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First Edition

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mathematics

**Jumpstarting a  
Schoolwide Culture  
of Mathematical  
Thinking  
Problems of the  
Month**

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The Noyce Foundation

# Welcome!

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**About Inside Mathematics  
and this series of  
practitioner guides**

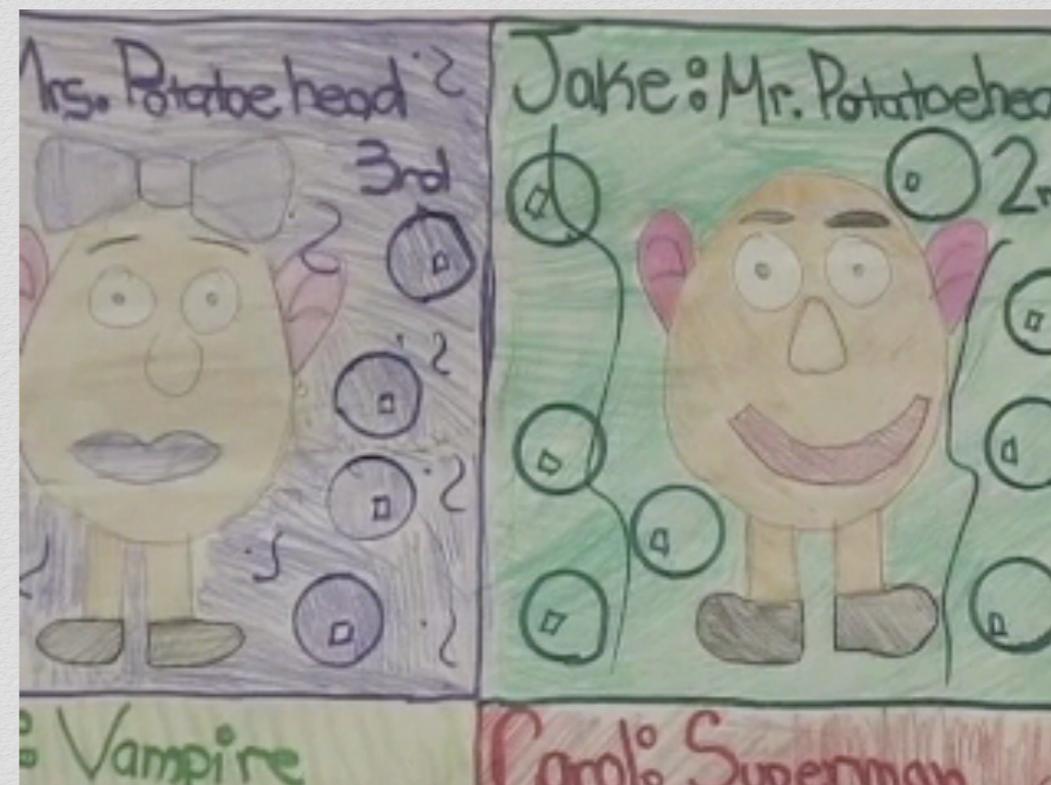
Problem solving is the cornerstone of doing mathematics. A problem that you can solve in less than a day is usually a problem that is similar to one that you have solved before. But in real life, a problem is a situation that confronts you and you don't have an idea of where to even start. If we want our students to be problem solvers and mathematically powerful, we must model perseverance and challenge students with non-routine problems. This guide will help you engage your teachers and students in problem solving in new ways. We call the tools described in this guide "Problems of the Month," and though you can choose to use them in multiple ways and various timelines, they are powerful ways to jump-start quantitative thinking and mathematical reasoning in K-12 learners.

To get started, let's imagine an elementary school. Urban, suburban, small, large— any one with hallways and bulletin boards will do. You're walking down the hallway and approach a multiage group of students gathered around student work hung on the walls. As you near the group, you see that there are kindergarteners asking questions of fourth and fifth grade students. One of the older students is facilitating a conversation. About math.

The teacher who's walking along with you, Brooke Menard, tells you that her fifth graders are explaining and defending their mathematical thinking to their kindergarten partners after both groups had worked on a complex mathematical problem for about a month. Brooke's students are ready to ask their partners to explain their thinking as well— what was challenging about this problem for them? How did they approach it?

Here, see for yourself:

## MOVIE 1.1 Anna Yates School Gallery Walk



"We all took about a month working on Problem of the Month, and right now, we're getting ready to do a gallery walk, where all of the classes that participated posted their posters around. My fifth graders are partnered up with the kindergarteners, and they're going to go around. The fifth graders are going to explain what they did in their process of thinking with the posters and then the kindergarteners are going to explain what they did to my fifth graders. My fifth graders have a list of questions they could answer if they want, on sticky notes, all the 5<sup>th</sup> graders have four sticky notes. Along with their kindergarten partners, they'll go around, and put, maybe, looking to see how students were thinking about the math: what was challenging, maybe, about the math, or something that they really thought, maybe they got a different answer than the poster did. They'll write it on a sticky note, why did they get that, or how did they get that-- different things like that, and they're going to be working together."

