CRITICAL MATHEMATICS: CREATING OPPORTUNITIES TO MATHEMATIZE THE WORLD IN HIGH SCHOOL MATH COURSES

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Creating Balance in an Unjust World

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CEMELA

NSF

Index Card and Introductions

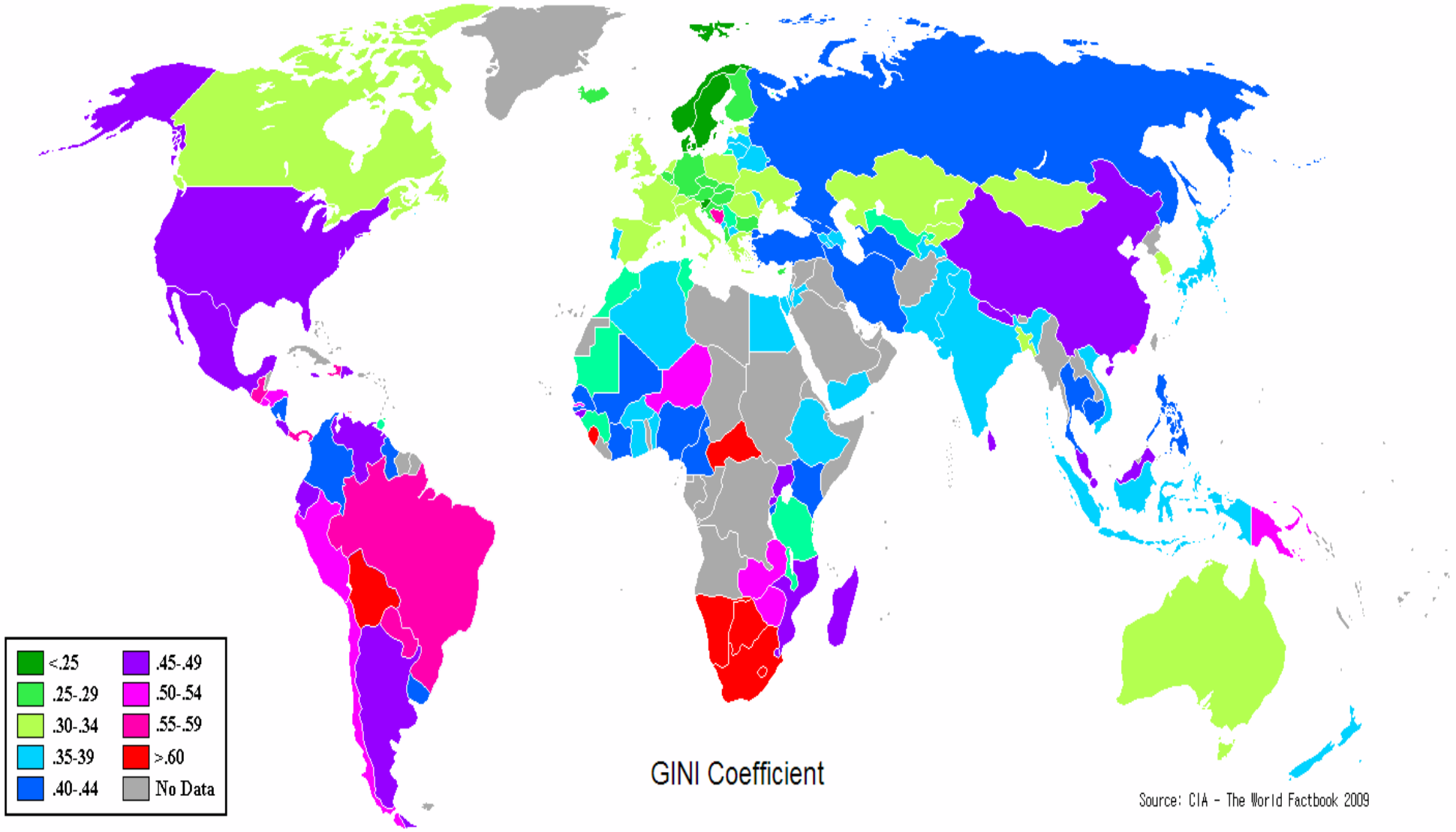
- **Front**: Write a number between 0 and 100 that you feel represents US income distribution.
  - There is no correct answer, just your thoughts.
- **Back**: Explain why/how you chose this number.
  - What factors played a role in your decision?

