

A First-Year Seminar on Mathematical Creativity

Sarah Mayes-Tang
University of Toronto



Quest University Canada

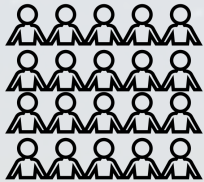
Context: Math Foundation Requirement



- Goal: Think like a mathematician



- Many options, none calculus or linear algebra



- Max 20 students per class



- Graduation requirement for all students

Motivation: Contemporary Mathematics

“Mathematics is one of the oldest of sciences; it is also one of the most active, for its strength is the vigour of perpetual youth.”

- Andrew Russ Forsyth

“Mathematics is one of the few subjects that a student can study throughout high school and even few years into college without coming into contact with any results invented since 1800.”

– Alan Hammond

Motivation: Creativity

“Creativity is a prime need of a human being and its denial brings about a pervasive state of dissatisfaction and boredom.”

- David Bohm and F David Peat, *Science, order, and creativity*

Understand key ideas from 3 areas of modern mathematics

Communicate mathematics with greater clarity and more confidence

Creativity in Contemporary Mathematics

Recognize important issues in the contemporary mathematical community

Create mathematics and understand the nature of mathematical creativity

Learning Goal 1

Understand key ideas from 3 areas of modern math

Number Theory

How do we describe the poetry of numbers?
What are the building blocks of numbers?
What qualities make a number special?

Group Theory

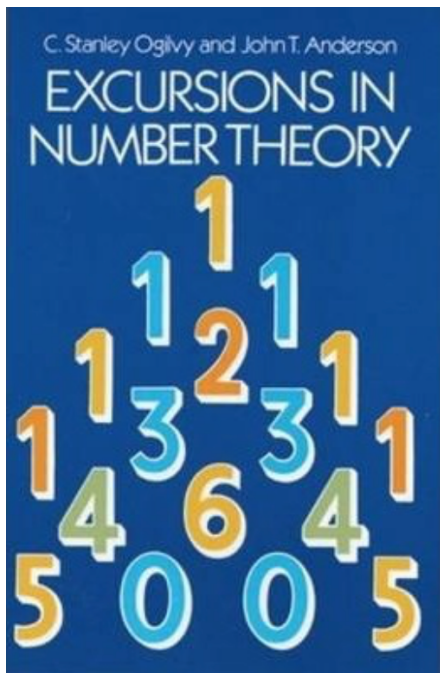
What is symmetry?
How many wallpaper patterns are possible?
What qualities do different mathematical systems share?

Topology

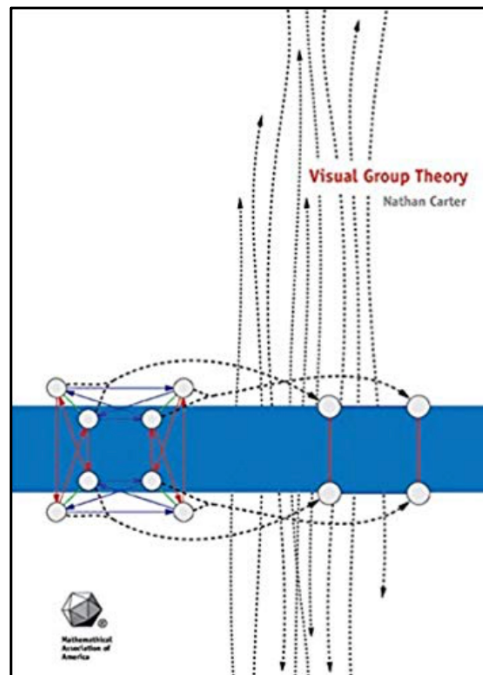
In what ways is a donut similar to a coffee cup?
How do we imagine ourselves in 4 dimensions?
What is the shape of the universe?

Learning Goal 1

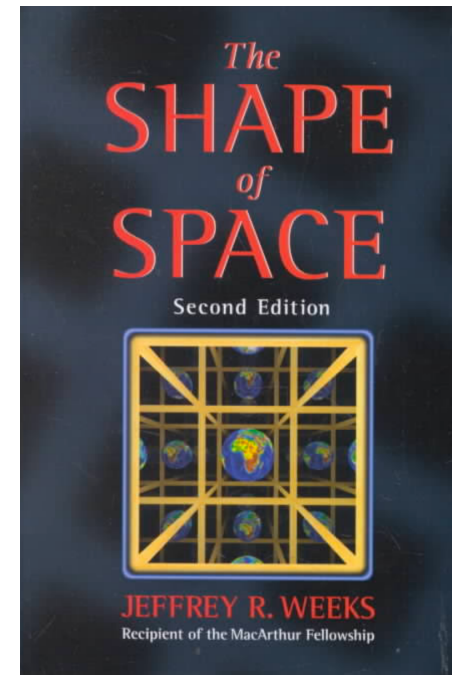
Math Resources



Excursions in Number Theory,
Ogilvy and Anderson



Visual Group Theory,
Carter



The Shape of Space
Weeks

Learning Goal 1

Example Math Activity



Learning Goal 1

Example Math Activity

MISSION 1:

