Mathematics of, for, and as Social Justice

Priscilla Bremser

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Background

First Workshop on the Mathematics of Social Justice
Rob Root, Lafayette College
May 2006

Second Workshop
P. Bremser, Chawne Kimber
Support from PA/NYCC; Middlebury, Lafayette, W.Chester, Moravian, E. Stroudsburg

Activities
Module development website
Google Group discussion
Sheila Weaver and Andy Miller: Mini Course, MAA Sectional mtg.
Book Chapter
Calculus I: Area between curves

- Two teams, purple and green, each with a total of $100
- Each person represents $\frac{1}{5}$ of a population (the Purples and the Greens)
Calculus I: Area between curves

- Two teams, purple and green, each with a total of $100
- Each person represents $\frac{1}{5}$ of a population (the Purples and the Greens)
- Purple team: each member has $20
- Green team: members have $5, $10, $15, $20, and $50, respectively
- As we move from left to right, we keep track of the cumulative wealth
Calculus I: Area between curves

- Two teams, purple and green, each with a total of $100
- Each person represents $\frac{1}{5}$ of a population (the Purples and the Greens)
- Purple team: each member has $20$
- Green team: members have $5, 10, 15, 20, 50$, respectively
- As we move from left to right, we keep track of the *cumulative* wealth
- Purple: $20, 40, 60, 80, 100$
Calculus I: Area between curves

- Two teams, purple and green, each with a total of $100
- Each person represents $1/5$ of a population (the Purples and the Greens)
- Purple team: each member has $20$
- Green team: members have $5, 10, 15, 20,$ and $50$, respectively
- As we move from left to right, we keep track of the cumulative wealth
- Purple: $20, 40, 60, 80, 100$
- Green: $5, 15, 30, 50, 100$
Calculus I: Area between curves

- Two teams, purple and green, each with a total of $100
- Each person represents $\frac{1}{5}$ of a population (the Purples and the Greens)
- Purple team: each member has $20$
- Green team: members have $5, 10, 15, 20,$ and $50$, respectively
- As we move from left to right, we keep track of the *cumulative* wealth
- Purple: $20, 40, 60, 80, 100$
- Green: $5, 15, 30, 50, 100$
- Purple as fraction of $100$: $\frac{1}{5}, \frac{2}{5}, \frac{3}{5}, \frac{4}{5}, \frac{5}{5}=1$
Mathematics OF Social Justice

Calculus I: Area between curves

- Two teams, purple and green, each with a total of $100
- Each person represents $\frac{1}{5}$ of a population (the Purples and the Greens)
- Purple team: each member has $20$
- Green team: members have $5$, $10$, $15$, $20$, and $50$, respectively
- As we move from left to right, we keep track of the *cumulative* wealth
- Purple: $20$, $40$, $60$, $80$, $100$
- Green: $5$, $15$, $30$, $50$, $100$
- Purple as fraction of $100$: $\frac{1}{5}$, $\frac{2}{5}$, $\frac{3}{5}$, $\frac{4}{5}$, $\frac{5}{5}=1$
- Green as fraction of $100$: $\frac{1}{20}$, $\frac{3}{20}$, $\frac{6}{20}$, $\frac{1}{2}$, $1$
Lorenz curves: Cumulative wealth (vertical) as a function of cumulative population.
To measure how far Green strays from equal distribution, consider the green area.
The *Gini Index* (or *Gini Coefficient*) is the ratio of the green area to the area of the triangle. Actually the area of the triangle is $\frac{1}{2}$, so we have

$$2 \int_0^1 (x - L(x)) \, dx,$$

where the Lorenz curve is represented by the function $L(x)$.

A low Gini Index means a distribution close to uniform.

See Wikipedia (really!), *Gini Coefficient*, for pros and cons.
Lorenz curves measuring energy consumption:
Mathematics for Understanding Criminal Justice Issues

A course intended to give an overview of topics in discrete mathematics together with their applications to criminal justice issues. Developed by Mike Olinick and others at MSJ2.

Mathematical topics include set theory, probability, counting principles, Markov chains, decision theory, and difference equations.

