

# EARTH DAY Math Activities



**FOR MIDDLE SCHOOL**

**USING RATIOS, UNIT RATES,**

**AND DATA ANALYSIS**

Earth Day is a great way to interest students in how math can be used to understand the world around us. With the resources below, students will engage in data analysis and conversations that inspire higher-order thinking about the environment!

## EARTH DAY ACTIVITIES USING A WORLD BANK DATA SET

### OBJECTIVE

Using data from the World Bank, students can use ratios, unit rates, and data distributions to compare different countries' carbon dioxide (CO<sub>2</sub>) emissions. This particular data set\* includes the annual amount of CO<sub>2</sub> emitted (in pounds) for each country, the population of each country, and its per capita income in U.S. dollars. The data set contains 106 countries, 23 world regions, and the world total for the year 2011, which is the most recent year available from the World Bank.

The key questions that students can address with the Earth Day math activities are

- Do poorer nations emit more or less carbon dioxide per person?
- Which countries are exceptions? Why?

Using the data set students should also have the opportunity to

- read numbers great than one million
- decide when and how to round numbers
- use technology to perform their calculations
- investigate data outliers
- grapple with scientific notation on calculators or computers

### BEFORE STUDENTS BEGIN

#### First, model how to create a ratio using the data.

With the data below, create a ratio using region data. The numerator is the number of kilotons of carbon dioxide produced in 2011. The denominator is population in millions. For the whole world, here is the ratio and unit rate.

$$\frac{76,402,110,015 \text{ pounds of CO}_2}{7,007,470,801 \text{ people}} = 10.9 \text{ pounds of CO}_2 \text{ per person}$$

This will be a benchmark that students can use to compare their countries (see below). You can also give students work as a class to use the data points from different regions to compare different regions to the world average. The 2011 per capita income for each region and country as part of the Earth Day math activities is also provided, so that students can discuss how income may be related to CO<sub>2</sub> emissions.

#### Next, assign countries to students.

Students will be assigned countries to complete the Earth Day activities. If you have 26 or fewer students per class, each student can be assigned found countries. If your class has more than 26 students, then assign three countries to each student.

## ACTIVITY IDEAS FOR STUDENTS

Use the download data set to discuss topics in statistics.

**In sixth grade**, students can create a line plot to spark discussion about the measures of the center and the variability. (The average quantity of CO<sub>2</sub> produced is 10.9 pounds per person, the median is 10 pounds per person, but the mode is one pound per person,) The data range from 0 to 97, but there is a larger cluster at the low end of the distribution. The distribution is skewed to the right.

**In seventh grade**, students can use line plots to compare the distribution of CO<sub>2</sub> among rich and poor countries. They can also draw informal inferences from the data about how a country's wealth affects its CO<sub>2</sub> emissions. While students can create line plots on their own, note that the plots are also available below.

Many interesting questions can be asked about why certain countries are outliers giving students a greater insight into global issues.

**The final product** of the activities can be a one- or two-paragraph description of what students learned about the countries they researched and how these countries compare to world and regional averages. They can explain whether their countries are typical or outliers, and why. (Many of the outliers are oil- or natural gas-producing countries. I was surprised to find Trinidad and Tobago among these countries!)

## BONUS IDEA

In conjunction with your school's Language Arts teacher, you could have students focus on any of several standards for writing informative/explanatory texts related to the Earth Day math activities, such as

- introducing the topic
- organizing the ideas, concepts and information
- incorporating tables
- using relevant facts
- using math vocabulary
- using formal style
- providing a conclusion

\*Data set from The World Bank: World Development Indicators Database

Original Sources Include: (1) United Nations Population Division. World Population Prospects, (2) United Nations Statistical Division. Population and Vital Statistics Report (various years), (3) Census reports and other statistical publications from national statistical offices, (4) Eurostat: Demographic Statistics, (5) Secretariat of the Pacific Community: Statistics and Demography Programme, (6) U.S. Census Bureau: International Database (7) World Bank staff estimates based on sources and methods in World Bank's "The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium" (2011), and (8) Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, United States.

