# JULIA ROBINSON MATHEMATICS FESTIVAL PROGRAM PROFILE 

This is a product of the Overdeck Family Foundation funded Math ReEngagement Project that profiled innovative math programs that can be used outside the school day. WestEd conducted high-level studies of each program by administering student and teacher surveys and organizing observations and/or teacher interviews. Learn more about this work and view other profiles at: WestEd.org/MathReEngage.

The Julia Robinson Mathematics Festival (JRMF) is a math education nonprofit on a mission to help all students build confidence, joy, and a positive identity around math. JRMF does this by hosting fun math events at schools, libraries, and other community centers called math festivals.

At a math festival, students explore a variety of fun, hands-on, standards-aligned math puzzles and games. JRMF has collaborated with mathematicians and educators to ensure that every activity at a festival is both fun and educational. Every JRMF activity helps students develop problem-solving skills as described in the Common Core Standards for Mathematical Practice, including making sense of problems, finding patterns and using them to make predictions, and justifying their thinking. A math festival is a place where all students have the opportunity to develop these fundamental problem-solving skills. JRMF has purposefully curated puzzles and games to spark curiosity, encourage productive struggle through playful explorations, build mathematical understanding, and boost mathematical confidence.

Math festivals are not only for students but also for the adults in their lives. JRMF trains volunteers (parents, teachers, or older students) from the community to lead math activities and provide motivation and encouragement along the way. Parents and family members are also encouraged to explore at a math festival and are often found persevering through math challenges alongside their children. A math festival is an opportunity for the whole community to come together and celebrate the joy of math. All materials are free and accessible through the program website. The games and puzzles can be played online or printed with an accompanying facilitator guide.

## In what ways does participating in the Julia Robinson Math Festival influence student and teacher math learning and enjoyment?

The games and puzzles curated by JRMF can be integrated into regular classroom instruction and/ or used after school with caregivers. The game and puzzle database on the website is searchable for connections to grade-level mathematics and also categorizes games by the type of thinking foregrounded in the activity (i.e., logic, number, shape). JRMF provides additional resources for teachers and caregivers, offering festival guides and teacher guides that demonstrate how to set up activities to maximize students' learning and enjoyment. Through these guidelines, students, teachers, and caregivers have the opportunity to learn through playful explorations, develop their problem-solving skills, develop their fluency with numbers and operations, and enjoy doing mathematics with others.

We surveyed more than $600 \mathrm{~K}-12$ students who participated in a festival. Analysis of students' responses indicate that the festivals tend to increase students' confidence in and enjoyment of mathematics:

- Thirty-seven percent of students reported feeling more confident about their mathematical ideas during the festival as compared to their regular classroom activities.
- Forty-four percent of students reported having more fun working on the mathematics games and puzzles during the festival as compared to their regular classroom mathematics activities.
- Eighty-three percent of students said they want to attend another festival.

Each of these findings is detailed below.

## Participation in the Julia Robinson Mathematics Festival enhanced students' confidence.

Across all surveys administered, 37 percent of students said that they felt more confident about their mathematics ideas during the festival than they do in their regular mathematics classroom activities. Fifty-two percent of students reported feeling the same level of confidence, and 11 percent of students reported a decline in their feelings of confidence.

At the Cityside Elementary School (pseudonym) festival, we asked students ( $n=73$, grades 3-6) to complete a math survey related to their attitudes toward mathematics and self-efficacy approximately 1 week before a school-based festival. These students also completed a postfestival survey related to their feelings of confidence and joy. We report these findings in Table 1. The Cityside survey analysis demonstrates which students experience enhanced confidence as a result of participating in the festivals.

## Students with low mathematics self-efficacy report higher shifts in mathematics confidence than do their counterparts.

Table 1 highlights that a majority of students ( 15 out of $28=54 \%$ ) who had low mathematics self-efficacy before the festival felt an increase in confidence during the mathematics festival. As demonstrated in Table 1, the rate of students who reported being good at math and feeling less confident during the festival ( 10 out of $41=$ $24 \%$ ) was nearly the same rate as students who reported feeling more confident ( 8 out of $41=20 \%$ ). Likewise, Table 2 demonstrates that students who reported that mathematics is not difficult for them and felt less confident during the festival ( 12 out of $61=20 \%$ ) was nearly the same as students who reported feeling more confident ( 16 out of $61=26 \%$ ). In contrast, students with lower self-efficacy reported feeling more confident during the festival at more than twice the rate of reported decreases in confidence. Table 1 indicates that 15 out
of 28 (54\%) students with low self-efficacy reported increases compared to 4 students (14\%) who reported decreases. Similarly, Table 2 demonstrates that 7 out 10 (70\%) students with low self-efficacy reported increases compared to 1 student (10\%) who reported a decrease.

