Storybook STEM:

Children's Literature as a Tool for Supporting Informal STEM Learning

Convening Summary

Scott Pattison, Gina Svarovsky, Smirla Ramos-Montañez, Patrick Kirkland
July 2020

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Storybook STEM is a collaboration between TERC and the Center for STEM Education at the University of Notre Dame. The project was funded through support from TERC and a grant from the National Science Foundation (DRL-1902536). Any opinions, findings and conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the funders.

We are grateful to the many individuals that contributed their ideas and expertise to support this work. Special thanks to the steering committee that provided guidance and feedback throughout the project: Maureen Callanan, University of California, Santa Cruz; Laura Huerta Migus, Association of Children's Museums; and Lauren Moreno, Catalysis, LCC. Thanks also to all the convening participants for generously sharing their time and expertise (see Appendix B).

 For questions about the project, contact Scott Pattison, scott_pattison@terc.edu.

Recommended citation: Pattison, S., Svarovsky, G., Ramos-Montañez, S., & Kirkland, P. (2020). *Storybook STEM: Children's literature as a tool for supporting informal STEM learning.* TERC. www.terc.edu/storybookstem/

Executive Summary

In December of 2019, TERC and the University of Notre Dame convened a group of 21 early childhood reading, family learning, and informal STEM education experts to explore the role of children's fiction books as a tool for supporting STEM learning with young children and their families. Participants included educators and researchers from across the country representing a broad range of learning contexts, professional roles, audience focus areas, and STEM discipline expertise.

Through the discussions, the group developed a series of recommendations for future work, with a particular focus on integrating diversity and equity perspectives into the use of storybooks for family STEM learning. Participants challenged researchers and educators to:

1. **Rethink how stories are developed**, including how families and scholars of color are represented and involved in the process of creating and selecting stories;
2. **Rethink what we mean by stories** by connecting with both written and oral story traditions and creating space for families to tell their own stories;
3. **Rethink our relationships with families** by engaging them as key stakeholders throughout the development, implementation, and research process;
4. **Rethink how we measure success**, including broadening our notion of STEM learning, connecting STEM and literacy, and attending to the goals of parents and children; and
5. **Rethink the connection between research and practice** by better sharing what we already know and involving educators and other practitioners as partners in the research process.

This report provides additional details about the convening, recommendations and research questions outlined by the group, and activities that led up to the convening discussion, including a national survey of educators and researchers involved in exploring the integration of storybooks and STEM for young children and their families. For more information about Storybook STEM project, visit the project website: https://www.terc.edu/storybookstem/.

Introduction

There is growing interest in supporting opportunities for science, technology, engineering, and mathematics (STEM) learning for families before children enter kindergarten, recognizing the important role that these experiences play in preparing children for school and building lifelong STEM learning pathways (Alexander et al., 2015; McClure et al., 2017; Morgan et al., 2016; Shwe Hadani & Rood, 2018). At this age, *children's storybooks* are a ubiquitous and critical learning resource, and one with huge potential to support STEM learning (Hassinger-Das et al., 2015; Hojnoski et al., 2014; Kelemen et al., 2014; Neuman & Kaefer, 2018). They are also a primary way that children learn about the world and engage in conversations with family members and other significant adults, even as the use of other media and technology increases (Common Sense Media, 2013; Geerdts et al., 2016).

> *There's still a lot of work to be done in how to best engage young children and their families in science—and doing that in ways that meets them where they are. Storytelling is a natural way to do that.*
>
> Convening participant

Although the idea of combining storybooks and STEM education is not new (e.g., Claud, 2000), there has been a renewed and expanded interest in this area, especially as an approach to broadening STEM access and learning in early childhood (Popov et al., 2017). A variety of active projects across the country are using fiction books and reading activities as avenues for STEM engagement with young children and families. However, there is almost no coordination among these groups to ensure that these efforts are building on prior work, aligning research questions, or sharing and synthesizing results.