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<http://web.worldbank.org/WBSITE/EXTERNAL/0,,contentMDK:22547097~pagePK:50016803~piPK:50016805~theSitePK:13,00.html>

## Teacher Data

REGION	Pounds of CO2 emissions in 2011	2011 Population	Pound of CO2 per capita in 2011	2011 per capita income
Arab World	3,758,241,542	360,761,571	10	\$4,909.81
Central Europe and the Baltics	1,587,512,781	104,174,038	15	\$10,950.95
East Asia & Pacific (all income levels)	28,671,177,143	2,219,079,073	13	\$6,968.79
East Asia & Pacific (developing only)	23,122,564,849	1,977,637,953	12	\$3,747.42
Euro area	5,299,390,719	336,958,644	16	\$33,467.19
Europe & Central Asia (all income levels)	14,850,942,183	893,094,109	17	\$21,174.07
Europe & Central Asia (developing only)	3,088,521,038	258,778,040	12	\$5,432.61
European Union	7,880,890,990	505,544,895	16	\$30,147.68
High income	33,590,105,555	1,376,081,481	24	\$30,657.26
High income: nonOECD	8,237,781,895	320,397,042	26	\$15,853.58
High income: OECD	25,554,035,608	1,055,684,439	24	\$35,851.58
Latin America & Caribbean (all income levels)	3,917,498,834	605,674,766	6	\$8,192.18
Latin America & Caribbean (developing only)	2,668,947,495	507,683,672	5	\$7,622.00
Low & middle income	38,532,779,488	5,631,389,320	7	\$2,997.31
Lower middle income	9,157,395,732	2,752,176,358	3	\$1,562.93
Middle East & North Africa (all income levels)	5,167,261,723	393,003,905	13	\$5,801.45
Middle East & North Africa (developing only)	2,887,302,768	337,638,042	9	\$3,039.29
Middle income	38,190,233,798	5,057,760,174	8	\$3,287.09
North America	12,770,092,372	346,128,976	37	\$42,199.98
OECD members	27,290,228,884	1,249,249,082	22	\$31,622.80
Sub-Saharan Africa (all income levels)	1,645,341,958	898,002,051	2	\$1,252.45
Sub-Saharan Africa (developing only)	1,629,275,603	897,163,692	2	\$1,246.91
Upper middle income	29,031,433,225	2,305,583,816	13	\$5,344.63
World	76,402,110,015	7,007,470,801	11	\$8,429.28

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## Teacher Data

COUNTRY	Pounds of CO2 emissions in 2011	2011 Population	Pound of CO2 per capita in 2011	2011 per capita income
Afghanistan	27,014,441	28,809,167	1	\$559.31
Albania	10,293,141	2,904,780	4	\$3,759.46
Algeria	268,470,659	36,717,132	7	\$3,885.73
Angola	65,510,625	21,942,296	3	\$2,171.23
Argentina	419,027,045	41,655,616	10	\$11,274.09
Armenia	10,939,999	2,967,984	4	\$3,084.51
Australia	813,732,199	22,340,024	36	\$47,002.96
Austria	143,772,454	8,391,643	17	\$42,345.82
Azerbaijan	73,774,246	9,173,082	8	\$4,090.89
Bahrain	51,684,018	1,306,014	40	\$12,319.34
Bangladesh	125,838,294	153,405,612	1	\$810.93
Barbados	3,452,609	280,602	12	\$14,428.18
Belarus	139,584,043	9,473,000	15	\$5,576.81
Belgium	215,573,781	11,047,744	20	\$39,046.01
Belize	1,212,860	329,193	4	\$3,141.49
Bolivia	35,544,891	10,078,238	4	\$1,675.96
Brazil	968,905,539	200,517,584	5	\$10,785.02
Bulgaria	108,793,564	7,348,328	15	\$6,098.06
Cameroon	12,484,375	21,119,065	1	\$1,012.26
Canada	1,070,446,199	34,342,780	31	\$41,100.80
Chile	175,096,591	17,201,305	10	\$10,576.65
China	19,888,037,664	1,344,130,000	15	\$4,240.38
Colombia	159,693,266	46,406,446	3	\$5,382.43
Congo, Dem. Rep.	7,552,076	68,087,376	0	\$204.79
Congo, Rep.	4,956,556	4,177,435	1	\$146.59
Cote d'Ivoire	14,214,722	20,604,172	1	\$1,091.82
Croatia	45,320,545	4,280,622	11	\$11,572.99
Cuba	79,207,860	11,323,570	7	\$5,312.24
Czech Republic	241,415,790	10,496,088	23	\$15,256.66
Denmark	89,032,028	5,570,572	16	\$50,637.80
Dominican Republic	48,263,752	10,027,140	5	\$5,250.39
Ecuador	78,779,316	15,177,280	5	\$3,913.58
Egypt, Arab Rep.	486,842,104	83,787,634	6	\$2,312.78
Equatorial Guinea	14,748,381	750,918	20	\$4,019.72
Estonia	41,124,048	1,327,439	31	\$13,623.78
Finland	120,760,452	5,388,272	22	\$41,484.28

