

Level/Course

The social justice goal of this lesson is that students consider poverty.

There are multiple parts that might be utilized at different mathematics levels:

- Part I is very simple mathematics and would be appropriate in middle grades or in any high school course.
- Part II involves graphing data and reasoning. It would be particularly appropriate in Discrete Mathematics or in other high school courses.
- Part III is more advanced and involves using the Trapezoid Rule for approximation of the area under a curve (definite integral), which would fit into Pre-Calculus or Advanced Functions and Modeling.

Objectives

- The learner will use graphs and data analysis to model real-world problems.
- The learner will use logic and deductive reasoning to draw conclusions and solve problems.

Activities

The activities in these lessons use all five of the NCTM process standards. The context is a real-world connection in a problem-solving format. Analysis involves reasoning with multiple representations of data and communication of conclusions.

Part I. What Is Poverty?

The reality of poverty is introduced and students are asked to consider whether they could live below the poverty level. They are asked to create a budget and to relate their own life to that of a family below the poverty line.

Part II. Who Are the Poor?

Students are given two tables from the U.S. Census Bureau and asked to analyze this data, to create graphs, and summarize their conclusions. The tables give the poverty level in the 50 states and the District of Columbia, and demographic characteristics of people in poverty such as age, race, and education.

Part III. How Has Poverty Changed?

Students are introduced to the Gini Coefficient to quantify the inequality of income across the population. Data is examined for the past 30 years and students are asked to explain results.

Part IV. What Can Be Done?

Students are given a number of sources to learn more about poverty.

Assessment

For each part of these lessons, students are asked to consider the real-world data. Either in group projects or individually, they analyze mathematically, reflect on their results, and submit written and/or oral reports of their findings and conclusions.

I. What is Poverty?

- A.** About the Hurricane Katrina disaster in New Orleans, Senator Barak Obama said

Whoever was in charge of planning was so detached from the realities of inner city life in New Orleans ... that they couldn't conceive of the notion that every American couldn't "load up their family in an SUV, fill it up with \$100 worth of gasoline, stick some bottled water in the trunk and use a credit card to check into a hotel on safe ground."
(Newsweek, Sept. 19, 2005)

- B.** Food, shelter, clothing, health care, transportation - these are only the beginnings of the basic necessities of modern American living. Each year, the federal government calculates the minimum amount of money required by families to meet these basic needs. The resulting calculation is what is commonly referred to as the "poverty line." For 2004, the government set the poverty guidelines as follows.

Table I. 2004 Poverty Line

Size of Family Unit	Weighted Average Thresholds
One person	9,645
Two persons	12,334
Three persons	15,067
Four persons	19,307
Five persons	22,831
Six persons	25,788
Seven persons	29,236
Eight persons	32,641
Nine persons or more	39,048

SOURCE: U.S. Census Bureau.

- C.** View the documentary "**Tour Poverty USA**" from the United States Conference of Catholic Bishops at

<http://www.usccb.org/cchd/povertyusa/tour.htm>

- Do you think your family could live with this income?
- How much would it bother you to give up many of the "extras?"
- Create a budget estimating what you spend for these "extras" in a normal year.
- How does your life relate to that of a family below the poverty line?

II. Who Are the Poor?

- A.** Table II-A gives the percentages and ranks of people below the poverty level in the 50 states and the District of Columbia. Select the ten states which are highest in percent of people below the poverty level. Using a spreadsheet (or a graphing calculator or graphing by hand), construct a line graph of states (horizontal axis) and percentage of people below the poverty level (vertical axis). Then on the same graph, plot the percentages of children below the poverty level. Label the graphs of total people and of children. What can you say about these variables?
- B.** Still using Table II-A, repeat the exercise in Part A above for the bottom-ranked ten states (lowest in poverty level). What can you say about these variables? What can you say about the comparison of the top and bottom ten states?
- C.** Table II-B gives percentages of several subgroups of people who are very poor (income at less than 50% of the poverty level). Select one characteristic, and construct a bar graph comparing the percentages of those subgroups who are "very poor." What can you say about your results? Repeat for two other characteristics. Write a summary of your conclusions.

