



# Mathematical Thinking

Feminist. Process. Learning. and Video Games.



# Changes in mathematical thinking

- ▶ Feminist pedagogies in school
    - ▶ Changes in math instruction
      - ▶ Creative problem solving
      - ▶ Systems thinking
  - ▶ Entrepreneurship
    - ▶ Business planning
    - ▶ Tech requirements
  - ▶ Passion in Hobbies that require tech
    - ▶ Photoshop
    - ▶ Final Cut
    - ▶ 3D Printing
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# Working Definition of mathematical thinking

- ▶ **Process and action, not symbols and definitive answers**

- ▶ The language of math (the symbols) are only necessary for specialized careers and should come after the student has mastered the basic mathematical thinking in a more efficient way (Devlin)

- ▶ **Seeing the abstract processes underlying dynamic representations**

- ▶ A hypotenuse
- ▶ A black hole
- ▶ Learning a new computer program or database
- ▶ A dragon fruit being sold in Alaska

- ▶ **Following and/or building a string of conditionals**

- ▶  $X + Y/2 = Z$ 
  - ▶ If  $X = 2$  and  $Y = 10$ , then  $Z$  is...?
  - ▶ If  $Z$  is 7 and  $X < 11$  and only positive, whole numbers are allowed, how many options for  $Y$  are there?
- ▶ Work shift + hobby + chores + sleep + commuting + meals = day
  - ▶  $WS + H + Ch + Sp + Co + M = 24$ 
    - ▶ If  $WS = 8$  and  $5 < Sp < 9$  and  $Co = 1$ , how many options are there for  $H$  and  $C$ ?
- ▶ Entrepreneurship
- ▶ Health, fitness, exercise programs
- ▶ What are the steps to developing empathy?



# Changes in education - The Symbol Barrier

- ▶ 97% vs 38% real world vs symbolic representation
  - ▶ Nunes, T., Schliemann, A. D., & Carraher, D. W. (1993). *Street mathematics and school mathematics*. Cambridge University Press.
- ▶ “How does science teaching alienate so many students from science? (...) The language of classroom science sets up a pervasive and false opposition between world of objective, authoritarian, impersonal, humourless scientific fact and the ordinary, personal world of human uncertainties, judgments, values and interests.”
  - ▶ Lemke, J. L. (1990). *Talking science: Language, learning, and values*. Ablex Publishing Corporation, 355 Chestnut Street, Norwood, NJ 07648



# Toxic masculinity in mathematical pedagogy

- ▶ The ways in which women are simultaneously included and excluded by the use of terminology in discourses of women and mathematics is reminiscent of the use of male pronouns as universal.”
  - ▶ Damarin, S. (2008). Toward Thinking Feminism and Mathematics Together. *Signs: Journal of Women in Culture and Society*, 34(1), 101–123.  
<https://doi.org/10.1086/588470>



# Principles from Dr. Keith Devlin

- ▶ Dr. Keith Devlin, is a mathematician at Stanford University, an author, and the Math Guy on NPR's Weekend Edition.
  - ▶ Creator of math game Wuzzit Trouble
- ▶ Shifting from application of known procedures to **creative problem solving**
- ▶ the ability to take a **novel problem, not well-defined, not having a single “right” answer,** and make progress on it, maybe “solving” it. The problems we need mathematics for today come in a messy, real-world context, and part of making progress is to figure out just **what you need from that context.**
- ▶ Tablet computers and video games provide **interactive, dynamic representations,** which means you can get closer to the thinking, and break through the Symbol Barrier.
- ▶ Mathematical thinking is the **abstract logic that underlies the procedures**
- ▶ because of the **Symbol Barrier, we should not make the symbolic representation the entry pathway into mathematics.** It disenfranchises too many otherwise able people. What video game technologies can do is provide a User Interface to mathematics that much better suited to beginner-level learning. Today, study of the symbolic representation can be postponed until after the student has mastered the basic mathematical thinking in a more efficient way.
- ▶ In the natural sciences, mathematics is the absolute ruler. If you break the mathematical rules, you are no longer doing physics, or astronomy, or whatever. But in the **human sciences, mathematics is just a tool.**



# From Previous course

- ▶ “How does science teaching alienate so many students from science? (...) The language of classroom science sets up a pervasive and false opposition between world of objective, authoritarian, impersonal, humourless scientific fact and the ordinary, personal world of human uncertainties, judgments, values and interests.” <sup>(3)</sup>
- ▶ Lemke, J. L. (1990). *Talking science: Language, learning, and values*. Ablex Publishing Corporation, 355 Chestnut Street, Norwood, NJ 07648



# Feminist Pedagogy – evolution of math instruction and video games

- ▶ Webb, L. M., Allen, M. W., & Walker, K. L. (2002). Feminist pedagogy: Identifying basic principles. *Academic Exchange Quarterly*, 6(1), 67-72.
- ▶ Gee, J. P. (2005, June). Good video games and good learning. In *Phi Kappa Phi Forum* (Vol. 85, No. 2, p. 33). THE HONOR SOCIETY OF PHI KAPPA PHI.
- ▶ Reformation of the relationship between professor and student
  - ▶ Co-design principle (VG)
  - ▶ Sandbox principle (VG)
- ▶ Empowerment
  - ▶ Customize principle (VG)
- ▶ Building community
  - ▶ Co-design principle (VG)
  - ▶ Creative problem solving (FoM)
    - ▶ Shared knowledge (VG)
    - ▶ System Thinking (VG)



# Feminist Pedagogy



- ▶ Privileging voice
  - ▶ Identity principle (VG)
- ▶ Respecting diversity of personal experience
  - ▶ Identity principle (VG)
  - ▶ Information from context (FoM)
  - ▶ Creative applications (change)
- ▶ Challenging traditional pedagogical notions
  - ▶ Poorly-defined problems lacking a “right” answer (FoM)
  - ▶ Overcoming the Symbol Barrier (FoM)
  - ▶ Just in Time knowledge (VG)



# Conclusion(?????)

- ▶ Video games as learning tools are adept at bringing feminist pedagogical principles into, specifically, the math classroom, where pedagogy is still very traditional, rigid, and male dominant and where new ways of introducing, understanding, using, and even transcribing the math are called for.