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## Teacher Data

COUNTRY	Pounds of CO2 emissions in 2011	2011 Population	Pound of CO2 per capita in 2011	2011 per capita income
France	747,065,314	65,342,776	11	\$36,995.46
Gabon	4,932,298	1,577,298	3	\$4,881.40
Gambia, The	929,860	1,749,099	1	\$384.69
Georgia	17,489,445	4,483,350	4	\$2,741.76
Germany	1,608,454,835	81,797,673	20	\$38,937.44
Ghana	22,227,686	24,928,503	1	\$1,210.36
Greece	185,325,046	11,123,213	17	\$20,545.66
Hungary	106,925,760	9,971,727	11	\$10,725.26
India	4,573,930,489	1,247,446,011	4	\$1,252.87
Indonesia	1,243,586,043	244,808,254	5	\$3,164.36
Iraq	294,708,869	31,810,191	9	\$3,781.15
Ireland	79,531,289	4,576,794	17	\$37,402.38
Israel	153,297,450	7,765,800	20	\$28,331.78
Italy	877,577,162	59,379,449	15	\$31,376.56
Japan	2,618,783,595	127,817,277	20	\$37,655.65
Jordan	49,080,411	6,181,000	8	\$4,163.32
Kazakhstan	577,184,022	16,556,600	35	\$6,021.85
Korea, Rep.	1,299,684,872	49,779,440	26	\$19,719.51
Kuwait	200,720,286	3,239,181	62	\$34,514.65
Kyrgyz Republic	14,586,666	5,514,600	3	\$801.71
Latvia	17,198,358	2,059,709	8	\$11,444.88
Libya	86,040,306	6,288,652	14	\$3,854.03
Lithuania	30,297,249	3,028,115	10	\$11,723.21
Luxembourg	23,885,261	518,347	46	\$61,307.35
Macedonia, FYR	20,586,281	2,065,888	10	\$4,091.90
Malaysia	497,652,732	28,572,970	17	\$7,982.41
Mexico	1,028,739,978	120,365,271	9	\$7,779.96
Moldova	10,980,428	3,559,986	3	\$1,932.13
Morocco	124,665,862	32,531,964	4	\$2,378.71
Mozambique	7,236,733	25,016,921	0	\$455.63
Netherlands	370,456,035	16,693,074	22	\$44,213.95
New Zealand	68,866,205	4,384,000	16	\$30,350.59
Nigeria	194,098,069	163,770,669	1	\$1,976.74
Norway	100,400,571	4,953,088	20	\$76,344.53
Oman	143,004,309	3,210,003	45	\$8,568.68
Pakistan	360,413,552	173,669,648	2	\$1,167.38

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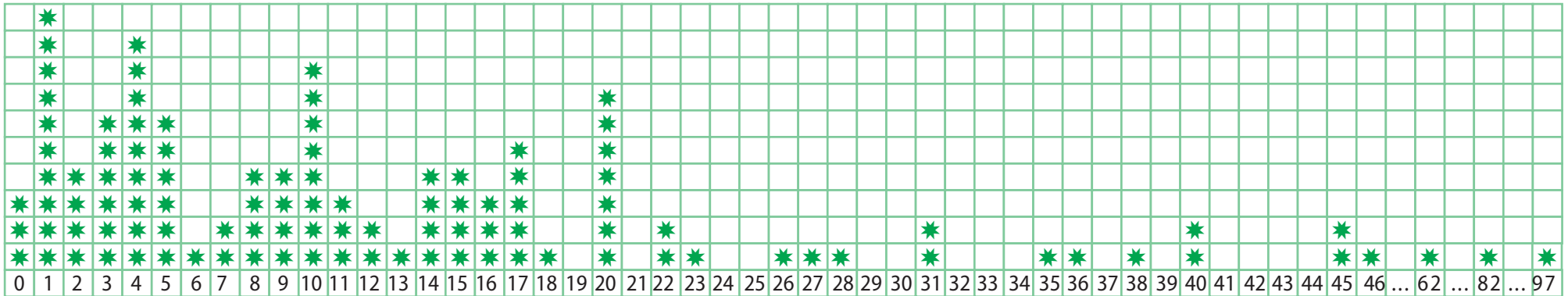
## Teacher Data