I have a 3 gallon jug and a 5 gallon jug. How can I get exactly 4 gallons into one of the jugs, using only these two jugs?

MISSION 2:

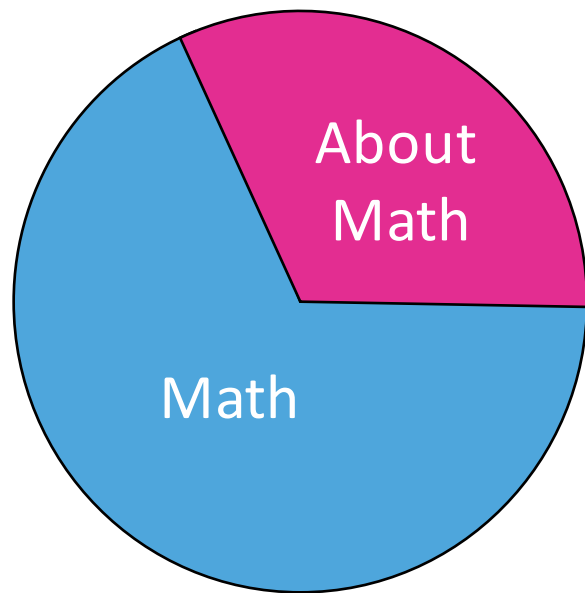
I have a 7 gallon jug and a 17 gallon jug. What amounts of water can I measure into the 17 gallon jug, using only these two jugs?

MISSION 3:

Choose a random prime number p and another number a that is smaller than p . Suppose that you have a jug that holds p gallons and another jug that holds a gallons. What amounts of water can I measure into the larger jug? Repeat several times, and describe a relationship between a and p that ensures that you are able to measure all possible amounts of water (1 gallons, 2 gallons, 3 gallons, ..., p gallons into the larger jug).

Learning Goal 2

Recognize important issues in the contemporary mathematics community



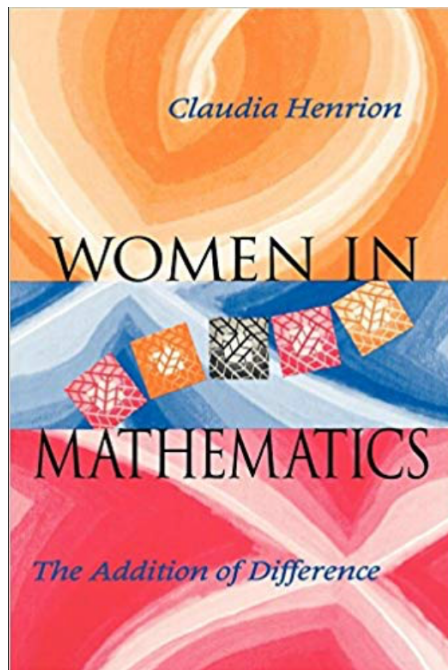
What groups are underrepresented in the contemporary mathematics community? Why?

How are our notions of creativity and genius related?

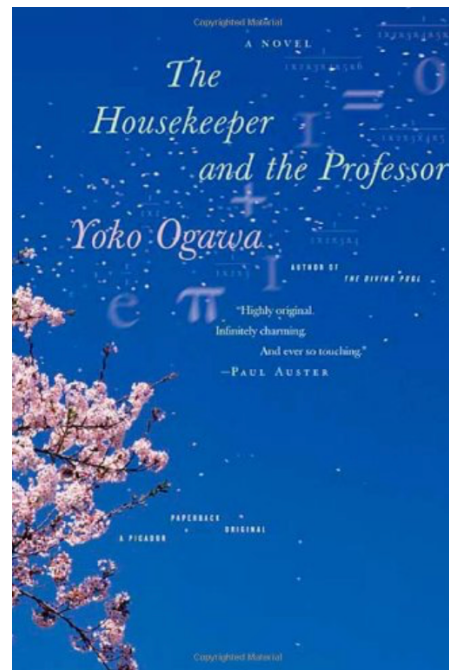
What is mathematical truth?