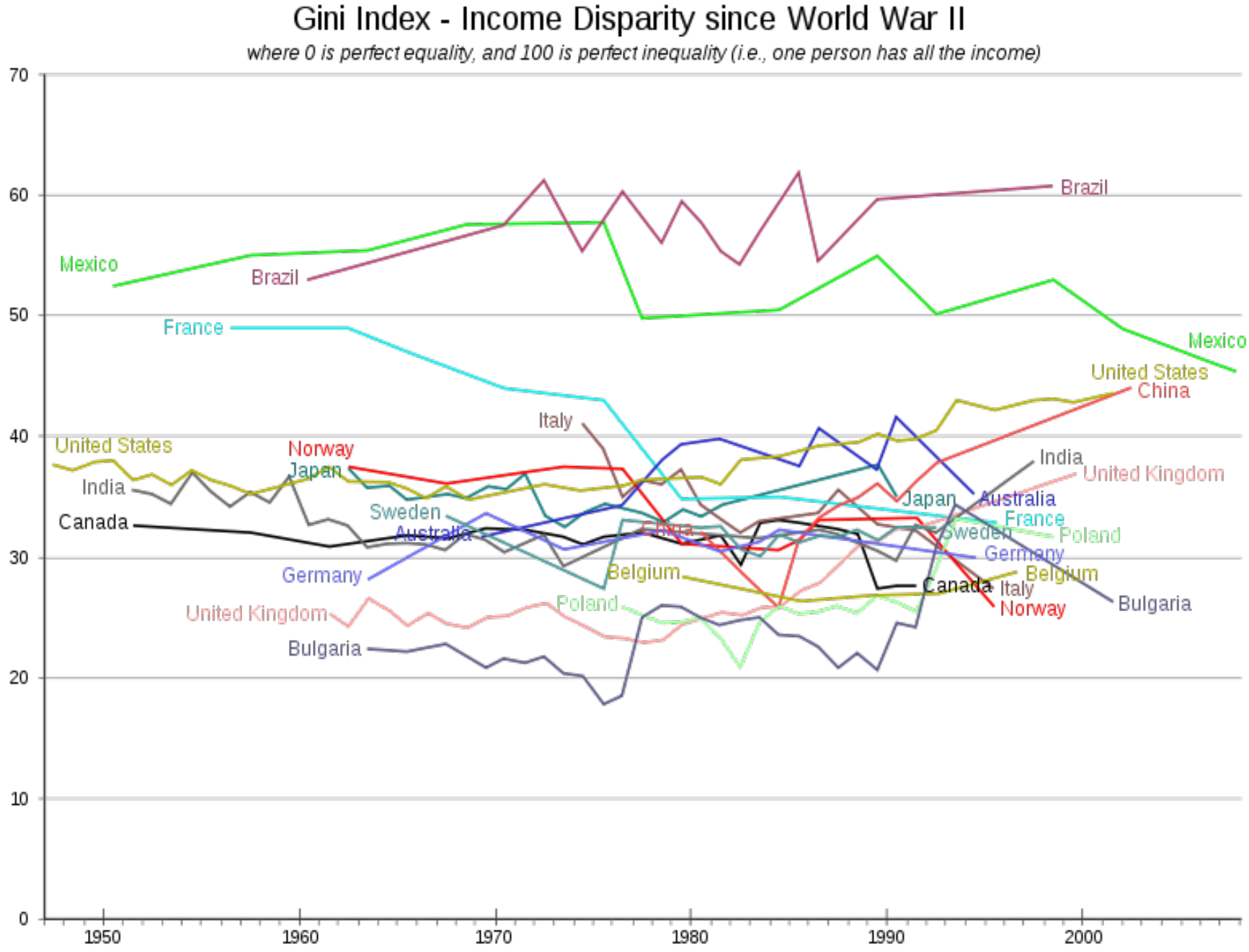
- We will go around room and introduce ourselves:
  - Name
  - Why you chose this session
  - Number
  - Factors