Storybook STEM was a National Science Foundation-funded conference grant led by TERC in partnership with the University of Notre Dame with the goal of engaging early childhood reading, family learning, and informal STEM education (ISE) experts from across the country to better understand and advance current work related to the integration of storybooks and ISE for families with young children. The project focused on educators and researchers working with or studying family learning for preschool-age children (three to five years) using early childhood fiction books as a tool for engaging families in STEM topics and skills. Specifically, the project was designed around the following goals:

1. Document current and past work in ISE and other fields in order to understand the approaches and perspectives that are being used, synthesize research findings and lessons learned, and clarify the goals for integrating storybooks with ISE.
2. Summarize key recommendations and resources from the reading, literacy, and early childhood development fields so that others can benefit from these substantial literature bases.
3. Outline promising directions for future work, including research goals, collaborations and partnerships, theoretical frameworks, and recommendations for ensuring that these efforts are informed by a commitment to diversity, equity, and inclusion.

Over two years, the Storybook STEM project team coordinated a series of activities to engage researchers and educators across the country: a national survey and an online forum, both summarized briefly below, and an in-person convening in December 2019, which is the primary focus of this report.

National Survey and Online Forum

To launch the project, we conducted a national survey in the summer of 2019 with researchers and educators across the country to describe how professionals from a variety of fields and sectors are using children's books to support STEM learning for preschool-age children and their families, especially in out-of-school settings. The electronic survey was distributed broadly through email, listservs, newsletters, professional organizations, and social media to individuals working in the following sectors: libraries, afterschool programs, museums and science centers, informal STEM education, early childhood education, and developmental and cognitive psychology. Survey questions addressed the focus areas of participants using children's books for STEM learning (role, audience type and age, content domain, and educational or research setting), their goals for incorporating children's books in programs or research, the ways they have incorporated children's books in these contexts, and resources that have been helpful for using children's books as an educational or research tool.

In total, 231 individuals responded to the survey, including educators and teachers from both formal and informal learning contexts (59%), researchers (34%), designers and developers (15%), managers and administrators (14%), and other roles (11%), such as policymakers, parents, children's book authors, librarians, and funders. These respondents reported using storybooks to support and enhance STEM learning across a range of ages (infancy to high school), audience groups (children, youth, families, professional development), STEM domains, and educational settings (libraries, classrooms, afterschool programs, informal learning institutions, homes, research labs, and more). Through the survey, respondents also shared over 200 unique resources related to the integration of storybooks and STEM, including research articles, children's books, projects, websites, and professional organizations.

After the online survey, the project team organized a two-week online, asynchronous forum discussion in the fall of 2019. The goal of these

Project Highlight

My Sky Tonight

The My Sky Tonight team has created a set of fun, story-based, science-rich astronomy activities for pre-K children and their families, as well as supporting resources for educators on how to effectively work with young children and engage them in science practices. For example, in one activity, children listen to the story *Moonbear's Shadow* and then recreate scenes from the picture book, using a bear figure and a flashlight (to represent the Sun). Children explore how the position of the light affects the size, shape, and position of the shadow.

LEARN MORE:
https://astrosociety.org/education-outreach/early-learners/my-sky-tonight.html

discussions was to explore themes that emerged from the survey at a deeper level, help researchers and educators connect with each other, and prepare for the in-person convening. Invitations were sent to those who participated in the survey and provided their contact information. As before, the invite was also distributed broadly through email, listservs, newsletters, professional organizations, and social media.

In total, 156 individuals registered to participate in the online forum. Of these, 27 posted only to the introductory thread and 32 made a least one post beyond the introduction. There were 233 posts across the two weeks. After the introductory thread, in which participants could introduce themselves and share resources from their own work, the discussion was broken up in to three primary topics: (a) the role of children's books in family STEM learning, (b) connections between STEM learning and early literacy, and (c) children's books as a tool for cultural inclusion. In the last few days of the forum, a final thread was created to discuss big ideas that emerged across the two weeks and to suggest next steps for research and practice.

The online forum discussions were critical for planning the final in-person convening. In particular, the ideas and questions generated through the online forum were synthesized into a convening framework that guided the planning and structure of the in-person convening (see Appendix A).

In-Person Convening

Building on the feedback gathered through the survey and online forum, the project team convening a group of 21 early childhood reading, family learning, and informal STEM education experts at TERC in December 2019 to explore more deeply the role of children's fiction books as a tool for supporting STEM learning with young children and their families. Participants included educators and researchers from across the country representing a broad range of learning contexts, professional roles, audience focus areas, and STEM discipline expertise (see Appendix B for complete list of convening participants). The overarching goal of the convening was to explore storybooks as a tool for supporting STEM learning for families with young children. More specifically, the discussions were design to allow participants to:

> *How can we use story to elevate voices that are not typically heard in a museum setting? What would it look like to create programs that disrupt the social structure?*
>
> Convening participant

- Share findings, resources, and perspectives with each other;
- Better understand current research, best practices, and promising approaches;
- Draft recommendations for researchers and educators; and
- Identify promising project ideas, research questions, and partnership opportunities for the future.