COUNTRY	Pounds of CO2 emissions in 2011	2011 Population	Pound of CO2 per capita in 2011	2011 per capita income
Papua New Guinea	11,530,258	7,001,172	2	\$1,080.46
Peru	117,016,757	29,759,891	4	\$4,319.41
Philippines	180,837,463	94,501,233	2	\$2,514.71
Poland	699,618,221	38,063,255	18	\$11,683.77
Portugal	109,642,567	10,557,560	10	\$18,551.74
Qatar	184,945,017	1,905,437	97	\$49,048.50
Romania	187,055,393	20,147,528	9	\$7,044.80
Russian Federation	3,986,801,014	142,960,868	28	\$10,481.24
Saudi Arabia	1,147,212,168	28,788,438	40	\$16,806.32
Senegal	17,327,730	13,357,003	1	\$926.06
Slovak Republic	75,795,680	5,398,384	14	\$13,943.03
Slovenia	33,968,173	2,052,843	17	\$19,624.16
South Africa	1,052,317,982	51,553,479	20	\$6,468.62
South Asia	5,134,013,181	1,652,487,921	3	\$1,198.99
Spain	596,840,443	46,742,697	13	\$25,936.24
Suriname	4,212,668	523,439	8	\$5,417.21
Sweden	114,979,152	9,449,213	12	\$51,309.02
Switzerland	80,695,635	7,912,398	10	\$70,660.27
Tajikistan	6,137,073	7,753,925	1	\$779.67
Tanzania	16,098,698	47,122,998	0	\$627.50
Thailand	668,932,857	66,902,958	10	\$3,976.05
Trinidad and Tobago	109,311,051	1,334,790	82	\$7,362.23
Tunisia	56,543,545	10,673,800	5	\$3,175.91
Turkey	707,453,298	73,199,372	10	\$9,839.45
Turkmenistan	137,190,666	5,106,672	27	\$2,453.19
Ukraine	631,132,045	45,706,100	14	\$2,802.46
United Arab Emirates	393,556,980	8,734,722	45	\$29,917.01
United Kingdom	988,359,818	63,258,918	16	\$35,551.60
United States	11,698,780,999	311,721,632	38	\$42,310.17
Uruguay	17,141,758	3,385,610	5	\$12,214.07
Uzbekistan	253,269,477	29,339,400	9	\$1,210.98
Venezuela, RB	416,342,581	29,427,631	14	\$8,278.57
Vietnam	381,929,693	87,840,000	4	\$1,158.35
Yemen, Rep.	49,161,269	24,234,940	2	\$956.01

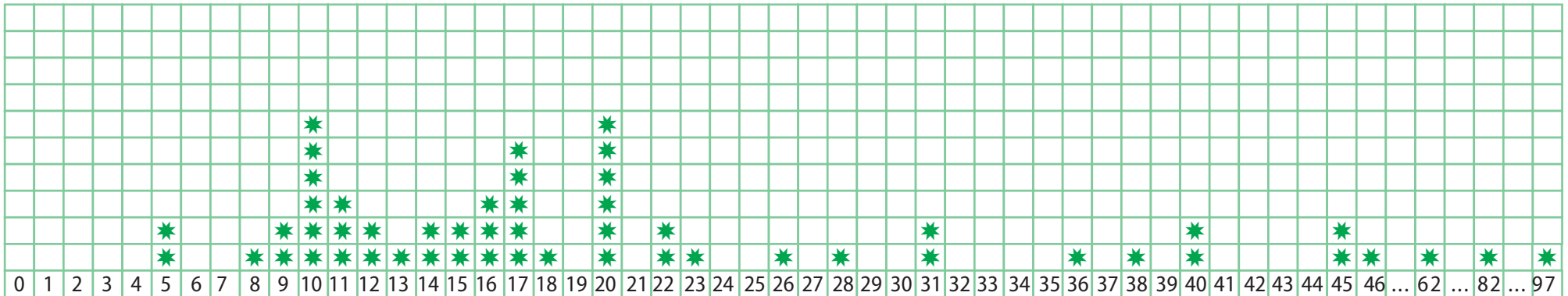
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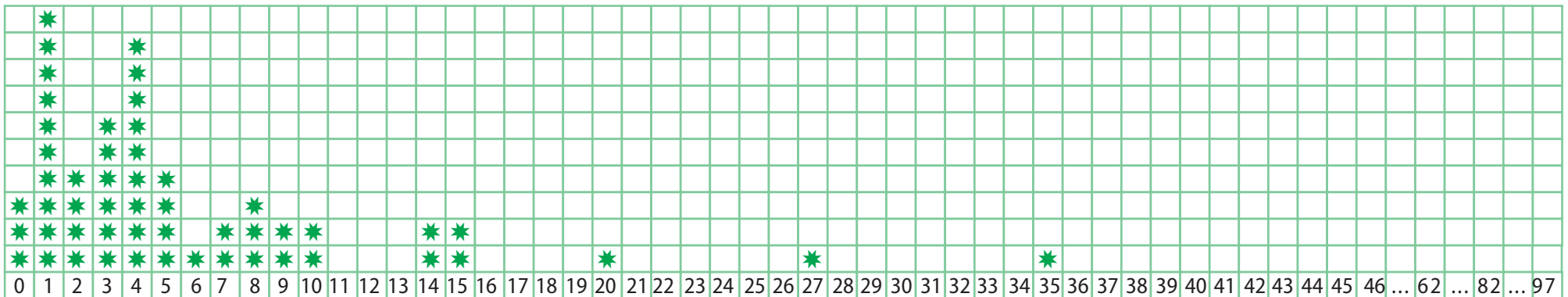
## Line Plots of Pounds of CO2 Produced by Country