Introduction to Gini Coefficient

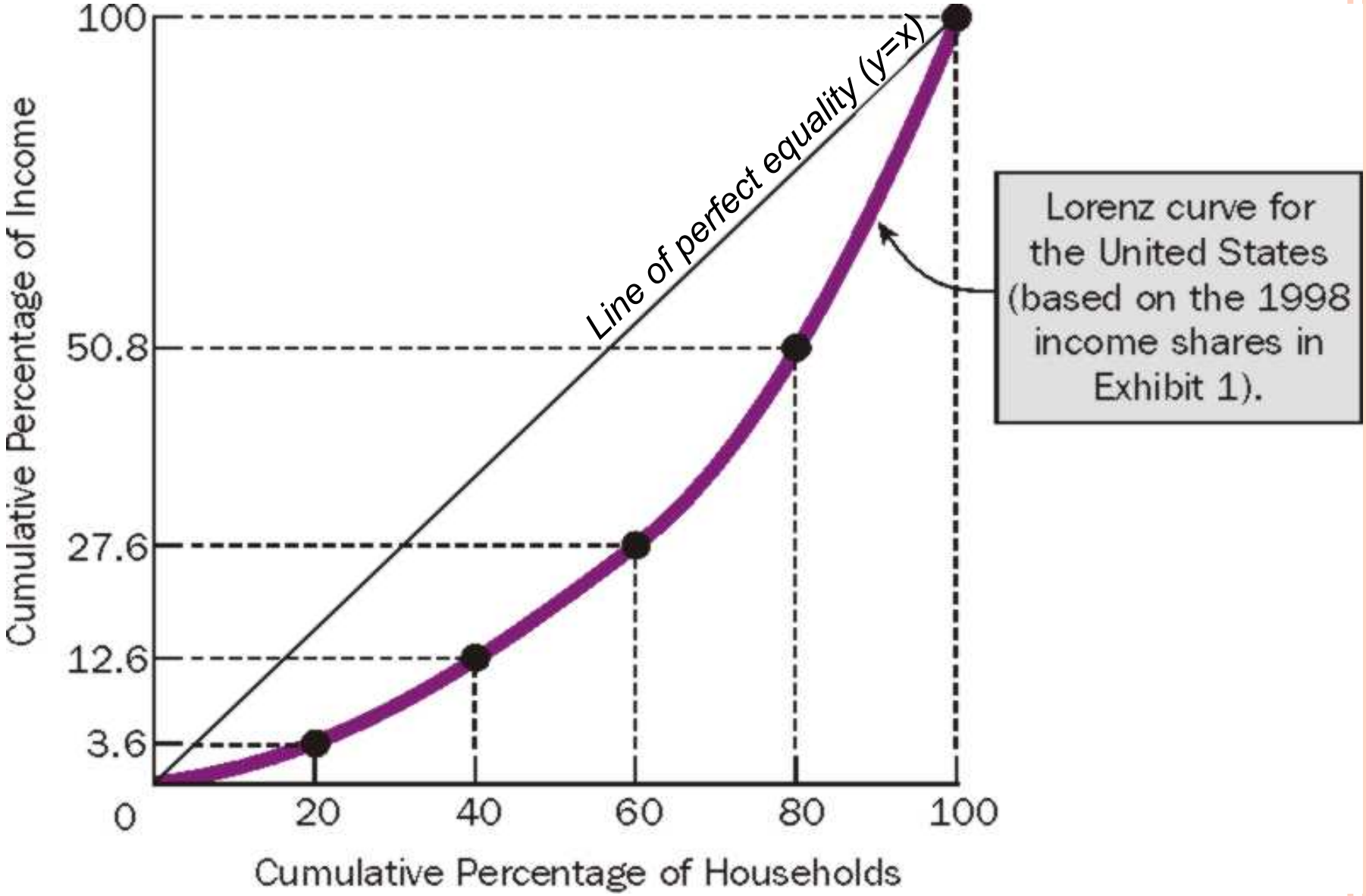
- The Gini Coefficient is a measure of the **inequality** of a distribution
  - Scale: 0 to 1 (decimal).
    - 0.0 = no inequality (total equality, everyone has same amount)
    - 1.0 = complete inequality (no equality, one person has everything).
  - Applications: Economics, health science, ecology, chemistry, engineering, etc.
    - Used by CIA, World Bank, United Nations, Organisation for Economic Co-operation and Development (OECD) Census Bureau, international banks (risk evaluation)
  - Example distributions of **family income** (Gini Index):
    - Highest: Namibia = 0.707 (2003)
    - Median: Israel = 0.392 (2008)
    - Lowest: Sweden = 0.230 (2005)
- New US numbers and reasons/factors → Share out

