Math That Feels Good

George Gadanidis

This article was originally published in CMS Notes *47, no 6 (December 2015) and is reprinted with the permission of the Canadian Mathematical Society. Minor amendments have been made in accordance with ATA style.*

For many young people, mathematics feels sterile and disconnected from the world. In this edition of "Education Notes," George Gadanidis provides several ideas and resources for connecting abstract mathematics to concrete activities that children can tell stories about. These activities allow children to talk about mathematics and stay engaged.

Despite popular views to the contrary, school math can be an aesthetic experience, full of surprise, insight and beauty. What's holding us back?

Children begin their lives as eager and competent learners.

Kids these days!

One obstacle is our negative view of what young children are capable of. We remember the good old days, when kids worked hard, were polite, paid attention and knew their math facts. And, of course, in those days we walked 10 miles to school and back, uphill both ways, and we never complained. If only the new generation measured up. Maybe then we could do some cool math with them, instead of the basic skills they seem to lack.

But if we step back and look at the generations that precede ours, we realize that our parents had the same views of us, and their parents of them and so forth. Daniels (1983) documents this generational pattern as far back as ancient Sumeria. So it's not surprising that as adults we are attracted to educational theories of what children cannot do, such as Piaget's stages of cognitive development, which "absolutely dominate in education" (Egan 2002, 105).

Papert (1980), who worked with Piaget, disagrees with the linear progression of his developmental stages, suggesting that it does not exist in children's minds but in the learning culture we create for them. "Children begin their lives as eager and competent learners. They have to learn to have trouble with learning in general and mathematics in particular" (Papert 1980, 40). Dienes, in an interview with Sriraman and Lesh (2007), comments that "Children do not need to reach a certain developmental stage to experience the joy, or the thrill of thinking mathematically and experiencing the process of doing mathematics" (p 61). Egan (1997), Fernandez-Armesto (1997) and Schmittau (2005) challenge Piaget's notion that young children are not capable of abstract thinking, which Egan identifies as an integral element of language development.

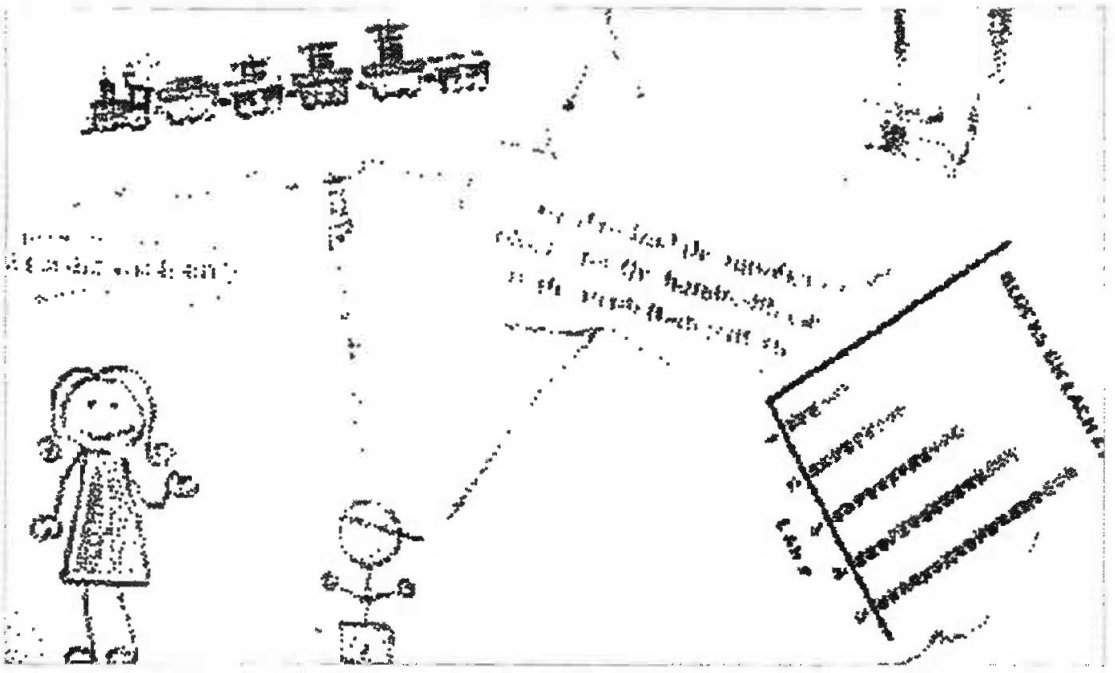
Movshovitz-Hadar (1994) notes the need for non-trivial mathematical relationships in eliciting mathematical surprise, and Gadanidis, Hughes and Cordy (2011) point to challenging mathematics as a corequisite for aesthetic mathematics experience.

