

Performing Mathematics



A Guide for Teachers & Students

George Gadanidis

Faculty of Education, University of Western Ontario

Janette Hughes

Faculty of Education, University of Ontario Institute of Technology



Table of Contents

Introduction	2
Context	2
The beauty of mathematics	3
A public celebration of mathematics	3
The 2008 Math Performance Festival	4
How to participate in the Math Performance Festival	4
Ideas for teachers	
How to write and perform a math poem	5
How to interview a math concept	6
How to perform a math problem	8
How to organize a math performance festival at your school	11
References	12



Introduction

The writing of this booklet is motivated by the 2008 Canada-wide Math Performance Festival for grades 4-6 students (<http://www.mathfest.ca>), sponsored by the Faculty of Education (<http://www.edu.uwo.ca>) at The University of Western Ontario, the Fields Institute (<http://www.fields.utoronto.ca>) and the Canadian Mathematical Society (<http://www.cms.math.ca>).

The Canada-wide Math Performance Festival is a celebration of young students', and teachers', mathematical imaginations. The Festival is a way of helping change the face of mathematics across Canada, by seeing it through the wonder-filled eyes and inquisitive minds of young mathematicians.

This booklet will help you and your students create math performances and also organize a Math Performance Festival in your own school.

Context

Mathematics has an image problem. As one prospective elementary school teacher commented, "Math is like an iguana. As long as it blends in its environment I don't mind it. But if I have to hold it, I'm not so fond of it." Another prospective teacher put it more bluntly: "I hate math!"

Most people in our society avoid mathematics. Mathematics is rarely shared or discussed outside of mathematics classrooms or communities of mathematicians.

Can you imagine people discussing mathematics with their family and friends? We can. And this booklet will help us start making this a reality.



The Beauty of Mathematics

In contrast to its public image, mathematics has a distinguished history of association with the sciences, the humanities and the arts. Mathematics is a fully human and a wonderfully beautiful experience, as noted by the following mathematicians.

Gilbert Labelle, Université du Québec à Montréal:

I like mathematics because it is beautiful, full of surprises, gives me complete freedom of thought and, at the same time, it can be applied efficiently to solve problems in science and society.



Art and mathematics are similar in that they both use human imagination and skill to combine things to create new things.

Nathalie Sinclair, Simon Fraser University:

I like mathematics because it so often shows how one small change, like transforming an equation, introducing a new dimension, or seeing a different representation can give you a whole new feeling of how something works and how it connects to other things that we do or think about. I like the feeling of understanding something, seeing new connections, and of being able to admire the creativity of other mathematicians.



I love how excited students can get about mathematics, how many of the topics can transform the way they think about or see things.

A Public Celebration of Mathematics

How do we change the public image of mathematics? How might mathematics re-invent itself in our society as the beautiful, artistic and fully human experience that it really is?

A powerful way for our society to experience and celebrate the beauty of mathematics is to see it through the wonder-filled eyes and inquisitive minds of young mathematicians.

This is where the Math Performance Festival comes in!



The 2008 Canada-wide Math Performance Festival

The Math Performance Festival is a Canada-wide forum for sharing and celebrating the mathematical performances of grades 4-6 students and teachers.

Students and teachers are invited to submit performances in digital form using the Festival's online portal, until June 30th of 2008. They may also decide to enter their performances in the Festival's Contest. The adjudication committee for the Contest includes the following:

- **Susan Aglukark**, singer, songwriter, 3-time Juno Award recipient, Officer of the Order of Canada award in 2005.
- **Tracy Bone**, singer, songwriter, "Best Female Artist" of the 2007 Canadian Aboriginal Music Awards.
- **Douglas Coupland**, novelist, playwright, filmmaker and visual artist, author of the bestseller jPod.
- **Bob Hallett** of Great Big Sea, latest album: The Hard and the Easy
- **Jay Ingram**, award-winning co-host and producer of DailyPlanet (Discovery Channel).

Adjudication will take place in the summer of 2008. Awards will be announced in the Fall of 2008.

- 3 top student performances chosen by each of our celebrity judges
- 10 top student performances
- 3 top teacher performances chosen by each of our celebrity judges
- 10 top teacher performances

How to Participate in the Math Performance Festival

The Math Performance Festival is a Canada-wide forum for sharing and celebrating the mathematical performances of young (grades 4-6) students.

Please submit performances through our Festival Portal, at www.MathFest.ca. You can submit performances in one of three ways (see www.MathFest.ca for more details):

- Record live performances directly into our Portal using a webcam.
- Upload video or picture files.
- Publish performances to your school website, and then submit the url at the Festival Portal.

Submissions are screened by a Festival Committee before they are publicly available through the Festival Portal.