Applications include reliability of eyewitness testimony and lie-detector tests, measuring recidivism, Should you accept a plea-bargain offer?, and forecasting future prison populations.
Prisoners on death row by race, 1968-2005

White

Black

Other

Source: U.S. Census Bureau, 2005 American Community Survey
Available at http://www.census.gov/
UNITED STATES POPULATION BY RACE 2005

<table>
<thead>
<tr>
<th>Category</th>
<th>Estimate</th>
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</thead>
<tbody>
<tr>
<td>Total:</td>
<td>288,378,137</td>
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<tr>
<td>White alone</td>
<td>215,333,394</td>
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<tr>
<td>Black or African American alone</td>
<td>34,962,569</td>
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<tr>
<td>American Indian or Alaska Native alone</td>
<td>2,357,544</td>
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<tr>
<td>Asian alone</td>
<td>12,471,815</td>
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<tr>
<td>Native Hawaiian/Pacific Islander alone</td>
<td>397,030</td>
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<tr>
<td>Some other race alone</td>
<td>17,298,601</td>
</tr>
<tr>
<td>Two or more races</td>
<td>5,557,184</td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau, 2005 American Community Survey
Available at http://www.census.gov/
Service-Learning in Mathematics Courses

Sheila Weaver, UVM
Course: Math and Social Justice, a liberal arts mathematics course
Content: financial math, game theory, fair division, probability and statistics
Community Partner: Vermont Campaign to End Childhood Hunger
Project Round 1: Students generated a data snapshot for each VT county, including
# eligible for food stamps and # who actually apply.
Project Round 2: Students are finding, e.g., the correlation between percentage of
those eligible who actually use food stamps in each town, and distance to nearest
state DCF office.

Ron Buckmire and Angela Gallegos, Occidental College
Course: Mathematics, Education, and Access to Power
Community Partner: NE Education Strategy Group, esp. Franklin High School, Los
Angeles
Project: Tutoring or assisting in Algebra 1
Mathematics FOR Social Justice

Mathematics for All: A First-Year Seminar

- Fifteen (well, 16) students
- Writing-Intensive
- Advising component

Interviews with students, teachers, parents, administrators

Class session with M.Hock, VT Assessment Director
Mathematics for All: A First-Year Seminar

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Interviews with students, teachers, parents, administrators

Class session with M. Hock, VT Assessment Director

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NECAP: A Parent’s Guide

Along with children throughout Vermont, New Hampshire, and Rhode Island, your child takes the NECAP (New England Common Assessment). As graduates of the standardized testing process, we understand the anxiety and confusion associated with testing. We hope that through our guide you gain an understanding of the goals of the NECAP, the design and makeup of the test, and the reasoning behind your child’s participation.
Two books:

  
  “Math illiteracy is not unique to Blacks the way the denial of the right to vote in Mississippi was. But it affects Blacks and other minorities much, much more intensely, making them the designated serfs of the information age just as the people that we worked with in the 1960s on the plantations were Mississippi’s serfs then.”

- *What the Numbers Say* by Derrick Niederman and David Boyum
  
  “What distinguishes good quantitative thinkers is not their skill with pure mathematics, but rather their approach to quantitative information... we are confident that you already know all the math you need... arithmetic, percentages, fractions, decimals, square roots, and exponents.”
Two books:

- **Radical Equations: Civil Rights from Mississippi to the Algebra Project**
  by Robert P. Moses and Charles E. Cobb, Jr.
  “Math illiteracy is not unique to Blacks the way the denial of the right to vote in Mississippi was. But it affects Blacks and other minorities much, much more intensely, making them the designated serfs of the information age just as the people that we worked with in the 1960s on the plantations were Mississippi’s serfs then.”

