

# Learning & Teaching

*Mathematics Teacher: Learning and Teaching PK-12*, is NCTM's newest journal that reflects the current practices of mathematics education, as well as maintains a knowledge base of practice and policy in looking at the future of the field. Content is aimed at preschool to 12th grade with peer-reviewed and invited articles. *MTLT* is published monthly.

ARTICLE TITLE:

AUTHOR NAMES:

DIGITAL OBJECT IDENTIFIER:

VOLUME:

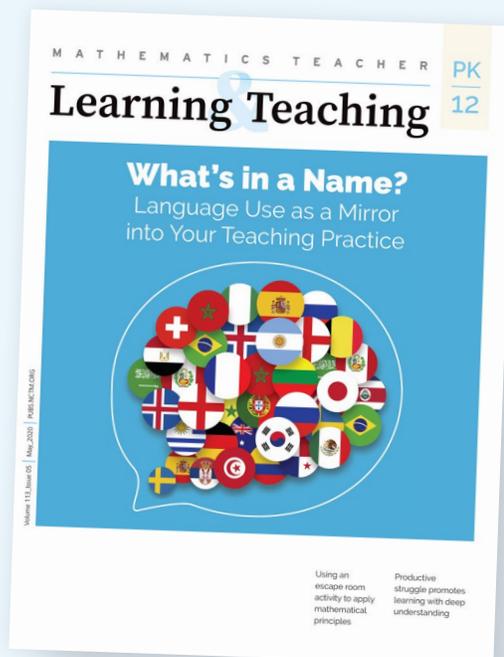
ISSUE NUMBER:

## Mission Statement

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Approved by the NCTM Board of Directors on July 15, 2017.

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# Family Math Fun Festivals Recharged and Reinvented

Family Math Fun Festivals can help change the narrative on what it means to do mathematics. Make a big impact at your festivals with low-floor, high-ceiling activities that are meaningful and highly engaging for all ages.

Gina Kling, Lucy Neville, Molly Moore, Kathryn Vance, and Dyana Harrelson

**There is nothing particularly** unique or original about Family Math Nights, as many schools have been hosting them for years. However, last year at Hope College in Holland, Michigan, we decided it was time to recharge the notion of a Family Math Festival and reinvent something high energy and high impact for the K–8 students, their families, and even the adult learners of our community. Is it time to reshape how your school's families engage with mathematics as well? Are you looking for an approach that could appeal across all grade bands? If so, read on for resources, “pro tips,” and

stories of impact with our Family Math Fun Festivals, Recharged and Reinvented!

## WHY DO WE NEED FAMILY MATH FESTIVALS?

The link between early numeracy and future success in mathematics is well established. Chen and colleagues (2018) found that a positive attitude toward mathematics “has a unique and significant effect on math achievement independent of general cognitive abilities” (p. 400). It follows that early experiences at

home engaging with informal mathematics *matter*, and a child's earliest mathematics teacher is usually a parent or guardian. In his book *Mathematics for Human Flourishing*, Su (2020) describes how even if we do not realize it, we are all teachers of mathematics, and the attitudes toward mathematics that we share, either consciously or subconsciously, can have a significant impact on others. This could help or hinder the development of our emerging mathematicians, as

studies show that parents with math anxiety pass on that anxiety to their children. In fact, math-anxious parents are more likely to pass on math anxiety if they try to help their kids with their math homework than if they don't. (Su, 2020, p. 9)

It appears many well-intended parents are affected by lingering distaste or even fear of mathematics, likely based in their own childhood experiences that presented a very fixed mindset toward mathematics. Therefore, one avenue for increasing children's interest and potential success in mathematics is to help provide experiences for their families to encounter mathematics as it is meant to be: active, exploratory, and full of meaning and sense making.

## WHAT TYPES OF ACTIVITIES REINVENT FAMILY MATH FESTIVALS?

A few simple "pro tips" can greatly enhance the atmosphere at your reinvented Family Math Festival.