Table 1. Students' Change in Confidence Related to Self-Efficacy in Response to the Prompt: I am really good at math.

|  | Agree/Strongly <br> agree | Neutral/Disagree/ <br> Strongly disagree | Totals |
| ---: | :---: | :---: | :---: |
| Increase in confidence | 8 | 15 | 23 |
| Decrease in confidence | 10 | 4 | 14 |
| No change in confidence | 23 | 9 | 32 |
| Totals | 41 | 28 | 69 |

Not all students answered all questions. Blank responses were omitted from these data.
Table 2. Students' Change in Confidence Related to Self-Efficacy in Response to the Prompt: Math is very hard for me.

|  | Agree/Strongly <br> agree | Neutral/Disagree/ <br> Strongly disagree | Totals |
| ---: | :---: | :---: | :---: |
| Increase in confidence | 7 | 16 | 23 |
| Decrease in confidence | 1 | 12 | 13 |
| No change in confidence | 2 | 33 | 35 |
| Totals | 10 | 61 | 71 |

Not all students answered all questions. Blank responses were omitted from these data.
Table 3. Students' Change in Confidence Related to Self-Efficacy in Response to the Prompt: I can solve difficult math problems.

|  | Agree/Strongly <br> agree | Neutral/Disagree/ <br> Strongly disagree | Totals |
| ---: | :---: | :---: | :---: |
| Increase in confidence | 2 | 21 | 23 |
| Decrease in confidence | 3 | 10 | 13 |
| No change in confidence | 26 | 8 | 34 |
| Totals | 31 | 39 | 70 |

Not all students answered all questions. Blank responses were omitted from these data.

## Participation in the Julia Robinson Mathematics Festival increased students' enjoyment of

 mathematics.Across all of the festival surveys, 44 percent of students reported having more fun working on the mathematics
games and puzzles during the mathematics festival as compared to performing their regular classroom mathematics activities. Once again, we analyzed the responses from the Cityside festival where students took a presurvey approximately 1 week before the mathematics festival. These results indicate that the students who did not report enjoying playing math games and/or did not report that solving math problems is fun disproportionately benefited from feelings of increased mathematics joy during the mathematics festival.

## Students who do not ordinarily enjoy mathematics during class reported feeling more joy during the festival.

Table 4 shows the responses from students who reported that they ordinarily enjoy playing math games. Most students ( 51 out of $70=73 \%$ ) agreed with the statement that they enjoy playing math games, and of those students, nearly half ( 23 out of $51=45 \%$ ) felt an increase in enjoyment during the festival and the other half reported feeling enjoyment similar to their ordinary gameplay. Yet, students who were neutral or did not agree with the statement overwhelmingly reported an increase in joy during the mathematics festival ( 12 out of $19=63 \%$ ). This demonstrates that for students who do not ordinarily experience joy in mathematics, JRMF can be a way to introduce mathematics that is positive and joyful.

Table 4. Students' Mathematics Joy Related to Regular Enjoyment of Math Games in Response to the Prompt: I enjoy playing math games.

|  | Agree/Strongly <br> agree | Neutral/Disagree/ <br> Strongly disagree | Totals |
| ---: | :---: | :---: | :---: |
| Increase in joy | 23 | 12 | 35 |
| Decrease in joy | 4 | 2 | 6 |
| No change in joy | 24 | 5 | 29 |
| Totals | 51 | 19 | 70 |

Not all students answered all questions. Blank responses were omitted from these data.
Similarly, we asked students whether solving mathematics problems was fun for them. Table 5 shows similar results as students' enjoyment with math games; however, this question reveals that although many students may experience joy while
playing mathematics games, this does not translate to enjoyment with mathematics problems in general. Only 37 students (approximately 50\%) agreed that solving math problems was fun, compared to 51 students who enjoyed playing math games. Students who reported having fun while solving math problems tended to report no change in joy (23 out of $37=62 \%$ ); in contrast, students who did not report having fun while solving math problems tended to report an increase in joy during the mathematics festival ( 26 out of $36=72 \%$ ). Taken together, these results indicate that JRMF has the potential to support students to experience joy in relation to mathematics. These benefits seem to most support students who do not ordinarily have joy and fun while engaging with mathematics.

Table 5. Students' Mathematics Joy Related to Regular Enjoyment of Math Games in Response to the Prompt: Solving math problems is fun.

|  | Agree/Strongly <br> agree | Neutral/Disagree/ <br> Strongly disagree | Totals |
| ---: | :---: | :---: | :---: |
| Increase in joy | 10 | 26 | 36 |
| Decrease in joy | 4 | 2 | 6 |
| No change in joy | 23 | 8 | 31 |
| Totals | 37 | 36 | 73 |

Not all students answered all questions. Blank responses were omitted from these data.