Learning Goal 2

Math Community Resources



*Women in Mathematics:
The Addition of Difference,*
Claudia Henrion



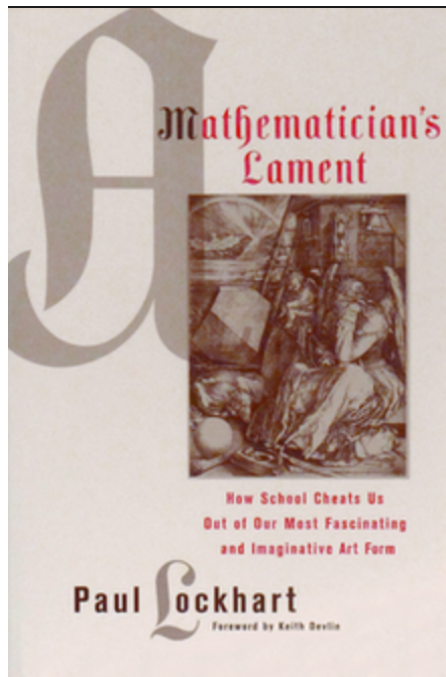
The Housekeeper and the Professor,
Yoko Ogawa



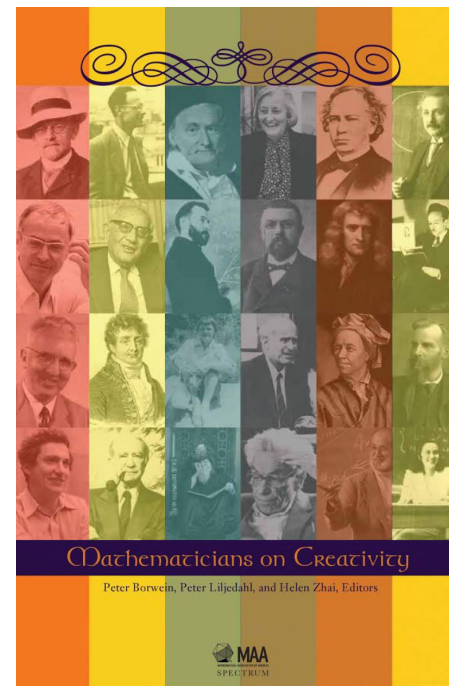
Articles from periodicals &
journals such as *AMS Notices*,
New York Times, *Macleans*,
The New Yorker

Learning Goal 3

Create mathematics and understand the nature of mathematical creativity: Resources



A Mathematician's Lament,
Paul Lockhart



Mathematicians on Creativity,
Brown, Liljedahl, Zhai (eds)

Learning Goal 3

Creations Project



Create a new geometric object

- Name it
- Define it (rigorously)



Find as many properties as you can for your newly defined creation and formulate relevant theorems about it

