

# Exploring Methods of Teaching Mathematics

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“It's education that's meant to take us into this future that we can't grasp. If you think of it, children starting school this year will be retiring in 2065. Nobody has a clue, despite all (our) expertise ..., what the world will look like in five years' time. And yet we're meant to be educating (our students) for (this world)”

-Sir Ken Robinson

**Jeffrey Anderson**  
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# Early Modern Universities and Math Education in Europe from late 1400s to early 1800s

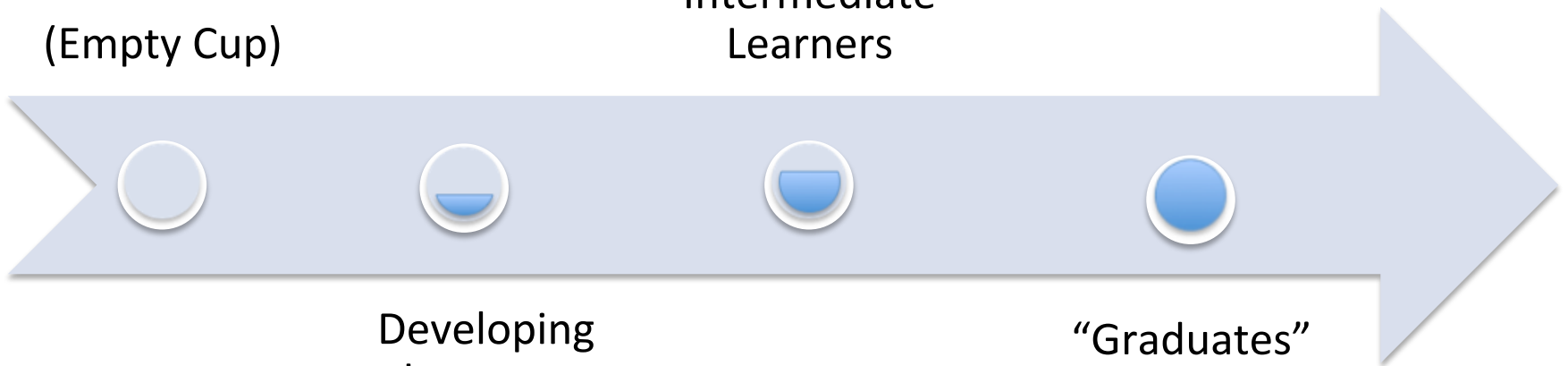
- Post-Enlightenment
- Industrial Revolution
  - Standard structural model:  
“student members controlled by faculty masters”
  - Emergence of science specific scholar vs than a general scholar
  - College education exclusive:  
Christian men of European decent (white)
- By 1700s, universities publish their own research journals
- Scientific ideas are being well circulated via improved printing technology and improved transportation

# Classic Model: Teacher Centered Approach to Math Teaching



Students as  
a Novices  
(Empty Cup)

Intermediate  
Learners



Developing  
Learners

“Graduates”  
as local Experts  
(Full Cup)

# **Buzz Words in Mathematics Instruction The Early Modern University**

- Socratic Method
- Rote Learning
- Exercises
- Standards-based mathematics
- Conventional Approach: Lectures, exercises, assessments
  
- Student enrollment relatively small (compared with today's colleges),
  - the learning environment was customizable to the individual students without too much hassle on the part of the instructor.

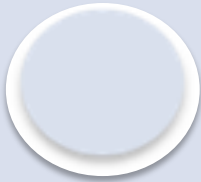
# Day to Day Activities

Teacher prepares lesson at home with access to lots of information that the student does not have access to