The structure of the two-day convening evolved as the discussions progressed. The first day focused on getting to know each other and critiquing the discussion framework that was developed from the survey and online forum (Appendix A). Small group sessions were organized around the guiding questions, cross-cutting themes, and STEM discipline-specific implications of engaging

families through storybooks. The first day also included presentations on the cross-cutting themes by three of participants (described in more detail below). The first half of the second day included time for participant to reflect on day one and talk more about the broader role of story and narrative, beyond children's storybooks. The meeting then pivoted to synthesizing emergent ideas and documenting recommendations.

During the convening, members of the TERC team also engaged a broader audience through social media (https://twitter.com/i/events/1207054209864159234).The online discussion produced 51 tweets, each of which had between 150 and 450 impressions each. On average, the video posts on Twitter had 39 views and 208 impressions each.

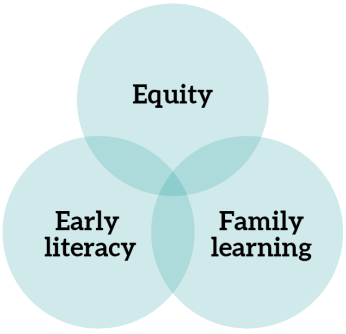
Project Evaluation

Project planning and implementation was informed by ongoing feedback from a steering committee of three experts: Maureen Callanan, University of California Santa Cruz; Laura Huerta Migus, Association of Children's Museums; and Lauren Moreno, Catalysis, LLC. The project team met with this group twice in before the in-person convening and once at the end of the project. Other evaluation activities included a convening evaluation form completed by participants at the end of the second day and a post-convening online survey sent to participants approximately two months after the meeting. As part of the online survey, participants provided feedback on an initial draft of the survey findings and recommendations outlined in this report.

Findings and Recommendations

Through the discussions, the group developed a series of recommendations for future work, with a particular focus integrating diversity and equity perspectives into the use of storybooks for family STEM learning. These recommendations were framed by presentations from three of the participants on several of the cross-cutting themes guiding the convening. We begin by summarizing these foundational perspectives. We then outline the recommendations that emerged from the discussions throughout the remainder of the convening.

Foundational Perspectives



On the first day of the convening, three of the participants (Laura Huerta Migus, Maureen Callanan, and Gigliana Melzi) presented brief talks on the cross-cutting themes of equity, family learning, and early literacy. These talks helped frame and motivate the remainder of the convening. Based on post-convening feedback, they also emerged as one of the most impactful aspects of the convening for participants. The group agreed that the ideas shared by the three speakers provide an excellent lens for thinking about the integration of storybooks and STEM and are especially relevant to understanding how this integration can support equity, diversity, and inclusion within the field of STEM education. In other words, these perspectives can be considered foundational to future research and education efforts to leverage storybooks as a tool for supporting family STEM learning in early childhood.

Equity

Laura Huerta Migus, Executive Director, Association of Children's Museums (ACM), provided an introduction to the concept of equity within the field of STEM education and learning. As an anchoring framework, she presented a continuum of approaches, with equality on one end and equity on the other (Figure 1). The continuum represents movement from initial approaches to addressing issues of inequality in STEM education, which acknowledge this inequality but may continue to support the underlying systems that create and perpetuate it, to deeper levels that begin to disrupt unjust systems and move towards a more equitable vision for STEM education and learning. The continuum highlights a fundamental distinction between trying to make everything and everyone "equal" to recognizing that long histories of injustice and discrimination require different interventions, support, and collaborations with different communities in order to achieve a deeper sense of social equity (Bevan et al., 2018; Migus, 2014, 2019).