Gini Coefficients: World CIA Report (2009)

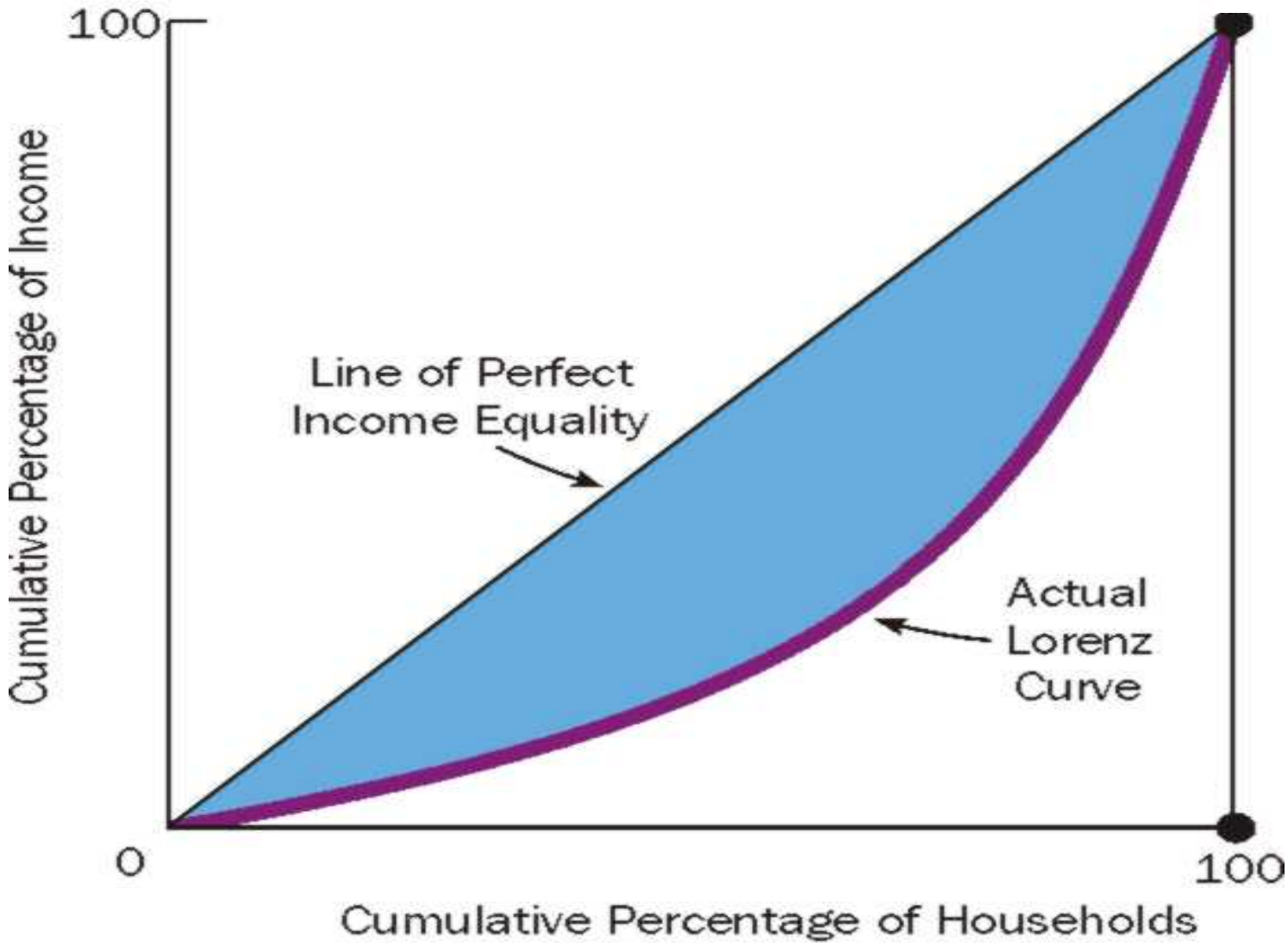



Gini Index - Income Disparity since World War II
where 0 is perfect equality, and 100 is perfect inequality (i.e., one person has all the income)
70
60
50
40
30
20
10
0
1950
1960
1970
1980
1990
2000
Mexico
Brazil
France
Brazil
Mexico
United States
China
Italy
United States
Norway
Japan
India
Canada
Sweden
Australia
China
India
United Kingdom
Japan
Australia
France
Sweden
Poland
Germany
Germany
Belgium
Belgium
Canada
Italy
Norway
Bulgaria
United Kingdom
Poland
Bulgaria

Calculate Gini Coefficient:
Graph Reality (Lorenz Curve)



Calculate Gini Coefficient:
Gap between Equality and Reality (Lorenz Curve)



Mathematical Applications

- Mathematical Modeling
  - Collect data
  - Identify and apply appropriate models
- Calculate Gini Coefficients
  - Collect and graph data
  - Calculate and find difference of areas (various techniques)
  - Integrals (area under a curve using limits)
  - Ratios
- Compare Ginis
  - Discussion of strengths and limitations of measure
- Analysis of trends over time
  - Slope
  - Derivatives

Still to come

1. Conceptual framework of Critical Mathematics Education (CM)
2. Practical applications of these ideas in a high school precalculus class
3. Teacher Voice: Challenges and promise of such work
4. Student Voices
5. Workshop