Student learns new material in class

Student uses the day's lesson to practice on new problem sets

Student Arrives at class having "mastered" last lesson



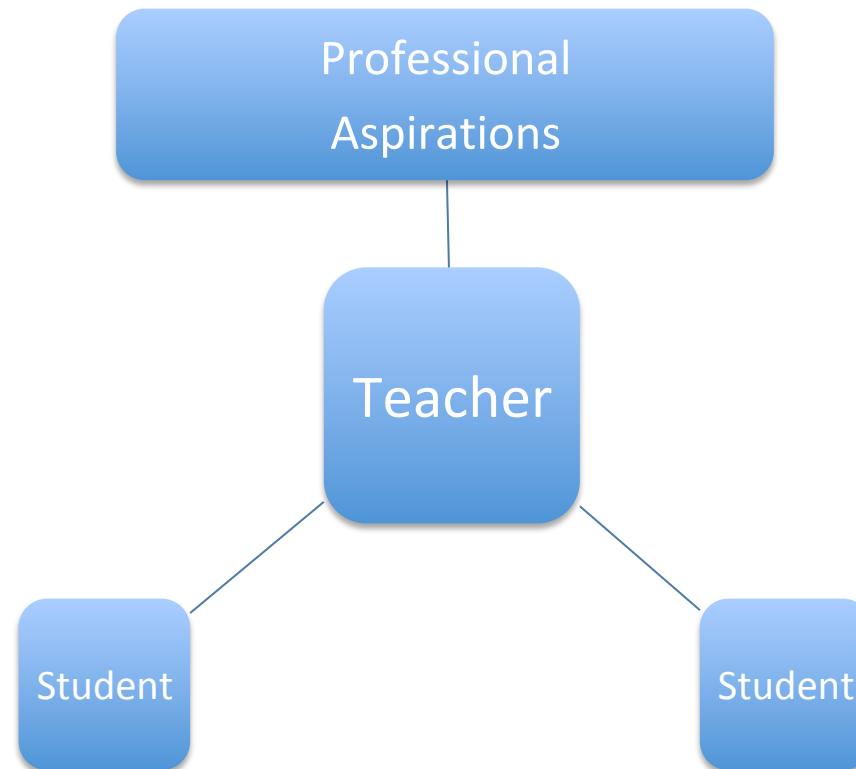
# College Education in the US from 1700s – Mid 1800s

- Harvard University: formed in 1636
- By 1796, nine chartered degree-granting colleges in the colonies
  - Modeled upon Oxford and Cambridge
  - Required Religious affiliations
  - College education exclusive: Christian men of European descent
- The Morrill Land Act of 1862:
  - Focused on establishing agricultural colleges
  - Frequent extensions to this act encouraged progress in edu.
  - Existing institutions expanded programs into science and technology and thus mathematics.

# US College Education: late 1800s – mid 1900s

- Modern Research institution takes shape in 1870s-1880s
  - Entrance examinations to college
  - High schools become prerequisite for college
  - Employers seeks college degrees
- 1900-1930s Large rise in enrollment for college education
  - College education becomes an entrance ticket to a profession
- GI Bill of 1944
  - College education had become a sign of upward mobility
- National Defense Act of 1958: More Americans with Degrees in Science and Engineering
  - Low interest Student Loans

# Buying into the University Education System





# Classic Model: Teacher Centered Methods for Math Education



- Content focused → good for teacher because we have mastered the content.
- One size fits all approach for homogeneous student body
- Sets well defined, centralized standards
- Maximizes instructor efficiency given real constraints (time, money, energy)
- Great for students that have a strong understanding of their end goal