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What's notable here is how the faculty have structured ways for multiage groups of students to engage with each other around the exchange of mathematical ideas. These habits of mind are those that advanced mathematicians regularly draw on; if your state has adopted Common Core State Standards, you'll observe that the students are demonstrating many of the Common Core Standards for Mathematical Practice (<http://www.corestandards.org/Math/Practice>), especially CCMP1, making sense of problems and persevering in solving them, and CCMP3, constructing viable arguments and critiquing the reasoning of others. Teacher Brooke Menard hasn't stated them explicitly to her students, but they are emerging from the task. That's the goal of Problems of the Month: to create authentic scenarios around which to engage students in collaborative problem solving and mathematical reasoning.

This guide will help you get your school started with one of the most-accessed resources on Inside Mathematics: The Problem of the Month (other guides are planned to help facilitate and extend practitioners' work through models of coaching, re-engagement, and other important foci.) We'll take you through:

- What a Problem of the Month is, how they're constructed and how they align to content and practice standards;
- What POMs imply for teachers' work in assessing student mathematical thinking;
- How POMs develop students' abilities to use and interrogate multiple representations of mathematical concepts;

- How POMs foster mathematical discourse and collaboration in children and teachers; and
- Evaluating the impact of Problems of the Month.

Throughout, we'll link directly to videos of POMs in action, professional development resources, and reflections by practitioners about their experiences with Problems of the Month. Let's get started!

# Who is this book for?

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This guide is intended for educators, particularly those who mentor and guide other teachers.



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So: why write this book for school leaders, teacher mentors, and district administrators? Isn't the responsibility for teaching mathematics squarely in the domain of classroom teachers' work? Isn't "math time" best organized by grade level, by textbook chapter sequencing, by accountability to standardized tests, by time of day?

No. But also: that sure seems like the way we usually do it.

Teachers are critically important in developing children's quantitative literacy, to build learners' capacities to ask good questions and find innovative answers to real-world problems through adroit manipulation of numbers, just as language arts experiences prepare them to engage with written text. But too often mathematics teaching and learning are experienced by teachers and children alike as disconnected from "real life," as uninteresting, as fast and broad instead of deliberate and deep. Who wants to teach that way? No one. And yet, lots of teachers do.

As a result, it's no big surprise that as a nation, we don't do as well as we should in international comparisons of student mathematics performance. And of course, it's worst for kids and teachers working in high-poverty and high-violence communities. But this is not intended to be a hand-wringing discussion of the latest PISA<sup>1</sup> results nor a high-level interrogation of societal inequities that need to be solved before any improvement can take root; this is intended to reconnect you, and the teachers around you, to the kinds of teaching and learning we entered this profession to make happen. We're particularly concerned about high-level mathematics teaching and learning.

You can surely recall some of the most inspiring moments of your career as an educator: the teacher and students alike sparking insights in each others' thinking, collaborating, seeing something a new way, finding a

touchstone moment and diving in to deep learning, experiencing flow. We carry those moments with us, and they fuel us during times when public discourse, day-to-day challenges, or external pressures threaten us with burnout. It's important to get through each day - week - month - school year, but it's also important to strive toward improvement.

We, the authors of this guide, have worked with all different kinds of teachers: those just beginning their coursework toward an initial teaching license, those with thirty or more years under their belts, and everyone in between. Not one of those people wants to be a mediocre teacher. But sometimes someone can't quite articulate a clear path to improve their teaching. That's where the role of the teacher leader, principal, coach and mentor, or district administrator comes in. You can be the key to jumpstarting school-wide conversations and collaborations around mathematics. You can offer a clearer path, by inviting your colleagues to join in a school-wide initiative to develop children's mathematical thinking.

### **About InsideMathematics.org**

Over the past several years, we have worked with the Noyce Foundation to create Inside Mathematics ([www.insidemathematics.org](http://www.insidemathematics.org)). As of this writing, tens of thousands of educators access the resources on that website every week. That's a lot of reach! But it's still important for us to try to extend that reach into impact. So this guide is specifically for the use of educators charged with leading, developing, and coaching other teachers.

Inside Mathematics offers many different resources for educators and parents: assessment guides, coaching supports, mathematical tasks and sets of student work samples, and more. We've found since launching

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Inside Mathematics that educators are eager to explore these resources for different purposes: some are looking for materials they can use in their classrooms immediately, others are looking for accomplished practices modeled by experienced practitioners, still others are seeking to extend and deepen their understandings of the Common Core content and practice standards.

There are also various ways in which educators are accessing these materials— some explore as individuals. Others gather together in grade-level groups. Professors of teacher education incorporate these resources in pre-service teacher preparation settings. State departments of public instruction link to the site to support curricular and pedagogical standards. But as with all educational improvement efforts, we know that the most traction happens in schools and classrooms. With particular educators deciding to do things differently to meet the learner needs identified in their setting.