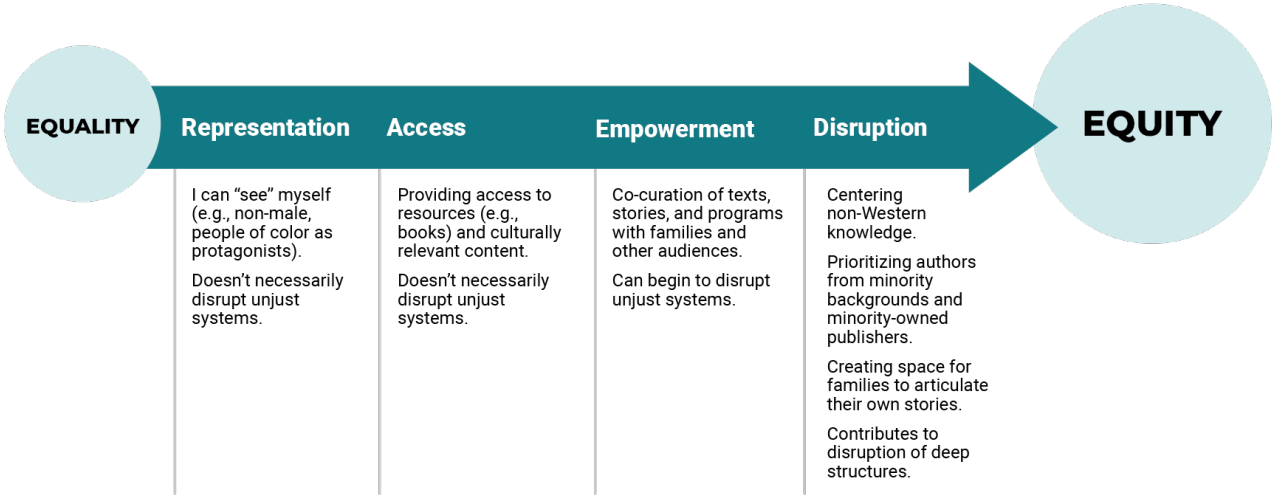


Figure 1. Equality-equity continuum, presented by Laura Huerta Migus.

For example, efforts to diversify the representations of children and families from different backgrounds in storybooks might fall within the "representation" category on the equality side of the spectrum. This approach allows families to see themselves in the stories but may perpetuate the ways that families are excluded from the process of creating stories and deciding how the stories are used to support STEM learning. On the other end of the spectrum, a "disruption" approach might include a focus on non-Western knowledge, ensuring that individuals from diverse backgrounds are leading efforts to create stories and connect books with STEM, and making space for families to lead their own storytelling as part of the learning experience.

Huerta Migus stressed that it is not necessarily wrong for a project to operate at one level instead of another. However, researchers and educators should be aware of how their efforts align with this spectrum, and as a field we should strive to work across the spectrum to address issues of equity.

Family Learning

Dr. Maureen Callanan, Professor of Psychology at the University of California, Santa Cruz, built on the first talk to address how families learn together, how this varies across cultures, and how this can guide our thinking about the integration of storybooks and STEM. In her talk, she outlined three themes.

1. *Families around the world tell and listen to stories in a variety of ways*. Dr. Callanan emphasized that narrative is a fundamental mode of thinking, aspect of human culture, and way of organizing everyday interpretations of the world (Bruner, 1986, 2000). In other words, stories are a powerful and familiar way for families to engage with STEM. However, different cultures vary in the ways that they tell and engage with stories (Marin & Bang, 2018; Solis, 2017). Although written storybooks may be a familiar learning format for white, middle-class families in the United States, oral storytelling traditional are more important in other cultures (Miller et al., 2005).

2. *Parents are uniquely positioned to build on their children's prior knowledge, experiences, and interests.* Numerous studies have documented how parents and other primary adult caregivers regularly facilitate rich STEM learning outside of school and are uniquely positioned to support this learning because of their intimate knowledge of their children's prior experiences, abilities, and interests (Alexander et al., 2012). Studies have documented the ways that parents provide explanations to their children during STEM-related experiences (e.g., "The bones get covered with layers of dirt and sand when the wind blows") and make personal connections to enhance relevance and build on prior knowledge (e.g., "This is what Aunt Judy used to do when she was an archaeology major!") (Callanan et al., 2017; Haden et al., 2014). In a recent study, personal connections talk in a fossil exhibit was actually a better predictor of children's engagement than science explanations (Callanan et al., 2017).

   Parents often seem uncertain about STEM content and may not connect the learning they engage in everyday with STEM topics and skills. For this reason, storybooks and stories more generally can be a comfortable approach to supporting parents' understanding even as they help guide their own children's learning.

