What Does a Mathematician Do?

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What do young students know about mathematicians, and how do we find out what they know? Picker and Berry (2001, 202) suggest that finding out more about students' images of mathematics can help teachers "understand their attitudes toward, misconceptions about, and opinions of the subject." They also suggest that "one way to discover these attitudes is to ask your students to create a drawing of a mathematician." We followed Picker and Berry's advice and asked 18 students in a Grade 2 class and 17 students in a Grade 3 class to draw mathematicians at work.

Picker and Berry (2000) conducted an international study a decade ago, and asked 476 students (age 12–13) to draw a mathematician at work. The major finding of the study was that "mathematicians are essentially invisible, with the result that pupils appear to rely on stereotypical images from media to provide image of mathematicians when asked" (p 88). Seven themes emerged from the drawings made by students in different countries (p 74):

(1) *Mathematics as coercion*—students "drew mathematicians as teachers who use intimidation, violence, or threats of violence to make their pupils learn material. This was a completely unexpected theme that emerged from the drawings";
(2) *The foolish mathematician*—"mathematicians were depicted as lacking common sense, fashion sense, or computational abilities";
(3) *The overwrought mathematician*—"mathematicians were depicted as looking wild and being overstrained";
(4) *Mathematicians who can't teach*—"a classroom is drawn which the mathematician cannot control, or in which he doesn't know the material";
(5) *Disparagement of mathematicians*—mathematicians "as being too clever or in some other way contemptible";
(6) *The Einstein effect*—drawings with a reference to Albert Einstein. Usually, those images were influenced by media, including books and cartoons;
(7) *Mathematicians with special powers*—including wizardry and math potions. "Something extraordinary is necessary in order to do mathematics."

Picker and Berry (2001) repeated the draw-a-mathematician survey with 201 ethnically diverse Grade 7 students in two schools and found that "no drawings emerged that represented that diversity" (p 204). Most drawings showed middle-aged males with glasses and/or a beard, bald or with weird hair, at the blackboard or computer. Such images raise important issues about how popular culture may deter many people from enjoying and studying math and may create stereotypes of mathematicians as mainly white, middle-class men; the stereotypes, in turn, could discourage other groups from engaging in math (Economic and Social Research Council 2008).

Grade 2 and 3 Students' Views of Mathematicians

We engaged the 35 Grade 2 and 3 students with the same tasks used by Picker and Berry in their study:

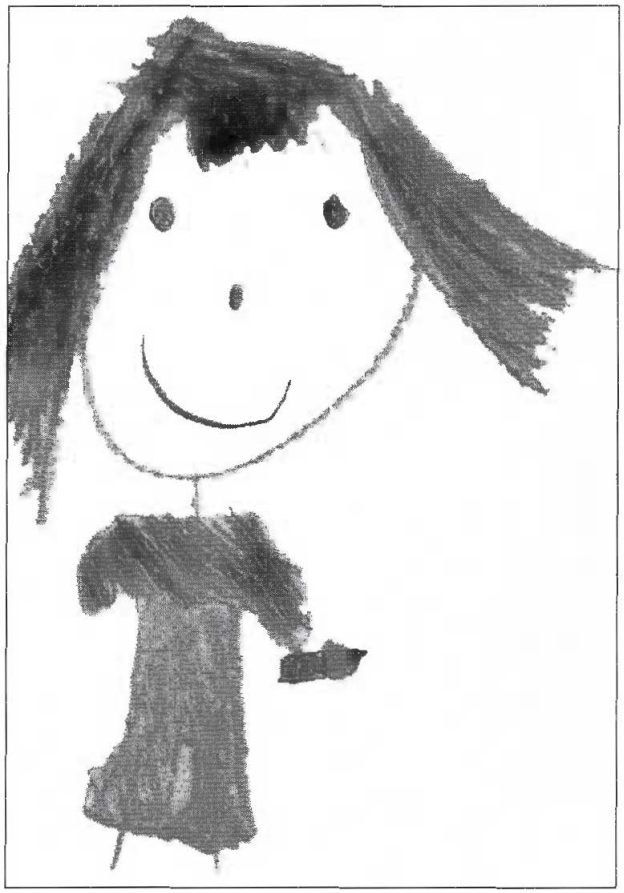
(1) When would somebody need to hire a mathematician?
(2) Draw a mathematician at work; and
(3) Explain your drawing in writing.

It should be noted that these two classes were part of a research project looking at "big math ideas across the grades," and that the draw-a-mathematician activity was completed before the research team started working in these classrooms.