## Students want to attend another Julia Robinson Math Festival.

At the end of festivals, we asked students whether they would attend another festival: 83 percent of students replied that they wanted to attend another festival. Another 12 percent of students were unsure, and 5 percent of students did not want to attend another festival.

Students wrote positive comments that described the festival as both fun and challenging:

I think it is so much fun doing the math problems. 3RD GRADE STUDENT
[The puzzles] weren't impossible but it made me think. . . they were all fun.

4TH GRADE STUDENT

I loved it. It was fun and I was thinking hard to solve them.

## 5TH GRADE STUDENT

Overall, students found the experience to be fun and the games and puzzles to be interesting.

## Students enjoyed encountering challenging puzzles and improving their problemsolving skills.

In the survey, we asked students to share which activity was their favorite. While every activity at the festival had at least one student note it as their favorite, four games and puzzles received more than half the votes from the students. Table 6 shows the frequency that students chose a game or puzzles as their favorite.

Table 6. Students' Favorite Game or Puzzle

| Name | Frequency |
| :---: | :---: |
| Cup Stacking | $45(32 \%)$ |
| Jumping Julia | $4(5 \%)$ |
| Apple Picking | $25(18 \%)$ |
| Domino Dissection | $18(13 \%)$ |
| Five other games / puzzles | $33(23 \%)$ |

I liked the cup stacking game because it challenged me!
3RD GRADE STUDENT
[The Konigsberg game] was my favorite because it was fun and tricky.

## 3RD GRADE STUDENT

I liked the cup game, you had to use different strategies to get all the cups.

5TH GRADE STUDENT

When students shared the reasons for their favorite games, they frequently described them as challenging and requiring strategy. In our observations of students during the in-school festival, we noted students' curiosity and wonderment as they made multiple attempts to solve the puzzles and/or win a game. Students appreciated the nonroutine and puzzling aspects of the activities, which led to enjoyment.

## Teachers recognize the benefits of students' participation in the Julia Robinson Mathematics Festival.

Overall, teachers are highly satisfied with the festival. Across several events, we asked teachers how likely they were to engage with JRMF in the future and how likely they were to encourage another teacher to use the activities.

- All teachers we asked said they would likely use a JRMF activity in their classroom.
- Nearly all teachers we spoke with said they would likely host a festival in the future. One teacher was unsure about their likelihood of hosting a future event.
- All teachers we spoke with said they would likely encourage a colleague to use JRMF activities.

Teachers were satisfied with the JRMF program and activities. The reasons for this satisfaction include teachers' observation that students were excited
and engaged by the activities and their appreciation for students' learning mathematics (particularly problem-solving) during the activities.

## Teachers recognized students experienced mathematics in new ways.

One reason that the teachers recognized the benefits of the festival is that they saw students experiencing mathematics in new ways. Teachers reported seeing students having fun and engaging in tasks more authentically at the math festival than during regular classroom activities.

> I heard many students commenting, "That was so much fun!"

4TH GRADE TEACHER

Students were engaged and excited to solve the problems. 7TH GRADE TEACHER

Festivals like the Julia Robinson Mathematics Festival will help break the barrier towards math that a lot of children develop.

COMMUNITY FESTIVAL HOST

The Julia Robinson Mathematics Festival has impacted students' perception of math greatly.

COMMUNITY FESTIVAL HOST
Teachers appreciated the problem-solving opportunities afforded by the activities.

Teachers appreciated and recognized the learning opportunities afforded by the activities. While some teachers recognized the connections to grade-level content in the games, overall, teachers appreciated the problem-solving that they saw students engaging in.

Teachers made the following remarks:
There were good opportunities to explain their thinking and reasoning.

## MIDDLE SCHOOL MATH TEACHER

Students needed to use critical thinking.

## 5TH GRADE TEACHER

We focus so much on teaching those algorithms in those processes that we kind of lose track of what math really is. Math is problem solving. They had a day where they could just figure out problems without having to worry about should I be adding or subtracting, or multiplying or, or following this step or solving this equation. In their mind, they're just playing games, but really what they're doing is problem solving.

6TH GRADE TEACHER

Not only did teachers appreciate problem-solving, they also saw that students persevered by engaging in the problem-solving process.

They had to be thinking for themselves, to try to figure things out and problem solve . . . they had to stop. They started to get a little frustrated, but really use some logic and see the patterns of what it was going to be.

## ELEMENTARY SCHOOL TEACHER

## Implications and Next Steps

Mathematics festivals hosted and/or supported by the Julia Robinson Mathematics Festival create new opportunities for students to be playful with mathematics, experience mathematics confidence, experience mathematical joy, and become mathematically curious. Time spent with puzzling problems and games leads to student learning and enjoyment and can support more students to develop positive dispositions toward mathematics!

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