Table II-A. Percent of People Below Poverty Level - 2004

State	Percent of People Below Poverty Level	Rank for People Below Poverty Level	Percent of Children below Poverty Level	Rank for Children Below Poverty Level
United States	13.1		18.4	
Alabama	16.1	9	23.3	8
Alaska	8.2	49	11.2	48
Arizona	14.2	16	20.3	17
Arkansas	17.9	5	25.9	5
California	13.3	20	18.9	21
Colorado	11.1	32	14.5	34
Connecticut	7.6	50	10.5	50
Delaware	9.9	41	13.8	38
District of Columbia	18.9	4	33.9	1
Florida	12.2	27	17.7	24
Georgia	14.8	13	21.3	12
Hawaii	10.6	38	14.4	35
Idaho	14.5	14	19.6	18
Illinois	11.9	29	16.8	28
Indiana	10.8	36	14.8	32
Iowa	9.9	41	12.4	44
Kansas	10.5	39	12.5	42
Kentucky	17.4	7	25.0	6
Louisiana	19.4	2	30.0	3
Maine	12.3	25	17.1	27
Maryland	8.8	46	11.4	47
Massachusetts	9.2	44	12.5	42
Michigan	12.3	25	17.6	25
Minnesota	8.3	48	10.7	49
Mississippi	21.6	1	31.0	2
Missouri	11.8	30	16.2	30
Montana	14.2	16	19.2	19
Nebraska	11.0	33	13.1	40
Nevada	12.6	23	18.8	22
New Hampshire	7.6	50	9.7	51
New Jersey	8.5	47	11.8	45
New Mexico	19.3	3	27.7	4
New York	14.2	16	20.7	15
North Carolina	15.2	12	21.9	11
North Dakota	12.1	28	15.5	31
Ohio	12.5	24	18.3	23
Oklahoma	15.3	11	20.7	15
Oregon	14.1	19	19.1	20
Pennsylvania	11.7	31	16.8	28
Rhode Island	12.8	22	21.0	14
South Carolina	15.7	10	22.8	10
South Dakota	11.0	33	14.8	32
Tennessee	14.5	14	21.1	13
Texas	16.6	8	22.9	9
Utah	10.9	35	13.3	39
Vermont	9.0	45	11.7	46
Virginia	9.5	43	12.9	41
Washington	13.1	21	17.2	26
West Virginia	17.9	5	24.4	7
Wisconsin	10.7	37	14.0	36
Wyoming	10.3	40	14.0	36

Source: U.S. Census Bureau, 2004 American Community Survey

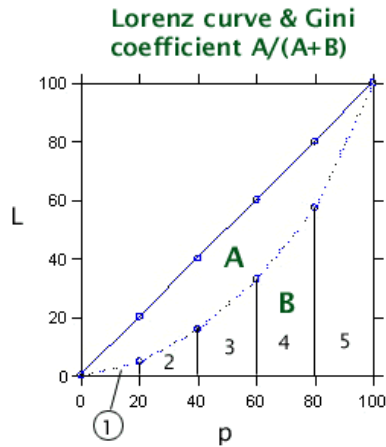
**Table II-B. Selected Characteristics of People at Specified Levels of Poverty
2004**