Figures 1 and 2 show two typical student drawings. Overall, the following patterns emerged:

(1) Most students (30 out of 35) associated the work of a mathematician with that of a teacher or tutor. This parallels the Picker and Berry finding that

Figure 1. Grade 2 student: "It is a pensell [pencil], because he is helping me with my math."



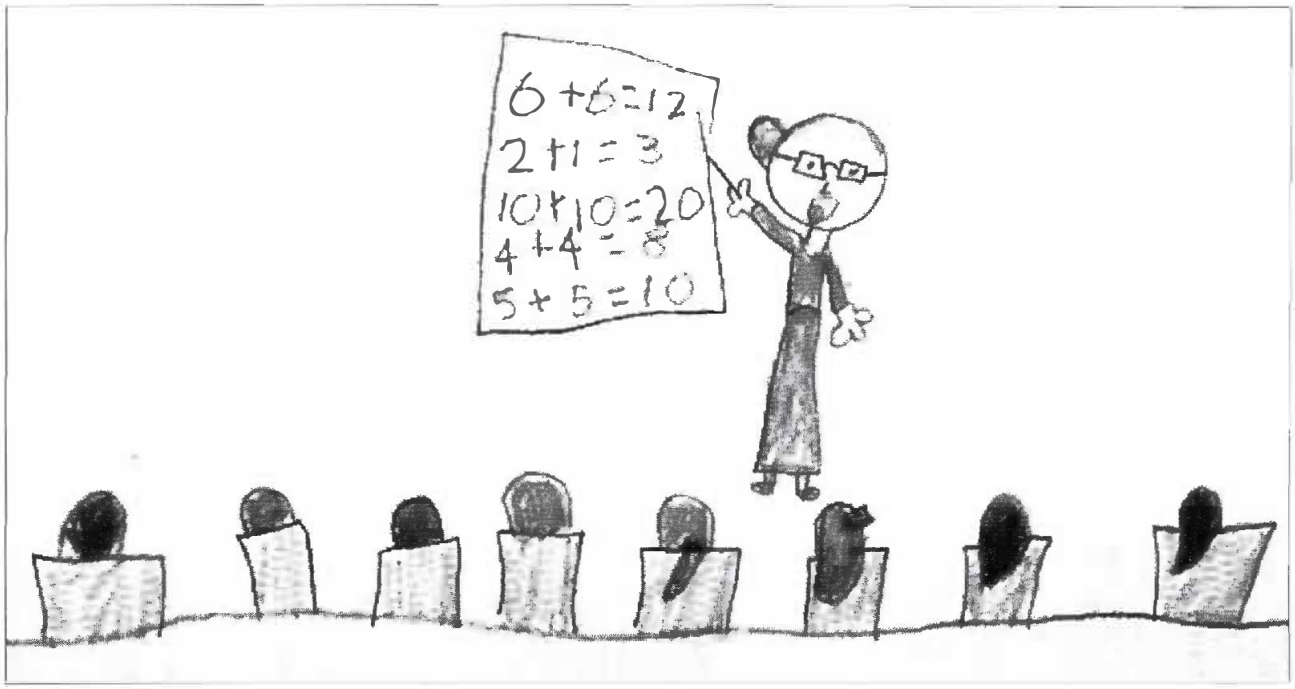
students do not have a good sense of what a mathematician does. Some students (5 out of 35) did state that a mathematician is someone who does math or works on math.

(2) Unlike the Picker and Berry study, in which students typically depicted mathematicians as male, the Grade 2 and 3 students depicted female mathematicians in 7 out of 18 drawings where we could clearly discern gender from the drawing or the description. In the Grade 2 class, taught by a female teacher, six boys and one girl depicted a male mathematician, and four girls depicted a female mathematician. In the Grade 3 class, taught by a male teacher, one boy and three girls depicted a male mathematician and three girls depicted a female mathematician. Interestingly, all of the female mathematicians were depicted by female students.

(3) Unlike the Picker and Berry study, in which mathematicians were depicted in negative and sometimes threatening ways, the Grade 2 and 3 students typically depicted smiling mathematicians and students in helping situations. In drawings where we could clearly discern facial expressions, most boys and girls depicted either smiling faces (25 out of 29) or faces with little expression (4 out of 29).

Although we cannot draw strong conclusions based on data from only 35 students, their drawings and some of the contrasts to the Picker and Berry study

Figure 2. Grade 3 student: "The teacher is teaching kids how to add."



do draw our attention to what Grade 2 and 3 students might know about mathematicians and how they might view them. It might be interesting to do a draw-a-mathematician activity in your own classroom. Your students' images could be compared to those from our Grade 2 and 3 classes or to those from the Picker and Berry study. Identifying the mathematician stereotypes your students depict and what knowledge they lack would be a first step toward planning classroom activities that disrupt their images and help them develop a better understanding of mathematicians. One resource that might be useful is discussed below.