Tell Me a Math Story

A second obstacle to school math as an aesthetic experience is that we have not developed a capacity for framing math ideas as stories that can be shared beyond the classroom. When I ask parents what their children say when asked "What did you do in math today?" the common responses are "Nothing," "I don't know" or the mention of a math topic, like fractions.

Story is not a frill that we can set aside just because we have developed a cultural pattern of ignoring it in mathematics.

Story is not a frill that we can set aside just because we have developed a cultural pattern of ignoring it in mathematics (Gadanidis 2012). Story is a biological necessity, an evolutionary adaptation that "train(s) us to explore possibility as well as actuality, effortlessly and even playfully, and that capacity makes all the difference" (Boyd 2009, 188). Story makes us human and adds humanity to mathematics. Boyd (2001)



Grades 1–2 students use comics to share with parents their learning about linear functions.

notes that good storytelling involves solving artistic puzzles of how to create situations where the audience experiences the pleasure of surprise and insight. Solving such artistic puzzles in mathematics pedagogy results in tremendous pleasure for students, teachers, parents and the wider community (Gadanidis 2012).

What Did You Do in Math Today?

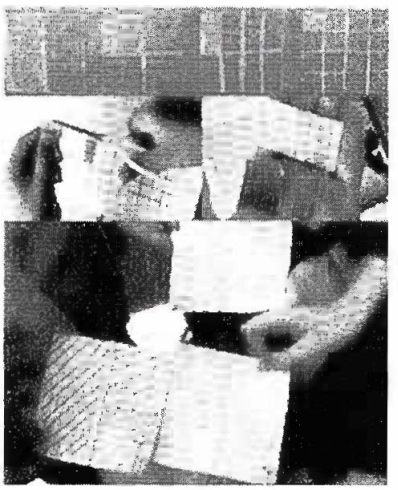
For several years I have been spending 50 to 60 days annually in elementary school classrooms, collaborating with teachers to develop aesthetic experiences for young mathematicians.

Here's how we work together:

1. We start with teacher needs. For example, when teachers asked for help with teaching area representations of fractions, we collaborated to develop an activity that covered this topic in the context of infinity and limit (see figure at right).
2. We don't change the curriculum. We simply add a richer mathematical context for teaching mandated content.
3. Our pedagogical goal is to prepare students to share their learning with family and friends in ways that offer mathematical surprise and insight, emotional engagement, and visceral sensation of mathematical beauty.

We seek to occasionally (say, once a unit) create mathematics experiences worthy of attention, worthy of conversation, worthy of children's incredible minds, which thirst for knowledge and for opportunities to explore, question, flex their imagination, discover, discuss and share their learning.

To the right are lyrics to a song that shares parent comments after Grade 3 children shared their learning of circular functions. You can view an animated music video of the Grade 3 students singing this song at http://researchideas.ca/wmt/c2d4.html.



Grades 2–3 students in Canada and Brazil discover that the infinite set of fractions 1/2, 1/4, 1/8, 1/16 and so forth fit in a single square, and share the surprise "I can hold infinity in my hand!"

Building Capacity

Toward the goal of "math that feels good," with funding from SSHRC, KNAER, the Fields Institute and Western's Teaching Support Centre, we have been developing online resources that publicly share ideas from research classrooms. Below are some examples. See more at http://researchideas.ca.