Because our festival was hosted at Hope College, we were not affiliated with a particular school or district; our goal was simply to spread mathematical joy throughout our community. As a result, we had families from many different schools across four counties register, and we thus knew planning and organization would be paramount to our success. We recruited volunteers from our faculty and student body and found it was important to assign stations to our volunteers ahead of time and provide instructions so they were prepared for meaningful engagement as soon as the doors opened. All volunteers also wore matching light blue T-shirts so that families could easily find a helper whenever needed. Colorful balloons, music playing from a family-friendly playlist, and snacks like donut holes or cookies were crucial for setting the right tone, making the festival feel more like a party than a mathematics lesson!

The heart of the festival, just as the heart of a mathematics lesson, still comes down to the quality of the mathematical tasks. Although the mathematics we explore in our classrooms may be highly engaging, meaningful, and rich in content, a great classroom task does not need to be flashy or exciting to be impactful. However, Family Math Festivals call for us to make a big splash to a broad audience during a very condensed time frame. One key to maximizing impact is choosing tasks that are "low-floor, high-ceiling"—in other words, activities that have a starting point that is accessible to young children but can be extended to challenge learners of all ages and mathematical

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doi:10.5951/MTLT.2025.0308

backgrounds. *Principles to Actions* (National Council of Teachers of Mathematics [NCTM], 2014) refers to these as tasks with multiple entry points, and combining this aspect with hands-on, physical, or even “oversized” activities can not only eliminate the fear of engaging in a mathematical activity but also enhance the festive vibe. We found that many of the activities on the Julia Robinson Mathematics Festival [n.d.] served that purpose well and are also freely available.

A Julia Robinson Mathematics Festival is designed to inspire students to engage with mathematics by providing enjoyable problem-solving activities that redefine what it means to “do math.” The Julia Robinson Mathematics Festival nonprofit organization was cofounded by Nancy Blachman and Joshua Zucker in 2007 and named in honor of Julia Robinson, the first woman mathematician elected to the American Academy of Arts and Sciences in 1984. Julia Robinson was renowned not only for her groundbreaking contributions to mathematics but also for her dedication to making the subject engaging and thought-provoking for students. The founders envisioned the festival as a celebration of mathematical exploration rather than a competition—a vision that has flourished, as shown by the growth of festivals held around the world. In a Julia Robinson Mathematics Festival, students are naturally drawn to various stations featuring colorful blocks, cups, cards, and other inviting materials. Brief instructions allow them to dive in immediately, and they often laugh and play both independently and collaboratively with their caregivers or peers. Some students may choose to explore a single activity for the entire event, while many joyfully move from station to station, eager to try everything. We now share examples of two high-energy activities from their expansive set of engaging resources.

Jumping Julia (link online) combines movement, problem solving, and pattern recognition as players move their way through a colorful 4-by-4 grid, as shown in Figure 1. Students “jump” from one tile to the next, depending on the numbers on each tile. The number that the participants land on will determine how many spaces they must jump next either horizontally or vertically in a straight line. The objective of the activity is to adhere to those jumping rules to move from the starting square and find a path that lands exactly on the “Goal” tile.

For example, on the game board shown in Figure 2, the student starts on a tile with the number 3, which means they must jump exactly three spaces to get to their next tile. The students have to decide whether to

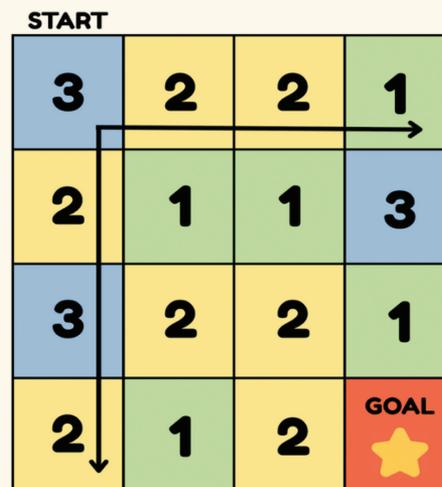
jump three spaces down to the “2” tile or jump three spaces to the right to the “1” tile. As they continue through the grid, players have an opportunity to explore a variety of different solution paths, make decisions using strategic thinking skills, and reevaluate and revise their thinking. It also allows participants to express and justify their thinking, as they can physically show how they solved the puzzle. We invite readers to take a moment and try to solve the puzzle in Figure 2 before reading on.

