Goats, Giants, and . . . Science?

Teaching Engineering Concepts through Fairy Tales

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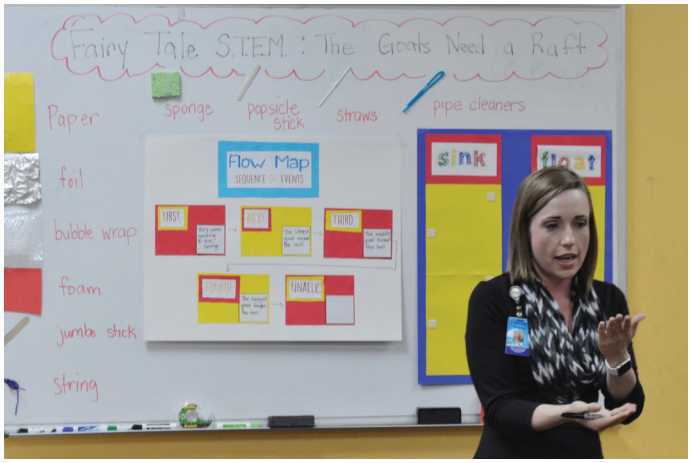

Curriculum Specialist Nicole Suarez Presents "The Goats Need a Raft."

In the past several years, STEM activities for children in libraries have exploded—literally and figuratively; LEGO contests, building blocks, snap circuits, coding challenges, maker spaces, computer classes, and science programs with exploding bags and bottles take place in libraries across the country. Anxious to rebrand ourselves for the modern age, we tell people that we are "not your grandmother's library" and let patrons know that we have much to offer beyond books.

But what if old-fashioned fairy tales and folk tales—the mainstay of our grandmothers' libraries—could help our children learn twenty-first century skills? In fact, these stories may be a key to teaching children, particularly girls, about math, science, and engineering.

A $7,500 Curiosity Creates grant allowed us to expand programs teaching STEM through fairy tales to seven of our sixteen locations. The concept of using fairy tales to teach STEM was not original (there are a number of resources and curricula which offer variations on this theme), but our curriculum specialist Nicole Suarez built on the concept by creating lesson plans focused around six fairy tales, integrating Common Core educational standards and creating pre- and post-tests to measure outcomes.

The project started with a training on how to teach STEM in libraries for the staff who would be presenting the series at branch locations. An experienced teacher, our curriculum specialist demystified Common Core for our staff members and emphasized that for STEM programs to be effective, they must incorporate use of the scientific method and provide children the opportunity to plan, predict, test, and reflect. Staff were shown how to introduce before and after questions (pre- and post-tests) without making children anxious or feel as if they were being tested. Our curriculum specialist also provided guidance on how to accommodate children with disabilities who may need frequent breaks, cooperative grouping, additional direction, simplified instruction, or help with transitions.

Kits prepared by the curriculum specialist were sent out to each of the seven locations presenting the program. Materials were divided into Ziploc bags for each child expected to participate. Many of the kits contained inexpensive or recycled items like toilet paper tubes, sponges, paper plates, Popsicle sticks, bubble wrap, coffee filters, toothpicks, straws, tape, newspaper, packing peanuts, foil, and cups. About half of the grant funds was used to purchase supplies for the forty-three programs that were held. Materials cost per child averaged less than $5.50.

Each module started with the reading of a familiar fairy tale. For example, in "The Goats Need a Raft," we read the folk tale "Three Billy Goats Gruff." (The version read in our programs was from *Yummy: Eight Favorite Fairy Tales* by Lucy Cousins, but a number of fairy tale books were used in the series, incorporating stories with diverse characters.) Children were encouraged to sequence the story, identifying the main events, the problem, and the central characters. They were encouraged to imagine an alternative ending and asked how the story might change if the goats had a raft that could allow them to evade the troll.

The rest of the program entailed learning about the essential question, "What makes something float or sink?" We introduced and explained new vocabulary. Household items were

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tested to see whether they would sink or float, and children learned about buoyancy, mass, force, and gravity.