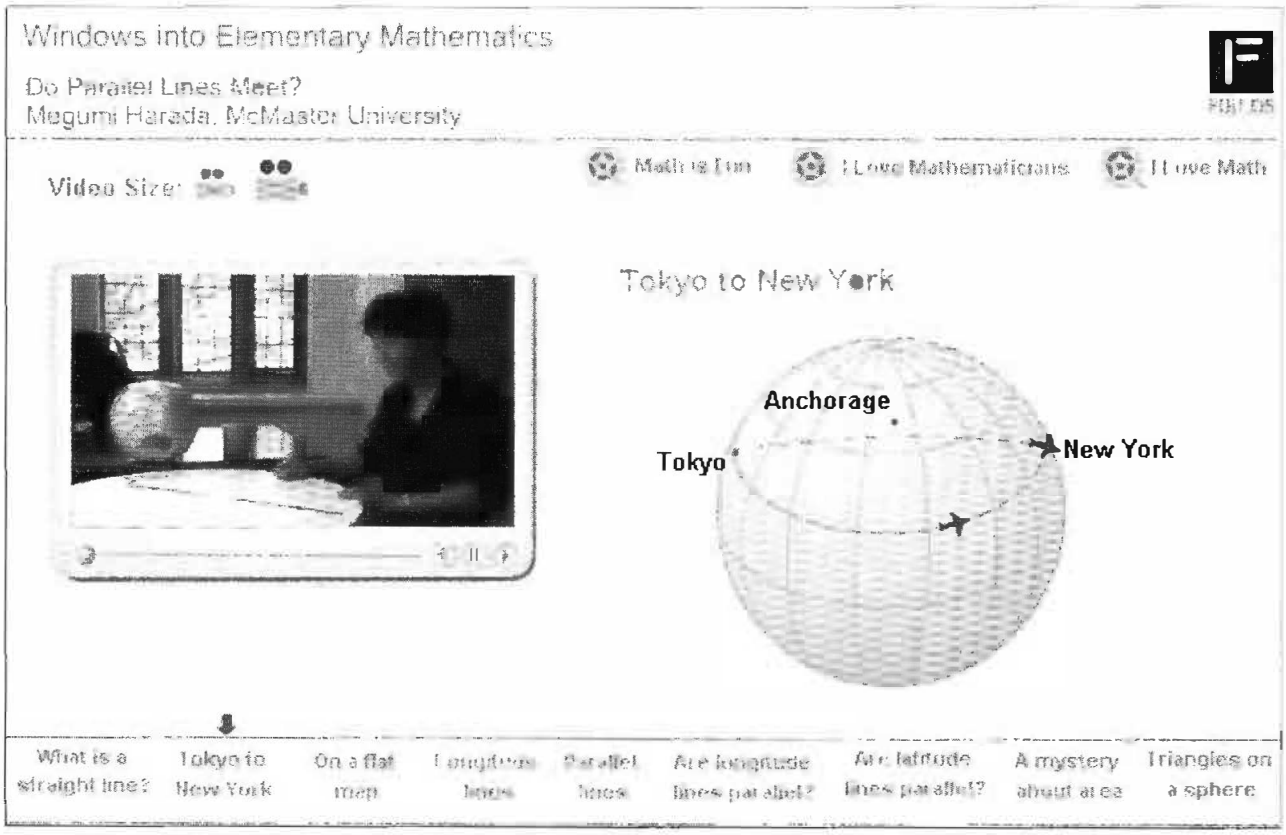
Windows into Mathematicians

How students see mathematicians also draws our attention to what teachers know about mathematicians and how we convey this knowledge to our students. To get better insights into the work and thinking of mathematicians, I have been interviewing mathematicians through a project funded by the Fields Institute, Windows into Elementary Mathematics, which invites prominent mathematicians to discuss topics from elementary mathematics.

In one of the interviews, Megumi Harada, from McMaster University (see Figure 3), who works in the area of geometry, talks about parallel lines and disrupts the idea that parallel lines never meet. We actually use these ideas from Harada's interview in Grades 1–3 classrooms to engage students with explorations of lines on the sphere on which we all live. You can see how a Grade 2 teacher explored this topic at www.edu.uwo.ca/mpc/bigideas/parallel, and you can hear her students singing a song based on their writing at www.edu.uwo.ca/mathscene/mathfest2009/mathfest232.html. Below is the sequence of activities in the classroom. The activities are designed to offer students opportunities to be surprised mathematically and connect emotionally with math ideas through characters in children's literature (Gadanidis, Hughes and Borba 2008).