How to Write and Perform a Math Poem

Write a math poem

Here is one way to write a math poem:

- **Pick a math topic** (like probability, division, measurement, fractions, or algebra).
- **Make a list of words and ideas** that relate to your topic.
- **Write metaphors and similes** about your topic using your list of words or ideas. Metaphors and similes link two things that are not usually connected but do share some common elements. Metaphors are phrases like "addition is a birthday party ". Similes are like metaphors but use the words "like" or "as", as in "graphs are like a radio".

- **Explain your metaphors and similes.**

For example:

- Addition is a birthday party, you always get more, you get a bit of money, and presents galore.
- Graphs are like a radio, both can bring bad news.
- **Write a poem** using your metaphors and similes and their explanations.

Numeration

*Numeration is a murderer,
7 ate 9,
When he got into court,
He said, 'I had to dine!'*



*Subtraction is like ice cream,
They both disappear,
I know someone who likes them,
And he is a peer.*



*Subtraction is like geometry,
They both use line segments,
Line segments are used a lot,
They're on the monuments.*



*Subtraction is a casino,
You never come out with more,
When you do get some cash,
You'll use it at the store.*



*Addition is a birthday party,
You always get more,
You get a bit of money,
And presents galore.*



*Division is like friends,
You have to share with both.
Both are essential,
For your childhood growth.*



*Multiplication is a herd of animals,
It's always getting bigger,
But when one set hits another,
I think they'll merge together.*



*Operations are really cool,
It's one of the things I like,
Math and fishing are also great,
We measured my caught pike.*



Vincent Kong

Graphs

*Graphs are flowers, always growing
Different shapes, various types
Graphs are a bird soaring,
ascending and descending
Graphs are a friendship,
having up and down points
Graphs are human life,
starting low, ending high*



*Graphs are like a radio,
both can bring bad news
Graphs are like a telephone,
both communicate
Graphs are like a stop watch,
can record time
Graphs are like a camera,
both show actions*



*Graphs are like a library,
both help you learn
Graphs are as well done as a famous painting
Graphs are as interesting as a mystery
Graphs are as accurate as a road map
Graphs are as simple as addition*

*Graphs are as educational as researching
Graphs are extraordinary!*

Jenn Weeks



Perform your Poem

Here are some ways to perform your poem:

- Illustrate the poem with your own artwork, like the poems shown on the right.
- Create a dramatic reading of your poem.
- Use Story Telling software, like Photo Story, Movie Maker, iMovie or iPhoto, to create a multimedia performance of your poem.
- Create a song based on the poem, and record its performance.

Share your Poem

Share a performance of your poem in our Math Performance Festival, at www.MathFest.ca.



How to Interview a Math Concept

Prepare for the Interview

Here is one way to prepare for the interview:

- **Pick a math concept** (like the number pi, the fraction $1/3$, the triangle, or the hexagon)
- **Make a knowledge web** for your topic.
 - Use a large, blank sheet of paper.
 - Write your concept in the centre.
 - All around your concept, write all the things you know and can find out about it (use your textbook; use Google; ask your peers).
 - Then write as many other things that your concept connects to (for example, the hexagon is found in beehives and in floor tiles; where else?).
- **Make a list of questions** and possible answers, using the ideas from your knowledge web. Good interviews offer some controversy and surprise. For example, here's a possible Q&A for the hexagon:
 - Interviewer: Hexagon, is it true that you are a honey thief?
 - Hexagon: Of course not. Where did you get such a crazy idea?
 - Interviewer: Tell us the truth, Hexagon. Why have you been spending so much time in beehives?

Write your Interview

Now you're ready to write the interview:

- **Sequence your questions** in an order that tells a good story.
- **Refine your Q&A.**
 - Be concise in your questions and answers.
 - Use expressive language.
 - Show humour and emotion.
- **Test your interview** with a friend.
 - Read it aloud, with one of you playing the role of the interviewer and the other playing the role of the Hexagon.
 - Reverse roles and try it again.
 - What works well?
 - What needs improvement?

A Real Square

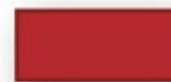
Our tireless math reporter has visited Flatland to interview the square.



Does it bother you that everyone thinks you're a square?

Not at all. A square is what I am.

If that's the case, then why have you been telling everyone that you're a rectangle?



Because I am a rectangle.

How can that be? You just told me you're a square.

A rectangle is a quadrilateral with four right angles. I'm a quadrilateral with four right angles.

Hmm. I see what you mean.

Most people think I'm a square, which is true, of course. But I'm also much more than that.

Can you explain?

You see, I belong to many different sets of shapes. The biggest set I belong to is the set of polygons. A polygon is a closed shape with straight sides. I also belong to the set of convex polygons and to the set of regular polygons.

