



ESA21

Environmental Science Activities for the 21st Century

Problem #1: Effects of supplemental activities on reading ability

Abstract: An educator conducted an experiment to test whether new directed reading activities in the classroom will help elementary school pupils improve some aspects of their reading ability. She arranged for a third grade class of 21 students to follow these activities for an 8-week period. A control classroom of 23 third graders followed the same curriculum without the activities. At the end of the 8 weeks, all students took a Degree of Reading Power (DRP) test, which measures the aspects of reading ability that the treatment is designed to improve.

Reference: Moore, David S., and George P. McCabe (1989). Introduction to the Practice of Statistics. Original source: Schmitt, Maribeth C. (1987), The Effects on an Elaborated Directed Reading Activity on the Metacomprehension Skills of Third Graders, Ph.D. dissertation, Purdue University.

Variable Names:

Treatment: Whether student participated in activities (treated) or not (control)

Response: Score on Degree of Reading Power test

Data and descriptions obtained from The Data and Story Library of Carnegie-Mellon University.

Treatment	Response	Treatment	Response
Treated	24	Control	42
Treated	43	Control	43
Treated	58	Control	55
Treated	71	Control	26
Treated	43	Control	62
Treated	49	Control	37
Treated	61	Control	33
Treated	44	Control	41
Treated	67	Control	19
Treated	49	Control	54
Treated	53	Control	20
Treated	56	Control	85
Treated	59	Control	46
Treated	52	Control	10
Treated	62	Control	17
Treated	54	Control	60
Treated	57	Control	53
Treated	33	Control	42
Treated	46	Control	37
Treated	43	Control	42
Treated	57	Control	55
		Control	28
		Control	48

Problem #2: Comparing amphibian populations

Abstract: To determine if the spraying of wastewater effluent was adversely affecting Jefferson salamanders (*Ambystoma jeffersonianum*) in central Pennsylvania, researchers estimated population sizes in areas with and without wastewater spraying. This species deposits their eggs in temporary ponds that fill in the late winter and usually dry in the mid to late summer. Eggs are deposited in "masses", with each mass being roughly the size of a baseball and containing 10 - 35 embryos. As counting the numbers of adults is quite difficult, breeding populations in each pond were estimated by counting the number of egg mass deposited during the breeding season. The number of Jefferson salamander egg masses were counted in 10 wastewater-irrigated and 10 natural temporary ponds in the spring of 1997 after breeding had ceased for the year.

Reference: Laposata, M. M. and W. A. Dunson (2000). Effects of spray-irrigated wastewater effluent on temporary pond-breeding amphibians. *Ecotoxicology and Environmental Safety* 46:192-201.

Variable Names:

Pond type: Ponds irrigated with wastewater effluent (Irrigated) or natural ponds with no effluent inputs (Natural)

No. of masses: Number of Jefferson salamander egg masses counted

Pond	No. of masses
Irrigated	0
Irrigated	2
Irrigated	1
Irrigated	2
Irrigated	1
Irrigated	0
Irrigated	0
Irrigated	0
Irrigated	86
Irrigated	7
Natural	10
Natural	10
Natural	35
Natural	105
Natural	62
Natural	8
Natural	5
Natural	99
Natural	115
Natural	257

Problem #3: Effects of copper concentration on *Lemna gibba*

Abstract: A researcher investigated the effects of potentially toxic copper concentrations in water on the growth of the aquatic plant, *Lemna gibba*. Five large glass bowls were filled with artificial pond water with no copper (0 parts per million, or ppm), and five with artificial pond water with 0.001 ppm, a naturally-occurring copper concentration in many lakes in the southeastern United States. Thirty-eight *Lemna* fronds placed in each bowl, and after seven days the number of fronds in each replicate was tallied.

Reference: Experiment and data based on Sutton, H.D. (1996). *Contaminant-induced peroxidase response in submerged and wetland plants*. Ph.D. Dissertation, Clemson University.

Variable Names:

Copper: Copper concentration in water in parts per million

No. of live fronds: Number of living fronds after 7 day exposure period.

Copper (ppm)	No. of live fronds
0	167
0	162
0	195
0	184
0	172
0.001	158
0.001	160
0.001	163
0.001	177
0.001	184

Problem #4: Comparing infant mortality in different regions

Abstract: Infant mortality rate has been shown to be a good predictor of standard of living, as countries with low rates of infant mortality are often those with good nutrition, affluence, and medical care. A demographer wanted to compare infant mortality rates in South America and the Middle East to estimate living standards in the two regions. She randomly selected six countries from each region, and looked up their infant mortality rates.

