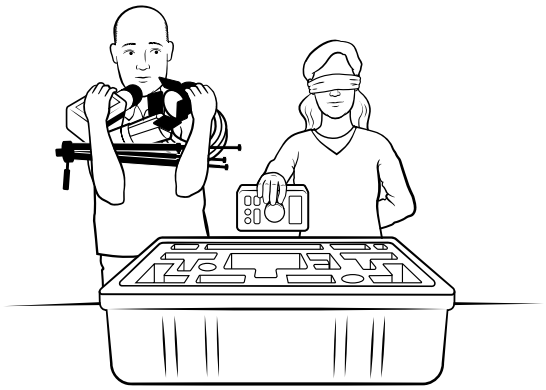
> ***"Before joining the team, I'd heard lore, like stories of Tetris-style packing of equipment and a very meticulous protocol for equipment protection called the no-scratch policies [philosophy]."*** –LEXY

"NASP has slipped into our shared lingo. Lexy, doing yoga outside, sets her laptop on a towel instead of directly on the concrete: "Nathan, come see my NASPiness." Parsimony is on our minds: Tying our shopping bags is easier than picking up spilled avocados, so says the law of parsimony. Parsimony is why we clean our boots and camping chairs before repacking them."

— LEXY AND NATHAN

The NSF-funded *Interpreters and Scientists Working on Our Parks* (iSWOOP) project brought new players into the mix. iSWOOP supported rangers in national parks as they facilitated discussions with visitors about all the science going on behind the scenes. In professional development sessions at Carlsbad Caverns, Acadia, Indiana Dunes, and Joshua Tree National Parks, we demonstrated laser scanners and high-speed cameras with all of their many lights, lenses, cables, memory banks, and power supplies, all of which took hours to set up and break down. We spread out $200,000 of equipment and entrusted rangers to learn how to use it, collect data with us, and tell their audiences about it. And that was the point — the equipment was used with care, trust, and joy. During iSWOOP, we found that setting expectations for how rangers handled the equipment was key for sustaining our research capacity. Rangers, like our own team members, were quick to adopt the NASP mentality.

Over time, NASP practitioners found that introducing this idea in a light-hearted way worked better than issuing warnings or scolding a team member who had damaged equipment. NASP became somewhat subliminal, an idea that faded in the background, but one that affected everything from packing and unpacking equipment to walking through a biologically sensitive area. When a group took up NASP, it seemed to elevate everyone's "game" by helping with focus, execution, and quality. This was a welcome effect: We worried less about working in difficult and dangerous conditions. We reduced falls and breakages to a minimum, and, with everyone's senses more tuned, we sensed and spotted snakes and scorpions while avoiding their stings. NASP supported a culture of focus, care, and excellence, which we want to share with you through these five tenets:



#1 Know your gear.

Know how the components click, lock, and release, how they pack, and where they go. If you don't know, a piece of gear can escape and land in the sand or get cracked on a rock. A backcountry expedition could come to a screeching halt with an expensive repair or replacement awaiting back home.

#2 Keep it clean.

Dry too! It's better to never get your gear dirty or wet than to try getting it back to an impeccable condition. If you drop a lens bag in sand or water, it's over. Furthermore, it's ultimately simpler to always clean your gear after using it than sometimes cleaning and sometimes not. If you never clean your gear, it will require much more strenuous cleaning when it begins to malfunction.

#3 No hard on hard.

Two objects with hard surfaces should never touch each other. Invest in resealable zipper bags, cases, and soft drink koozies to keep hard surfaces from touching. If you keep hard surfaces from touching, you avoid scratches. Without scratches, things look and work like new — always!

#4 Practice! NASP is for everyone.

Practice by setting achievable goals for yourself. "Not a scratch" can sound daunting at first, which is why we feel it's important to say that NASP really isn't so difficult. The more you practice, the more effortless and fun it becomes. Anyone who follows these tenets will find that NASP quickly becomes second nature. Get a friend on board too. NASP is not an exclusive club for people with special skills or a PhD. NASP is for anyone and everyone.

#5 Be parsimonious.

Be thrifty not just in terms of spending (as parsimonious implies in everyday usage) but take this idea of parsimony to its philosophical and scientific roots. In scientific circles, parsimonious means efficient and simple as well as economical. Check equipment *before* leaving, and make a backup plan. Keep movements simple to save time, save money, and save energy. The parsimonious individual, when presented with competing scenarios to similar outcomes, knows that the simplest one is preferred. Consider this: you just left Base Camp for a long drive to a field site before realizing that you forgot something that may or may not be important. It is simpler (and more parsimonious) to turn back and pick it up now than to risk realizing the forgotten item is critical and having to turn around later … if you even have time. In short, being parsimonious means keeping it simple to save time, save money, and save energy.

If you buy into our Not A Scratch Philosophy, you buy into a certain awareness that carries over into relationships with teammates and respect for people and places. From our team to yours, we hope that NASP can help you spend less time pestering about equipment and more time doing great work.

On my first expedition I learned that my role would be setting up unfamiliar equipment in the dark, on rocky terrain, under thousands of peeing bats. I decided to practice setting up and breaking down all the gear in the yard of the base camp. I did it twice. Was it overkill? Maybe. Did the NASP mindset pay off in a smooth shoot later? Absolutely.