3. *Families from different cultural backgrounds vary in the ways they learn together.* Just as families differ in the ways they engage with story, there is also variation in the ways families talk to each other and learn together more broadly (Rogoff, 2003). For example, white middle-class families are more likely to ask their children questions and engage in pedagogical, child-focused interactions, while families from different cultures are more likely to involve children with "learning through observing and pitching in" as part of adult activity (Rogoff, 2014). Although it may not look like the learning typical in Western schools, research shows that the observation-based approach can support a variety of STEM-related skills, such as observing, collaborating, and focusing on evidence (Alcalá et al., 2018; Solis & Callanan, 2016). Interventions that encourage parents to talk more to their children or emphasize interaction styles not typical in their communities may be uncomfortable at best and at worst undermine the cultural strengths and practices of the families the programs are

meant to support. Therefore, it is critical that researchers and educators reflect on ways to support and honor how families learn and tell stories together.

Early Literacy

Dr. Gigliana Melzi, Associate Professor in the Department of Applied Psychology and affiliated faculty at the Center for Latin American and Caribbean Studies at New York University, provided a final presentation about early literacy research and its implications for the integration of storybooks and STEM. To begin, she defined early literacy as encompassing the foundational oral language skills supporting reading and writing (Snow & Matthews, 2016). She then outlined two primary perspectives in the existing research literature: (1) the *mainstream perspective* and (2) a *sociocultural perspective* focused on issues of diversity, equity, and inclusion.

From a mainstream perspective, there is abundant empirical evidence that sharing books with young children supports early learning and development across a variety of domains related to early literacy and beyond (e.g., Bus et al., 1995; Mol & Bus, 2011; Senechal & LeFevre, 2002). In other words, reading can be seen as the "apple a day for your child's brain." Furthermore, storybook sharing can be easily incorporated into the routines of most families, making them a powerful focus for early childhood development and education interventions (e.g., Canfield et al., 2020).

On the other hand, research using a sociocultural perspective highlights that storybook reading with children is a culturally grounded activity that is not necessarily shared equally or similarly across families from different cultural backgrounds (Melzi et al., 2013, 2019). Families who value other forms of storytelling and communication routines might be willing to incorporate more book reading into their lives, but an overemphasis on book reading can create unnecessary barriers to recognizing and capitalizing on the existing literacy practices of families from diverse backgrounds. An equity-oriented approach to storybooks, therefore, not only focuses on improving access to books, but also on sustaining and leveraging heritage, community, and family perspectives and practices to support early literacy, STEM learning, and other education outcomes. Dr. Melzi suggested that a promising approach to integrating family storybooks and STEM learning is to find the right balance between these two perspectives, as depicted in Figure 2.

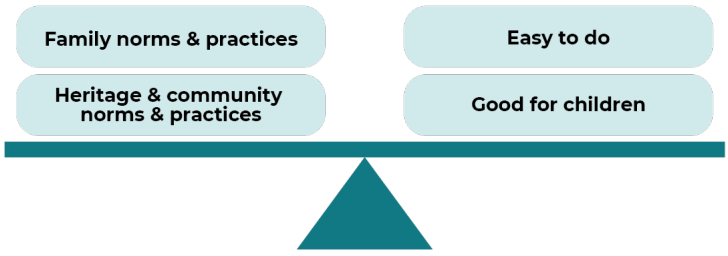


Figure 2. Balance between mainstream and sociocultural perspectives on early literacy, presented by Gigliana Melzi.

Recommendations for Research and Practice

Building talks outlined above, convening participants shared their perspectives on current work, discussed promising practices, and worked to outline recommendations for both researchers and educators. In the end, aligned with the foundational perspectives, the group emphasized the need to more directly address issues of diversity, equity, and inclusion when integrating storybooks, STEM, and family learning, both for current and future efforts. This commitment is echoed in the five recommendations that emerged from the two-day discussion and are described below.

(1) Rethink and Reconfigure How Storybooks Are Developed

As several participants noted, the vast majority of children's storybooks, whether they are explicitly related to STEM or not, are written and illustrated by White individuals and arguably represent White, middle-class values and cultural perspectives. For example, one study found that of children's picture books published in 2018, less than 25% included "any characters of color; of those that do, many are thematic books about particular racial or cultural groups, festivals, or historical figures (CCBC, 2019; Mortensen, 2019; SLJ, 2019)" (Kliman, 2019). This lack of diversity has also been shown for STEM-related children's books specifically (Kelly, 2018). Furthermore, the children's publishing field is predominantly White, limiting the cultural perspectives shaping the development and selection of books (Kliman, 2019).