Theory ↔ Practice

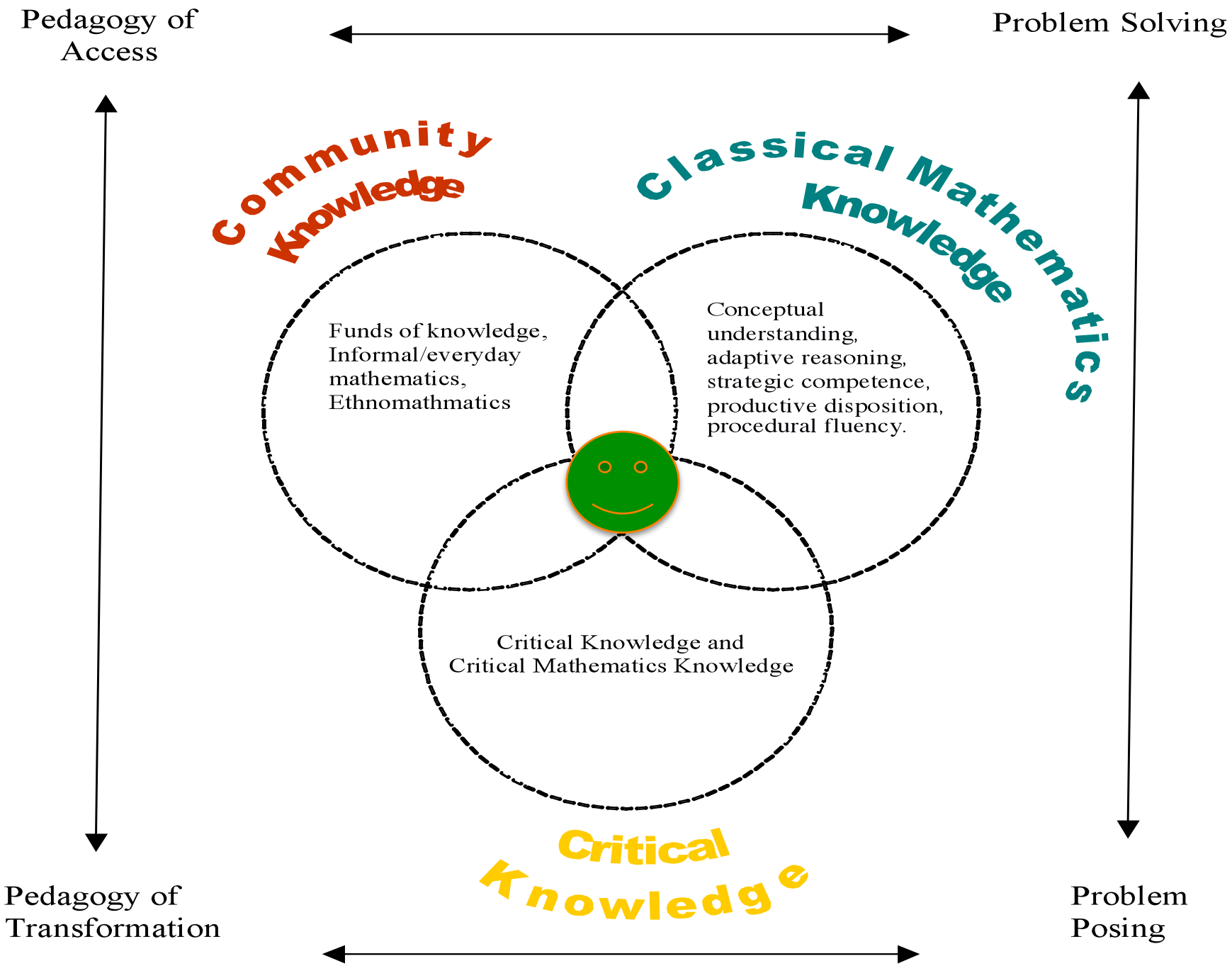
CRITICAL MATHEMATICS EDUCATION

- Purpose of education is to promote equity and social justice in schools and society (Freire, Critical Pedagogy)
- Beyond functional literacy to deconstruct power structures that marginalize certain groups (Critical Literacy)
- Mathematical literacy is "knowledge for liberation from oppression" (Gutstein, 2006).
- Math as a tool to understand, critique, and change world
- Math education to contribute to the creation of a critical citizenry and to support democratic ideals
- Emphasis on the voices of the marginalized as doers and creators of mathematics (Ethnomathematics, Funds of Knowledge)

GUTSTEIN, E. (2006). KNOWLEDGE BASES ~THE THREE C'S~

- Argued for problem-posing curriculum and pedagogy with three integrated components:

1. **COMMUNITY knowledge**
   - "Ordinary" people have and produce knowledge about their lives, experiences, and contexts
   - Funds of knowledge
2. **CRITICAL knowledge**
   - Knowledge to understand sociopolitical context
   - Supports mathematical investigation by offering relevance, authenticity, and insight into a topic of inquiry
3. **CLASSICAL knowledge**
   - Skills and competencies typically seen in mathematics classrooms (master traditional texts and assessments)


Pedagogy of Access
Problem Solving
Community Knowledge
Classical Mathematics Knowledge
Funds of knowledge, Informal/everyday mathematics, Ethnomathmatics
Conceptual understanding, adaptive reasoning, strategic competence, productive disposition, procedural fluency.
Critical Knowledge and Critical Mathematics Knowledge
Critical Knowledge
Pedagogy of Transformation
Problem Posing

CONTEXT AND PARTICIPANTS

- Local high school = Arroyo*
  - 1,300 students: 50% Latin@, 40% White, 10% Black
- Precalculus class
  - 32 students; mostly students of color; mix of 10-12 graders
  - Purpose: 4th year math credit, AP track, college credit
- Why Precalculus
  - Capstone math experience or transition to college math
  - Flexibility – after high school exit exam (AIMS)