The Skyscrapers activity (link online) encourages spatial reasoning, logic, and persistence as players try to arrange their “buildings,” which are snap-cube

**Figure 1** Families Problem-Solving With “Jumping Julia” With the Help of Festival Volunteers



**Figure 2** An Example “Jumping Julia” Puzzle



towers of varying heights, to fit certain parameters. The basic version involves a 3-by-3 grid on which nine buildings (three short, three medium, and three tall) must be arranged so that each row and each column contains exactly one building of each particular height (short, medium, and tall), similar to a Sudoku puzzle. In addition to this, each game board has particular parameters that indicate the number of buildings that should be visible from a certain perspective. In the example shown in Figure 3, the building in the top left corner must be tall, as the “1s” on the arrows indicate that only one building should be visible when viewing either the row or column containing it. Placing a tall building in that space will hide the two smaller buildings to the right or below it. In contrast, an arrow showing “3” indicates that the shortest building must be placed in that square, as all three buildings must be visible from that arrow’s perspective. It follows that the middle row of the grid must contain short, medium, and tall buildings from left to right and the middle column must contain short, medium, and tall buildings from top to bottom. The locations of the remaining buildings can then be determined as shown in Figure 3b. Advanced versions of the game use a 4-by-4 grid and four different building heights, providing an ongoing challenge and continued engagement for Skyscraper fans! Also, check out the article “Create Your Own Skyscraper Puzzles” by Boyd et al. (2024) for ideas on having students engineer their own skyscrapers.

**ENGAGING OUR YOUNGEST MATHEMATICIANS**

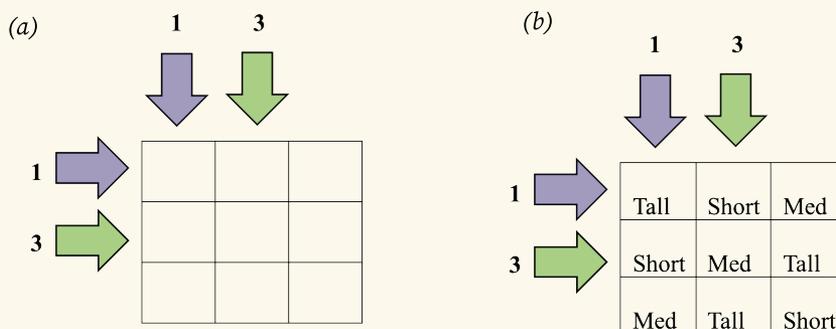
Our Family Math Festival was an early fall event, where more than half of the registrants were incoming K–1 students. Although the Julia Robinson Mathematics

Festival activities generally have wide appeal, a few of their activities may be a bit too complex to engage most 5-year-olds. Wanting to be sure these youngest mathematicians would find ample activities that appealed to them, we created some “oversized” versions of favorite early childhood games by using giant playing cards, giant ten-frames, and giant hundreds charts.