Subject	All People for Whom Poverty Status is Determined	People at Less than 50% of the Poverty Level
Population for whom poverty status is determined	284,577,956	5.7%
GENDER		
Male	139,214,726	5.0%
Female	145,363,230	6.4%
AGE		
Under 18 years	71,810,759	8.3%
18 to 64 years	178,561,896	5.3%
65 years and over	34,205,301	2.1%
RACE OR ETHNICITY		
White	215,298,360	4.3%
Black or African American	34,576,665	12.6%
American Indian and Alaska Native	2,137,754	11.4%
Asian	12,076,732	5.6%
Native Hawaiian and Other Pacific Islander	401,425	8.6%
Some other race	14,733,087	8.2%
Hispanic or Latino origin	40,219,766	8.6%
HOUSEHOLD TYPE		
In married-couple family households	180,844,134	1.9%
In other households	103,733,822	12.2%
EDUCATIONAL ATTAINMENT		
(Population 25 years and over)	186,534,177	
Less than high school graduate	29,976,049	8.0%
High school graduate (includes equivalency)	55,055,121	4.2%
Some college or associate's degree	51,091,603	3.1%
Bachelor's degree or higher	50,411,404	1.9%
CITIZENSHIP STATUS		
Native	250,346,192	5.6%
Foreign born	34,231,764	6.6%
DISABILITY STATUS		
With disability	37,771,428	7.2%
No disability	226,399,338	5.1%
WORK STATUS		
(Population 16 to 64 years)	186,589,012	
Worked full-time, year-round	88,904,929	0.3%
Worked less than full-time, year-round	59,720,615	6.8%
Did not work	37,963,468	15.2%
HOUSING		
In owner-occupied housing units	198,711,099	2.5%
In renter-occupied housing units	85,866,857	13.0%

Source: U.S. Census Bureau, 2004 American Community Survey

III. How Has Poverty Changed?

In economics, one measure of inequality is called the **Gini Coefficient**. This statistic allows us to quantify the distribution of income across a population. The Gini Coefficient ranges from 0 to 1, where 1 is perfect inequality (one part of the population has all the income and the rest have none) and 0 is perfect equality (all in the population have equal shares). The general shape of the graph is



By definition, the **Gini Coefficient** is the ratio of the area between the 45 degree equality line and the **Lorenz Curve** which is the graph of our population (P) and income (L) data. This area represents the amount of inequality. So, in this graph the **Gini Coefficient** is equal to Area A/(Area A + Area B). The closer the Lorenz curve is to the line of perfect equality, the smaller the Gini coefficient, and the less the inequality.

Since we don't know the equation of the curve, we will use the **Trapezoid Rule** to approximate the area (B) under the curve by finding the areas of the polygons:

Polygon 1 is a triangle, $((b * h)/2)$

Polygons 2-5 are trapezoids, $(h * (b1 + b2)/2)$.

Note: the bases are vertical lines.

(Area A + Area B) will always be $(100*100)/2$

Area B will be (Area 1 + Area 2 + Area 3 + Area 4 + Area 5)

Area A will be (Area A + Area B) – Area B

The Gini Coefficient can also be represented by the following formula

$$G = \left| 1 - \sum_{k=1}^{k=n} (X_k - X_{k-1})(Y_k + Y_{k-1}) \right|$$

where k= the number of partitions.

We will compare data in 10 year increments from 1970 to 2000.

Share of Aggregate Income Received by Households

Year	Lowest fifth	Second fifth	Third fifth	Fourth fifth	Highest fifth
2000	3.6	8.9	14.8	23.0	49.8
1990	3.8	9.6	15.9	24.0	46.6
1980	4.2	10.2	16.8	24.7	44.1
1970	4.1	10.8	17.4	24.5	43.3