- **What the Numbers Say**
  by Derrick Niederman and David Boyum
  “What distinguishes good quantitative thinkers is not their skill with pure mathematics, but rather their approach to quantitative information... we are confident that you already know all the math you need...arithmetic, percentages, fractions, decimals, square roots, and exponents.”
Figure 2. Predicted nutrition label score by literacy or numeracy status. Models were adjusted for age, gender, race/ethnicity, income, insurance status, presence of chronic disease, education level, literacy or numeracy, status of being on a specific diet, and label reading frequency. Dashed lines represent 95% confidence intervals. **Grade levels are approximations based on the REALM and WRAT-3 scores. REALM, Rapid Estimate of Adult Literacy in Medicine; WRAT-3, Wide Range Achievement Test, edition 3.
Figure 18: Proportion of Active Accounts of the Six Largest Card Issuers with Various Interest Rates for Purchases, 2003 to 2005

Source: GAO analysis of data reported by the six largest credit card issuers.
## Mathematics and Social Justice - Examples

### Fall 2007 Grades 03-08 - NECAP Tests

#### Disaggregated State Results

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<thead>
<tr>
<th></th>
<th>Reading</th>
<th></th>
<th>Math</th>
<th></th>
<th>Writing</th>
<th></th>
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<td></td>
<td>Tested</td>
<td>Level 4</td>
<td>Level 3</td>
<td>Level 2</td>
<td>Level 1</td>
<td>Tested</td>
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<td><strong>All Students</strong></td>
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<td></td>
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<td></td>
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<tr>
<td>All Students</td>
<td>39338</td>
<td>17%</td>
<td>53%</td>
<td>19%</td>
<td>11%</td>
<td>39347</td>
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<td><strong>Primary Race/Ethnicity</strong></td>
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</tr>
<tr>
<td>American Indian or Alaskan Native</td>
<td>88</td>
<td>2%</td>
<td>28%</td>
<td>31%</td>
<td></td>
<td>87</td>
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<tr>
<td>Asian</td>
<td>599</td>
<td>20%</td>
<td>52%</td>
<td>14%</td>
<td>6%</td>
<td>600</td>
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<tr>
<td>Black or African American</td>
<td>650</td>
<td>9%</td>
<td>42%</td>
<td>24%</td>
<td>26%</td>
<td>651</td>
</tr>
<tr>
<td>Native Hawaiian or Pacific Islander</td>
<td>40</td>
<td>10%</td>
<td>72%</td>
<td>18%</td>
<td>0%</td>
<td>40</td>
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<tr>
<td>No Primary race/Ethnicity</td>
<td>621</td>
<td>13%</td>
<td>49%</td>
<td>23%</td>
<td>15%</td>
<td>622</td>
</tr>
<tr>
<td>White (non-Hispanic)</td>
<td>37340</td>
<td>17%</td>
<td>53%</td>
<td>19%</td>
<td>11%</td>
<td>37340</td>
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<tr>
<td><strong>Gender</strong></td>
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<tr>
<td>Female</td>
<td>19222</td>
<td>22%</td>
<td>53%</td>
<td>17%</td>
<td>8%</td>
<td>19219</td>
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<tr>
<td>Male</td>
<td>20116</td>
<td>12%</td>
<td>53%</td>
<td>22%</td>
<td>14%</td>
<td>20129</td>
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<tr>
<td><strong>LEP Status</strong></td>
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<tr>
<td>Currently receiving LEP Services</td>
<td>021</td>
<td>12%</td>
<td>46%</td>
<td>21%</td>
<td>21%</td>
<td>020</td>
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<tr>
<td>LEP All Other Students</td>
<td>38447</td>
<td>17%</td>
<td>53%</td>
<td>19%</td>
<td>11%</td>
<td>38448</td>
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<tr>
<td><strong>IEP</strong></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>IEP All Other Students</td>
<td>34533</td>
<td>19%</td>
<td>57%</td>
<td>17%</td>
<td>6%</td>
<td>34543</td>
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<tr>
<td>Students with an IEP</td>
<td>4805</td>
<td>1%</td>
<td>19%</td>
<td>32%</td>
<td>48%</td>
<td>4805</td>
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<tr>
<td><strong>SES</strong></td>
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<tr>
<td>Economically Disadvantaged Students</td>
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<td>8%</td>
<td>45%</td>
<td>27%</td>
<td>20%</td>
<td>12338</td>
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<tr>
<td>SES All Other Students</td>
<td>27032</td>
<td>21%</td>
<td>56%</td>
<td>16%</td>
<td>7%</td>
<td>27042</td>
</tr>
</tbody>
</table>

*Level 4 = Proficient with Distinction; Level 3 = Proficient; Level 2 = Partially Proficient; Level 1 = Substantially Below Proficient*