## Line Plots of Pounds of CO2 Produced by Country, 53 Richest Countries



## Line Plots of Pounds of CO2 Produced by Country, 53 Poorist Countries





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High income: OECD	25,554,035,608	1,055,684,439		\$35,851.58
Latin America & Caribbean (all income levels)	3,917,498,834	605,674,766		\$8,192.18
Latin America & Caribbean (developing only)	2,668,947,495	507,683,672		\$7,622.00
Low & middle income	38,532,779,488	5,631,389,320		\$2,997.31
Lower middle income	9,157,395,732	2,752,176,358		\$1,562.93
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Algeria	268,470,659	36,717,132		\$3,885.73
Angola	65,510,625	21,942,296		\$2,171.23
Argentina	419,027,045	41,655,616		\$11,274.09
Armenia	10,939,999	2,967,984		\$3,084.51
Australia	813,732,199	22,340,024		\$47,002.96
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Azerbaijan	73,774,246	9,173,082		\$4,090.89
Bahrain	51,684,018	1,306,014		\$12,319.34
Bangladesh	125,838,294	153,405,612		\$810.93
Barbados	3,452,609	280,602		\$14,428.18
Belarus	139,584,043	9,473,000		\$5,576.81
Belgium	215,573,781	11,047,744		\$39,046.01
Belize	1,212,860	329,193		\$3,141.49
Bolivia	35,544,891	10,078,238		\$1,675.96
Brazil	968,905,539	200,517,584		\$10,785.02
Bulgaria	108,793,564	7,348,328		\$6,098.06
Cameroon	12,484,375	21,119,065		\$1,012.26
Canada	1,070,446,199	34,342,780		\$41,100.80
Chile	175,096,591	17,201,305		\$10,576.65
China	19,888,037,664	1,344,130,000		\$4,240.38
Colombia	159,693,266	46,406,446		\$5,382.43
Congo, Dem. Rep.	7,552,076	68,087,376		\$204.79
Congo, Rep.	4,956,556	4,177,435		\$146.59
Cote d'Ivoire	14,214,722	20,604,172		\$1,091.82
Croatia	45,320,545	4,280,622		\$11,572.99
Cuba	79,207,860	11,323,570		\$5,312.24
Czech Republic	241,415,790	10,496,088		\$15,256.66
Denmark	89,032,028	5,570,572		\$50,637.80
Dominican Republic	48,263,752	10,027,140		\$5,250.39
Ecuador	78,779,316	15,177,280		\$3,913.58
Egypt, Arab Rep.	486,842,104	83,787,634		\$2,312.78
Equatorial Guinea	14,748,381	750,918		\$4,019.72
Estonia	41,124,048	1,327,439		\$13,623.78
Finland	120,760,452	5,388,272		\$41,484.28