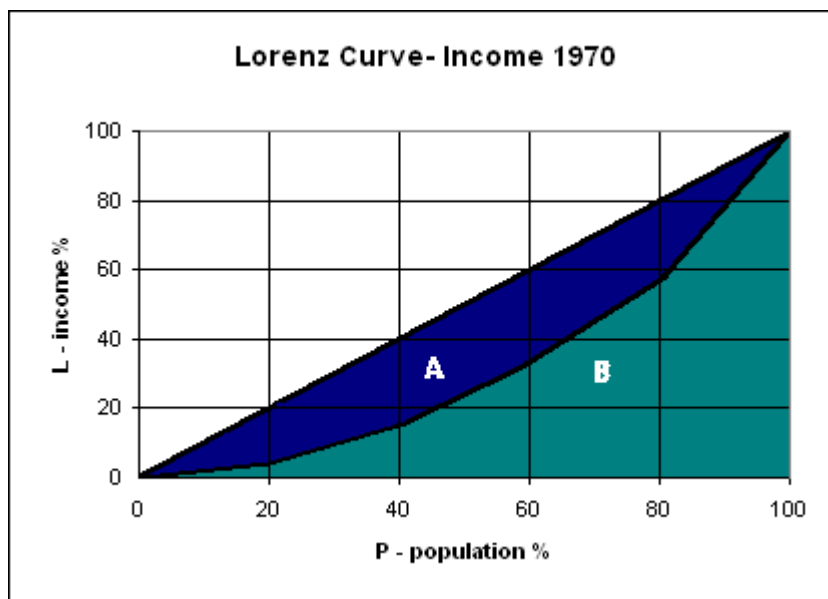
Source: U.S. Census Bureau

For the year 1970:

First, we will arrange the data in a working table and calculate **P** = the cumulative share of the population (%) and **L** = cumulative share of income (%) for each fifth of our population year. (Spreadsheet is recommended, but it could be done by hand or with calculator.)

Gini 1970

Income Category	Share of Total Income %	P %	L %
Bottom Fifth	4.1	20	4.1
2 nd Fifth	10.8	40	14.9
3 rd Fifth	17.4	60	32.3
4 th Fifth	24.5	80	56.8
Top Fifth	43.3	100	100.1



The next task is to calculate.

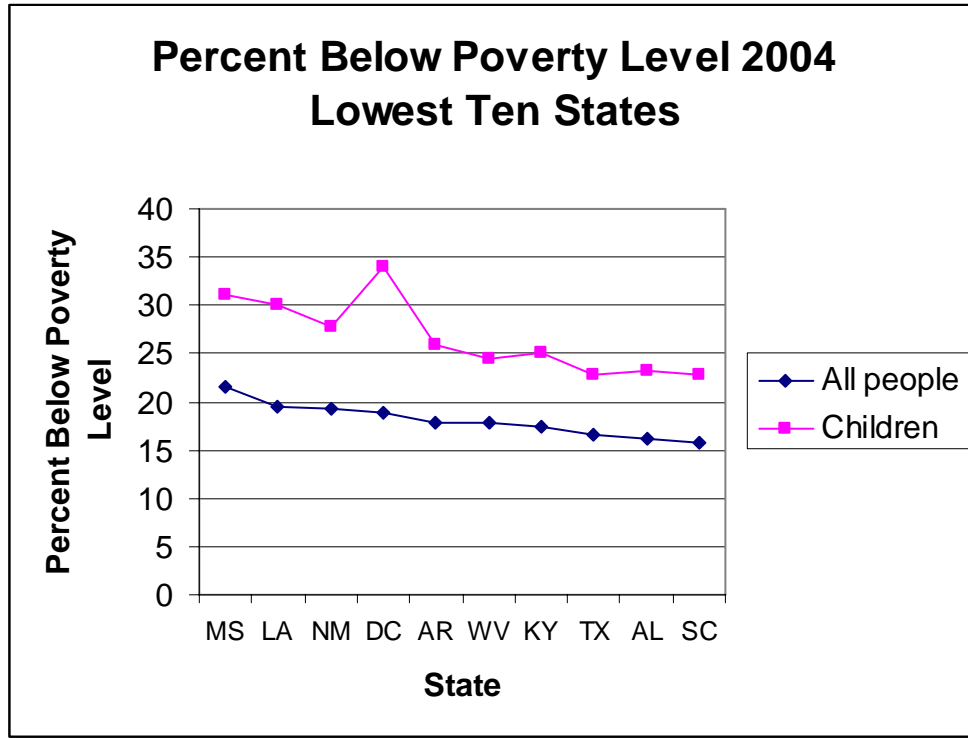
Area A + Area B	$100 \times 100 / 2$	5000
Area 1 = $((b \times h) / 2)$	$20 \times 4.1 / 2$	41
Area 2 = $(h \times (b_1 + b_2) / 2)$	$20 \times (4.1 + 14.9) / 2$	190
Area 3 = $(h \times (b_1 + b_2) / 2)$	$20 \times (14.9 + 32.3) / 2$	472
Area 4 = $(h \times (b_1 + b_2) / 2)$	$20 \times (32.3 + 56.8) / 2$	891
Area 5 = $(h \times (b_1 + b_2) / 2)$	$20 \times (56.8 + 100.1) / 2$	1569
Total Area B = (Area 1 + Area 2 + Area 3 + Area 4 + Area 5)		3163
Area A = (Area A + Area B) - Area B	$5000 - 3162$	1837
Gini Coefficient = $(\text{Area A} / (\text{Area A} + \text{Area B}))$	$1837 / 5000$	0.367