At this point, you might be feeling uncomfortable. While you have experience in teaching and in mentoring and guiding other teachers, you might not see yourself as a “Math Expert.” And you wouldn’t be alone. Multiple studies of teacher efficacy in mathematics have shown that the majority of elementary and middle school teachers feel more comfortable teaching language arts than mathematics. Jo Boaler, in her engaging and accessible 2009 book *What’s Math Got to Do with It?* describes a vivid contrast between how mathematics has traditionally been taught in K-12 schools and the contemporary world of work of professional mathematics. She writes:

*“Mathematics is a performance, a living act, a way of interpreting the world. Imagine music lessons in which students worked through hundreds of hours of sheet music, adjusting the notes on the page, receiving*

*checks and crosses from the teachers, but never playing the music. Students would not continue with the subject because they would never experience what music is. Yet this is the situation that continues, seemingly unabated, in mathematics classes. Those who use mathematics engage in mathematical performances. They use language in all its forms, in the subtle and precise ways that have been described, in order to do something with mathematics. Students should not just be memorizing past methods; they need to engage, do, act, perform, and problem solve, for if they don’t use mathematics as they learn it, they will find it very difficult to do so in other situations, including examinations” (p. 29).*

Imagine, then, what the learners in your setting might feel like if they could experience mathematics not as a time-bound and high-stakes receptive learning experience, but as a performance, as a joy, as an active and playful engagement with conceptual rigor. That’s what we aim to develop with the Problems of the Month.

You might not have a degree in mathematics. You might not have a high level of facility identifying essential questions for particular math concepts. But you know teachers, and you know teaching. You don’t have to (and in fact can’t) be an expert in every concept taught by the teachers with whom you work, just as a symphony conductor doesn’t have to be a virtuoso in every instrument. But a conductor launches the performance, sets the tone and tempo, and brings in the various musicians to express their interpretations of the score. If you lead like a conductor, then your whole community gets to experience what the practice of math can be like— identifying patterns, recognizing and repeating reasoning, engaging in spirited exchange of ideas and testing of strategies.

Modeling how to grapple with struggle is essential; administrators, teachers and parents can facilitate and support students in the process of at-

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tacking and reasoning about problems. In doing so, the solution is not as important as the process of problem solving. Struggling to get started is a natural part of learning to problem-solve. In fact, encouraging and supporting the struggle with some frustration is exactly what the student needs. A good problem-solver tries, fails, reevaluates, and tries anew. The same is true of school leaders and teacher mentors.

# The Structure of a Problem of the Month

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How to read and begin with the Problems of the Month.



Each Problem of the Month is constructed around a central theme or idea and has five levels, A through E. The Level A problems are intended to be the most approachable, which is not to say they don't require consideration, even for advanced students. Level A sets an important baseline for subsequent levels. Each learner should begin with Level A, and move on to other levels after presenting, explaining and defending their thinking.

### Levels of a Problem of the Month

Let's begin by looking at "Party Time," the Problem of the Month used by the faculty of the Anna Yates School.

#### MOVIE 3.1 Faculty Discussion of "Party Time" POM



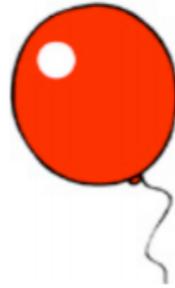
"First, can you tell me why you chose the Problem of the Month that you did?"

While one teacher jokingly describes their rationale as "Who doesn't like parties?" it is important that teachers and children alike feel a sense of authenticity and connection to the central premise. Sixth grade teacher Anthony Rogers observes that "students can use visual models with it." This engagement serves as the hook: "How many of you have been to a party?"

In this Problem of the Month, students use mathematical concepts of logic, deductive reasoning, counting principles/strategies, and a variety of mathematical representations such as tree diagrams, Venn diagrams, tables, charts, and matrices. In Level A, the scenario involves inviting friends to a party, each of whom in turn invites others, and those others still more (note that "Primary Version Level A," located at the end of the Problem of the Month, provides an approach through which teachers can engage pre-literate students conversationally with the problem). Students must create representations to show how many people are at the party in the end. In their thinking, students might seek out the "right answer," showing their CCMP6, Attend to Precision, as well as CCMP4, Model with Mathematics. How can they determine how many guests are at the party without drawing each guest? What structures help them represent and defend their model?



## Problem of the Month Party Time



### Level A

Cindy had a party. She invited two guests. Her guests each invited four guests, and then those guests each invited three guests.

How many people were at Cindy's party?

Explain how you determined your solution.

In Level B, students are asked to use partitions and simple fractions to determine the number of girls with short red hair at a party given a set of clues.

### Level B

At Leslie's party  $\frac{1}{4}$  of the people had long hair. One half of the people at the party were boys,  $\frac{1}{4}$  of the girls had short blond hair. None of the boys had long hair.

If there were 32 guests, what is the maximum number of girls who could have had short red hair?

Show how you determined your answer and why you know you have a correct solution.

In Level C, students again work through a logic problem, using a set of clues about names, costumes, and time of arrival at the party to match each person accurately.

### Level C

Mia, Jake, Carol, Barbara, Ford and Jeff are all going to a costume party. Figure out which person is wearing what costume and when they arrived at the party.

- The person that arrived fourth was wearing bathing suit.
- Barbara was the last to arrive.
- Jake and Mia arrived and stayed together.
- The first person was dressed as a French Maid.
- Superman arrived right before Barbara.
- The Potato Heads were always together at the party.
- Ford was a Surfer Dude.
- The French Maid was not Carol.
- The Vampire arrived after Superman.