Reference: United States Census Bureau International Database

Variable Names:

Inf-Mort: Infant deaths per 1,000 births

Region: South America (SA) or Middle East (ME)

Country: Nation name

Country	Region	Inf-Mort
Colombia	SA	25
Brazil	SA	38
Argentina	SA	18
Ecuador	SA	35
Peru	SA	41
Venezuela	SA	26
Iran	ME	30
Iraq	ME	62
Jordan	ME	21
Lebanon	ME	29
Syria	ME	35
Saudi Arabia	ME	53

Problem #5: Comparing life expectancies in different regions

Abstract: Life expectancy has been shown to be a good predictor of standard of living, as countries with high life expectancies are often those with good nutrition, affluence, and medical care. A demographer wanted to compare life expectancies in South America and the Middle East to estimate living standards in the two regions. She randomly selected six countries from each region, and looked up their life expectancies.

Reference: United States Census Bureau International Database

Variable Names:

Life-Exp: Life Expectancy at Birth

Region: South America (SA) or Middle East (ME)

Country: Nation name

Country	Region	Life-Exp
Colombia	SA	70.3
Brazil	SA	62.9
Argentina	SA	75.1
Ecuador	SA	71.1
Peru	SA	70.0
Venezuela	SA	73.1
Iran	ME	69.7
Iraq	ME	66.5
Jordan	ME	77.4
Lebanon	ME	71.3
Syria	ME	68.5
Saudi Arabia	ME	67.8

Problem #6: Comparing total fertility rates in different regions

Abstract: Total Fertility Rate (TFR) is defined as the average number of children a woman is expected to have in her lifetime, and this measure provides an estimate of a population's rate of increase. For populations to remain stable, the average TFR should equal 2.1. This number is slightly higher than 2.0 (two children replacing the two parents in the population) since some children die before reproducing and not all women bear children. The major goal of population control measures is to get TFR's down to 2.1, thereby stabilizing the global human population. A demographer wanted to compare TFR's in South America and the Middle East to estimate growth rates in the two regions. She randomly selected six countries from each region, and looked up their total fertility rates.

Reference: United States Census Bureau International Database

Variable Names:

TFR: Total Fertility Rate

Region: South America (SA) or Middle East (ME)

Country: Nation name

Country	Region	TFR
Colombia	SA	2.7
Brazil	SA	2.1
Argentina	SA	2.5
Ecuador	SA	3.2
Peru	SA	3.0
Venezuela	SA	2.5
Iran	ME	2.2
Iraq	ME	4.9
Jordan	ME	3.4
Lebanon	ME	2.1
Syria	ME	4.1
Saudi Arabia	ME	6.3

Problem #7: Comparing crude birth rates in different regions

Abstract: Crude Birth Rates are the number of births in a population per 1,000 individuals, and this measure provides an estimate of a population's rate of increase. A demographer wanted to compare crude birth rates in South America and the Middle East to predict future population sizes in the two regions. She randomly selected six countries from each region, and looked up their crude birth rates.

Reference: United States Census Bureau International Database

Variable Names:

Births: Crude Birth Rate

Region: South America (SA) or Middle East (ME)

Country: Nation name

Country	Region	Births
Colombia	SA	23
Brazil	SA	19
Argentina	SA	19
Ecuador	SA	27
Peru	SA	24
Venezuela	SA	21
Iran	ME	18
Iraq	ME	35
Jordan	ME	26
Lebanon	ME	20
Syria	ME	31
Saudi Arabia	ME	37

Problem #8: Physiological effects of immigration

Abstract: A study was conducted to compare systolic blood pressure in Mexican females living in their native country and those living in the United States. The researchers attempted to determine if the changes in culture, activity patterns, and diet could be correlated with measurable physiological changes.

Reference: D. D. Davis (2000). Unpublished data.