You're a convex polygon because all your angles are less than 180. And you're a regular polygon because you have equal sides and equal angles.
Now you're catching on.



And you're a parallelogram, which is a quadrilateral with opposite sides parallel.
That's true.



And you're a rhombus, which is a parallelogram with all sides equal.
I am all these things. But my friends call me square.

Thank you, square, for telling us about yourself.
My pleasure.



How to Interview a Math Concept - cont'd

- **Write a brief introduction.**

- Tell us where the interview is taking place: where does the Hexagon live? Mathville? Flatland? Shapeville?
- Tell us one piece of information about the interviewer: for example, whom does she work for?


Perform your Interview

Here are some ways to perform your interview:

- Create a dramatic reading of your interview. Record a radio show performance.
- Write your interview as a comic strip, with appropriate pictures/expressions for different parts of the interview.
- Use Story Telling software, like Photo Story, Movie Maker, iMovie or iPhoto, to create a multimedia performance of your interview.
- Write a poem or song based on the interview.
- You might want to create a classified ad for your concept.
- You might also want to create a poster for your concept. See two samples below.

WORK WANTED
Hard working fraction seeks employment.
Can finish a job in half the time.
Will work for half the money.
Pay me half now and half when the job is done.
Don't settle for one or two when One Half will do!
Call 000.5000 anytime.

$\frac{1}{2}$

WANTED 
Unit fractions one half, one third and one quarter have escaped from Fractionville.
May be disguised as percents or decimals.
Known to offer their services for a fraction of normal cost.
Appear quite rational.
Last seen loitering in discount stores.

Share your Interview

Share a performance of your interview in our Math Performance Festival, at www.MathFest.ca.



How to Perform a Math Problem

Select and solve a good problem

A good math problem can be approached in a variety of ways. It also leads to new problems.

Of course, a good math problem doesn't do these things on its own. It's your creative thinking that does it!

Keep an open mind. Use your imagination. Don't be afraid to make mistakes. Have fun!

Here are a few examples that you might try:

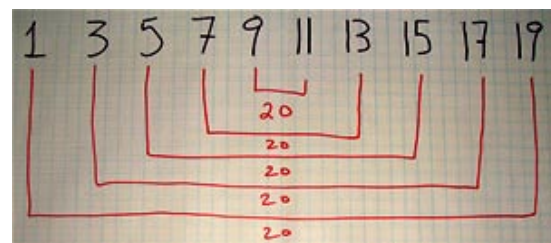
PROBLEM 1. How many blocks to create the first 100 stages?

- Imagine a pattern like the one on the right.
- The above pattern has 5 stages. *How many blocks would you need to create the first 100 stages?*



Method 1

- You might start by counting the blocks.
- You might notice that the first stage has 1 block, the second 3 blocks, the third 5 blocks, the fourth 7 blocks, and the fifth 9 blocks.
- Aha! They are all odd numbers!
- If we add the first 5 odd numbers we get 25.
- How many blocks would we need for the first 10 stages?
- We might notice the pattern shown on the right and get an answer of 100.
- So for the first 100 stages we need to find the sum of the first 100 odd numbers.
- Can you see how you might solve this problem using the method in the diagram?



Method 2

- If you play with the first 5 stages you might notice that they fit together to form a square.
- How does this help you find the sum of the first 5 odd numbers?



the first 10? the first 100? the first 1000?

Extension

- What if we took 1 block away from each stage?
- Now we have the even numbers!!





How do we find the sum of the first 100 even numbers? Does the following pattern help?

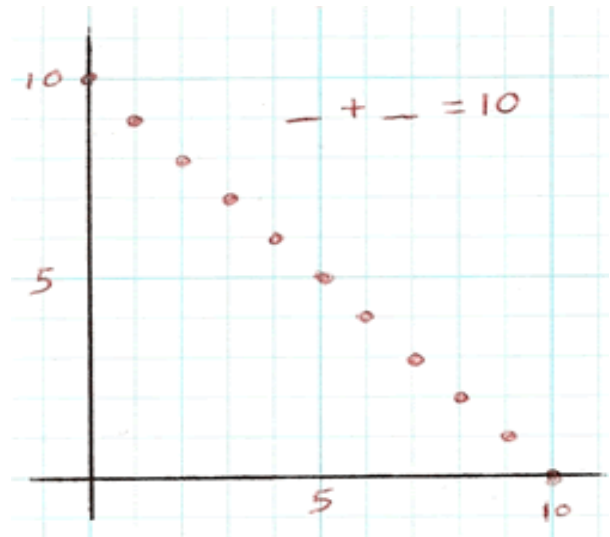


PROBLEM 2. The answer is 10. What was the question?

