We all live by narrative, every day and every minute of our lives. Narrative is the human way of working through a chaotic and unforgiving world...Facts presented in stories are much easier to remember. Likewise, facts that stir up intense emotions are quickly and easily stored in our brains, and well-told stories are a great way to tie emotions to facts. Researchers have also demonstrated that the common marks of good storytelling—metaphors and analogies that draw the audience in—work because they allow the audience to tie the story to previous knowledge and experience. (E.O Wilson: “The power of story.”)

This theme drew a large and active group of participants, who were eager to hear the expert panel, but also eager to share their own resources and experience. The facilitator for the theme was David Barnes, currently part of the senior leadership at NCTM and also the senior mathematics educator on staff. The panel included Amy Alznauer, who teaches math at Northwestern University and the author of many math story books for children; Latrenda Knighten, a District Elementary Mathematics Instructional Specialist in East Baton Rouge Parish School System in Baton Rouge, LA; Trena Wilkerson, the current President of the National Council of Teachers of Mathematics and a mathematics education professor at Baylor University in Waco, Texas; and Christine Anne Royce, the column author for Teaching Through Trade Books which appears in Science and Children.

The panelists first addressed why story-telling is important to them as math educators. They expressed that storytelling promotes an active, imaginative engagement with ideas that have mathematical meaning, while being firmly situated in human lives and activities. This rich mix facilitates understanding, provides meaning and context for mathematical thinking, and helps the student connect in a personal way with the story—including the mathematical elements in it.

Trena Wilkerson said that integrating literature “invites creativity, [with] lots of connections to their world, and to the larger world of personal lives, their story. And literature and storytelling spark imagination, promote a lot of questioning, both the problem posing and problem solving and critical thinking. She sounded an additional note that came up more than once, which is the value of storytelling as a way for children to communicate their own ideas and questions, “an opportunity for students to be empowered in mathematics and for them to see themselves as mathematicians and doers of mathematics and science.”

Latrenda Knighten also spoke of the way that participation in stories builds students’ confidence and “math identity. “It's so powerful in building that identity because even for very little kids, when the character is just an animal, they think, oh, well, if this person or this animal can do it, I can do it. So it helps to build confidence and identity.”

Christine Royce noted that literature can help students encounter other cultures and experiences that they have not had themselves. Furthermore, they can see people struggling, striving, and finding their
way forward — and even find exemplars and guides: “Children's literature helps kids escape the digital side, and even just their own worlds. They can find different people and different characters and experience their trials and tribulations as they go through life, as well, and find out how they overcame it. And often the characters in books today are mentors.”

Last, Amy Alznauer told of how she was introduced to mathematics as a field full of beauty and wonder as child. “My father discovered in a Cambridge library, in a box of old papers, what is now known as the lost notebook of Ramanujan. So this completely transformed his life. It started this Renaissance in mathematics around Ramanujan, and for me, growing up with this story, - I just saw mathematics as a journey, a quest, a discovery of something beautiful...I eventually studied mathematics in grad school, now I teach it, I've wanted to bring that same sense of joy and quest to students. And so, you'll see when I talk about one of my books later that it's really that story and that passion that I wanted to bring into the classroom.”

2. How can the connecting of math and science with literature and storytelling? How do we see that in action?

The panelists and participants named important areas in which STEM is enriched by being combined with storytelling and other expressive arts: providing math (and other STEM) content; exploring the nature of math, and opportunities for integration across the curriculum; and changing ideas of who does (and can do) math. At every point, panelists and participants offered abundant resources that teachers or other practitioners can easily find and use (see “Resources” for this Theme on the Multiplex.)

Content. Panelists spoke of using stories for setting the context for the use of math, using stories as a source for project ideas, and strategies for problem solving and problem posing. Beyond specific suggestions and illustrations of math-in-action, such stories can help students see themselves in the stories, and imagine themselves as questioners and problem solvers. As Christine said, “...books can provide the content for students, and not that they're going to get all of their content [from stories]. We want them to investigate. We want them to pose problems. We want them to try and solve things, but they can actually learn from the books.”

Nature of math, and integration across the curriculum. Amy asked “What counts as doing math? Bringing storytelling into the classroom does two things. It builds a common language into any community setting, in a family, a community at church, a neighborhood, a classroom.” The recognition that math is an integral part of everyday life in many spheres is reinforced when teachers can tell stories from their own experience, which can be more immediate and personal than even very good books — a point that was made by several participants in the discussion forum as well.