Variable Names:

Country: Country of Residence

B.P.: Systolic Blood Pressure

Country	B.P.	Country	B.P.
Mexico	120	U.S.	164
Mexico	120	U.S.	140
Mexico	110	U.S.	118
Mexico	120	U.S.	130
Mexico	130	U.S.	118
Mexico	120	U.S.	120
Mexico	120	U.S.	120
Mexico	130	U.S.	120
Mexico	120	U.S.	126
Mexico	160	U.S.	108
Mexico	110	U.S.	108
Mexico	120	U.S.	101
Mexico	130	U.S.	110
Mexico	110	U.S.	100
Mexico	120	U.S.	140
Mexico	120	U.S.	132
Mexico	110	U.S.	142
Mexico	110	U.S.	118

Problem #9: Effects of nitrate on embryonic development in wood frogs

Abstract: To determine if elevated levels of nitrate (a nitrogen compound found in wastewater) led to higher incidence of deformities in amphibians, researchers reared eggs of the wood frog (*Rana sylvatica*) in experimental solutions with varying nitrate levels. Five sets of 15 eggs were exposed to solutions with zero parts per million (ppm) of nitrate, and an additional five sets were exposed to solutions with 25 ppm of nitrate. The tadpoles were examined under a microscope after hatching, and the proportion of tadpoles with deformities was determined.

Reference: Laposata, M. M. and W. A. Dunson (1998). Effects of boron and nitrate on hatching success of amphibian eggs. *Archives of Environmental Contamination and Toxicology* 35:615-619.

Variable Names:

Nitrate: Nitrate level of 0 or 25 ppm.

Deform: Proportion of tadpoles exhibiting developmental deformities.

Nitrate (ppm)	Deform
0	0.07
0	0.07
0	0.07
0	0.20
0	0.14
25	0.27
25	0.60
25	0.50
25	0.27
25	0.27

Problem #10: Comparing growth in two strains of soybeans

Abstract: Researchers planted various strains of soybean seeds and measured the crop output produced by each. Each type of seed was planted in 10 separate experimental plots, and total biomass of soybeans produced was measured in kilograms. All other factors (sunlight, watering level, fertilizer) were the same in all plots. The outputs from two seed varieties are listed in the table below.

Reference: Fictional data.

Variable Names:

Seed: Variety of seed (Variety A1 or B1)

Output: Soybean production in kg

Seed	Output	Seed	Output
A1	41.0	B1	38.9
A1	42.6	B1	31.2
A1	42.5	B1	33.2
A1	40.2	B1	30.4
A1	41.5	B1	35.5
A1	38.6	B1	28.6
A1	36.8	B1	29.7
A1	32	B1	28.2
A1	35.5	B1	32.2
A1	40.1	B1	34.3

Problem #11: Effects of clearcutting on terrestrial salamanders

Abstract: To determine if soil conditions in clearcut sites adversely affect salamanders, researchers enclosed 10 salamanders in cages on clearcut sites, and 10 salamanders in identical cages in uncut forests. After a 30 day exposure period, the concentration of water in the salamander's tissues was determined. The clearcut sites in the study generally had drier soils than forest sites, and the researchers wished to determine if salamanders on clearcut sites would have "drier" tissues as a result.

Reference: Laposata and Dunson (unpublished data).

Variable Names:

Site: Clearcut (CC) or Forest (F)

Body H2O: Proportion body weight from water

Site	Body H2O	Site	Body H2O
CC	0.8439	F	0.8415
CC	0.8290	F	0.8570
CC	0.8452	F	0.8467
CC	0.8459	F	0.8398
CC	0.8305	F	0.8413
CC	0.8446	F	0.8547
CC	0.8274	F	0.8464
CC	0.8390	F	0.8314
CC	0.8405	F	0.8380
CC	0.8376	F	0.8559

Problem #12: Comparing the effectiveness of two insecticides

Abstract: Scientists working for an agricultural chemical company wanted to compare the effectiveness of their company's insecticide to their competitor's product for tobacco plants. The company's pesticide was applied to 10 experimental plots of tobacco plants, and the competitor's pesticide was applied to another 10 experimental plots. All other factors (sunlight, watering level, fertilizer) were the same in all plots. After 6 weeks, the number of tobacco-consuming insects per leaf was counted for each plot. The averages for all 20 plots are provided below.

Reference: Fictional data.

Variable Names:

Brand: Company's insecticide (A), Competitor's insecticide (B)

Density: Number of insects per leaf

Brand	Density	Brand	Density
A	8.4	B	5.1
A	5.4	B	10.4
A	5.5	B	11.1
A	5.0	B	8.4
A	6.7	B	8.5
A	9.8	B	6.7
A	8.1	B	9.6
A	6.5	B	5.9
A	9.0	B	7.3
A	8.6	B	7.8