Learning Goal 4

Communicate math with greater clarity & more confidence: Activities



Read



Present



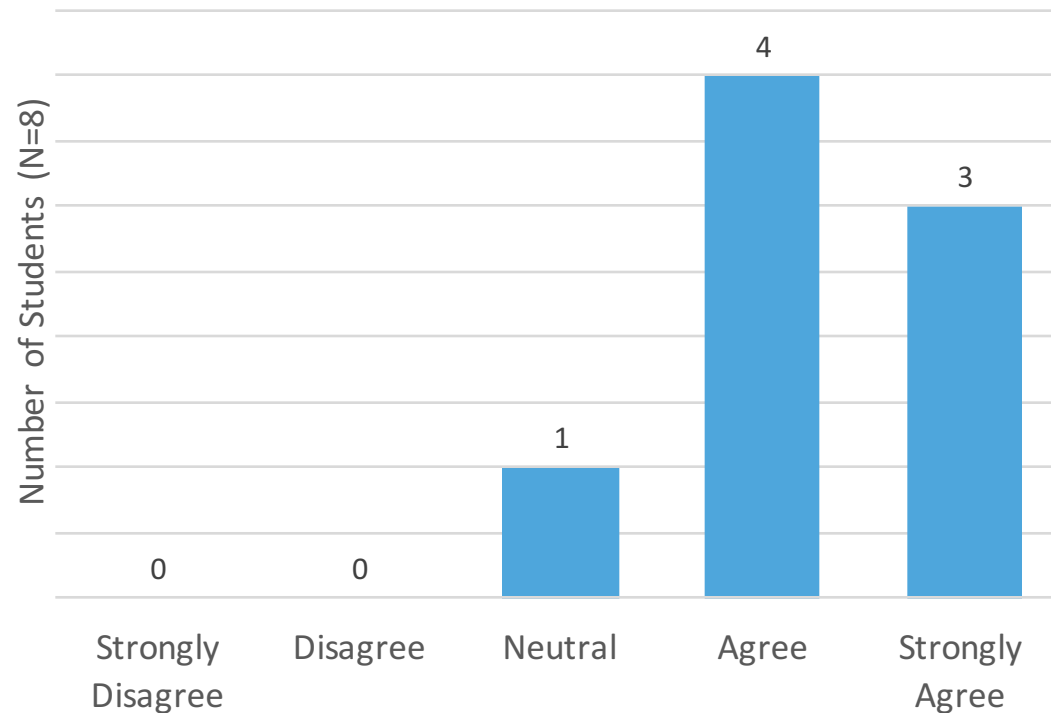
Discuss



Write

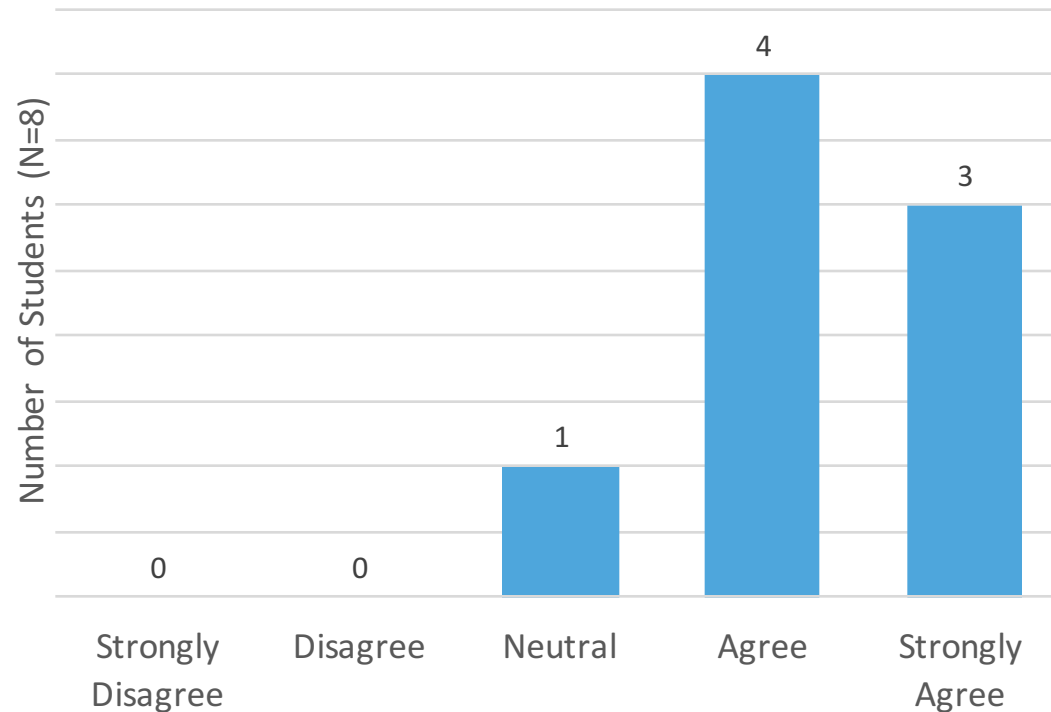
End-of-Semester Survey

Creativity in any discipline can be fostered through hard work and personal effort



