

# Teaching Guide

## Our Approach

The primary goal of our events is to promote an enjoyable and meaningful experience for participants, thus helping students develop positive mathematical identities. We want children to play with mathematics the way mathematicians do, and to be successful at tackling challenging questions creatively. Play also takes mathematics to a familiar and safe space, which helps build student confidence.

## Our Facilitators

- Are respectful, enthusiastic, patient, and good listeners.
- Ask guiding questions to promote discovery, without giving away answers.
- Know when it's appropriate to give hints and when it's not.
- Help students appreciate and learn from failures.
- Encourage different problem solving strategies and techniques.
- Allow students to choose the problems they want to pursue.
- Foster collaboration.
- Ensure that students leave saying: "This was fun! I can do this!"

## The Problem Solving and Innovation Cycle

This cycle serves as a framework for solving problems and nurturing creativity. Incorporating reflection throughout each stage is an essential component that cannot be neglected.

1. **Understand the Problem:** Ensure that participants fully understand the problem. Gauge understanding with questions like: What are we looking for? What are we trying to do? Are we missing any information?
2. **Strategize:** Encourage participants to consider different strategies such as:
 

<ul style="list-style-type: none"> <li>• logical reasoning</li> <li>• pattern recognition</li> <li>• working backwards</li> <li>• using a different point of view</li> <li>• considering extreme cases</li> </ul>	<ul style="list-style-type: none"> <li>• solving a simpler analogous problem</li> <li>• organizing data</li> <li>• making a visual representation</li> <li>• trying all possibilities</li> <li>• informed guessing and testing.</li> </ul>
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3. **Implement:** Support participants as they implement their strategies, and help them reflect on their findings and observations. Remember to celebrate successes and appreciate failures. For example, if a strategy doesn't yield the desired results, ask, "What did we learn from this?" Promote the iteration of the first three stages of this cycle in pursuit of a deeper understanding of the problem, refined strategies, and implementation leading to success.
4. **Innovate:** Once a solution has been found we may ask, "Are there other solutions?" If we're certain that we've completely solved a problem—or if we seem to be making no substantial progress—we may ask, "What's next? What else can we discover? What new (and related) questions might we consider?" That is, identify the problem. Go back to the first stage. Repeat.

This document was produced by the [Julia Robinson Mathematics Festival](#) and authored by Hector Rosario, the founder of [CYFEMAT](#). Hector based this document on [his work](#) with the North Carolina School of Science and Mathematics and his math circles. The JRMF team along with Hector edited, revised, and finalized the current document.

## Interaction Guidelines for Facilitators

It is important to be aware of factors such as gender, age, disability, personality, feelings toward math, and other differences, and how these might affect participation. The following are general suggestions to foster a positive experience for everyone.

### Joy

- Instead of criticizing a comment or statement, ask, “What leads you to that conclusion?”
- When offering genuine praise and recognition, be specific. For example, “I like how you asked a simpler question.” or “I liked how you made a thoughtful conjecture, even if it didn’t turn out to be true.”
- As you handle behavioral challenges, ensure that frustration does not cause you to become negative. Always address the unwanted behavior and not the student.

### Play

- Discuss the value of productive struggle, which includes getting stuck, making mistakes, and learning from mistakes.
- Be patient when answering questions. For example, if a student asks, “Is this right?”, you may respond, “I need to look at it more carefully. Can we think through this together?”
- Do not rush participants. Let them explore at their own pace.
- If students are engaged and confident, encourage them to find all solutions to a puzzle or problem before moving on.

### Agency

- Build student agency by allowing students to choose what to pursue.
- Set a friendly and inclusive tone, and ensure that voices from females and students from underserved/underrepresented groups are heard.
- Create a welcoming environment.
- Be prepared to intervene to increase the inclusion of quieter participants. “Pedro, we’d love to hear from you. How would you approach this problem?”

### Collaboration

- Encourage participants to learn from one another by explaining their ideas to each other: “Jamie, can you explain your reasoning to Alex?”
- Encourage students to appreciate each other’s work: “Can someone share something they like about Amber’s approach?” If no student participates, model the behavior you want to see and say something like, “I’ll tell you what I like. I like that she ...”
- Encourage discussion: “Do you agree or disagree with Rahul’s idea? Why?”
- Be cognizant of those being more reticent to participate, particularly females and students from marginalized groups.

# Supporting Exploration through the Problem Solving Cycle

## Opening Questions

- What are we looking for? What are we trying to do?
- What do you notice? What do you wonder?
- What do we already know about this problem? How might we approach it?

## Questions to Overcome Hurdles or Misconceptions

- Is there anything about this problem that you don't understand?
- What do you think might have gone wrong?
- Is this a computational error or did we miss something about the problem?
- Can we approach the problem in a different way or use another strategy?

## Questions to Support Pattern Recognition

- Is there a way to organize our findings to understand them better?
- Can we ask a simpler question? What happens if we consider smaller numbers?
- Do we have enough data?
- Once a student identifies a pattern, you may ask, "Why don't you try a larger or more complex problem? Does your pattern still work?"
- Can we generalize this idea?

## Questions to Support Logical Reasoning

- Can you show why that works?
- Is there more than one solution, or is the solution unique?
- Can you prove this is impossible? Emphasize that we accept that something is impossible only when we can explain why it is impossible.
- Encourage students to make conjectures, and name conjectures after the students proposing them. For example, "What do you think of Julia's conjecture?"
- Can you think of some examples? Can you show a counter-example?
- How is this connected to previous work? Have we seen something similar?

## Questions to Foster Creativity

- How can we change this problem to make it more challenging/simple/interesting/fun?
- Would you like to try creating your own puzzles?
- What new questions arise out of this problem? Would you like to explore them?