—TRENT

Acknowledgements

iSWOOP is an NSF-funded project run by TERC PIs in collaboration with other educators, scientists, artists and designers. You can learn more about iSWOOP at **https://www.terc.edu/projects/interpreters-and-scientists-working-on-our-parks/**

iSWOOP Team

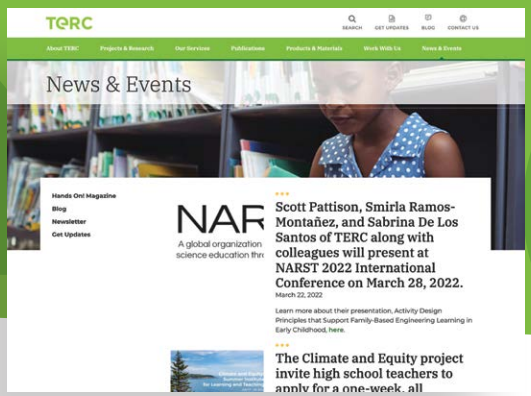
Our team members include: biologists like Georgina Dzikunu, Taylor Jones, Jenniffer Riley and Joe Lightsey, educators like Selene González, filmmakers like Chris Amodio, Raunak Kapoor and Jonathan Pfundstein, visual artists like Carrie Shaw and Andrew Mirmanesh, and designers like Dionysius Nikolaidis who explore new places and nagging questions with tools from diverse disciplines.

We call ourselves CATs (Coalition of Artisan Thinkers) and playfully invent a new language that adds an absurd number of consonants to everyday terms; it's schpanqtastic. The team has articulated eight principles that guide our work and its expression via the arts. NASP is an outgrowth of that culture. For more on NASP, CATs, iSWOOP and TERC, see **www.terc.edu/iswoop**

Be a NASPer

Interested in starting your own NASP movement? Download the NASP poster at **https://www.terc.edu/iswoop/what-next-what-now/**

What's New at TERC.edu?



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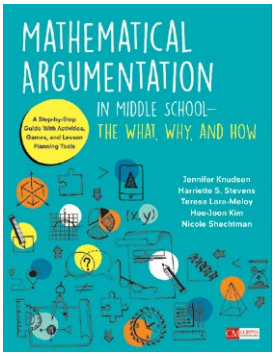
terc.edu/news-events

Math Workshops in Summers 2022-23 and School-Year Support

https://www.terc.edu/viste/viste-pd-information/

Join coaches and teachers from across the country in (paid) PD designed for middle school math coaches and the teachers they work with. PD features:

- Fun and supportive community and activities
- Coaching techniques and tools for these pandemic times, using multiple equity lenses
- Expert PD leaders and authors of *Mathematical Argumentation in Middle School*



The PD is offered as part of the Visualize Teaching (VisTe) Project at TERC. Participants are part of a research study, with data collection (e.g., interviews, surveys, and video recording specific lessons). These are all reflective learning experiences and not onerous.

Data Science for Everyone

https://bit.ly/3IA4pmM

Watch the Ask-Us-Anything panel with Andee Rubin from TERC, Lisa Neshyba from the Young Data Scientists League, and Michelle Mann from NetApp discuss how after-school, in-class, and summer data science program providers help students use data science to solve real-world problems. Panelists talk about expanding data science education through programs that get students working with datasets on topics THEY choose for real-world problem-solving.

2022 STEM For All Video Showcase: Acess, Inclusion, & Equity

https://stemforall2022.videohall.com

You're invited to View, Discuss & Vote! This year's STEM Videohall will have over 275 short videos depicting innovative, federally-funded projects aimed at improving Science, Math, Engineering and CS education.

Discuss the videos online with the presenters and other visitors. Vote for your favorite presentations for the Public Choice award. Thousands of researchers, educators, higher ed faculty, and parents will take part in this free, NSF-funded event.

Save the Dates! May 10th – 17th

Facilitating Family Learning in Museums: Re-Thinking our Assumptions and Approaches

Scott Pattison and Smirla Ramos-Montañez

In their chapter of the new book, *Museum Education for Today's Audience*, Scott Pattison and Smirla Ramos Montañez outline a series of research-based principles for understanding family learning and provide examples to illustrate how these principles play out in museums. Specifically, the importance of (a) recognizing that families have multiple goals, (b) appreciating the central role of parents and other adult family members, and (c) understanding how a museum visit is a brief moment in a family's long-term learning trajectory.

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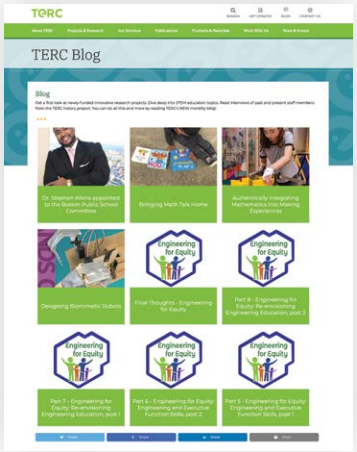

From Teacher to Social Science Researcher on Native Students' Experiences and Community Cultural Wealth

A second-year doctoral student, Angela D'Souza was an intern with the TERC Scholars Program and worked on the *Native STEM Portraits* project, illuminating the ways in which Native students and professionals navigate their multiple intersecting identities.

https://bit.ly/3NLcoBh

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