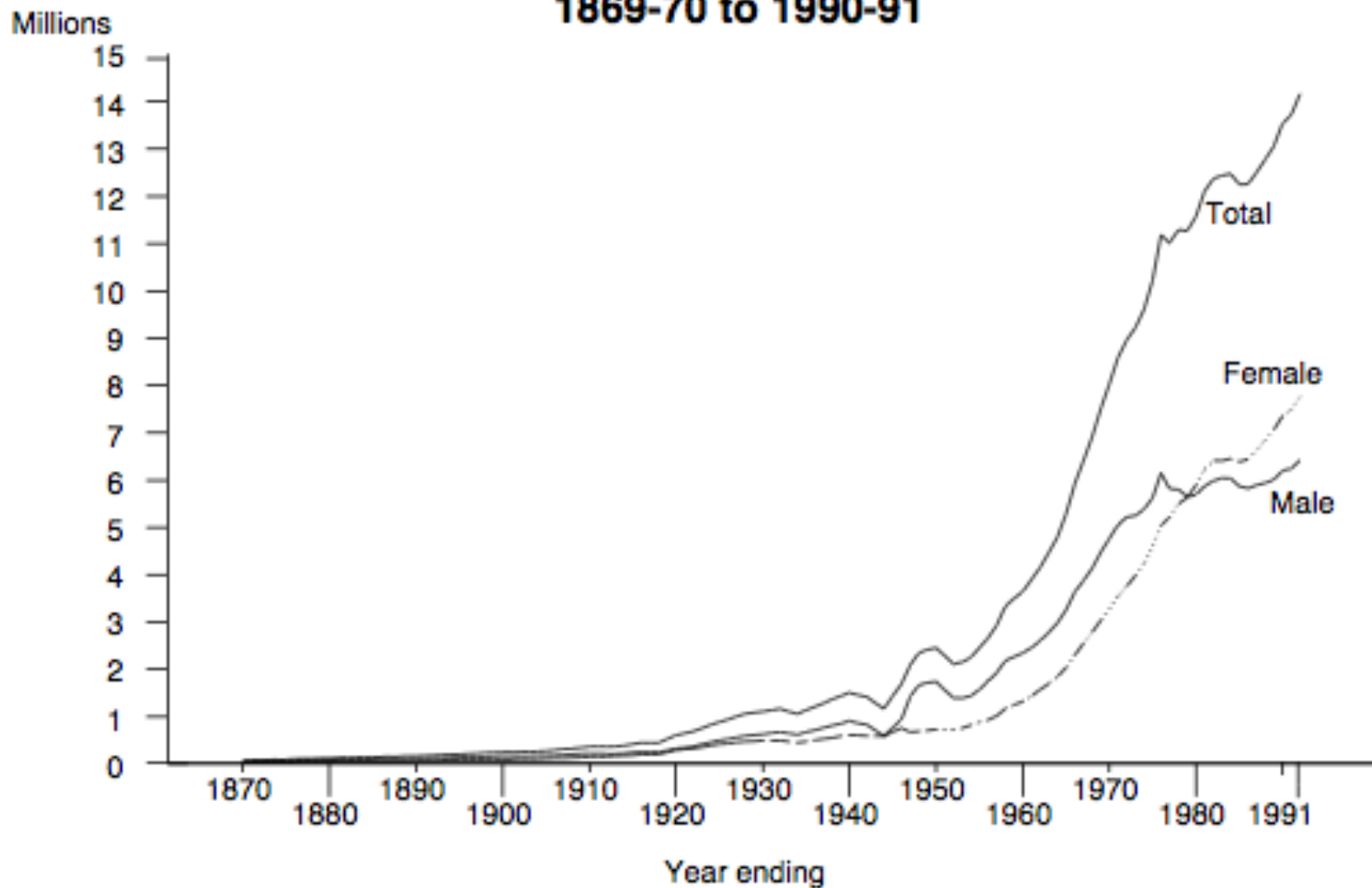
- Neglects Students prior experience
- Leaves little room for creativity
- Is not easily customizable
- Not designed for students who are still discovering what they want to do with their lives