Many families are familiar with the beloved childhood game, Go Fish™. To recharge this game for our math festival, we made three major changes. First of all, we used giant playing cards to increase the playful element of the game (see Figure 4). Next, we ordered inexpensive ocean-themed plastic tablecloths to serve as our “fish ponds.” Finally, we altered the objective of the game so that players sought combinations of 10 (3 + 7, 4 + 6, 8 + 2, etc.) as their matches, as combinations of 10 form a critical facts group necessary for developing basic fact fluency (Bay-Williams & Kling, 2019; Kling, 2011). To do this, we removed the jacks and kings from the decks and designated aces as ones, queens as zeros, which incorporated practice with the combinations 1 + 9 and 0 + 10 as well. It is our hope that this supercharged version of the game will inspire families to continue playing it at home, particularly if they have children in grades K–1 where combinations of 10 and the related making 10 strategy are a major focus (National Governors Association Center for Best Practices and Council of Chief State School Officers, 2010).

Ten frames (grids composed of two rows of five squares) are also important tools for helping children learn to structure to the benchmark of 10 and are commonly used in early childhood mathematics classrooms. To integrate a physical element for our festival, we ordered large vinyl ten frames and paired

**Figure 3** A Beginning Skyscrapers (a) Puzzle and (b) Solution



them with the bean bag game “cornhole,” as shown in the middle image in Figure 4. Two teams “raced” to fill their ten frames by earning counters each time they had a successful bean bag toss into the cornhole. The game facilitator elicited mathematical thinking by asking questions like, “How many more do you need to make to fill your ten frame?”

A final example of using oversized materials to increase appeal was to use a giant hundreds chart floor mat and oversized custom dice for families to race small stuffed animals to 100 (see the image on the right of Figure 4). The dice were labeled with +10, +20, +30, -10, -20, -30 and +1, +2, +3, -1, -2, -3 so that children could notice and make use of place value patterns in the structure of the hundreds chart as they moved their toy animal. This station could easily be adapted for older children by playing addition or subtraction games designed for the hundreds chart as well.

**EVIDENCE OF IMPACT: FEEDBACK FROM FAMILIES**

The upbeat, high-energy vibe of a math festival can certainly give an in-the-moment impression of success. However, we wanted to learn more about how our participants felt about the event; therefore, as families were leaving, we asked them to complete feedback surveys. We provided children with a survey created by the Julia Robinson Mathematics Festival Organization (see Figure 5) that was based on the *Attitudes Towards*

*Mathematics Inventory* developed by Lim and Chapman (2013). Consecutive items allowed us to assess how students felt about the festival compared with their

**Figure 5** Student Feedback Survey

1. I felt comfortable trying out new ideas at today's math festival.

☹️ ☹️ ☹️ 😊 😊

2. I usually feel comfortable trying out new ideas in math class.

☹️ ☹️ ☹️ 😊 😊

3. The math festival made my brain work.

☹️ ☹️ ☹️ 😊 😊

4. Math class usually makes my brain work.

☹️ ☹️ ☹️ 😊 😊

5. I had fun at today's math festival.

☹️ ☹️ ☹️ 😊 😊

6. I usually have fun in math class.

☹️ ☹️ ☹️ 😊 😊

7. I would go to a math festival again.

☹️ ☹️ ☹️ 😊 😊

**Figure 4** Early Childhood Games Focusing on Combinations of 10 and Structure



experiences in mathematics class. Across the board, children indicated they recognized a distinct difference in these two experiences. Specifically, children reported that they felt more comfortable trying out new ideas at the math festival, rated that they “had fun” at the festival nearly a full point higher than their rating for mathematics class, and said the festival made their brain work more than mathematics class. The vast majority (77.9%) said they would very much like to come to a festival again, as shown in Figure 6.

We also created a caregiver survey that asked questions such as “Did the Family Math Festival feel like math to you?” and “Would you go to a math festival like this again?” Our analysis of the caregiver surveys also found overwhelmingly positive responses to the festivals, where only 22% of the caregivers said it felt like math, while 100% of the respondents said they would go to a math festival like this again! Below are a few responses to the question “Has this festival changed how you think about mathematics? If so, in what way(s)?”