Here's one possible way to think about this problem:

- Let's assume that the question involved adding two numbers.
- We can form a number sentence like this: $_ + _ = 10$
- If we look at the possible solutions in an organized list, we might get:

- $0 + 10 = 10$
- $1 + 9 = 10$
- $2 + 8 = 10$
- $3 + 7 = 10$
- $4 + 6 = 10$
- $5 + 5 = 10$
- $6 + 4 = 10$
- $7 + 3 = 10$
- $8 + 2 = 10$
- $9 + 1 = 10$
- $10 + 0 = 10$



- We could make ordered pairs out of the pairs of numbers that give us 10:
(1,10), (1,9), (2,8), (3,7), (4,6), (5,5), (6,4), (7,3), (8,2), (9,1), (10,0)
- If we plot these ordered pairs on a grid, we get a neat pattern: all the points line up!!
- This might lead you to wonder about the following:
 - What if we used negative numbers as well?
 - What if we used decimals?
 - What if the answer was 6 or 12? How would the graph change?
 - Can we make up a number sentence whose graph sloped in a different direction? Or curve?



Perform your Problem

Here are some elements of good mathematical performances:

They connect mathematical ideas.

- The first problem connected physical patterns to odd and even numbers, and to different ways of finding their sums.
- The second problem connected the sum of numbers to number sentences, to ordered pairs, and to patterns in graphs.

They offer some surprise.

- In the first problem, it was surprising that the stages of the pattern formed a square, which helps us solve the problem.
- In the second problem, it was surprising that the points lined up!

They express feelings and emotions.

- Mathematics, like all human activities and experiences, involves both thinking and feeling.

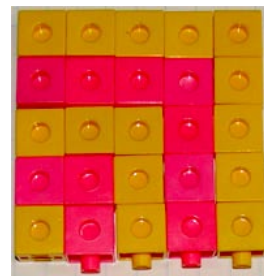
We can imagine performances of the first problem that include the following:

I made this L-pattern using linking cubes. Then I wondered: how many cubes would I need to make 100 stages? I played with the Ls and noticed that they fit together to form a growing square. Look, isn't this neat? I love this square. Even when it's not in front of me I like thinking about it, imagining the Ls sliding together. I feel a sense of fit and beauty.



Or this:

I was looking at this square and I noticed something hiding inside of it. Let me show you. See these Ls. The square is full of them. But what's even neater, and what gave me the most pleasure, is that I noticed that the Ls represent the first five odd numbers. Now every time I see a square, I wonder: How many odd numbers are hiding inside? Can you see what I see?



Share your Problem

Share a performance of your problem in our Math Performance Festival, at www.MathFest.ca.



How to Organize a Math Performance Festival at your School

Start small

There are many ways to organize a successful Math Performance Festival. Here is one suggestion.

- Select a single focus for your festival: we suggest that you start with **Math Poetry** (see **How to Write and Perform a Math Poem** on page 5).
 - A single focus simplifies organization and communication.
 - A single focus simplifies teacher planning and encourages teacher collaboration.
 - A single focus helps give students and teachers a clear purpose.
- Select which grade or grades will participate (for example, grades 4-6).
- Set a time period during which students will work to write and illustrate their poems, and to create dramatic readings or songs based on their poems.
- Encourage students to author collaborative poems and to create group performances.
- Invite artists to participate and assist in the Festival.
 - Contact local artists.
 - Inquire into the artists-in-schools program in your area.
 - Involve the arts teacher(s) at your school.

Think BIG

Math performance is a celebration of students' mathematical imaginations.

- Plan a celebration.
- Post students' illustrated poems in classrooms and school hallways.
- Take pictures of students working on their poems and pictures of their illustrated poems.
- Create a slide show from the pictures.
- Organize an assembly.
 - Invite parents.
 - Invite local news media.
 - Invite local celebrities.
 - Show a slide show of student work, with a sound track.
 - Have some students from each class perform their poems.
- Copy and bind all of the poems to create a math poetry anthology.
 - Print a copy for each student.
- Post the performances on your school website (with parental permission).

Share student performances

Share student performances in our Math Performance Festival, at www.MathFest.ca.

Gadanidis, G. (forthcoming). A lust for mathematics. *Canadian Mathematical Society Notes*.

Gadanidis, G. (2003). *Becoming a mathematics teacher: A mathematical romance*. Whitby, ON: MathAdventures.com Publications.

Gadanidis, G. & Borba, M. (forthcoming). Our lives as performance mathematicians. *For the Learning of Mathematics*.

Hughes, J. (Editor) (1999-2001). *MathMania* magazine.