1. Complete the graphs and calculations for the Gini Coefficients for 1970, 1980, 1990, and 2000. (You may either put them on the same graph or create separate graphs.) Make a table of the Gini Coefficients for all the years. Look at the graphs and the Gini Coefficients. What can you say about your results? Is there a trend? What conclusions can you draw?

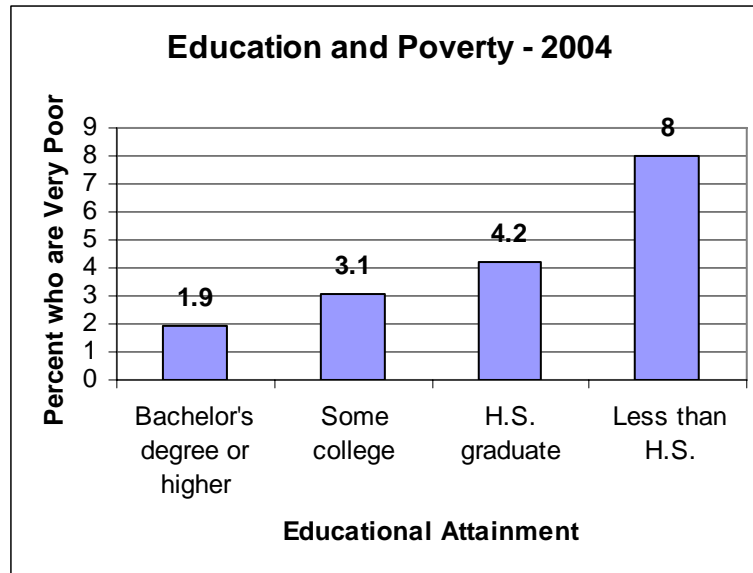
IV. What Can Be Done? Learn More. Care More. Do More.

- Children's Defense Fund
 - <http://www.childrensdefense.org/>
- Educate to End Poverty in America
 - <http://www.usccb.org/cchd/povertyusa/involved.shtml>
- Fight Hate and Promote Tolerance
 - <http://www.tolerance.org/>
- How to End Poverty (Time Magazine)
 - <http://www.time.com/time/covers/1101050314/>
- National Center for Children in Poverty (Columbia University)
 - <http://www.nccp.org/>
- Race, Poverty, and Katrina (NPR)
 - <http://www.npr.org/templates/story/story.php?storyId=4829446>
- U.S. Census Bureau Poverty Data
 - <http://www.census.gov/hhes/www/poverty/poverty.html>

II-A.



II-C. Example:



III.

y70		y80		y90		y00	
P	L	P	L	P	L	P	L
20	4.1	20	4.2	20	3.8	20	3.6
40	14.9	40	14.4	40	13.4	40	12.5
60	32.3	60	31.2	60	29.3	60	27.3
80	56.8	80	55.9	80	53.3	80	50.3
100	100.1	100	100	100	99.9	100	100.1

	y1970	y1980	y1990	y2000
A + B	5000	5000	5000	5000
A1	41	42	38	36
A2	190	186	172	161
A3	472	456	427	398
A4	891	871	826	776
A5	1568	1559	1533	1504
Ar B	3163	3114	2996	2875
Ar A	1837	1886	2004	2125
Gini	0.367	0.377	0.401	0.425