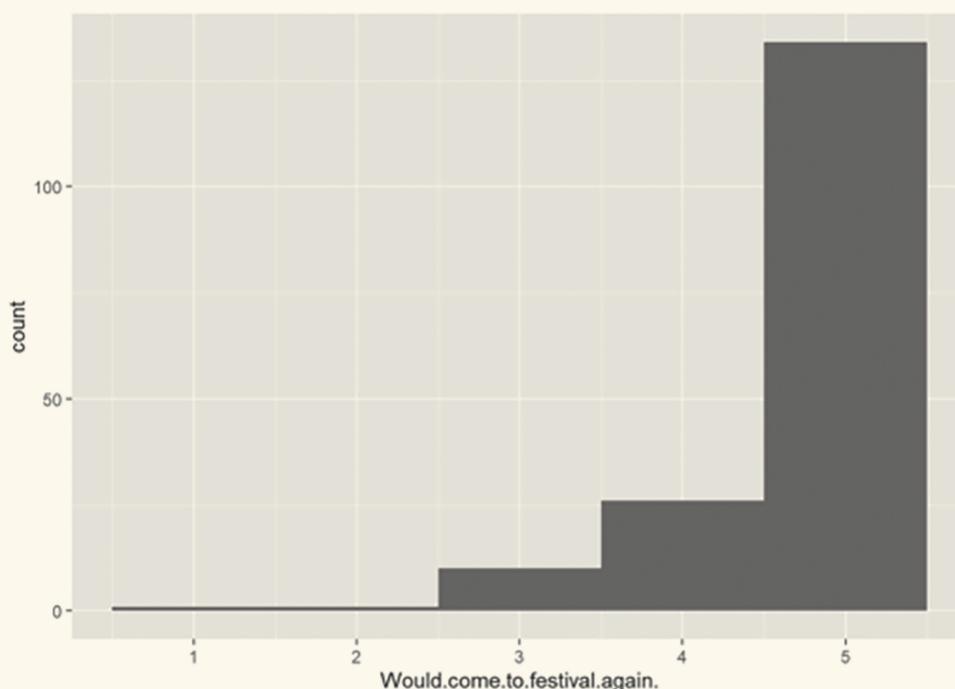
- *No, but it was very effective at making math fun for my kid (second grader).*
- *It was fun, so math can be fun!*
- *Math is more than  $+$   $-$   $x$   $\div$ .*

- *It can be about patterns as much as numbers.*
- *My son asked me how the game we were playing is considered “math” and I really had to think about that! I’m guilty of thinking of math as mostly numbers, but I know it’s more like space and shapes and how we think about things in three dimensions.*
- *I would consider getting more math games for home.*
- *Yes, math can be fun and hidden in games that my child will love to play.*
- *Yes, it was fun, interactive, and challenging but not in a way it was too hard.*
- *Yes, I wish it was frequent. Making it maybe monthly or weekly would be fun!*
- *It was fun. I couldn’t get my third-grade granddaughter to leave at 8 p.m., and we got here at 6 p.m. She loved it!*
- *It made my child feel smart.*

### EXPANDING MATH FESTIVALS TO HIGH SCHOOL AND YOUNG ADULT LEARNERS

Energized by the success of our K–8 festival, we developed two similar events for our Hope College students. We chose several activities, including Jumping Julia and Skyscrapers, to use in Halloween and Valentine’s

Figure 6 Responses to “I Would Go to a Math Festival Again”



Day Math Fun Festivals for the campus community to engage with during a free period between classes. Once again, the activities were a hit! These adult learners even expanded the Jumping Julia task to try to create their own puzzles by rearranging the mats. The open-ended nature of the Julia Robinson Mathematics Festival tasks and their ideas for expansion create plenty of potential for healthy struggle when using these tasks with older mathematics learners. Mathematics is often taught with an “obsessively numerical” focus (Boaler et al., 2016), which made the visual and tactile nature of these tasks a refreshing change for older students worn out from fixed, symbolic approaches to learning mathematics.