During the expert panel, Christine pointed out that for teachers, story-telling “brings an opportunity for them to start to integrate their subject areas and ask questions. It also brings a lot of opportunities to overlap into those different areas that we start to see are so valuable that we sometimes forget early in the curriculum.” Amy added, “It's exactly what I would want to do in the classroom with stories like this... Even in my calculus classrooms, I try to bring in stories like this, so that they can see these concepts as living throughout history and mattering to people.”

Trena Wilkerson brought in yet another dimension as she talked about how she used the old story Flatland as an way to connect with current social issues that high school students take seriously: “ the first half of the book actually sets up Flatland and it is very powerful to use even today, especially today, when it's talking about society and the way, what we would refer to as people and their designations. There's a lot of inequity. There's a lot of problems that are going on and there are reasons why it's happening, and it is a powerful discussion that I had with my high school students.” As Amy said, “Even
in my calculus classrooms, I try to bring in stories like this, so that they can see these concepts as living throughout history and mattering to people.”

Math identity, and who does math? It has been mentioned above that stories can help students build their own “math identities”, and one way that this happens is that stories can show students that all kinds of people can and do use math (or other STEM subjects). As Amy said, “Stories can really challenge our idea of who a mathematician is…Is a mathematician young or old?... Is a mathematician male or female?” Latrenda Knighton added, “It's so important for our students to see, "Oh, a scientist does not have to be a male in a white lab coat, or a mathematician is not someone with the little glasses with the little geeky things on the side and they've got the sheet protector and the pocket protector and things of that nature. These are tools and these are things [that] we use to explore our lives every single day....putting it in the context of a story, for so many of the students that I've had the opportunity to work with, it makes them feel more comfortable...It's really giving students an opportunity to see themselves as mathematicians and as scientists, because they see a diverse group of characters, or circumstances and situations in which these things are having and some of the problem posing that takes place.”

On the same note, Christine mentioned a book entitled “Counting on Katherine, which tells the story about Katherine Johnson [one of the first African-American scientists to work with NASA] as a young girl and how she got involved in mathematics and then how she ended up working for.. sending people to the moon.” In the discussion, Cass Arsenault spoke of indigenous knowledges, and the work that she and others are doing to make students aware of Native American mathematical practices.

Question 3: What does the connecting of math and science with literature and storytelling bring to students? What does it bring to teachers, and to leaders?

In reflecting on these questions, the panelists focused on the capacity of stories to weave together many elements of the students’ world — a world which, as John Dewey pointed out, is experienced by the young as a complex whole, but which our disciplinary structures tend to fragment in ways that can hinder the young learner. Teachers are often seeking ways to help students place their learning in context once more; narrative can facilitate kind of meaning-making. As Christine said “ it connects families, it connects interest, it connects all of those things that we want students to do...I also think it talks about the challenges and the overcoming in that true integration of STEM. I think the stories for teachers allow them to bring those experiences into the classroom and engage the students. So, the reason students use children's literature and the reason teachers use children's literature overlap, but the teacher's use of the children's literature allows those students to even expand their worlds even more.”

Recommendations for teacher leaders
As with other innovations, teacher leaders can play a key role in experimenting with storytelling in math (and STEM more generally). In this experimentation, they can find materials and strategies to recommend to their colleagues.

Furthermore, the use of storytelling across the curriculum may require — or make possible — changes in school culture as well as teacher practice. As Brent Criswell said in the discussion, “Can we find and support a cadre of STEM teachers who believe in and support the use of storylines and literature in STEM classes so that they can encourage and provide guidance to other teachers who want to try this approach but either lack the expertise or confidence to do so?”
**Recommendations for researchers**

The experts in our panel, and the participants in the webinar and subsequent discussion, gave ample evidence from their experience of the value and effectiveness of the use of story-telling as a source of content, to provide resources for meaning-making by contextualizing the use of math (and STEM) by all kinds of people in all kinds of activities, as a vehicle for integration across the curriculum, and as a way to support the formation of students’ math (STEM) identity.

The renewed interest in story-telling as part of STEM pedagogy may provide new opportunities for researcher-practitioner collaborations (as well as for teacher-researcher investigations) to understand more fully what the teachers are seeing, and what the longitudinal effects may be on students’ content knowledge and STEM identity.

Finally, little research has been conducted on the impact that adopting such a pedagogical approach may have on teachers’ content knowledge, sense of STEM self-efficacy, and increased capacity to facilitate project-based (student-centered) learning.

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**The STEM Teacher Leadership Network is pleased to partner with NCTM on this Theme of the Month!**

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**Written by: Brian Drayton, Co-Director for the Center for School Reform at TERC.**

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