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In Level D, students are asked to determine when a party game is fair for both players, justifying and explaining their findings.

### **Level D**

Your Aunt is having a baby. You have created a party game for a baby shower. It is called pick the gender. You put pink and blue tiles into a bag. You ask two guests to pick one tile out of the bag without looking. You tell your guests that if they are the same color, player A wins and if they are two different colors, then player B wins.

How many tiles of which colors did you put into the bag to make sure that both players have an equal chance of winning?

Explain your solution and why it is fair.

In Level E, students are asked to solve a complex logic puzzle, defend their solution and explain how they solved the puzzle.

### **Level E**

A man and his wife invite 5 other couples to a dinner party. As the guests arrive for drinks before dinner, they shake hands. Not everybody shakes everybody's hands, and of course no one shakes hands with his own spouse. Later, as they sit down to dinner, the host asks each other person, including his wife, "how many hands you shake?" He notices, to his surprise, that each respondent shook a different number of hands.

How many did his wife shake?

Explain your solution and justify your reasoning.

You can see in these examples that the complexity of the problems increase over time, but all involve the same central idea— understanding relationships and possible connections between items in a set.

### **Comparing Different Problems of the Month**

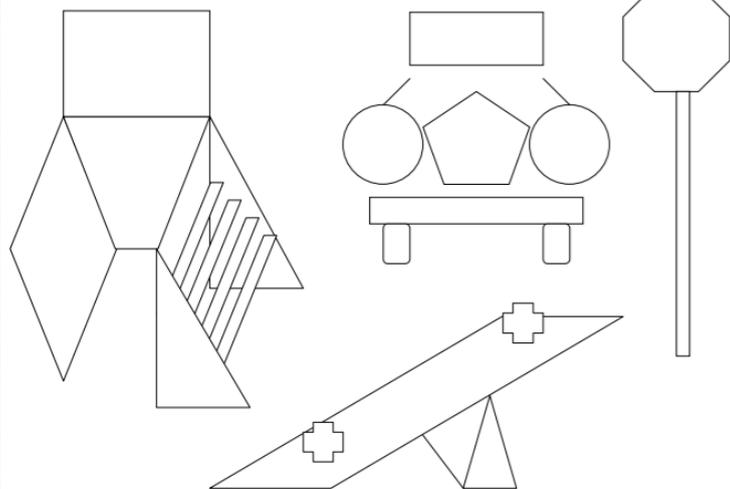
To compare these leveled structures, let's look at Level A in two different problems, Party Time and The Shape of Things, a POM focused on geometric thinking and reasoning.

In Level A, both Party Time and Shape of Things establish an important ground level for the thinking and reasoning to follow. In each, the ideas and quantities are accessible to even the youngest learners. Neither relies heavily on disciplinary academic language, unlike the more advanced levels. But for older learners, the nature of what constitutes a high quality explanation in determining the solution could be very cognitively intensive.

The Problem of the Month  
**The Shape of Things**



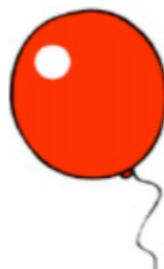
Level A:



Examine the scene of the playground above. There are a lot of different shapes that make up the toys and play-equipment. Name, draw and describe clearly all the shapes you can see in the playground picture.



Problem of the Month  
**Party Time**



**Level A**

Cindy had a party. She invited two guests. Her guests each invited four guests, and then those guests each invited three guests.

How many people were at Cindy's party?

Explain how you determined your solution.

In the more advanced levels, command of mathematical academic language becomes more essential (e.g. equally, hexagon, opposite; justify, reasoning, conjecture). The lexile level is much higher, and there are multiple pathways to reasonable responses. They require higher-order thinking skills: analysis, evaluation, conjecture. But the structure of the problem is still related to real-world scenarios, specific approaches for setting up the problems are inexplicit, and the students must extract the mathematics from the event described.

**Level E:**

Laurie and Kristina wanted to share a cake equally. The cake was in the shape of a regular hexagon. Kristina said, "There are two ways to cut the cake to make equal size pieces. Either cut from one vertex to the opposite vertex or cut from the midpoint of one side to the midpoint of the opposite side. Those are the only two ways to make one straight cut and have two equal size cakes." Laurie said, "No, there are other ways to make one straight cut and share the cake equally besides your two ways." Who is right?

Prove your findings. If Kristina is correct prove why the two ways work and why there are only those two ways. If Laurie is right, state the method(s) for cutting the cake equally and prove your conjecture.

**Level E**

A man and his wife invite 5 other couples to a dinner party. As the guests arrive for drinks before dinner, they shake hands. Not everybody shakes everybody's hands, and of course no one shakes hands with his own spouse. Later, as they sit down to dinner, the host asks each other person, including his wife, "how many hands you shake?" He notices, to his surprise, that each respondent shook a different number of hands.

How many did his wife shake?

Explain your solution and justify your reasoning.

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So when a teacher approaches this, it's important to understand where the POM begins and ends, what kinds of thinking are involved for learners, and what different methods of engagement might work for the climate and culture of the classroom.