The children completed a recording sheet and had the opportunity to draw a plan of their raft. They were asked to predict which materials would make their raft the strongest. They then broke into small groups to engineer and build a raft together, using only the materials provided in their kit. The challenge was to build a raft that would float, rather than sink, and that would be strong enough to hold the most pebbles.

In creating this program, we experienced several surprises. Even though we started with what we thought were familiar fairy tales, we found that many children weren't familiar with the story. Some children had no idea what a raft was. Slightly less than 40 percent of children doing "The Goats Need a Raft" program were able to answer all four pre-test questions correctly. At the end of the program, 92.4 percent of children answered all four questions correctly. This was a significant learning gain for a program that lasted only one hour!

The collaborative portion of the program was essential to its success. In their small groups, children shared ideas of how to make the raft stronger, without making it too heavy. Those whose rafts did sink early on seemed enthusiastic about trying a different approach to improve their raft.

Perhaps they would have felt more self-conscious about failing if they had built rafts individually and had to test them. Instead, when a group's raft sank, they just made modifications, tried again, and cheered one another on. It was clear from the excitement and the time they devoted to improving their raft that they felt intrinsic motivation to learn, and there was no need for prizes or incentives to encourage them. Research supports the importance of working cooperatively, particularly for African American children and for girls, who learn better in relational contexts.[1]

The pairing of the fairy tale with the engineering challenge was important for two reasons. First, the program drew a different audience than might have been attracted for a strictly STEM program, and second, the narrative element helped the children contextualize the experiment they were conducting. Many girls came to the program excited about the fairy tale aspect, but remained engaged and interested for the STEM learning. When we compared the percentage of boys and girls registering for these programs and to those registering for our Whiz Kids technology classes for kids, we found a significant gender difference: 58 percent of registrants for whom we could determine gender were female for the STEM fairy tale programs, compared to 39 percent for the Whiz Kids classes.

If children are given a challenge to construct a raft, some may take on the challenge with enthusiasm, while others may hang back and wonder about the purpose of the exercise. But if the activity starts by talking about three little billy goats needing to escape the big, ugly, menacing troll, the children will immediately understand the purpose of creating a raft, even if they know that the story is fictional. The fairy tale is the narrative hook that contextualizes that engineering activity—an element that is often lacking in traditional STEM library programs.

This contextualization is generally more important for girls than boys, and more important for children growing up in low-income households than others. For example, a study using storytelling to teach geometry to kindergartners in urban and suburban contexts found that storytelling was effective in helping kids learn, retain, and transfer geometric concepts, and the gains were particularly beneficial for girls and for the kids in the urban school who came from a more racially and economically diverse setting. Many cognitive scientists have viewed stories as "the most natural package of organized knowledge in the cognitive system," which helps people learn and retain knowledge.[2]

In the book, *Engineering in Pre-College Settings*, Christine Cunningham and Cathy LaChapelle stress that the first principle of inclusive curriculum design for teaching engineering to kids is to "use narrative to develop and motivate students' understanding of the place of engineering in the world." Providing a storyline can help boost participation of girls and other underrepresented students and provide a point of entry into a field where they might have fewer models.[3] It is critical for children to have the opportunity to plan, predict, test, and reflect on their findings in a small group setting where they can learn from one another, innovate, and cooperate.

Libraries today may have increasingly sophisticated technologies that even our youngest patrons can learn to use, but remember that our common stories—our fairy tales and folk tales—still can play a role in helping children understand how those technologies work.

How exciting to think that your scientific knowledge can help Little Red Riding Hood zip away from the Big Bad Wolf, Jack parachute away from the giant, or three billy goats avoid a bridge with a mean, ugly, menacing troll! &

References

1. Beth Casey et al., "Use of Storytelling Context to Improve Girls' and Boys' Geometry Skills in Kindergarten," *Journal of Applied Developmental Psychology* 29 (2008): 29–48.
2. Ibid.
3. C. M. Cunningham and C. P. LaChapelle, "Designing Engineering Experiences to Engage All Students," in *Engineering in Pre-College Settings: Synthesizing Research, Policy, and Practices*, edited by S. Purzer, J. Strobel, and M. E. Cardella (Lafayette, IN: Purdue University Press, 2014), 117–40.