In order to realize the potential of storybooks to broaden STEM access and engagement for families with young children, therefore, it is critical to increase the diversity represented in the children's books, as well as the teams that develop and study them. At a basic level, this means increasing the diversity of the individuals and contexts represented in these books so that children and families from all communities can see themselves in the stories. At a deeper level, it means helping to ensure that professionals of color are involved at every stage of story development, selection, distribution, and research. As participants emphasized, this requires not only working with families in the development process, as described below, but also supporting senior professionals of color, including writers, illustrators, and researchers, to lead and bring their perspectives to the process. This shift mirrors the move from representation to empowerment and disruption described by Laura Huerta Migus and invites educators and researchers to reflect on the underlying issues power and privilege related to who selects and tells stories and who decides how these stories are integrated with STEM for families.

> *We want to invite as many people into science, engineering, and mathematics as possible and part of that work is getting people who are already there to tell their stories in interesting and compelling ways.*
>
> Convening participant

(2) Rethink and Broaden What We Mean by Stories

The Storybook STEM project intentionally focused on children's storybooks as a promising tool for supporting STEM engagement and learning for families with young children. However, from the

Project Highlight

Tech Tales

Tech Tales invites parents to take on new roles as learners with their children while they learn about programming, engineering design processes, and related science concepts. Unlike many programs that use competitions as a context for engaging with robotics, we use storytelling to engage families in robotics in order to tie into cultural practices around storytelling, connect to families' personal and cultural histories, and leverage the unique professional expertise of librarians in connecting people with stories.

LEARN MORE:
https://techtales.online/

outset participants questioned the exclusive focus on storybooks rather than other forms of narrative and storytelling. Again, children's storybooks are a common resource and component of home learning for White, middle-class families that may not be as common or as familiar for families from other communities. As Maureen Callanan and Gigliana Melzi emphasized in their talks, a focus on storybooks must be balanced with approaches to supporting other family storytelling practices and creative ways for integrating these practices with STEM learning.

This broader approach includes empowering families to share and tell their own stories as part of STEM programs, which promises to create a deeper sense of relevance to the STEM topics and puts families in a central role for shaping the way story and STEM are integrated. Most importantly, participants emphasized the importance of not assuming that the same approaches, outcomes, and practices are appropriate for all communities. Ideally, educators, researchers, and families work together to understand and support the storytelling practices within each community and leverage these to create relevant and accessible entry points to STEM.

(3) Rethink and Extend Our Relationships with Families

Participants also stressed the importance of moving beyond thinking about families as solely the audience for STEM and literacy programs that integrate children's storybooks. Instead, educators and researchers should involve children, parents, and other significant adult caregivers as collaborators at every step of the process, including identifying education and research goals, prioritizing outcomes and measures, developing or selecting stories, and implementing and studying programs. As noted above, families should also be involved in creators of stories, supporting existing narrative and storytelling traditions within different communities. This approach will not only ensure that programs and research studies are relevant and accessible for families but will also help put families in control of how stories become a resource for their children.

This re-orientation implies a different perspective on intergenerational learning and the multiple roles of parents. This perspective builds on the research on family learning highlighted by Maureen Callanan. Parents are not just contextual factors in their children's development but are educators and learners themselves. Programs for families that connect storybooks with STEM learning should support meaningful, enriching interactions between parents and children, engage parents as collaborators in program development and implementation, and support parents' own learning about literacy and STEM. Both research and educator efforts should also acknowledge the diverse

approaches to parenting and family learning across cultures that influence how families engage with books and stories more broadly.

(4) Rethink and Expand how We Measure Success

As researchers and educators, our definitions of success guide our work and also reveal our own biases and assumptions about storybooks, STEM, and education. As the group discussed applying and diversity and equity lens to the integration of storybooks and STEM, they explored ways that our outcomes are defined and measured should be broadened and expanded. From a disciplinary perspective, this might include emphasizing STEM practices just as much as content knowledge and vocabulary. From a family learning and child development perspective, this also requires thinking about the ways that storybooks not only focus on STEM learning but also support and honor other family goals, such as early literacy development, cultural values, and spending time together. And from an equity perspective, educators and researchers should work closely with families and community stakeholders to decide what outcomes are of the highest priority and how existing family assets and strengths are highlighted and supported. Participants acknowledged that this balancing act, as depicted by Gigliana Melzi, is challenging but also critical to ensure that these efforts are successful for all communities.