1. ***What will you do in math today?*** (www.researchideas.ca/wmt)—This resource shares mathactivities from classroom-based research. It is used as a classroom resource by teachers, for professional development and for mathematics teacher education courses. It includes lesson development, interactive content, simulations, interviews with mathematicians working on the same math tasks and classroom documentaries.
2. ***Math e-cards*** (www.researchideas.ca/randomacts)—This online tool allows you to share short videos of the math surprises in the above resource as math e-cards. Teachers can send these to parents to inform them of what their children are studying. They can also be used to share cool math ideas more widely.
3. ***Short courses for teachers*** (www.researchideas.ca/wmt/courses.html)—In collaboration with the Fields Institute, we offer short courses for teachers on number, pattern and algebra; measurement and geometry; and data and probability. The courses are freely available. Teachers can register and receive certificates of completion for a minimal fee of $30/course, or school districts can use these courses to offer their own certificates of completion.
4. ***Math + Coding***—We have been exploring the intersection of coding and mathematics education as another way to model, investigate and experience mathematical beauty The following are some resources we have made available:
   a. *Math + Coding 'Zine* (www.researchideas.ca/mc)—an online magazine offering ideas for incorporating coding in mathematics teaching and learning
   b. Math+ Coding Events (www.researchideas.ca/coding-events)—a Fields-funded project that offers support for organizing student-led math + coding community events
   c. Math+ Coding Symposium (www.researchideas.ca/coding)—videos of keynotes by Celia Hoyles, Yasmin Kafai and Richard Noss at a recent symposium funded by Fields and SSHRC
   d. Math + Coding Resources (http://researchideas.ca/mathncode)—math + coding simulations, games and more.
5. ***Math Music*** (www.researchideas.ca/jx)—Funded by the Fields Institute, we have been performing math songs from research classrooms for elementary schools across Ontario. Songs and music videos are available at this website.

Dots, Clocks and Waves

my daughter explained
how to conduct experiments
and make bar graphs
plotting the results

she was amazed
by the wave pattern
excited to explain it
to her brothers at home

a dot on a car tire
makes a wave pattern
at first I thought
it would be a spiral

the wave pattern
is still there
even if the wheels
even if they are square

it's great to see my
son excited
about school and about math
it's great to see enthusiasm
and interest in school math

my son enjoyed
testing his hypothesis
he was surprised
surprised by the result

he shared his comics
of what he learned
about math waves
on tires and clocks

the height of every hour
on a grandfather clock
plotted on a bar graph
makes a wave shape

like the height of a dot
on a rolling tire
or seasonal temperatures
or sunrise and sunset times

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Comments from Your Executive

The article by George Gadanidis brings up an interesting point about how we view "kids these days." I believe that it is important that teachers maintain a positive outlook on the students sitting in their classroom. A teacher cannot write off a room full of kids and their mathematical abilities because of a widespread belief that they are not hard working, or that they are not able to tackle hard problems because of a lack of ability. This article shows that students at any age can be introduced to complicated ideas like infinity through the use of fractions and a simple piece of paper. It is these types of topics that are going to inspire curiosity, which will lead to more mathematical exploration and a sense of excitement. In my opinion, this excitement is t"g through some of the resources listed at the end of the article. As a computer science major, I am constantly looking for ways to introduce coding into the math class, so I was really excited to see a host of resources related to this topic. To me, coding and math go hand in hand. The type of thinking that goes into coming up with a successful algorithm is the same thought process as solving a complicated math problem. Having students involved with this type of problem will have them excited to get to math class. If more students came home from school excited to talk about what they did in math class, I am sure we would see an impressive improvement in students' mathematical abilities.

Matthew McDonald is a recent graduate of the Werklund School of Education at the University of Calgary. He received a bachelor of education with a concentration in secondary mathematics. Outside of education, Matthew has a passion for musical theatre and competitive curling. Recently he received his first temporary contract and has been teaching Grade 10 mathematics in Calgary.