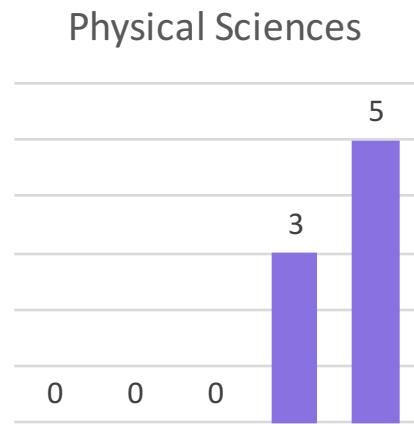
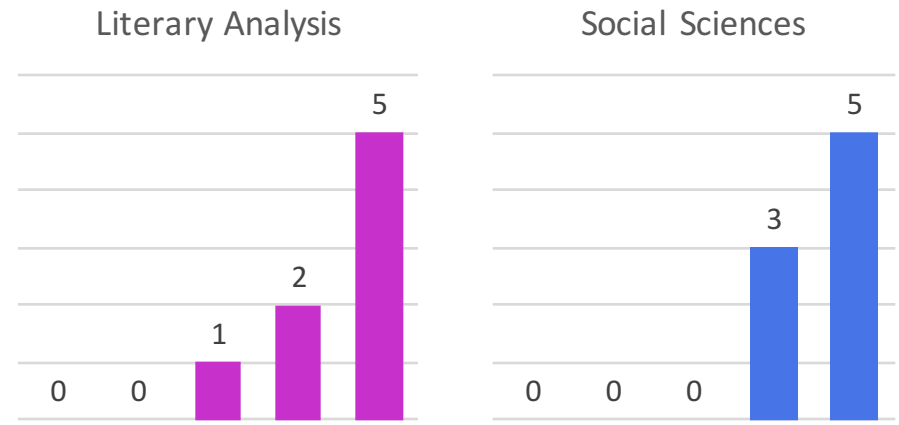
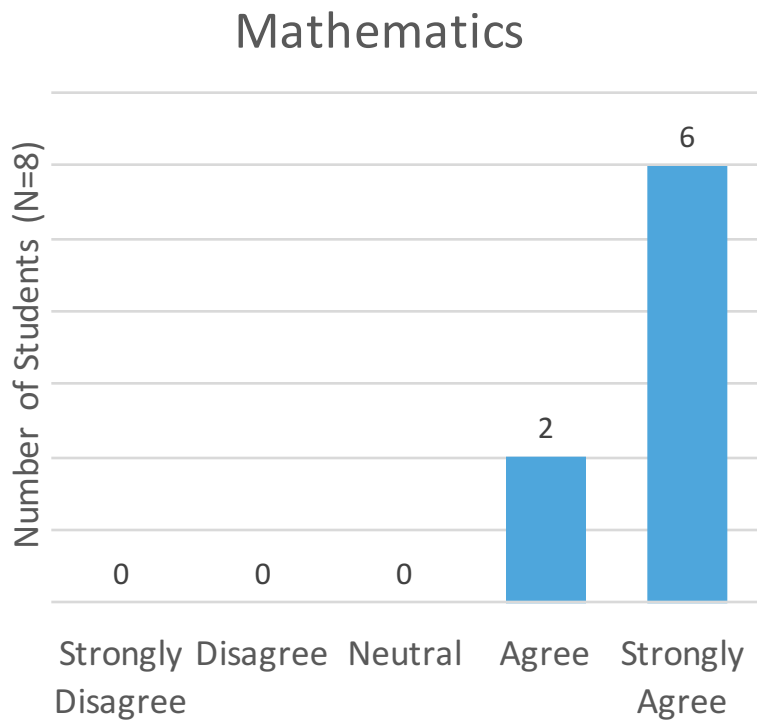
End-of-Semester Survey

I see myself as a more creative person now than I did at the beginning of the [semester]



End-of-Semester Survey

Creativity Plays a Fundamental Role in...



“It definitely had the feeling that you could kind of get a personal grasp on... what it is like to be a mathematician. Like you kind of step into your own world of being creative and thinking like a mathematician....You actually get to experience it. . . it’s pretty cool.”

- Student on the Creations Project

References & Images

Borwein, Peter, Peter Liljedahl, and Helen Zhai, eds. *Mathematicians on creativity*. MAA, 2014.

Carter, Nathan. *Visual group theory*. Vol. 32. MAA, 2009.

Colley, S J. "What is Mathematics and Why Won't it Go Away?." *PRIMUS* 21.3 (2011): 211-224.

Henrion, Claudia. *Women in mathematics: The addition of difference*. Indiana University Press, 1997.

Lockhart, P. *A Mathematician's Lament*. Bellevue Literary Press, 2009.

Ogawa, Yōko, and Stephen Snyder. *The housekeeper and the professor*. New York: Picador, 2009.

Ogilvy, Charles Stanley, and John Timothy Anderson. *Excursions in number theory*. Courier Corporation, 1988.

Weeks, Jeffrey R. *The shape of space*. CRC Press, 2001.

Icons: The Noun Project

Matthigs Nielson (Brain), Storm Icons (Dots), Ranjit (Cap), dDara (shapes), Anbileru adaleru (idea icon), Franc (reader), Gregor Cresnar (presentation), Bharat (discussion), Thijs Rentier (writing)