The engagement of our college students in the Julia Robinson Mathematics Festival tasks demonstrates the K–16 appeal of these activities, suggesting they have potential for effective use with high schoolers as well. Admittedly, hosting a Family Math Festival at the high school level is likely to face many logistical and motivational challenges, so here are three suggestions for how high school mathematics teachers might more easily capitalize on the positive impact of math festivals:

1. Have a monthly “math festival day” where one regular class period is replaced with exploration of hands-on, open-ended tasks set up in stations throughout the classroom.
2. Set up an extra desk, table, or countertop as a station with a hands-on task or puzzle. Each week, a new task can be displayed and students can wander over to explore it during work time or before or after school.
3. Work with high school students to plan and host a Family Math Festival for the elementary and middle school students in your district. The high school hosts can become “experts” on the station assigned to them, which is likely to broaden their mathematical understanding as well! This could be done as a class assignment or to fulfill volunteer requirements, such as National Honor Society.

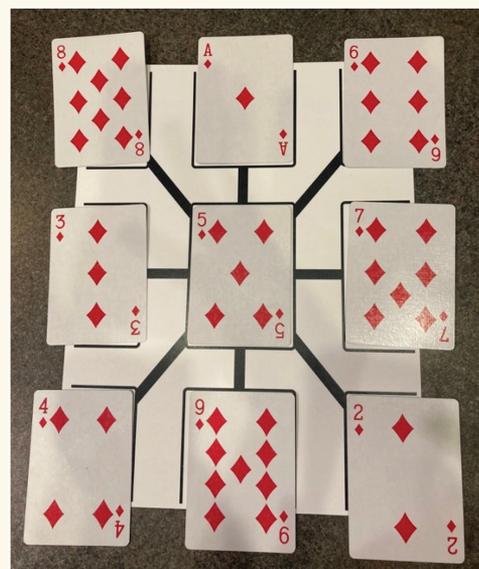
### MAKING YOUR RECHARGED FAMILY MATH FESTIVAL A REALITY

Our team at Hope College was particularly fortunate to have secured a generous grant from the Mathematics Association of America that allowed us to purchase the Julia Robinson Mathematics Festival kits. Although this

saved us time and effort when hosting our festivals, there are many low-cost alternatives that can allow you to host a fabulous mathematics celebration regardless of funding. First of all, game boards and instructions for their activities are freely available for printing at the Julia Robinson Mathematics Festival website (online).

Most of their activities use common elementary mathematics materials, including pattern blocks, snap cubes, card decks, and dice. Instead of purchasing these items, check with your elementary school colleagues to see if you can borrow them for your festival. For example, each station of the Skyscrapers game just requires sets of snap cubes of four different colors and heights, such as four red towers of height four, four blue towers of height three, four yellow towers of height two, and four green towers of just one cube. A similar game called Star Battle (link online) can easily be played with small, inexpensive beads, although it does require mats to be printed in color. In contrast, the game Magic Flowers (link online) only requires simple, black-and-white game mats and ordinary playing card decks, as shown in Figure 7. This low-cost game provides highly valuable and engaging computational practice, as students search for arrangements of cards that make the same sum in all directions.

**Figure 7** A Magic Flowers Puzzle with Sum of 15



One of the most popular activities at our Family Math Festivals has been the Jumping Julia activity shown in Figure 1. The physical nature and challenging puzzles it features captivate both children and adults, and although the colorful locking mats shown in Figure 1 are useful, the puzzles can be replicated using “spot floor markers,” or colorful, nonslip rubber circles that are commonly used in elementary classrooms, particularly for physical education. You may also be able to find inexpensive, interlocking foam mats similar to those shown in Figure 1 at home improvement stores. Permanent markers or painter’s tape can be used to create numbers for the markers or mats and can be removed later if needed. The painter’s tape can serve a secondary purpose: You can use it to create giant ten-frames on the floor and then use laminated construction paper stars to replicate the ten-frame cornhole game shown in Figure 4, using a cornhole set borrowed from a willing family in your school or community.