Project Highlight

R-SUCCESS

Reading Success Using Co-Constructive Elaborative Storytelling Strategies is a classroom-based oral storytelling program that incorporates the oral narrative traditions of Latino and African heritage families into the classroom. The program provides web-based professional development to early childhood educators to help them integrate the unique cultural knowledge and practices of students and their families in order to support language and literacy development.

LEARN MORE:
https://wp.nyu.edu/steinhardt-lfeld/r-success/

(5) Rethink and Reinforce the Connection Between Research and Practice

Finally, participants agreed that more work needs to be done to connect researchers and practitioners at all stages of the process. For example, the group felt that not enough has been done to share the research that does exist with teachers, educators, and other professionals working directly with families or to provide training and professional development opportunities for these individuals around the types of questions, issues, and approaches highlighted during the convening. Similarly, practitioners can be engaged in the earliest stages of research and development to ensure that efforts are aligned with the needs of different professional audiences and incorporate insights from both research and direct experience with families. Overall, the convening participants felt that the cross-disciplinary nature of the discussions should serve as a model for future efforts—catalyzing collaboration and communication across sectors, disciplines, and professional roles.

Questions for Future Research

The group also outlined several focus areas for future research. Many of these again highlighted the need for a better understanding of how storybooks, and stories more broadly, can best be leveraged

to support STEM learning for families from diverse communities. The group also identified a series of research questions about the role of books and story across STEM domains and for supporting different learning goals.

Focus Area 1: Research to identify effective approaches for empowering parents and communities through storybooks and making family stories and practices visible and valued

As noted, convening participants emphasized the importance of collaborating with families at all stages of research and development to think about how to integrate stories and STEM, what stories to use, and how success is measured. Some of these ideas can be borrowed from other fields and research traditions, such as funds of knowledge theory (González et al., 2005) or participatory research (Israel, 2013; Reason & Bradbury, 2013). Researchers can also advance the field by studying these collaborative approaches in the particular context of integrating storybooks and STEM. For example, convening participants highlighted the following research questions to guide future work:

1. *What are the existing family practices and knowledge related to STEM (or more broadly) that can be supported by books and stories?*
2. *How can researchers effectively collaborate with practitioners and families throughout the research process?*
3. *What is the alignment (and misalignment) between approaches and communities? For example, when is dialogic reading (Lacour et al., 2013; Whitehurst et al., 1988) appropriate and when is it not?*

Project Highlight

Making Space for Story-Based Tinkering to Scaffold Early Informal Engineering Learning

In partnership with the Chicago Children's Museum, the team is investigating the impacts of oral storytelling approaches to designing and facilitating engineering learning opportunities. The project will address when and how parent-child engagement in spatial thinking and reflection is supported by story "door-openers" that offer reasons for needing to solve problems and whether the tinkering stories children and their families tell support lasting STEM learning.

LEARN MORE:
https://www.informalscience.org/collaborative-research-advancing-early-stem-learning-opportunities-through-tinkering-and-reflection

Focus Area 2: Research to investigate the role of books, story, and narrative across different STEM domains and for different goals

The convening discussions also highlighted a number of research questions related to the role of stories and storybooks in STEM engagement. Many existing studies focus on the design and content of storybooks and how these factors influence STEM engagement and learning, often measured with the context of a laboratory setting. While this research is important, convening participants emphasized the need to think more broadly and connect with questions that are immerging from practice and educational programs. For example, convening participants highlighted the following research questions to guide future work:

1. *What are effective strategies for integrating books and stories with other activities and programs?*
2. *How does the potential role of stories and narrative vary across STEM disciplines? (For example, in mathematics, storybooks are often used to promote mathematical conversations within families (e.g., Hojnoski et al., 2014), while in science and engineering, storybooks are often used to create the context or motivation for inquiry investigations or engineering design challenges (e.g., Milto et al., 2020; Pattison et al., 2020). Do these differences reflect arbitrary tendencies within the professional communities or more fundamental differences across STEM domains?)*
3. *What are effective approaches to balancing multiple goals (e.g., STEM learning, cultural relevance, engagement and interest, literacy development) when selecting, incorporating, and studying stories and STEM?*