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Gambia, The	929,860	1,749,099		\$384.69
Georgia	17,489,445	4,483,350		\$2,741.76
Germany	1,608,454,835	81,797,673		\$38,937.44
Ghana	22,227,686	24,928,503		\$1,210.36
Greece	185,325,046	11,123,213		\$20,545.66
Hungary	106,925,760	9,971,727		\$10,725.26
India	4,573,930,489	1,247,446,011		\$1,252.87
Indonesia	1,243,586,043	244,808,254		\$3,164.36
Iraq	294,708,869	31,810,191		\$3,781.15
Ireland	79,531,289	4,576,794		\$37,402.38
Israel	153,297,450	7,765,800		\$28,331.78
Italy	877,577,162	59,379,449		\$31,376.56
Japan	2,618,783,595	127,817,277		\$37,655.65
Jordan	49,080,411	6,181,000		\$4,163.32
Kazakhstan	577,184,022	16,556,600		\$6,021.85
Korea, Rep.	1,299,684,872	49,779,440		\$19,719.51
Kuwait	200,720,286	3,239,181		\$34,514.65
Kyrgyz Republic	14,586,666	5,514,600		\$801.71
Latvia	17,198,358	2,059,709		\$11,444.88
Libya	86,040,306	6,288,652		\$3,854.03
Lithuania	30,297,249	3,028,115		\$11,723.21
Luxembourg	23,885,261	518,347		\$61,307.35
Macedonia, FYR	20,586,281	2,065,888		\$4,091.90
Malaysia	497,652,732	28,572,970		\$7,982.41
Mexico	1,028,739,978	120,365,271		\$7,779.96
Moldova	10,980,428	3,559,986		\$1,932.13
Morocco	124,665,862	32,531,964		\$2,378.71
Mozambique	7,236,733	25,016,921		\$455.63
Netherlands	370,456,035	16,693,074		\$44,213.95
New Zealand	68,866,205	4,384,000		\$30,350.59
Nigeria	194,098,069	163,770,669		\$1,976.74
Norway	100,400,571	4,953,088		\$76,344.53
Oman	143,004,309	3,210,003		\$8,568.68
Pakistan	360,413,552	173,669,648		\$1,167.38

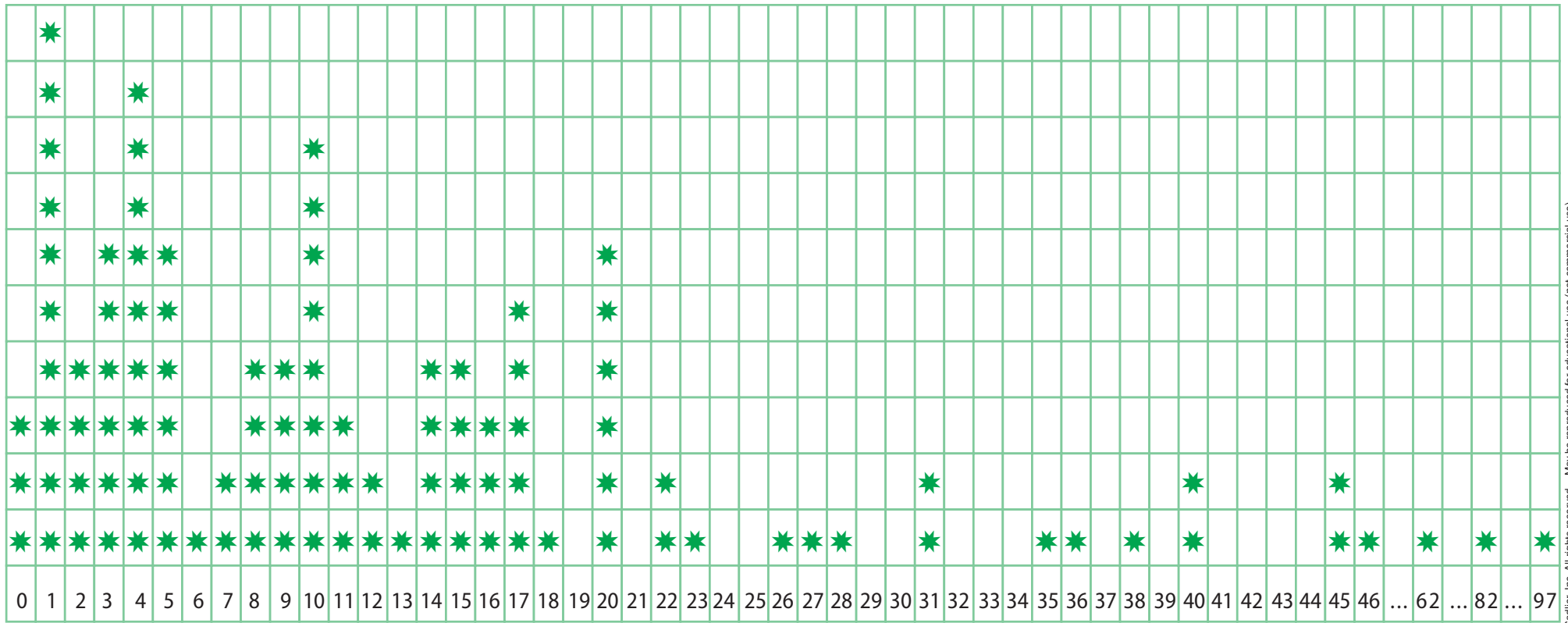
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## Student Data