# College Education in the US

## From 1960s to 1990s

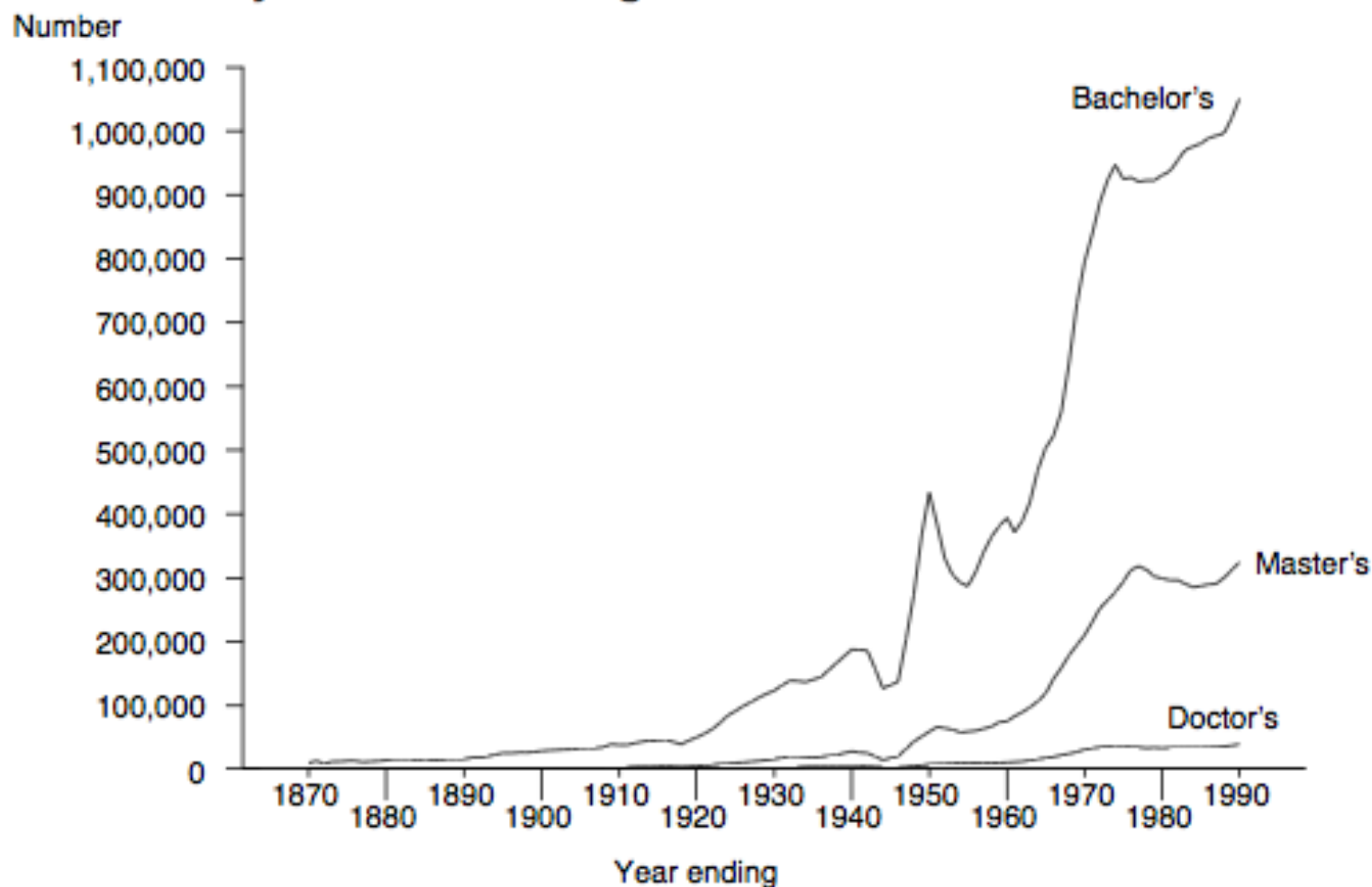
- California Master Plan in 1960
- Civil Rights Act of 1964
- Higher Education act of 1965 and 1972
- Title IX in 1975
- 1960 – 1985: Cold war fears = national investment in Edu.

**Figure 14.—Enrollment in institutions of higher education, by sex:  
1869-70 to 1990-91**



Source: U.S. Department of Commerce, Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1970*; and U.S. Department of Education, National Center for Education Statistics, *Digest of Education Statistics*, various issues.

**Figure 16.--Bachelor's, master's, and doctor's degrees conferred by institutions of higher education: 1869-70 to 1989-90**