Conclusion

One of the fundamental goals of the Storybook STEM project was to catalyze cross-disciplinary thinking and partnerships, both for convening participants and for other researchers and educators across the country thinking about the integration of storybooks and STEM. Evaluation findings suggest this was an importan outcome of the project. Participants reported that the convening was a valuable experience that achieved its stated goals. Many were particularly inspired by the equity discussions, the broader notion of story and narrative beyond books, and the opportunity to engage with researchers representing such a broad range of fields, learning contexts, and STEM domains. Since the discussions, participants have continued to build on the ideas and connections developed through the convening, bringing new ideas into their current work, adapting and creating new programs and research studies, and developing collaborations and funding proposals with members of the convening.

> *I have connected with four individuals from the convening, and we are now working on several projects. The science is more present in my mind than before, and it has shaped how I read the stories I adapt for my current projects.*
>
> Convening participant

The project brought this group of experts together across disciplines, fields, and professional roles to better understand the work that has been done related to the integration of storybooks and STEM for young children and their families and to provide guidance for future research and educational efforts. What emerged from the convening is, we believe, something even more profound: A call to action for researchers and educators to think more critically about this integration and how it supports a vision of equity in STEM education for all communities. This call to action is timely and aligns with a growing movement across education and the STEM fields to move beyond superficial notions of access or representation and more fundamentally address the systems of oppression, inequity, and injustice that are ingrained within our society (Brown et al., 2019; Calabrese Barton & Tan, 2020; Garibay & Teasdale, 2019; Hall, 2020). We hope this convening and the recommendations that have emerged serve as one small contribution to these efforts.

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Appendix A: Convening Guiding Questions

Meeting Charge

Develop recommendations for both researchers and educators that address the guiding questions below and support those who are using or studying children's books as a tool for STEM learning with young children and their families.

Guiding Questions

These questions emerged from the national survey and online forum that were conducted earlier in the year as part of the Storybook STEM project.

- *Goals*—How can educators think about balancing multiple goals and priorities when using storybooks as a tool for STEM engagement and learning with families (e.g., accuracy, cultural relevance, engagement, STEM content and practices)?
- *Context*—What different roles can books play by themselves or as part of a larger program to support STEM engagement and learning with families? What role can books play in framing or motivating STEM activities?
- *Design*—How does the design, genre, and content of the book influence the potential for STEM engagement and learning?
- *Professionals*—What strategies and resources are necessary to support educators and parents using storybooks as a tool for STEM engagement and learning?
- *Narrative and story*—What are broader ways to use story and narrative, including the narratives and stories from families, to support STEM learning and engagement?

Cross-Cutting Themes

These themes have motivated the project from the beginning and were also evident in responses and conversations from the national survey and online forum.

- *Equity*—How do storybooks help dismantle barriers to STEM learning and reflect multiple ways of knowing and being across diverse communities?
- *Family*—How do storybooks as a tool for STEM learning support and honor the ways that families learn and tell stories together?
- *Early literacy*—How does STEM learning through storybooks support early literacy more broadly and leverage findings from research on early literacy development?

Appendix B: Convening Participants

Project Team

Scott Pattison, TERC (*Principle Investigator*)

Gina Svarovsky, University of Notre Dame (*Co-Principle Investigator*)

Smirla Ramos-Montañez, TERC

Jana Borgen, TERC

Steering Committee

Maureen Callanan, University of California Santa Cruz

Laura Huerta-Migus, Association of Children's Museums

Lauren Moreno, Catalysis, LLC (steering committee)

Invited Participants

Jessica Andrews, WGBH

Rachel Castro-Diephouse, Franklin Institute

Catherine Haden, Loyola University

Claudia Haines, Homer Public Library

Anna Hurst, Astronomical Society of the Pacific

Deborah Kelemen, Boston University

Marlene Kliman, TERC

Gigliana Melzi, New York University Steinhardt

Elissa Milto, Tufts University

Julia Plummer, Penn State University

Merredith Portsmore, Tufts University

David Purpura, Purdue University

Michelle Rodriguez, Lawrence Hall of Science

Carrie Tzou, University of Washington Bothell

Marijke Visser, American Library Association

See the project website for more information about convening participants: https://www.terc.edu/storybookstem/.