Characteristics of Class

- Curricular Focus:
  - Conceptual (Derivatives, Integrals) vs. Computation (Algebra 3)
    - pre**CALCULUS** vs. **PRE**calculus
  - Integrate 3 C's: Classical, Community, Critical
  - **Mathematize the World**, Humanize Mathematics
    - See the role of math in one's life, institutions, and societal structures
    - Keep mathematical investigations and findings in context, not forgetting the human experiences behind the data; combat decontextualization
- Specific Critical Mathematics Activities:
  - 10 Chairs of Inequality, World Wealth Distribution, Payday Loans, Unemployment Data, Local Poverty Higher Education Statistics, AIDS, Earthquakes (Haiti), Gini
- Pedagogy:
  - Group work, conversations, discussions, and debates that integrate personal and community knowledge

EXAMPLE #1: WHERE'S THE MATH? MATHEMATIZING STUDENTS' WORLDS

- Asked students to mathematize news topics of their choice (recurring assignment)
  - Similar to Current Events
  - Consider the role of mathematics in *any* topic
- Purpose:
  - Invite students to bring personal interests to class
    - Generative Themes for future investigations
  - Learn how students see the role of math in their lives
  - Integrate 3 C's:
    - Classical: Apply math knowledge and skills
    - **Community**: How math relates to students' lives
    - **Critical**: Role of math in social issues
- Example: Budget crisis and education cuts

EXAMPLE #2: AIDS LAB
MATHEMATIZING AND HUMANIZING AIDS

- Mathematical modeling approach to understanding the spread of AIDS as logistic growth, NOT exponential growth
  - Read article from 1980s about "exponential" spread of AIDS
  - Analyzed specific demographics (i.e., African American women and South Africans)
- Complemented with additional information and visual representations of data (www.gapminder.org)
- Lab Report:
  - **Classical**: Limitations of exponential model; data comparison for specific demographic groups
  - Community: Invited student conversations about their experiences and myths around AIDS
  - **Critical**: Critiqued article; considered factors in disparate effect on different demographics

Making CM Happen in the Classroom

- Cycle: Planned curriculum, enacted curriculum, engagement/ resistance, adaptation, outcomes
- 3 avenues to integrating critical mathematics (prioritization)
  1. Students bring topics to mathematize (Community)
  2. Teacher provides critical topic to investigate (Critical)
  3. Begin with established curriculum and inject critical investigation (Classical)
- Gravitational pull toward Classical (e.g. Trig unit)
- Unique Teacher: Critical knowledge base to complement curriculum allowed him to maneuver avenues and fight gravity
- Additional resources: UA researcher and faculty

Challenges/Tensions

- Students push back
- Writing reports, and presentations
- Very little support as far as curriculum
- Very time consuming (planning)
- Demands passion, commitment, and flexibility
- Low Department expectations for success in Precalculus
- Movement of students from other Precalculus classes
- Keeping Math focus when dealing with Social Justice issues
- What should be covered in a Precalculus class
- Go deep or Go wide

PROMISE

- Students interact with rigorous math by applying it to contemporary issues in their communities
  - See how math is used, not just procedures
- Students mathematize issues that they confront daily
  - See how math impacts their lives
- Opportunities to collaborate with other teachers
  - Interdisciplinary investigations of topics (e.g., history, English)
  - Conversations in any class, but math is relevant and important
- Capstone math students create their own math narrative
  - Math and math education as useful and powerful
- Students make convincing arguments supported by math
  - Math = Power

Student Voices: End of Year Focus Group

YOU ARE NOT ALONE

- Resources: Reform curricula, texts, magazines, blogs, web pages
  - Too may options for too few days
- National networks and conferences
- http://radicalmath.org/
- http://www.gapminder.org/
- Collaboration among teachers and with scholars
- Others in this room have created and implemented innovations

WORKSHOP (45 MINUTES)

- Whole Group: Share innovations (10-15)
  - What have you tried, where did it come from, and how did it go?
  - Short comments to allow for several ideas to be shared for group considerations → Follow-up in small groups
- Small Groups: Identify content/context for activities (15-20)
  - Where in your curriculum could you integrate critical mathematics investigations?
  - Be a PLC/CFG: Share contact information to remain in communication, share plans and experiences, continue to adapt
- Whole Group: Share out (15-20)
  - Main ideas from each group so everyone hears what kinds of innovations are coming out of this session → Can follow-up

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THANK YOU!!!

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