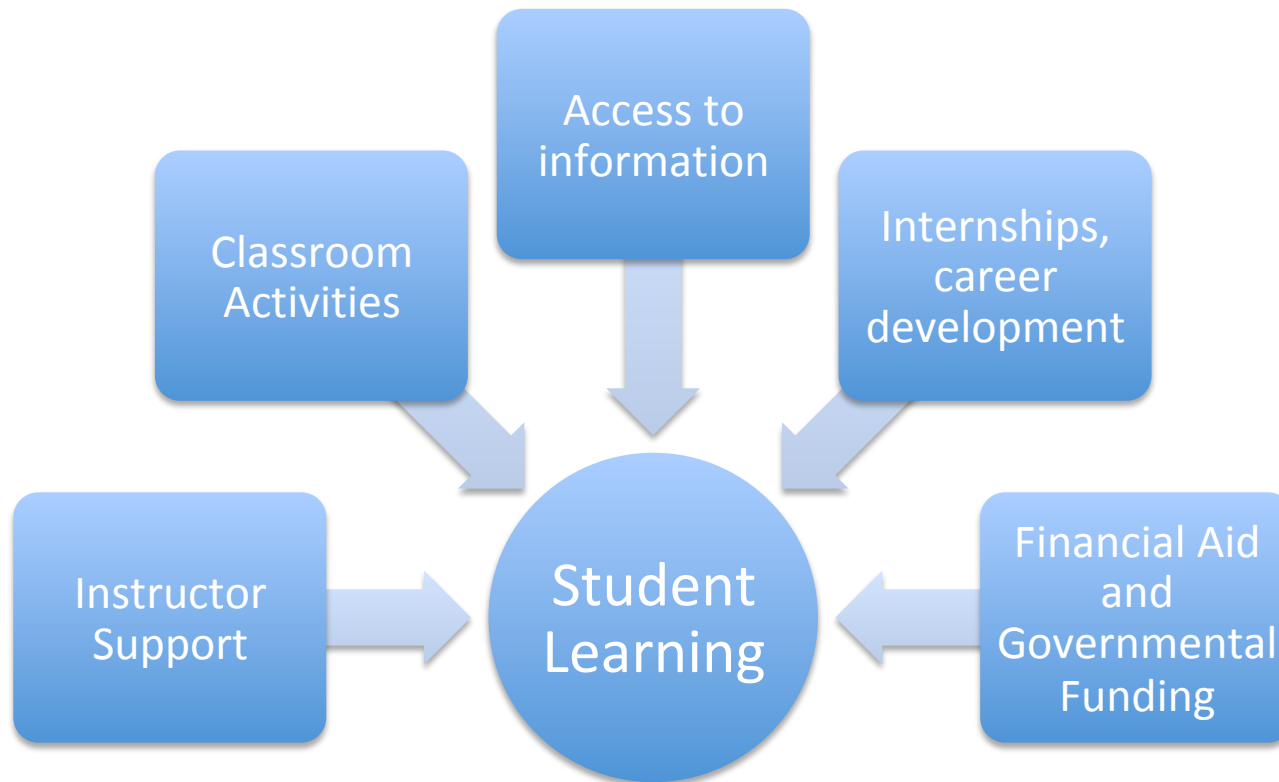


Source: U.S. Department of Commerce, Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1970*; and U.S. Department of Education, National Center for Education Statistics, *Digest of Education Statistics*, various issues.

# Major Challenges facing Math Educators from 1990 - Present

- Customize the math classroom to the students
- Provide technical training to DIVERSE student body
- Teach abstract mathematical methods to students who do not necessarily know why they want to know these ideas
- Deal with larger enrollments
- Provide career training and help students bridge the gap between their education and their career

# Emerging Model: Student Centered Approach to Math Education



# Math Education Reformulated

“Learning results from what the student does and thinks and only from the student does and thinks. The teacher can advance learning only by influencing what the student does to learn.”

-Herbert A. Simon,  
One of the founders of the field of Cognitive Science,  
Nobel Laureate,  
University Professor at Carnegie Mellon University

# **Buzz Words in Present Mathematics Instruction**

- Formative Assessment
- Peer Instruction
- Flipped Classrooms (Front loading, Thayer Method)
- Hybrid Design
- Online Learning
- Problem Based Learning
- Standards-based mathematics



# Development of the Internet as a Tool for Math Education

- TCP/IP Protocol 1972-1983
- 1982-1990: Internet Service Providers formed
- Initial development of html: 1990-2000
- Google Developed 1996 - 1999
- YouTube 2005
- iPhone 1 – 5: 2007 – 2012 (Smart Phones)
- Khan Academy: 2009-2012