COUNTRY	Pounds of CO2 emissions in 2011	2011 Population	Pound of CO2 per capita in 2011	2011 per capita income
Papua New Guinea	11,530,258	7,001,172		\$1,080.46
Peru	117,016,757	29,759,891		\$4,319.41
Philippines	180,837,463	94,501,233		\$2,514.71
Poland	699,618,221	38,063,255		\$11,683.77
Portugal	109,642,567	10,557,560		\$18,551.74
Qatar	184,945,017	1,905,437		\$49,048.50
Romania	187,055,393	20,147,528		\$7,044.80
Russian Federation	3,986,801,014	142,960,868		\$10,481.24
Saudi Arabia	1,147,212,168	28,788,438		\$16,806.32
Senegal	17,327,730	13,357,003		\$926.06
Slovak Republic	75,795,680	5,398,384		\$13,943.03
Slovenia	33,968,173	2,052,843		\$19,624.16
South Africa	1,052,317,982	51,553,479		\$6,468.62
South Asia	5,134,013,181	1,652,487,921		\$1,198.99
Spain	596,840,443	46,742,697		\$25,936.24
Suriname	4,212,668	523,439		\$5,417.21
Sweden	114,979,152	9,449,213		\$51,309.02
Switzerland	80,695,635	7,912,398		\$70,660.27
Tajikistan	6,137,073	7,753,925		\$779.67
Tanzania	16,098,698	47,122,998		\$627.50
Thailand	668,932,857	66,902,958		\$3,976.05
Trinidad and Tobago	109,311,051	1,334,790		\$7,362.23
Tunisia	56,543,545	10,673,800		\$3,175.91
Turkey	707,453,298	73,199,372		\$9,839.45
Turkmenistan	137,190,666	5,106,672		\$2,453.19
Ukraine	631,132,045	45,706,100		\$2,802.46
United Arab Emirates	393,556,980	8,734,722		\$29,917.01
United Kingdom	988,359,818	63,258,918		\$35,551.60
United States	11,698,780,999	311,721,632		\$42,310.17
Uruguay	17,141,758	3,385,610		\$12,214.07
Uzbekistan	253,269,477	29,339,400		\$1,210.98
Venezuela, RB	416,342,581	29,427,631		\$8,278.57
Vietnam	381,929,693	87,840,000		\$1,158.35
Yemen, Rep.	49,161,269	24,234,940		\$956.01

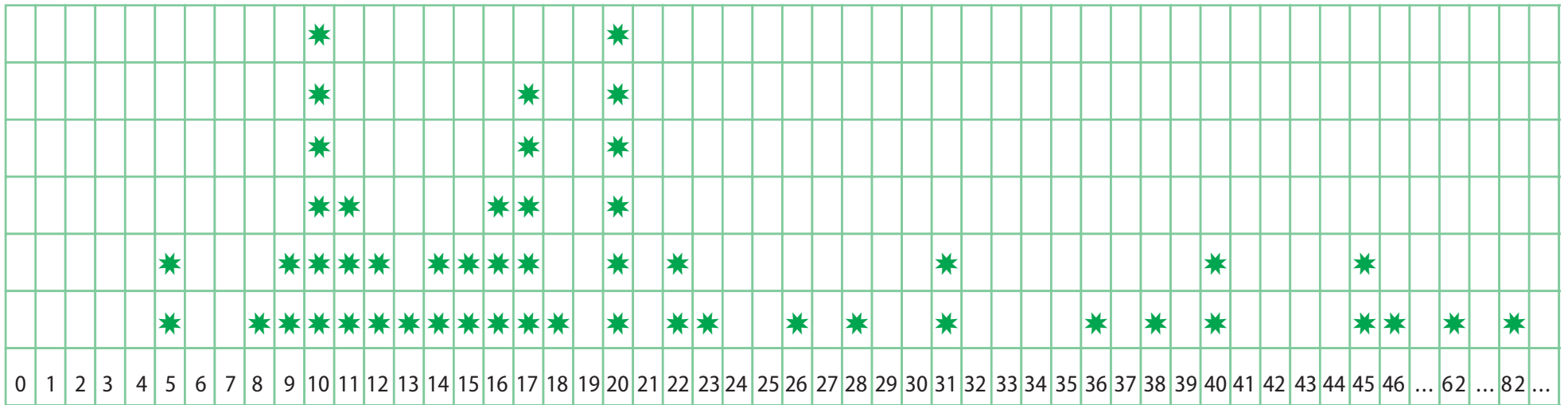
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# Line Plots of Pounds of CO2 Produced by Country