Each Problem of the Month on Inside Mathematics is preceded by a one- or two-page explanation of the key mathematical ideas of the problem, as well as how they align with content and practice standards. This section can be used as an abstract, to help teachers quickly skim and determine whether a particular POM is a good match for the current ideas being explored in class, or a good way to deepen student understandings of a challenging set of concepts.

On the Inside Mathematics website, the POMs can also be searched by mathematical concept or progression, such as Counting and Cardinality, Measurement and Data, Functions, Geometry, and so on.

### **Alignment with Standards and Frameworks**

All of the Problems of the Month available on Inside Mathematics have been aligned with Common Core State Standards for mathematical content and mathematical practices. Because of the multi-leveled nature of each POM, students may not remain in their grade level content standards, but may go far beyond, just as older learners may find “beginning” POM levels challenging because of the ways in which they are expected to show their thinking processes. These multiple levels and access points provide an opportunity for teachers to explore the connections between the conceptual progressions (like Number and Operations, or Measurement and Data) and help the students see connections between their work at their grade level, and either more advanced or less advanced linked concepts in the adjacent grades.

Additionally, all of the POMs have been aligned with the Common Core standards for mathematical practice, which represent the "habits of mind" of college- and career-ready quantitative thinkers. The CCMP represent a significant area of learning for learners and teachers alike; historically, our mathematics teaching and learning has been lopsided, emphasizing some mathematical practices over others. If your teachers, for example, have spent more time helping their students "attend to precision," you may find that they need support in helping their students model with mathematics, or make sense of problems and persevere in solving them, or express regularity in repeated reasoning. The problems of the month all address more than one mathematical practice because of their structural design.

# Engaging Learners in Problem of the Month

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**Problems of the Month  
work best in classrooms  
where learners are actively  
engaged in mathematical  
thinking and discourse.**

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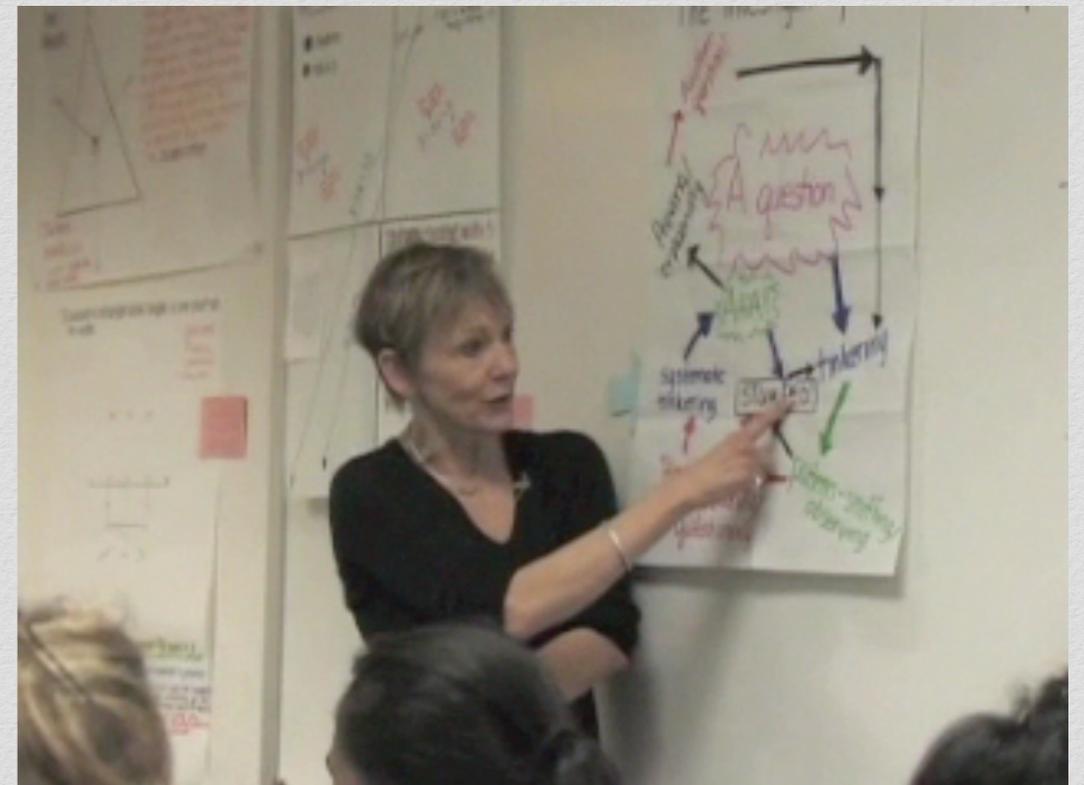
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While the structure and nature of the Problems of the Month are designed for quick uptake by multiple audiences, they work best when teachers understand effective methods of engaging children with deep mathematical thinking. So they aren't a set of worksheets that can be quickly moved through and beyond. Each is intended to engage students in considering their approach to problem solving, trying out ideas, persevering when they reach inevitable moments of challenge, and so on.