- Students looked for parallel lines around the classroom (tiles on the floor and ceiling, lines on the cupboard doors, wires on the guinea pig cage and so forth).
- We considered the following puzzle and students guessed at the colour of the bear.
  - Molly steps out of her tent.
  - She walks south 1 kilometre.
  - She walks west 1 kilometre.

Figure 3. Megumi Harada interview.



- She sees a bear, and gets scared.
- She runs north 1 kilometre, arriving back at her tent.
- How is this possible?
- And what colour was the bear?

- We read the story *Do Parallel Lines Meet?* (Gadanidis and Gadanidis 2009).
- We explored the story and the puzzle by looking at lines on the globe.
- Students drew pictures and wrote to describe what they learned.
- Student writing was compiled to create the song shown in Figure 4.
- Students met another Grade 2 class in the library and they sang their song together.

In her interview, Megumi Harada also provides a unique insight into her attraction to mathematics:

> I love mathematicians. When I was in university I studied a lot of things. I studied literature, I studied anthropology, I studied linguistics, I studied philosophy. It wasn't until my fourth year of university that I decided to pursue math. So I was doing a lot of other things before that—in fact, I was an East Asian Studies major before I was a math major. I knew a whole lot of people as a young student and I can say without any doubt that the math students were the most fun to be around, and I think it's because, as a group, mathematicians love what they do more than many, many other groups of people I know.... Mathematicians are a group of people who love math more than they love themselves. Somehow math is this huge, beautiful world that we're just a part of, we're just playing in it, swimming in it, and sometimes we find wonderful jewels embedded in it. Somehow the world of math is bigger than us. Somehow there's a sense of humility that mathematicians share that really keeps us a tight-knit community, a supportive community I'd like to think, and makes it really, really fun to work with and talk with and explore with other people who share that same passion.

To illustrate what Megumi Harada says about mathematics and about her work, we have used her words to write a song called "I Love Mathematicians" (see Figure 5). You can see a performance of this song at http://joyofx.com/music/mst-song2.html. Through a second project funded by the Fields Institute, called Joy of X, we perform this song, as well as student songs that emerge from our work in elementary school classrooms, in math concerts for elementary schools.

Conclusion

For the most part, what mathematicians do and what they are like as people remain invisible in our society. At the same time, the image of mathematicians that our students (and we, as teachers) hold can affect how we see and value mathematics, so it's important that we help our students better understand mathematicians. The Windows into Elementary Mathematics resource could be one source of such knowledge.

Figure 4. "Parallel Lines" song

Parallel Lines

Paaaraaalleeell lines
Paaaraaalleeell lines

Tiles on the ceiling
Lines on the cupboard
Wires on the guinea pig cage

Paaaraaalleeell lines

Parallel lines
Never meet
But they meet, at the North Pole

Paaaraaalleeell lines

The world is a sphere
A 3-D solid
The world is not flat like a circle

Paaaraaallell lines

Molly in her tent
How did she get back
She saw a bear, what colour was it?

Paaaraaalleeell lines

Molly went south
Then went west
Then went north, how did she get back?

Paaaraaalleeell lines

Parallel lines
in a triangle
At the North Pole, is how she got back

Paaaraaalleeell lines

Paaaraaalleeell lines

Figure 5. "I Love Mathematicians" song

I Love Mathematicians

I think math is beautiful
The geometry I do
Is so intuitive
Something I can doodle

I studied many things
Literature, anthropology
Linguistics, philosophy
But I love mathematicians

They are the most fun
They love what they do
More than many many
Other people I know

La lala lala
La lala lala
I love math
I love mathematicians
La lala lala
La lala lala
I love math
I love mathematicians

We stay up with a problem
Work on it together
This sense of solidarity
Attracts me to math

I love doing math
Everyone contributing
Reminding each other
Why we do what we do

Math is a treasure trove
Playing, swimming
Finding jewels in it
Math is bigger than me

La lala lala
La lala lala
I love math
I love mathematicians
La lala lala
La lala lala
It's what keeps me in math

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George Gadanidis is an associate professor in the Faculty of Education of the University of Western Ontario. His most recent project involves helping students develop performance skills for answering the question, "What did you do in math today?" He enjoys turning student thinking into songs that he and his band perform for K–8 schools, with funding from the Fields Institute. You can see some of their music videos at www.joyofx.com. George also heads the Math Performance Festival, www.mathfest.ca.