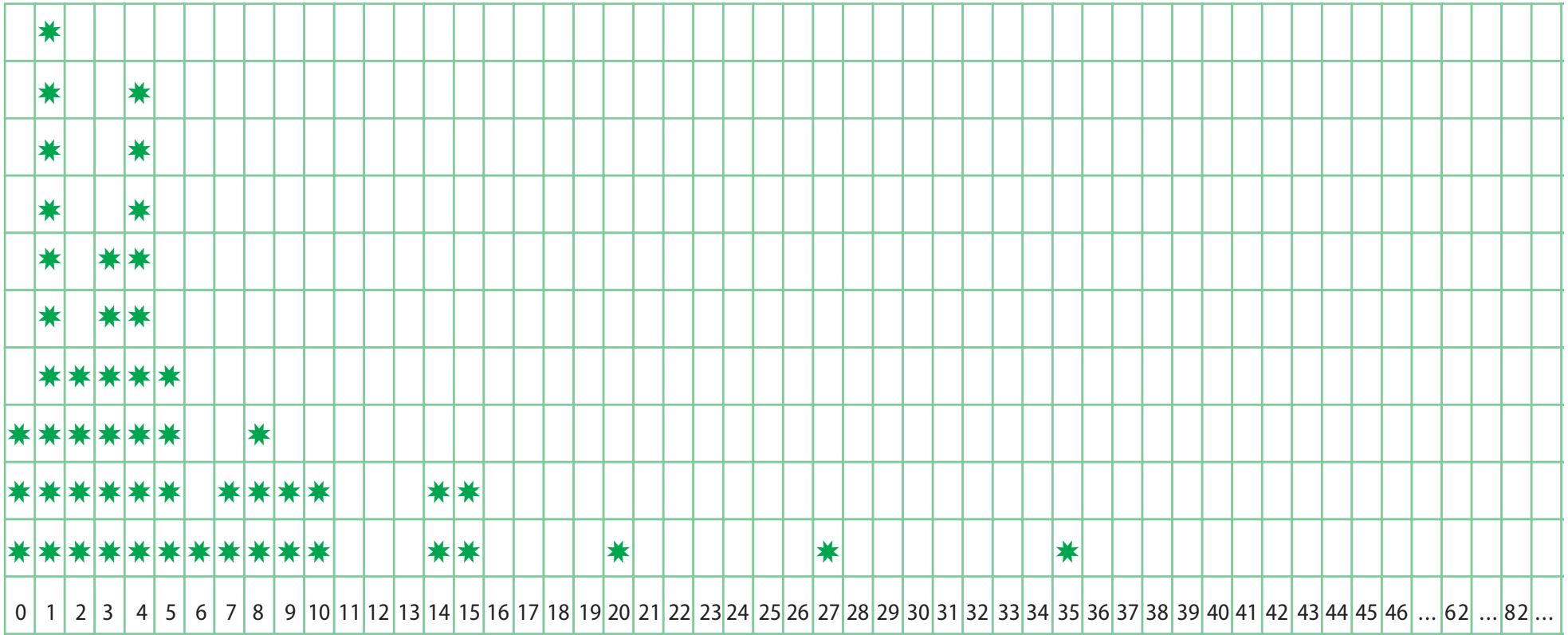
Pounds of CO2 Produced Per Capita in Countries of the World

## Line Plots of Pounds of CO2 Produced by Country 53 Richest Countries



## Line Plots of Pounds of CO2 Produced Per Capita in Countries of the World Top 50% of Per Capita Income

### Line Plots of Pounds of CO2 Produced by Country 53 Poorest Countries



Line Plots of Pounds of CO2 Produced Per Capita in Countries of the World  
Bottom 50% of Per Capita Income