Cathy Humphreys, whose high school students engage with one level of "The Shape of Things" POM on Inside Mathematics, makes this process explicit to her students. She calls it "The Investigative Process," and refers to it to remind her students that if they can immediately envision an answer to a problem, then "it's not a problem for you." However, if they collectively grapple with mathematical investigations, key components of the process include "tinkering," "STUMPED!" and "AHA!"

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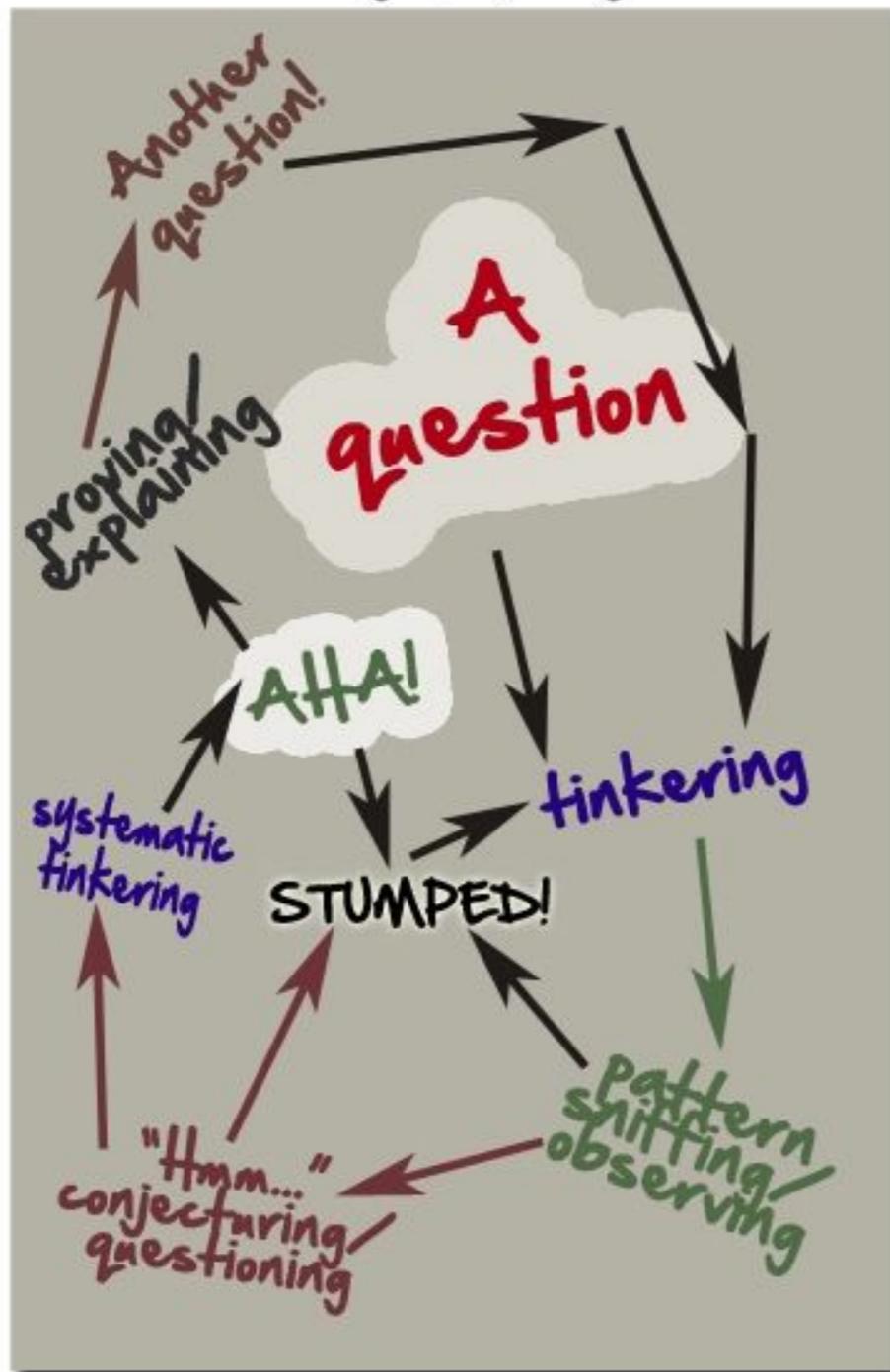
## MOVIE 4.1 The Investigative Process



Cathy Humphreys reviews the norms for group problem solving.

# The Investigative Process

Cathy Humphreys



This same engagement should be true of teachers. If you use the Problem of the Month through a “teach and move on” approach, you’re missing the complexity of Humphreys’ investigative process. But if you, your colleagues, and your learners engage with the POMs through tinkering, pattern sniffing, conjecturing and questioning, systematic tinkering, and so on, they and you will gain a great deal more out of the experience. So using the POM you choose, be prepared to engage and re-engage yourself and your learners with the central ideas. What patterns exist? What methods of trying out solutions work well for your learners? What can you do when you move in one instant from an “AHA!” to “STUMPED?”