At the time we are writing this article, our team at Hope College is about to host our fourth community Family Math Fun Festival in just over a year, and nearly two thirds of the families registered for our latest festival have attended at least once before. Clearly, a little joyful mathematics can go a long way! As your festivals start to gain momentum, you may be in a stronger position to pursue additional avenues for raising funds. You can have a Family Math Fun Materials Drive where school parents can sign up to donate or purchase a specific set of materials for the festivals. You could reach out to community businesses to sponsor a specific game or activity at the festival (similar to how businesses might sponsor a designated hole in a charity golf tournament). A classic fundraiser

like a car wash or pop can drive can provide all families with an opportunity to contribute to the effort by donating their time rather than treasure. Finally, it is always worthwhile to check with your school administrators and support organizations like parent-teacher organizations for small grants your district might offer to teachers to launch efforts such as this.

## CONCLUDING THOUGHTS

According to McCray and colleagues (2019),

When teachers host family math nights where parents and children read math-related books, solve math problems, and play math games together, then they are giving families the tools to engage children in mathematical conversations. Parents and children can take math games and other meaningful math activities or math conversation starters home with them. These provide frameworks for home math learning that are high in meaning but low in stress. (p. 197)

Family Math Festivals are the perfect venues to provide students and their caregivers with the types of meaningful experiences needed to change the narrative of what it means to do mathematics. As Gaskin (n.d.) described it, “Math is like ice cream, with more flavors than you can imagine—and if all your children ever see is textbook math, that’s like feeding them broccoli-flavored ice cream” (para. 1). Reinvented Family Math Festivals can provide a wide variety of mathematical flavors, encouraging children and their families to develop more positive mathematical dispositions. —

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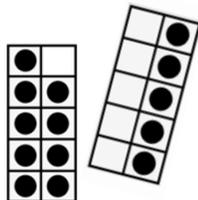
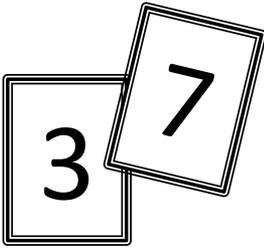
**ACKNOWLEDGMENTS**

Support for the Family Math Fun Festivals described in this article was provided by the Mathematical Association of America and the John and Mary Neff Foundation.



## Thank you for attending our Family Math Fun Festival!

Just because you are heading home doesn't mean the learning has to end! Please see the websites below for great mathematics games and activities to explore at home together!

<p>The Julia Robinson Mathematics Festival Online Puzzles <a href="http://www.jrmf.org/puzzles">www.jrmf.org/puzzles</a></p> 	
<p>Math Fact Fluency (Bay-Williams &amp; Kling, 2019) Companion Website <a href="https://kcm.nku.edu/mathfactfluency/">https://kcm.nku.edu/mathfactfluency/</a></p>  	<p>Michigan Math Essentials Early Math Games <a href="https://drive.google.com/file/d/1i3OHEic7GD5UMncyiPfPcCea89xUaIXf/view">https://drive.google.com/file/d/1i3OHEic7GD5UMncyiPfPcCea89xUaIXf/view</a></p>  
<p>Investigations in Number, Data, and Space Game Website (Grades K-5) <a href="https://media.pk12ls.com/curriculum/math/Investigations3/gamecenter/english/index.html#/Grade:1/">https://media.pk12ls.com/curriculum/math/Investigations3/gamecenter/english/index.html#/Grade:1/</a></p>  	<p>Connected Mathematics Project Game Website (Grades 6-8) <a href="https://connectedmath.msu.edu/covid-19-cmp-resources/resources-for-families/online-student-activities/">https://connectedmath.msu.edu/covid-19-cmp-resources/resources-for-families/online-student-activities/</a></p>  