One way that teachers can model this repeated engagement is through using the various levels of the POM formatively. They might give their students one level to work independently or in groups. You and the classroom teacher might then evaluate the students’ work, discuss commonalities or interesting differences, and then re-engage the learners with the task. The classroom teacher can then present two different approaches, and ask the class as a whole to evaluate what each person or group might have been thinking. The teacher can ask: “What was Learner/ Group A’s approach? How about Learner/ Group B? What would be your recommendations to them about their next steps?” The students can then return to the same task, with a greater level of clarity about their own focus and process.

To get started with the Problem of the Month, you might facilitate a faculty discussion how to engage learners with the key idea. (Remember the faculty from Anna Yates school, “How many of you have been to a party?”) Teachers can identify ways of explaining the essential concept or idea for the problem of the month in kid-friendly language to their

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learners, which is stated on the overview page, and describe for them the scenario in Level A.

Various first questions used by the faculty documented on Inside Mathematics include “What information is important here?” “What is this problem asking us to figure out?” and “What should we do first?” In your conversation with faculty, you can engage in these same questions. To fully engage as many participants as possible, you might use varied participation structures— a good resource for modeling high engagement with learners is the New Teacher Center’s Oral Language Development website (<http://old.newteachercenter.org/>).

Without evaluating these ideas, gather as many as possible, post them where all can see, and then orient the students to work together on the task. If the group is small or the learners are young, a whole group configuration might work well. Many of the teachers on Inside Mathematics have the students work on POMs in small groups of no more than four. It helps to have the group generate norms for working well in groups (Tahedah Wren’s 5<sup>th</sup> graders use “six inch voices”), so they feel accountable to each others’ right to a peaceful work environment.

# Fostering Mathematical Discourse

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What do learners sound like when they speak like mathematicians? How do effective small groups engage in the Problem of the Month?

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In traditional mathematics classroom settings, it is very common for the majority of math talk to be done by the teacher. One of the signature features of the Problems of the Month, however, is that the majority of the talk is designed to be engaged in by students. To be sure, the teacher is responsible for launching, describing and orienting groups of students to their work, however at that point the students' responsibility for facilitating the group process takes over. In mentoring and supporting teachers, it's critical to help them make that shift to eliciting more mathematical thinking and discourse from the students.

### **Attending to Precision**

CCMP6 addresses the importance of communicating precisely and clearly to others. Students need to understand key terms in order to make themselves understood. You can help your teachers ensure that students can use each term appropriately and post a visual definition to support their independent work. This might mean engaging faculty in conversations around mathematics word walls: what would a word wall look like in first grade? In eighth? What kinds of sentence stems might teachers want to post to help students interrogate each others' thinking? Encourage your teachers to consider not only content vocabulary ("equal," "hexagon") but process language as well ("analysis," "explanation," "conjecture.") Ask teachers and learners: What would we hear in a room where mathematicians are doing their work? How do mathematicians communicate so that they understand each others' thinking and build better ideas? What are criteria to decide if an explanation is "carefully formulated," as CCMP6 requires, compared to one that is less so? You can work with your teachers to create and share anchor charts or sentence stems ("I think that there are \_\_\_\_\_ people at the party be-

cause....") to help students understand high standards of mathematical talk and explanation.

### **Using Non-verbals**

It's also important to consider the role of non-verbal behaviors in a group discussion, and the role not only of avoiding negative non-verbals, but developing positive non-verbals. Some of your teachers might already have robust practices for non-verbal engagement practices. If so, they should model them, actively involving their colleagues in a simulation. If not, you might encourage them to watch some of the InsideMathematics videos together, picking up on the ways the learning environment and behavioral expectations are modeled for the students.

Mine these perspectives and practices from your teachers so that they can move from classroom to classroom. In some of your teachers' rooms, If a child needs more time in thinking, other students might encourage them to persevere through a nonverbal "keep going" hand motion (some use a fist-over-fist roll, or pushing two fists with thumbs touching each other away from the body, the ASL sign for "persevere."). Other nonverbal signals used by your faculty might include a quick check by the teacher to see where students are in their process and understanding, having students indicate with a thumb at an angle their relative confidence with the concept. In this conversation, experienced math teachers discuss how important the role of nonverbals can be both in whole group and small group math work. In faculty discussion, ask What kinds of ways do we learn how fully students feel they understand the material, and how frequently are we able to check in with them? Can the students use these nonverbals with each other in group settings?

## Modeling Group Work

If your school's students are not accustomed to extended small group work, the teachers need to help students build that capacity. That may mean engaging them in "fishbowl" conversations, where the majority of

### MOVIE 5.1 Taheedah Wren's Gr. 5 Group Work



Fifth graders work on multiple levels of "Party Time" POM.

students act as observers for a small group discussion, afterwards debriefing their process. Teachers might provide different roles for particular students to assume during a group's work. Such roles might include questioner, resource manager, facilitator, and so on. The level of sophisti-

cation of math talk of course is developmental, so while all students benefit from modeling and explicit descriptions of expectations, younger

### MOVIE 5.2 Anthony Rogers' Gr. 6 Group Work



Sixth graders work on three levels of Party Time.

learners will also need more time to integrate group work expectations.

## Managing Multiple Groups' Work

Because of the design of Problem of the Month, it is possible and even probable that different groups of students may be working on different levels simultaneously. In Taheedah Wren's fifth-grade classroom, for ex-

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ample, she facilitates groups working at two different levels. Ask your faculty: what questions can they ask of groups to quickly get up to speed on what the group is tackling at that moment? How can they leave the group with a concrete next step that will allow them to work independently?

In her colleague Anthony Rogers' sixth-grade classroom, the students are working on three different levels. This is not to say that younger students cannot proceed beyond the initial Level A of any given POM, so early grade teachers should be prepared to support younger learners in going beyond the first level of the problem.

In opportunities for students to exchange their ideas with each other, like classroom visitations and collaborations between two or more classrooms (as in the Vallemar School example) or a Gallery Walk (as in the Anna Yates School example), showing multiple classrooms' work posted publicly, in the cafeteria or auditorium. Both honor the students' thinking and engage others in interrogating the work produced during the Problem of the Month. Your teachers can collaborate to design different ways for students to share their work that will be responsive to the dynamics of your school setting.

# Evaluating Impact



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How do you know if the  
Problem of the Month is  
making a difference?

As we've reinforced throughout this guide, it's critical that school leaders lead by example. If you embrace the concept of problem solving and model problem solving leadership, being a facilitator of non-routine problems, then others will be more likely to opt-in to a reconsideration of their practices. Begin by facilitating a session with the teachers in which they explore the POM prior to presenting the problem to the students. Invite

### MOVIE 6.1 The Principal's role



Principal Jaguanana Lathan reflects on faculty work to create a schoolwide climate supporting math teaching and learning.

them to use the same Investigative Process Cathy Humphreys uses with her students.

Once the problem is presented to the students, the teacher leaders/ mentors/ principal should be visible in facilitating the tasks alongside the teachers. Visiting and/or leading a class as students share ideas and approaches with the other students encourages and empowers both teachers and students. The principal or instructional coach can also play a role in examining the student products with their teachers.

### Evaluating Impact

So how do you know whether the Problem of the Month is making a difference in your school community? In this era of “data-informed” instructional decision making, it's important that we think about what kinds of data might be relevant to answer that question. Because the POMs are intended to engage students across grade levels, it's not a simple task to clearly link one POM to one grade level content target. Instead, these are robust opportunities to engage your school's learners in doing math together, modeling and gaining experience in the mathematical practices used by advanced mathematicians. This is critical for school leaders to understand, because (rightfully) teachers may feel strong allegiance to content learning targets, and feel that any deviation from them will mean a challenge to pacing standards in place.

Similarly, it's important not to expect that every child in a classroom will reach the same level. The depth of student thinking and the ways in which they engage in defending their strategies is more important than how quickly they move from Level A upwards. In fact, the last thing we want to do is communicate that all students should be able to “hit” level B, for example. Active engagement in mathematical thinking is the goal.

It may be that by developing your school's engagement in mathematical practices that it will have an impact on quantitative measures of content.

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But this is more likely to result from students' increased thoughtful engagement, their increased perseverance, than any one content area uptick. So what we traditionally think about as valued "data" in a school setting may require some critical reconsideration. It's also important to consider different forms of data that might not be as visible on those assessments, particularly those having to do with habits of mind or mathematical practices. Measures around school climate and culture might also be important to your site, as Anna Yates Principal Lathan described.

You might consider measuring and evaluating students' capacities to work together, to persevere, to identify a productive starting point. If so, then focus groups or interview protocols might be a good tool for data collection. Or if social-emotional outcomes are of interest, teachers might use a similar observational protocol to note how students' responses to challenging work evolve over time. Angela Duckworth's work on "grit" and self control are thought-provoking-- how might your learners (and teachers!) respond to affinity scales like "I have overcome setbacks to conquer an important challenge" before and after work with Problems of the Month? Or how might you measure pre- and post-POM effects on your learners' capacity to identify key features of a problem?

Your colleagues are assets in this process. Engage them in identifying: "What are we curious about? What do we hope will happen? What do we worry will (or won't) happen? Are there interesting individuals or groups we want to pay close attention to during this process? What will we listen for to see if students are persevering, or critiquing each others' reasoning? What data gathering methods or needed supports might help us best find out what difference this process is making? How are we going to track and share our noticings along the way and new questions that arise?"

Once you have group consensus around those questions, you can identify faculty who feel like they have preferences for gathering different kinds of data and interrogating them for impact. You can set benchmarks for sharing back, and then together chart a course for your school's work with Problems of the Month.

### **Involving the Community**

You also don't have to only include the teachers and learners in this process. How might you engage parents and caregivers? Or district or state-level administrators, elected officials, policy-makers? Might they enjoy working the Problems of the Month at home? Bringing in and sharing their work with each other at a Saturday morning "pancakes and problem-solving" celebration? What ways do you already communicate with families, and how can you further strengthen those processes? What would your school community look like if mathematics becomes something we perform together?

Remember, you're the conductor of this orchestration. What do YOU want the symphony of quantitative collaboration to sound like? We look forward to learning from you how your work to implement Problems of the Month unfolds!

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## MOVIE 6.2 Epilogue: POM Essential Ideas



*Overview of POM to share with your faculty colleagues*